Proceedings of
International Conference on
Science and Technology
Education(ICSTE2013)

August 12-15 2013
Michael Okpara University of Agriculture,
Umudike-Nigeria

Edited by
Jacinta A. Opara, PhD
Organising Partners
International Society for the Scientific Research (ISSR)
International Association for Teaching and Learning (IATL)
Michael Okpara University of Agriculture, Umudike-Nigeria

Co-Sponsoring Partners
Human Resource Management Research Society (HRMARS), Pakistan
International Association for the Scientific Knowledge, Portugal
Universidad Azteca, Mexico
Mediterranean Center for Social and Educational Research, Rome-Italy
Indian Society for Education and Environment
Federal College of Education (Technical), Omoku-Nigeria
Asia Pacific Forum on Science Learning and Teaching, Hong Kong
European Chemistry Thematic Network Association, France
Afro-Euro Centre for Development Studies, Spain
Maxwell Scientific Organization, United Kingdom
Universidad Central de Nicaragua, Managua-Nicaragua
International Digital Organization for Scientific Information, UAE
Development Africa Consortium
Beverly Resources International
Science and Education Foundation, Bulgaria
Prague Development Centre, Czech Republic
Vocational Training Institute, Mauritius
European School Science Project, Spain
Raphael Nosike Foundation
International Association for Teaching and Learning, Spain
SAVAP International
Bentham Science Publishers Ltd
European Scientific Institute, Macedonia
Professor Dr Gerhard Berchtold
Chairman, Executive Commission
International Society for Scientific Research
Sir(Dr) Nkasiobi Silas Oguzor, JP, CT, PHF, KSC, PhD
Vice-Chairman, Executive Commission
International Society for Scientific Research (ISSR)
Dr Jacinta Agbarachi Opara

Convenor

International Conference on Science and Technology Education (ICSTEE2013)
Programme of Event (Draft)

Monday 12 August
08:00 – 09:30 Registration
09:30 – 11:45 Welcome Ceremony
11:45 – 14:30 Special Sessions
14:30 – 14:45 Lunch Break
14:45 – 16:45 Special Sessions
16:45 – 17:15 Coffee Break
17:15 – 18:00 Plenary Sessions
20:30 – 10:30 Welcome Cocktail

Tuesday 13 August
08:30 – 10:00 Special Sessions
10:00 – 10:30 Coffee Break
10:30 – 13:30 Plenary Sessions
13:30 – 14:45 Lunch Break
14:45 – 16:45 Plenary Sessions
16:45 – 17:15 Coffee Break
17:15 – 18:45 Plenary Sessions

Wednesday 14 August
08:30 – 10:00 Special Sessions
10:00 – 10:30 Coffee Break
10:30 – 13:30 Plenary Sessions
13:30 – 14:45 Lunch Break
14:45 – 16:45 Plenary Sessions
16:45 – 17:15 Coffee Break
17:15 – 18:45 Plenary Sessions

Thursday 15 August
08:30 – 10:00 Special Sessions
10:00 – 10:30 Coffee Break
10:30 – 13:30 Plenary Sessions
13:30 – 14:45 Lunch Break
14:45 – 16:45 Plenary Sessions
16:45 – 17:00 Coffee Break
17:00 – 18:00 Special Sessions/Communiqué
18:00 – 19:00 Closing Sessions

Friday 16 August
Departure
INFORMATION TECHNOLOGY IN NHS DIRECT USING WIRELESS MARK-UP LANGUAGE (WML) ENVIRONMENT

Peter Okpamen
Ambrose Alli University, Ekpoma-Nigeria

Abstract
National Health Services (NHS) Self-help guide is simply an application of mobile phone in a platform independent (WML) environment to sort out solutions to health symptoms. Essentially, the success of this project goes a long way in simplifying the pressure on the already stretched services in the NHS, London. The project is principally based on the openwave technology which enables such wireless platform independent services. The service provides an opportunity for the user to access the ‘search page’ in the network, and identify the symptoms he or she has; thereafter deal with the questions in the ‘question card’. Application of this model no doubt has helped in dealing with the pressure faced by the health services of NHS, London. It is imperative therefore, for developing countries and other organizations to take advantage and invest in the enabling technologies in place, in order to deal with the huge pressure faced by health institutions; as well as help in dealing with other forms of conflicts in organization.

Keywords: Information Technology, Mobile Phone, NHS (National Health Service), Switchboard, Symptoms, Management, WML (Wireless Mark-up Language).

I INTRODUCTION

The main task in this project is to design and implement a mobile application based on NHS Self-Help Guide. The WML (wireless mark-up language) environment and the Openwave technology (openwave refers to the company that provides the application infrastructure for wireless data), will be used to create the application. The advent of technology has made this application possible, and in the case of a mobile phone technology it is unique in the sense that its application is platform independent. In order words, the user could be anywhere, and as long as the network system is in place the user can always adopt the NHS Self-Help Guide. This is as a result of the breakthrough in the world of Information Technology.

Information Technology has been a blessing to modern day organization because of its immense benefits to the organization. The beauty of the mobile application technology is in its feature of platform independent. The use of the mobile application in the NHS Direct model appears to be the fastest way for health managers to have quick access to
the problems of the numerous patients out there, irrespective of where the patient may be at any particular time.

Resolution of the symptoms if not complete can be achieved tentatively. So it is necessary for management in other organizations to develop such model and encourage people in organization to imbibe the use of this model in order to deal with pressure within the system. Management therefore owe it a point of duty to make sure the system is secure in terms of identity protection, as well as making sure the system is effective and efficient at any time. In the past, quick access to the consultant is not possible because of the absence of the mobile system.

However, the application involves a few stages and also requires the user to know a simple practical application on how to operate the mobile phone to achieve the desire objective. Knowledge of the application codes is not necessary for the user in this case.

Objective of the project
The basic objective of this project is to demonstrate the application of mobile application to NHS Self-Help Guide. As a result of the impact of this technology, NHS patient can seek solutions to their basic problems without necessarily going to the hospital to queue up waiting to see a consultant. This is also a direct challenge to other organizations to explore the benefits of such mobile application for the overall development of the organization.

Significance of the research
The need to reduce the pressure from patients attending the NHS daily cannot be over emphasized; and this has motivated the desire for this project. The application of Self-help guide provides the relevant advice to the user before deciding on whether to contact the NHS Direct or to dial 999 for emergency. It is therefore imperative that this project will be of immense benefit to all concern users of NHS and other organization that care to emulate such application.

Limitation of the Project
The obvious limitation of this project boils down to the fact that, it cannot be used in an environment without the enabling technology; especially in less developed countries. Furthermore, the knowledge of technology and platform independent is not available in such environment. In London where this project was developed, the system is highly efficient and resourceful to the users. However, Information technology revolution did not help matters as it was purely in favour of the “G7” who solely designed it without necessarily putting into consideration the place of the poor nations that are disadvantageous in the information technology world. Attempting to use this application in these poor countries will obvious lead to an investment in frustration. (Capra, 2002. pp.139).

II MOBILE APPLICATION TECHNOLOGY IN NHS:
The Oxford Advanced Learners Dictionary, 8th edition, defines Information Technology as electronic equipment such as computer for the purpose of storing, analysing, and distribution of words, figures and pictures. Its application in an organization has therefore created greater improvement in terms of efficiency, ability to work without time or resources wasting, information communication and management; as well as helping in the process of evaluating and control within the organization. The advent of Mobile Application in the NHS structure therefore, has actually transformed the organization into a digital health institution. Its application in NHS has therefore provide management with a measure of problem solving such as symptoms management, increase in quality of production, increase in speed of processing, improvement of patient services, enhanced communication and collaboration, etc. The use of mobile application has become a critical success factor in the operations of this organization, especially in the area of NHS Self-Guide that has reduced the level of pressure in the system. Information Technology no doubt has led to major improvement in human ability to collect, process data and disseminate information. With the advent of the internet and the World Wide Web, Information Technology is better felt in organization in recent times. Telecommunication infrastructure, coupled with massive growth of personal computers and mobile phone devices provide vast amounts of information to users at any time. In addition to the above, the improvement in advanced information technology has led to a platform for human progress. Amongst the benefits of technological breakthrough include cheaper products resulting from data transformation. Also it is much quicker to access information, data storage, data manipulation, retrieval of data and information, and transfer of data more quickly and effectively.

The advent of advanced information technology, coupled with positive improvement has made global economy somehow like a ghost, cyber-linked, and projected towards a high level of success. Although copra is of the view that information technology has further compounded workers’ stress in the organization. As a result of improvement in modern technology, work can now be carried out much faster than before, and more time is now being saved. The idle time on the other hand is now channelled into more avenues by way of making the workers to do more work in order to generate more profits for the owners. In addition, “it is evident that the various key components of today’s business environment such as the global competition, corporate mergers, turbulent markets, increasing workloads, “24/7” accessibility via e-mail/cell phones etc, have all constituted a highly stressed and unhealthy situation” (Capra, 2002. P.127).

Although, the world of information technology that presented the whole world as a global village is now under serious scrutiny by way of information and access control management. Despite all odds in the business arena there has been argument for business success without constraints, in areas like health, education, capital, communication, consumers, corporations, etc (Ohmae, 2005.p.20). Apart from IT affecting the structure of the organization, it has also created a lot of benefits to the organization especially in the aspect of solving health problems and management of problems within and outside the organization. The level of pressure in the system these days appears to have reduced when compared to the past. Things are better organised in the organization now and detection of symptoms and subsequent resolution to these symptoms is faster and more
accurate. In terms of competitive edge, the involvement of IT has helped the NHS to gain a wide range of competitive advantage over others in the same line of business. The design of creative applications such as this model has paved the way for NHS to compete more effectively in the health industry. Another traditional benefit of this application to NHS is that, it has helped in the reduction of cost in terms of operations and in terms of dealing with patients. The application has also helped in the automation of clerical task geared towards reducing cost.

III METHODOLOGY

The Mobile Application

Essentially, the application is simple to adopt as it does not require expertise knowledge of the use of mobile phone. The only technical aspect is the code for the application which is of no relevance to the ordinary user; but for the purpose of this project the codes are included alongside the application with detail explanations of the necessary aspects. The mobile application involves a few steps to be carried out by the user.

The first stage contains a switchboard which contains a simple program version/code on how the user can get started. On assumption of the code is a form known as the openwave environment. This automatically takes the user to the “Hello” page as displayed on the mobile phone below. The first thing you observe on the screen is the NHS Direct logo and contact information space. The link therein is there to enable the user access to the application. The subsequent second page of the application is arrived at through a click on the select button.

The next stage is the search stage page. It presents before the user a list of diseases classified in letters of English alphabet. On the basis of this the user selects an alphabet indicating the symptom. In order words, click on the letter to find out your symptom(s). For example, click on F- for Fever; or click on C-for Cough.

The next stage that follows is the question card which displays written questions to the user based on the disease that he/she chose. The code used for this card is presented in the later part of this project. Here you will be asked some simple questions, and you are expected to select answers to the questions. For example;

NHS Operator: - Do you have a severe headache?
USER: - YES/NO.

Based on the interaction, coupled with your answer, the NHS Nurse will advise you on whether you need medical attention, and if you do, how quickly you should get help before ringing NHS Direct or 999. In line with the above development, if the user’s answer to the question asked is YES, Card 2 would be displayed with a picture to tell the user to phone an NHS Direct nurse. On the other hand, if the answer from the user is NO, then the NO card would be displayed advising the user to undertake a self care as it is safe to manage this problem yourself.
Implementation of the Switchboard

The switchboard was designed to provide introduction to the user who wants to use the application. This is the code used for this purpose. The switchboard enables the user to enter the openwave environment, and this contains a display of the NHS logo and a link to help the user access to the application. Usually, the user is expected to simply click on select to go to the next page.

```xml
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//OPENWAVE.COM/DTD WML 1.3//EN" "http://www.openwave.com/DTD/wml13.dtd">
<wml>
<card id="NHSDirect" title="NHSDirect">
<p>
<img src="logo.bmp" alt="Health"/><br/>
</p>
<p>
Enter</p>
<p>
<a href="minimum.wml">link</a></p>
</card>
</wml>
```
The search page

The Search Page enables the user to choose what disease he thinks that he/she has based on the symptoms. Generally the user can choose from a list starting with letters of the English alphabet, and then the symptoms would be displayed afterwards. In the program, if the user choose click on the soft button then another card would be displayed showing a choice of diagnosis. At this stage the user is faced with a huge volume of information to choose from. The important thing is to make the right choice of letter indicating the symptoms he/she has. Below is the set of codes presented in the search card below.
Click on the Letter to find your Symptoms

FEVER

* Headache In Adults
* Coughing Adults
* Fever In Adults
* Fever In Children
Here is how it looks like in the Openwave emulator.

The question card

This card displays a written question to the user based on the disease that he/she has chosen. The user is expected to give the right answer in order for the NHS Self-Help Guide to have useful value for the user. For instance; is the fever severe? The user is expected to give a YES or NO answer. A YES answer will lead the user to another stage of the card, while a NO answer could direct the user to adopt a self solution as the symptom is not a serious type to warrant a call to the NHS nurse or 999. Below is a set of codes displayed in the question card.
The code for this card is:

```xml
<wml>
<template>
   <do type="accept" label="Blank">
      <noop />
   </do>

   <do type="accept" label="Health Check">
      <go href="#card1" />
   </do>

   <do type="accept" label="YES">
      <go href="#card2" />
   </do>

   <do type="accept" label="NO">
      <go href="#card3" />
   </do>

</template>

<card id="card1" title="Card 1">
   <p>
      <img src="logo.bmp" alt="Health" />
   </p>

   <tr>
      <td>
         <p>
            <img src="logo2.bmp" alt="Health" />
         </p>

         <p>
            <b>Please Select Answers</b>
         </p>

         <p>
            <b>Do you have a Severe Headache</b>
         </p>
      </td>
   </tr>
</card>

<card id="card2" title="Yes">
   <WML>
      <p>
         <img src="logo.bmp" alt="Health" />
      </p>

      <tr>
         <td>
            <p>
               <img src="logo3.bmp" alt="Health" />
            </p>

            <p>
               An NHS Direct nurse will advise you on whether you need medical attention and if you do, how quickly you should get help; and before ringing NHS Direct or 999, it would be helpful if you think about the following and be ready to answer questions if asked.
            </p>
         </td>
      </tr>
   </WML>
</card>

<card id="card3" title="No">
   <WML>
      <p>
         <img src="logo.bmp" alt="Health" />
      </p>

      <p>
         <img src="logo4.bmp" alt="Health" />
      </p>

      <p>
         <b>Self Care</b>
      </p>

      <p>
         It is safe to manage this problem yourself at home.
         A common cause of early-morning headache is grinding your teeth at night. You should see your dentist.
      </p>
   </WML>
</card>

</wml>
```
Here is how it is displayed in the emulator.
Here is the outlook of the above code on the openwave emulator.

User reads the instruction and the question.
Here is the outlook on the emulator

Choice of answer that the user needs to select
If the user chooses YES then Card2 would be displayed. Here is how it looks.

Picture to tell the user to phone an NHS Direct nurse

More explanations on the subject
If the answer of the user is No, then the NO card would be displayed.

IV  CONCLUDING REMARK
Application of NHS Direct has made life easier for users seeking to adopt the NHS Direct Self-help project, because oftentimes there are queues here and there in hospitals which eventually lead to frustration amongst the patients. Advent of technology and the openwave environment has enabled a mobile application in a platform independent (WML) environment. It is therefore imperative to extend this type of application to other organizations to help deal with other forms of crisis in the organization.

References


http://encyclopedia2.thefreedictionary.com/Openwave
THE CAUSES OF PIRATE ATTACK ON THE GULF OF GUINEA AND THE ADOPTED SOLUTION IN AFRICA

Akwara U.C
Vintel Global Communication, Lagos, Nigeria

ABSTRACT

In this paper, the study of pirate attack on the gulf of guinea, the causes and the adopted solution in Africa is welcome. This intrigue is to address the abnormality paraded and ongoing on the gulf of guinea and also the lost of lives, goods, properties, ships, income, import and export materials and equipment that worth million dollars and investment lost to pirates especially the countries that sail across the gulf of guinea from 2004 to 2011. The experiment was analyzed and validated from samples collected from African statistics online, Nigeria statistics online, the cry of citizens that are victimized by pirate attacks, NGO’s and the local media. The procedure was conducted on Pentium IV Systems, 40GB Hard disk, 3.2GB RAM, 2.5GB Processor and Microsoft office packages.

KEYWORDS: Guinea, Africa, Pirate, Attack, Foreigner, Sea, Ocean, Bounded, Gulf.

1. INTRODUCTION

The operations of pirates have existed for more than 13 years and up to dates at different locations, places, region, countries and the world at large. Pirate attacks have doubled its capability since the menace have not been controlled and rectified by the government, private establishment, NGO’s and other bodies that could prevent such operations. The number of pirate attacks on the gulf of guinea has become African problem and the rest of the world and have not seen any vital solution to solve the trend. Pirate attack, as the name goes, is the severe and consistent attacks on life’s, properties, ships, import and export goods and services by unscrupulous individual, group and people both on-shore and off-shore on countries bounded by the gulf. The gulf of guinea in Africa has been bedeviled by these illegal operations since 2003 and has brought numerous problems to the countries bounded by the sea. There are literature updates to these effects;

Olawale [1] discovered MEND attacks worsen piracy in gulf of Guinea. Nigeria coast rated second to Somalis’. Trans-national mafia fingered. He reported that the recent attacks on security personnel by the movement for the emancipation of Niger Delta (MEND) may have worsened Nigeria’s rating on the handling of piracy in the gulf of Guinea. Nigeria is on the second place in the world after Somalia with a total of 58 pirate attacks on ships off Nigeria’s coast in 2011 while Li [2] pioneered gulf of Guinea: Pirate attack mimic Somali tactics. He reported that the hijacking of a combined chemical and oil tanker off Benin has raised concerns that Somali tactics are being copied off West Africa. They hijacked the vessel and stole the cargo but did not take any crew members hostage as this is not really a trend in the gulf of Guinea.

Further more, Bockmann and Sheridan [3] discovered pirate’s double gulf of Guinea attacks, Lured by tanker cargoes. They reported that pirate attacks in the gulf of Guinea doubled last month as more tankers were hijacked so their stolen oil-product cargoes could be solid on shore while Murdock [4] implemented piracy in West Africa’s gulf of Guinea threatens local and world economics. He reported that from BBC reported two crew members were kidnapped and another injured on Tuesday, in the latest attack off the West coast Africa. A third crew member was missing after eight armed Dutch-owned cargo ship.
2. PROBLEM

This section highlights the causes of pirate attacks paraded on the gulf of guinea in Africa from 2004 to 2011.

2.1. JOBLESS YOUTH IN AFRICA

In Africa, about 58% of the youths are jobless and those with job are now out of jobs due to job cut by companies and industries as a result of economic meltdown experienced since 2002. As these youths are out of jobs, they become aggressive, angry, restless and starving. Series of wrong ideas and imagination kept creeping in. As a result of these causes, they look for ways of surviving in order to feed themselves and their families. They join groups, gangs and factions that attack and terrorized people on the sea shore, across the boarder and on the coastal area of guinea. These groups used speed boats and pirate ships to attack, steal, loot and kidnapped citizen and foreigners for ransom of money on the sea shores.

2.2. UNSECURED BOARDER PROBLEM

Boarder checking and control are majorly carried out by immigration officers, NDLEA, military personnel, police force and special control team across the gulf of guinea. Each country that have access to this coastal sea of guinea in Africa are required to produce agents on the boarders to control import and export goods and services, investment into the country, save guard foreigners and trans-boarder control but unfortunately African continent in lacking in such areas. About 52% of the boarders in Africa are not properly secured against pirate’s attacks, terrorist, hoodlums and illegal operations. As these boarders are not controlled, the pirates build up their camps, halts and hide out in caves, creeks etc. They import guns and ammunitions into the country through the weak boarders; they gather information from indoor informant about ships, goods, oil tanks and foreigner into the country. These immigrations and NDLEA agents etc are not properly motivated to give their best, leaving people, pirates and groups unchecked at the boarder and at the end, the pirate attacks kept expanding, causing havoc to the society and the foreigner on the gulf of guinea.

2.3. MULTIPLE POVERTY IN AFRICA

Africa is poor, know doubt about it. The level of poverty is growing tremendously and is springing up different negative effect on the people in Africa. One of the deadly effects of multiple poverty in Africa is pirate attack on the coastal sea of guinea. More than 52% of the people leaving in Africa are poor. Majority of them can’t get correct square meal regularly. 22% of them get 3 square meals per day, 33% of them get 2 square meals per day and 45% of them get 1 square meal per day as a result of multiple poverty created by the government, corruption in Africa and money laundry. Poverty in many families can not be controlled. As families can not get access to basic amenities, social amenities and even proper education, they become poor. At the end of the day, the bread winner of each family is forced to look for other alternatives which lead to pirating, kidnapping, stealing, raping and terrorism across the gulf of guinea.

2.4. UNFUNDED PATROL TEAM IN AFRICA

The governments in Africa are sole responsible for the funding of patrol team across the gulf of guinea. The police force, the naval force and the joint task force that comprise of civil defense, mobile police, and state security service (SSS) and surveillance team are responsible for the joint patrol across the gulf of guinea. It’s very sad to say that these teams are not properly funded by the government and other allied. Little or no remuneration are provided for them, life assurance scheme are not offered to them and their families incase of sudden death on duty, adequate ammunitions, and fighting equipments are not provided to combat pirate attacks. Also, surveillance and patrol vans, cameras, vehicles, aircraft, helicopters are not provided etc. All these fact, boiled down to unfunding by government. As these patrol teams are not provided with these funding, they become weak and defenseless to combat the hidout and whereabouts of pirates on the shore and off-shore. Even, majority of the patrol connive with pirates by supplying them with guns and ammunitions and later becomes their commandant in kidnapping people, stealing, rapping and demanding for ransom of money.

2.5. HUMAN TRAFFICKING ON THE SEA-SHORE
The number of human trafficking across the sea-shore is increasing day by day on the countries bounded by the gulf of guinea. Nigeria, Ghana, Guinea and other countries that share the coastal sea are faced with such problems. Each day, the media kept reporting the level of human trafficking on the sea-shore and the boarders. During trafficking, many of traffickers never get to their destinations. Some of them end up half way, killed and left in creeks, caves and rock across the sea-shore and since they can not return or cross to the other developed countries they leave in the creeks and caves. Since there are no means to livelihood, they end up forming groups, pirating with speed boats and ships, kidnapping people, killing sailors, impounding on export goods and jumping from ships to ships, making the pirate attacks more intense and hard to control on the gulf.

2.6. **INEFFECTIVE LAWS IN AFRICA**

There are millions of Laws and Acts pronounced by the government in Africa which are not helpful to the society at large. These are wrong Laws which could not eliminate pirate attacks. Such Laws causes more pirate attacks on people while the useful Laws that should protect the people are not implemented and monitored. Laws like freedom of speech, Bridge of freedom, Terrorist acts, Pirates acts etc are not implemented and monitored. Pirate attacks are waxing stronger and people’s lives and properties are not protected due to ineffective Laws. Africa is yet to get, the proper motive of Laws enactment, implementation and follow up. Until, the right Laws are pronounced, the menace of pirate attacks would persist and continue to exist on the country bounded by the gulf of Guinea.

2.7. **THE FALLOUT OF WAR IN AFRICA**

Few decades ago, African continent has been under war, is either the military is fighting the civilian or the civilian is fighting the government or rebels are fighting allied forces or military forces implement coup to overthrow the existing government or the president refused to step down after being defeated in an election. These are avenue that spring up fallout of war in Africa. As these wars are on going, people ran far to protect their life’s, parents and youth, camps are setup for attacks etc. As the military and war fighters engaged in war battle, the whole country is disturbed. When the war is over, people become restless, starving, and angry and finally fall into hardship. Since the citizens can no longer secure their properties, wealth and children as a result of war fallout, they go pirating to survive. They spring up groups and gangs on the sea-shore, killing, stealing and attacking innocent people across the sea. This is a major cause of pirate attack experienced for so long on the gulf of Guinea in Africa.

3. **SOLUTION**

This section highlights the proposed solution that would solve the lingering problems emanating from the causes of pirate attack on the gulf of Guinea from 2004 to 2011.

3.1. **PROVISION OF COUNTLESS JOBS FOR THE YOUTH**

It is the duty of the government, companies and industries owners to provide jobs for the jobless youth. The youths need to be engaged in one or two jobs to make them responsible to the society. “An idle mind is a devil workshop”, this is a popular saying in Africa especially in Nigeria. When youth are out of job, negative thought and thinking creep in. Many of these pirate groups are jobless youth who do not have government jobs, employment in companies, industrial jobs or be self-employed. When government and other agents provide jobs and 68% of the people are able to get employment, then the idea of pirate attack, killing innocent’s people, kidnapping foreigners and citizens and capturing of sailors and ships with goods across the sea would automatically be eradicated on the gulf of Guinea.

3.2. **ERADICATION OF POVERTY IN AFRICA**

As mentioned in section 2.3, poverty in Africa needs to be eradicated to the fullest. “Imagine an African without poverty instinct”, how wonderful it would look. Poverty is bad, know doubt about it, it should be eradicated gradually from Africa. The ways suggested in eradicating this poverty in Africa which serves as a tool to pirates on the gulf of Guinea includes; the government should stop corruption, Looting and Money laundry experienced in Africa should stop. The wealth generated should be disbursed to all quarters of the federation to improve infrastructure, facilities, management, implementation and welfare of the citizen. The citizenry should be educated
to aid poverty eradication and uncivilized people should be made civilized. When all these points are put implemented, pirate attack experienced for so many years would vanish into the thin air.

3.3. **ENACTMENT OF PIRATE LAWS**

People are not meant for Laws but rather Laws are meant for the people to obey and adopt. The state house or the government in Africa should enact pirate Laws that would eliminate pirate attacks on the gulf of Guinea. Laws like; jail terms to any pirate offenders, life sentence to any pirate person or group found guilty of killing innocent citizens and foreigners, jail term to any person found trafficking of human across the boarder and the coast of Guinea, 10 years imprisonment to any citizen that bridge freedom of expression and 5 years jail term to any citizen and foreigner found kidnapping for ransom of money. When all these Laws are forcefully implemented, on the countries bounded by the gulf of Guinea then pirate attacks would disappear.

3.4. **FUNDING OF ANTI-PIRATE PATROL SQUAD**

Anti-pirate patrol squad is group of people legally established by Law or act to fight the menace of pirates across the region, oceans, seas, boarders, air or at rail terminal. This anti-pirate patrol squad required government backing and funding in order to execute their various functions. A maximum amount of money should be allocated to fund anti-pirate patrol squad and bridge insecurity in the state or country.

![Figure 1. Anti-pirate patrol ship on the gulf of Guinea.](image)

This anti-pirate patrol required total funding which include; welfare package, ammunitions, guns, weapons, ships, combat trucks, surveillance aircraft and helicopters, Laptops, cameras, web facilities, training kits, insurance package, oversea training and new techniques in combating crimes at the sea level. As a means of solution, other agencies, NGO's, United Nations and Africa union should deliberate on a round table discussion on ways and modalities of funding anti-pirate patrol squad on the gulf of Guinea. At the end, some conclusive measures should be taking which would automatically eliminate the pirate attacks on the coastal areas of guinea.

3.5. **ERADICATION OF HUMAN TRAFFICKING ACROSS THE BOARDERS**

There are different boarders attached to the gulf of Guinea. Such boarders include; Nigeria boarder, Ghana boarder, Cameroon boarder, Guinea boarder, Angola boarder etc. These are boarders where human trafficking takes place on daily basis. As mentioned in section 2.5, human trafficking is also a major cause to pirate attack. The question is? Can human trafficking be eradicated without yielding any pirate hide out on the gulf of Guinea? To eradicate human trafficking across the boarder, we should; improve boarder checking during the day and at night, prevent human traffic overflow on the boarders, eliminate bribery and corruption carried out by agencies, eliminate the enthusiasm of greener pasture oversea presents in our society, importation of goods, human and services should be controlled and checked, Anti-pirate squad should be introduced to stop trafficking. When all these points are implemented, automatically human trafficking that causes pirate camps and hide out would be eradicated on the gulf of Guinea.

3.6. **ELIMINATION OF WAR IN AFRICA**

War in Africa should be eliminated and total discarded. The fallout of war is devastating and unpleasant. Tolerance should be encouraged, ethnic values, religion, culture and tradition of all in African should be encouraged. What so ever would spring up war should be eradicated from Africa. War out brake, is one of the factor that causes pirate spring up on the gulf of Guinea. All hands should be on desk to eradicate war in Africa so that pirate attacks recorded by the countries bounded by the coastal gulf sea would be eliminated.

4.0 **RESULT AND DISCUSSION**
This section highlights the result obtained from the samples analyzed from different quarters on the percentage level of the causes of pirate attack on the gulf of Guinea from 2004 to 2011 in Africa.

Table 1. The validation table of data sampled on the percentage level of the causes of pirate attack on the gulf of Guinea.

<table>
<thead>
<tr>
<th>S/N</th>
<th>LC (%)</th>
<th>2004 (YR)</th>
<th>2005 (YR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JOBLESS YOUTH</td>
<td>62</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>UNSECURED BOARDER</td>
<td>80</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>POVERTY IN AFRICA</td>
<td>70</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>HUMAN TRAFFICKING BY SEA</td>
<td>63</td>
<td>66</td>
</tr>
<tr>
<td>5</td>
<td>INEFFECTIVE LAWS</td>
<td>71</td>
<td>72</td>
</tr>
<tr>
<td>6</td>
<td>WAR FALLOUT IN AFRICA</td>
<td>63</td>
<td>59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YR (YR)</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>63</td>
<td>58</td>
<td>57</td>
<td>58</td>
<td>60</td>
<td>59</td>
</tr>
<tr>
<td>2005</td>
<td>78</td>
<td>81</td>
<td>75</td>
<td>73</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>69</td>
<td>66</td>
<td>65</td>
<td>63</td>
<td>59</td>
<td>56</td>
</tr>
<tr>
<td>2007</td>
<td>67</td>
<td>70</td>
<td>69</td>
<td>67</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>69</td>
<td>67</td>
<td>65</td>
<td>62</td>
<td>60</td>
<td>57</td>
</tr>
<tr>
<td>2009</td>
<td>57</td>
<td>61</td>
<td>58</td>
<td>59</td>
<td>57</td>
<td>53</td>
</tr>
</tbody>
</table>

**KEY:**

LC (%) = % LEVEL OF THE CAUSES OF PIRATE ATTACK ON THE GULF OF GUINEA.

YR = YEAR

Table 1. Represents the validation table analyzed from the samples collected at different location that justify the percentage level of the causes of pirate attack on the gulf Guinea.

In 2004, the percentage level of jobless youth is 62%, 58% in 2007, 60% in 2010 and 59% in 2011. There is a mix increase and decrease from 2004 to 2011 while on the percentage level of unsecured boarder, 80% in 2004 then from 2005 to 2007, there was increase from 76% to 81%, it remain static in 2007 and 2008 and then dropped from 75% to 70% in 2009 to 2011.

The percentage level of poverty in Africa was about 70% in 2004, 67% in 2005, then from 2006 to 2011, there was a sharp decrease from 69% to 56% while the percentage of human trafficking by sea shows that there was a sharp increase from 63% to 72% in 2004 to 2008 and then dropped from 72% to 64% in 2008 to 2011.

The percentage level of ineffective Laws increases from 71% to 72% in 2004 to 2005, then suddenly dropped from 69% to 57% in 2006 to 2011 while for war fallout in Africa, the percentage level decreases from 63% to 57% in 2004 to 2006, 61% in 2007 until, it dropped to 58% in 2008, it increase to 59% in 2009 and finally dropped to 53% in 2011.
Figure 2. The validation graph of the percentage level of the causes of pirate attack on the gulf of Guinea.

Figure 2. Represents the validation graphs with respect to the causes of pirate attack on the gulf of Guinea in Africa. In the graph; the yellow spot represents the percentage of jobless youth which has a maximum of 62% in 2004. The pink spot represents the percentage of unsecured border, with a minimum of 70% in 2011. The blue spot represents the percentage level of poverty in Africa, with a maximum of 70% in 2004. The brown spot represents the percentage level of human trafficking by sea, with a maximum of 72% in 2008. The light pink spot represents the percentage level of ineffective Laws in Africa, which has a minimum of 57% in 2011 and finally, the purple spot represents the percentage level of war fallout in Africa with a maximum of 63% in 2004.

Figure 3. The validation line graph of the percentage level of the causes of pirate attack on the gulf of Guinea.

In figure 3, the line graph shows a wave form from 2004 to 2011. The red line represents the percentage level of jobless youth, the blue line represents the percentage level of unsecured boarder, the light green line represents the percentage level of poverty in Africa, the green line represents the percentage level of human trafficking by sea, the pink line represents the percentage level of ineffective Laws while the brown line represents the percentage level of war fallout in Africa.

5.0 CONCLUSION

We have simply analyzed and validated the results obtained from the samples. The experimental analysis has shown to be robust, authentic and effective to justify the causes of pirate attack on the gulf of Guinea and the proposed solution adopted to solve the lingering problems. The implementations of these solutions would automatically solve
the challenges faced on the cause of pirate attack in Africa. The future papers expected include; the after effect of militant group in Niger delta and the effect of continuous bombing in Nigeria.

REFERENCES


ROLE OF BLENDED LEARNING APPROACH IN DEVELOPMENT OF INTERNATIONAL DISTANCE EDUCATION PROGRAMS – CASE STUDY FROM CENTRAL AMERICA

Seetharam Chittoor Jhansi
Coordinator, Gujarat Research Society’s Pushpa Navnit Shah Centre for Lifelong Learning, Dr. Madhuri Shah Campus, Ramkrishna Mission Road, Corner of 16th & 17th Road, Khar (W), Mumbai, 400052, Maharashtra, India.

Abstract
Distance education is less a philosophy and more a method of education. Students can study in their own time, at the place of their choice (home, work or learning centre), and without face-to-face contact with a teacher. Technology is a critical element of distance education. International distance education program, in its broader perspective, aims to provide a multinational platform where the latest trends in distance education can be shared and discussed in a friendly environment with the aim to learn from each other. This process, in turn, results in global learning. However, building a dynamic international distance education program can be a complex operation. This paper primarily aims to discuss a model for global learning that utilizes a blended learning approach. It will describe how a blended learning approach was implemented in an international instructional technology program. The paper concludes that:

- the development of an international distance education program includes many factors that must be taken into consideration and addressed in all phases of program development; and
- through an international distance education program that utilizes a blended learning approach, all countries and individuals participating can learn and expand their knowledge.

Keywords: Distance education, blended learning, approach, learning, and technological communities.

Introduction
“Distance education” (or “distance learning”) is a mode of delivering education and teaching, often on an individual basis, to students who are not physically present in a traditional setting such as a classroom. It can be very effective use of instructional materials with visual, auditory, audiovisual and multimedia content. Today, distance education can hardly be imagined without the significant use of information and communication technologies (ICTs, which have been touted as potentially and powerful enabling tools for educational change and reform).

Learning in an online and distance education context is becoming a very common phenomenon in institutions of higher education. Transforming traditional learning contexts to mirror an increasingly technological world and to support a global community is critical to ensure the success for a larger cross-section of diverse learners (Hicks, Reid, & George, 2001). Moreover, given the recent evidence that indicates the opportunities of using distance learning to transform the student learner, there is reason to believe that using a blended learning (defined as “education that combines face-to-face classroom methods with computer-mediated activities”) approach, or one where a technological and a face-to-face learning component is included, can help in the development of better global, technological communities.
This paper aims to discuss a model for global learning that utilizes a blended learning approach. It will describe how a blended learning approach was implemented in an international instructional technology program to the benefit of both universities and countries involved. The discussion will focus on a specific framework for developing an international blended learning program with special consideration of cultural differences in: (a) language, (b) teaching philosophy, and (c) education.

Conceptual Framework of Blended Learning
Blended learning, which can generally be defined as an amalgam of text-based, online technology with face-to-face learning, is a low cost, but effective way to transmit knowledge in a global world. Researchers and educators have defined blended learning in a variety of ways. These interpretations have ranged from a supplemental addition of a web-based tool for a course to a more pedagogical blend of instructional online tools that support learning (Driscoll, 2002). Essentially, the use of blended learning is a new way to both teach and learn in a higher education setting.

One of the most specific advantages of blended learning is the opportunity to quickly establish a sense of community amongst student learners (Garrison & Kanuka, 2004). Within the blended learning classroom, students generally meet in face-to-face instruction, and then have opportunities to communicate with open dialogue, to experience critical debate, and essentially participate in a variety of forms of communication in a “safer setting”. These opportunities can facilitate greater reflection on course content and broaden students’ learning experiences.

Blended learning also may provide other distinct benefits over more traditional classrooms. Pedagogical theorists have recently suggested that lectures that only transmit information rather than focusing on learning are not very effective for students in terms of long-term retention and use (Salmon, 2000). In other words, students need to learn the material in a novel and interactive way that takes individual needs and interests into account, so that these skills may transfer into real-world settings (Derntl & Motschnig-Pitrl, 2004). This may be particularly true in the field of instructional technology, where it is essential that the notions of transfer (real-world problem-solving), collaboration, and team effort (working in groups) are reinforced. Moreover, to be able to design, develop, and evaluate processes and resources for learning technology, as practitioners in the field do on a daily basis, students need to be able to learn to use technology as a tool in itself. Consequently, blended learning is not only a means of learning the subject matter, but also a way of putting the course content into practice.

Blended learning also provides the opportunity for students to not only build a connection with each other but a rapport with the instructor. Further, this approach provides consistency in learning. In this type of approach, students experience new methods and ways of learning and also put into practice the familiar, traditional method of learning in a face-to-face environment. A blended learning approach may also be an ideal method to utilize within an international distance education program for several reasons. For instance, it can:

- reduce costs yet encourage rapport building, and
- provide consistency and the skills that transfer into real-world settings.

Perspectives on Learning in a Blended Learning Technology Program
There have been several models posited on how educators should teach their subject matter. Models, specifically centered on developing distance learning programs, focus on planning and implementing distance education as opposed to being centered on learning. These models have
included a concentration on the structural elements of distance learning such as: (a) facilities, (b) program management, (c) student services, and (d) course management systems.

Planning models have also focused on support for the infrastructure of distance education programs where support for students, faculty, and program administrators is critical in implementing and evaluating these types of programs. Although these planning models are useful when implementing a new distance education program, other models may be more useful when examining the learning outcomes of such new programs. When the focus is on what program administrators are learning in the process of developing these programs, it may be valuable to examine and apply learning models to program development.

One technology-learning instructional model that has been proposed in recent research has focused on how students actually applied their learning in blended learning classrooms and evaluated the subsequent results (Alonso, Lopez, Manrique, & Viñes, 2005). This model is composed of following seven phases: (a) analysis, (b) design, (c) development, (d) implementation, (e) execution, (f) evaluation, and (g) review.

This seven phase instructional model is useful in the sense that it focuses on student learning objectives rather than on technological implementation (Bloom, 1956). Moreover, this seven phase model is focused on the application of learning. So, students are learning how to apply knowledge and are given time to evaluate the results. However, when applying this model to a global context, some important additions are needed. First, in the global context of blended learning, culture and cultural differences must be taken into account. For example, there will be inevitable difficulties with language due to translation. Some languages may not have translatable linguistic terms for technology. As a consequence, miscommunication between student and teacher and even between teacher and the country’s administration can occur. Furthermore, culture has a substantial impact on student learning along dimensions such as power distance, uncertainty avoidance, nurturing/competitive learning environments and societal perspectives such as individualism/collectivism (Hofstede, 1984).

**Globalization**

Globalization is the bringing together of values and cultures that were at one time isolated to specific countries or regions of the world (Skair, 1999). One can argue that economic or financial globalization is one of the most important developments in recent decades. As governments are more willing to open their markets to the global community to allow free movement of goods and materials, the quality of life for many international counterparts has improved (Simmons & Elkins, 2004). However, as critics of globalization point out, as economies are becoming increasingly global (and use of technology becomes more critical), the risk of falling behind for developing countries becomes even greater (Tschang & Della Senta, 2001).

Globalization is also noted as an “ongoing process of greater interdependence among countries and their citizens that is complex and multifaceted” (Fischer, 2003). Some of the complex problems that relate to globalization are economic, while others relate to aspects of life (such as social status). In general, the reality of globalization means that the consumers in one country are more likely to utilize the products of another country, invest in other countries, and earn income from other countries (Fischer, 2003). As a consequence, in order to be competitive in an international market, countries need to have access to technology as well as to workers skilled in using information technology. However, the technological consequences of economic globalization are substantial. What it means is that in countries with technological inequities, poverty is increasing and integration into the global economy may or may not be good for
growth. There is, thus, need for developing countries to improve their knowledge base regarding technology and to provide educators with a means to train future generations on technological issues to facilitate the country’s own economic progress in a global community. Moreover, recently, there has been a push for institutions of higher education to take on this challenge of expanding these technological opportunities by moving into developing countries and providing an educational service to help these countries participate in a more global economy (Larsson, Boud, Dahlgren, Walters, & Sork, 2005).

Program Development: A Case Study from Central America
One collaborative partnership was developed between a North American University (NAU) and a Central American University (CAU) in the year 2002. Negotiations began in the summer of 2002, when the NAU was contacted by the CAU in order to discuss the creation of a partnership that would support:

- a Professional Instructional Technology Certificate that would be awarded by the Instructional Technology Department at the NAU,
- a Master’s degree in education to all qualifying students completing the approved program of studies that would be awarded by the NAU, and
- a Master’s degree in Education to be awarded by the CAU for students not able to pass the Test of English as a Foreign Language (TOEFL).

During the initial Memorandum of Understanding (MOU) discussion, the Provost of NAU, the President of the Central American country, and the Minister of Education of the Central American country were present. After the initial meeting, representatives from both universities (approximately 60 individuals representing both universities and both countries) negotiated the proposed degree and certificate offering. A Memorandum of Agreement (MOA) preceding a formal MOU was then drafted, in November 2002, between the two universities. The need for the program within this Central American country and the multiple certificate and degree offerings made available to students attending CAU was outlined within the MOU. It was also noted that this agreement can be revisited on an annual basis, modified, and revised according to the needs of the participants according to the renewal section in the MOU.

During negotiations, it was predicted that the program would be attractive to other international institutions and individuals involved in the field of educational instructional technology within the continent, since it was an innovative program that would increase access significantly for individuals from various social economic statuses. There was a strong need for the program, since there was no other educational technology degree or program of this nature available in this Central American country. Finally, capacity building was incorporated into the program so that the Central American country would have the tools it needed to integrate technology into teaching and learning in its public school programs.

Blended Learning Approach: Case Study Application
In this international distance education program, the seven phases of the technology-learning model can be clearly observed. At the program outset during the analysis phase, faculty across both institutions worked together to develop the planned coursework for students, and decided how the classes would be implemented (e.g., how content would be made available to students). A critical element during analysis of what to teach in this international program was to make sure there was consistency in courses traditionally taught on campus in relation to courses taught in the blended learning program. Another element involved specifying the learning objectives. During this phase, as part of the MOU, the learning objectives were identified and the partnership between the two institutions was defined. One of the most significant challenges in
defining what to teach was developing an understanding of the students who would have the opportunity to participate in the program. The students who were targeted for inclusion had many hurdles to overcome, such as difficulties accessing equipment and downloading documents in a country with very little bandwidth. In addition, although English-proficient, it was discovered that CAU students comprehended the materials more efficiently when side-by-side translations were provided in their native language.

During the “design phase” of program development, educators from both institutions determined how to teach the subject matter. After developing the program to meet the needs of the students, the next step administrators and faculty took in developing the cross-national program was to hire a liaison that would ensure that “courses were compatible with the other university’s academic guidelines”. Also, the liaison checked to make sure that the process of designing the program would work across both institutions especially since they each had differing styles of education. In this phase, how course content was to be presented to students was discussed (e.g., number of face-to-face sessions, translation of materials, faculty responsibilities regarding student evaluation). Further, the road map of the courses was set to ensure consistency of learning from semester to semester. One of the largest problems faced in this step was staffing of the blended learning classrooms. The CAU faculty had little to no training in technology and only some NAU faculties were fluent in both languages. Consequently, the course of programs had to be carefully chosen so that faculty from both institutions could learn the necessary skills from one another.

In the “third phase” (or “development phase”), resources and materials were prepared and shared across the institutions. Course materials were burned onto compact disc for easier student accessibility. Information regarding registration and student registration procedures was shared and negotiated. For example, students at the international institution registered once for their entire student career, whereas in case of new blended learning program, students needed to register for each semester of involvement. This phase also involved setting up computer labs and satellite campuses across the country. Although computers were provided to set up the main lab at the CAU, there were also 20 satellite labs that were set-up around the country to make access easier for students who had to travel a great distance. Consistency and maintenance of equipment was a challenge. The equipment that was available at each site varied a great deal. For example, one site had a working computer, but no access to the internet. Another lab had a working computer, but no printer. In addition, responsibility for maintenance of the equipment and updating software was unclear.

The “next phase” (“implementation phase”) involved learning and knowledge transfer. In this step, administrators and faculty built the translated websites for the courses (concurrent with the design phase) and began teaching the courses. Much of the student learning took place in the online environment, through online group discussion and electronic mail. However, face-to-face sessions helped to facilitate the development of the online communities (Garrison & Kanuka, 2004). These sessions fostered a stronger community for the students. Moreover, as some of this online discussion was meaningfully related to course content, students had the opportunity to use one another as resources in their own learning and in learning about the program in general (Lewis & Abdul-Hamid, 2006).

During the “fifth phase” (“execution phase”), program administrators evaluated problems with implementation and determined how much students were learning in their individual coursework. This process was evaluated by conducting comprehensive online surveys for each course as students completed them and also by evaluating the process of communication between
faculty and administrators. One issue that immediately became obvious in this phase centered on differences in educational systems. Students appeared to be processing content. However, there were challenges in submitting required course assignments. That is, it appeared that some students were learning the material yet not producing any specific outcomes or assignments as a result.

During the “evaluation phase”, the program and learning environment were evaluated in terms of progress towards the learning objectives. In this phase, it was necessary to investigate whether the blended learning environment was meeting the needs of the diverse learners in the program overall. In the instructional technology program, this process was facilitated by conducting a formative evaluation of the program. The evaluation provided immediate feedback to program administrators as to some of the specific problems students and faculty were experiencing within the program. The evaluation also assessed the progress of the collaboration between the two institutions.

Finally, during the “last phase” (“review phase”), the outcome of the evaluation was analyzed and the program was adapted. After reviewing individual courses and students’ concerns with the program, it was apparent that communication across faculty was essential for students’ success (as opposed to communication with the liaison or other administrators). As a consequence, there was an effort:

- to include more meetings of faculty across both institutions, and
- to provide professional development opportunities to all faculties involved.

In addition, in planning these types of international blended learning programs, it became clear that it was essential to ensure that there was greater understanding of students’ needs. As a result, it was determined that spending more time in the analysis phase would be beneficial and produce better learning outcomes for the students.

### Issues for Concern

There are three overarching concerns: (a) culture, (b) funding, and (c) the structure of the educational system. Throughout the collaboration, several cultural issues and misunderstandings were encountered that involved:

- language,
- power,
- use of time, and
- students’ perspectives and expectations.

Despite efforts made in communication and translation, misunderstandings were inevitable because of the many differences between cultures and languages. Language can convey a wealth of information other than the primary content of the message (Sue & Sue, 2003). Spanish in one country is not the same as Spanish in another country. There are many dialects and slang words used in everyday language. Local nuances were sometimes missed during communication and within the translations.

The power structure within countries was also quite different. Within the Central American country, the Ministry of Education accredits all universities, both public and private. Therefore, they were the overall entity that cleared all final program decisions within the Central American
country. In addition, they paid for all students’ tuition, books, and transportation costs within the cohorts; and, additional faculty meetings and some supplies needed for program development.

Another concern that needed to be addressed was the course assignments. Assignments at the CAU were usually due at the end of the course. As a result, CAU students assumed the same classroom culture would apply during the collaborative program and did not turn in homework assignments as listed within the syllabus. At first, NAU faculty thought CAU students were perhaps not understanding the assignments or not completing their homework in a timely fashion. After learning about the CAU academic culture around assignments and various hardships that students were experiencing (i.e., lack of affordable computer equipment, inability to access the internet, etc.), a re-negotiation occurred and NAU faculty shifted their (academic) cultural perspectives and made some adjustments to their teaching techniques. It is crucial to have a good understanding and consciousness of students’ needs and cultural expectations as well as an awareness of the educational systems that are contributing to the collaboration.

**Recommendations**

After evaluating the program administration and learning outcomes for students, faculty, and program administrators, following recommendations for building international programs using a blended learning approach can be proposed:

- It is critical to spend a significant portion of time in the analysis phase to learn about potential students’ needs and special challenges that students may face in an international blended context.
- An awareness of students’ technological resources such as online course accessibility (especially in countries with poor bandwidth) needs to be considered.
- There is need to evaluate and assess the needs of the faculty participating in the blended learning program.
- Within international blended learning programs, developing an awareness and sensitivity to cultural and political differences (particularly “prior to the implementation phase”) is helpful in the planning process and ensuring appropriate learning outcomes for the diverse students who make up these programs.

**Conclusions**

The development of an international distance education program includes many factors that must be taken into consideration and addressed in all seven phases of program development. From analysis to review, one major challenge for developing countries is to obtain technological knowledge (Moore & Kearsely, 2005). Since developing countries do not have as much knowledge or resources to create higher institutional components of knowledge itself, it is essential that other institutions of higher education from developed countries provide support and seek collaborative partnerships to create programs that will meet the needs of both students and their respective countries. The two institutions that formed this partnership have continued their virtual collaboration with the goal of providing this Central American country with a stronger role in globalization. When the goals of the project have been met, it is hoped that the CAU will be able to implement a similar program on its own. True globalization requires that knowledge be shared from developed to developing countries. Through an international distance education program that utilizes a blended learning approach, knowledge can be shared, and all countries and individuals participating can learn and expand their knowledge. Overall, this appears to be an optimal situation for all parties involved.

**References:**


STRATEGIES FOR MATHEMATICS EDUCATION TO STUDENTS WITH DISABILITIES

Santosh Kumar Mishra
Population Education Resource Centre,
Department of Continuing and Adult Education and Extension Work,
S. N. D. T. Women's University, Patkar Hall Building, First Floor,
1, Nathibai Thackerey Road, Mumbai - 400020, Maharashtra, India.

Abstract
The students with difficulty remembering mathematics facts, concepts, rules, formulas, sequences, and procedures, are referred to as “learning disabled”. Teaching “mathematics education” (which refers to “the practice of teaching and learning mathematics, including research”) to such students is a major challenge before teachers/mathematics educators. Use of technology enables teaching mathematics to students with disabilities with greater ease. This paper primarily aims to give an insight into the strategies that can enhance the mathematical learning of all students, but especially those students with mathematics difficulty. The paper concludes that over the years, the commitment to improving outcomes for students with mathematics difficulty continues to grow. One strategy that needs additional attention involves the use of technology designed to teach mathematical concepts in non-traditional ways. At present, the sheer quantity of educational software and other tools that are available for teachers to use in the classroom is significant. Additionally, the cost of much of this hardware and software is relatively low. One major goal of educators of students with mathematics difficulty should be to conduct ongoing research to determine the best use of existing technology for enhancing mathematical learning.

Key Words: Learning disability, mathematics education, students, and technology.

Introduction
It is said that mathematics is the gate and key of the science. One who is ignorant of mathematics cannot know other things of the world. Mathematics has played a very important role in building up modern civilization by perfecting all science. In this modern age of science and technology, emphasis is given on science such as physics, chemistry, biology, medicine and engineering. Mathematics, which is a science by any criterion, also is an efficient and necessary tool being employed by all these Sciences. As a matter of fact, all these sciences progress only with the aid of mathematics. So it is aptly remarked, “Mathematics is a Science of all Sciences and art of all arts”.

It is, thus, imperative to impart mathematics education (which refers to “the practice of teaching and learning mathematics, including research”) to all students, especially to students with disabilities. All students, including those with disabilities and those at risk of school failure, need to acquire the knowledge and skills that will enable them to figure out mathematics-related problems that they encounter daily at home and in future work situations. This paper primarily aims to give an insight into the strategies that can enhance the mathematical learning of all students, but especially those students with mathematics difficulty (including students with dyscalculia). It discusses how FASTT (Fluency and Automaticity through Systematic Teaching
with Technology) model can be used to assist students in the development of declarative fact knowledge.

**Role of Teachers – Important Considerations**

Teachers are the key to improving mathematics education. What teachers know how to do and what they choose to do when delivering instruction in their classrooms determine what content students learn and which students learn that content (United States Secretary of Education, 2000). The preparation, certification, and ongoing professional development of teachers define what they are able to do with their students. Two important facets shape teacher preparation:

- *what* mathematics (the teachers need to know to teach), and
- *how* they learn to teach that mathematics.

Ensuring that well-prepared and competent teachers are in every mathematics classroom means considering the following questions:

- What should teachers of mathematics know and be able to do?
- How do teachers need to learn this material and these skills?
- What is the nature of coursework that will prepare prospective teachers to be effective teachers of mathematics?
- How can schools and school systems institutionalize a system of ongoing professional development?
- How can schools and school systems create a professional working environment to make teaching more attractive?

**Mathematical Knowledge and Learning**

In order to better understand how to enhance mathematical thinking and learning in today’s students, especially students with math difficulty, it is essential to understand the nature of mathematical knowledge. Mathematicians and cognitive scientists appear to agree that at least three basic types of mathematical knowledge exist and are required for the development of mathematical literacy and competence. These three types of knowledge are ‘declarative’, ‘procedural’, and ‘conceptual’. A brief overview of these knowledge types is provided below:

- **Declarative knowledge**: Declarative knowledge can be considered factual knowledge about mathematics. Examples of this type of knowledge are $4 + 7 = 11$. Declarative knowledge serves as the building blocks for procedural knowledge.
- **Procedural knowledge**: Procedural knowledge can be defined as the rules, algorithms, or procedures used to solve mathematical tasks.
- **Conceptual knowledge**: Conceptual knowledge goes beyond mere knowledge of discrete facts and procedural steps to a full understanding of interrelated pieces of information. It can be thought of as a connected web of information in which the linking relationships are as important as the pieces of discrete information that are linked. For example, procedural knowledge that is linked to conceptual knowledge can help students select the appropriate mathematical operation to use in a particular situation, because the conceptual knowledge helps them understand the underlying reasons for selecting that operation.

A variety of technologies are available to enhance students' mathematical competency by building their declarative, procedural, and conceptual knowledge. There are six purposes of technology use for supporting student mathematical learning, including:

- building computational fluency;
- converting symbols, notations, and text;
- building conceptual understanding;
- making calculations and creating mathematical representations;
- organizing ideas; and
These six purposes support the development of students’ declarative, procedural, and conceptual knowledge. Declarative knowledge is developed through technologies that help build computational fluency. Challenges with procedural knowledge are surmounted with the assistance of technologies that help with converting mathematical symbols and notations, calculating mathematical operations, and inputting/organizing data. Finally, conceptual knowledge is enhanced by technologies designed to build conceptual understanding, problem solving, and reasoning.

**Building Computational Fluency**

The research on computational fluency suggests that the ability to fluently recall the answers to basic mathematics facts is a necessary condition for attaining higher-order mathematics skills. The rationale for this thinking is that all human beings have a limited information-processing capacity. That is, an individual simply cannot attend to too many things at once.

The implication for mathematics is that some of the sub-processes, particularly basic facts, need to be developed to the point that they are done fluently and automatically. If this fluent retrieval does not develop, then the development of higher-order mathematics skills - such as multiple-digit addition and subtraction, long division, and fractions - may be severely impaired. Indeed, studies have found that lack of mathematics fact retrieval can impede participation in mathematics class discussions, successful mathematics problem-solving, and even the development of everyday life skills.

**Normal Development of Fluent Mathematics Facts**

Given the importance of the fluent recall of basic facts, the main concern is how this ability develops. For many children, at any point in time from preschool through at least the fourth grade, they will have some facts that can be retrieved from memory automatically and some that need to be calculated using some counting strategy. From the fourth grade through adulthood, answers to basic mathematics facts are recalled from memory with a continued strengthening of relationships between problems and answers that results in further increases in fluency (Ashcraft, 1985). The acquisition of mathematical facts in most normally developing children generally progresses from a deliberate, procedural, and error-prone calculation to one that is fast, efficient, and accurate (Ashcraft, 1992). In contrast, most students with mathematics difficulty, along with those lacking consistent mathematics fact instruction, show a serious problem with respect to the retrieval of elementary number facts.

**Developing Fluency in Mathematics Disabled Children Using Technology**

Educators today have turned to educational technology with varying degrees of success to help students achieve fluency in mathematics facts. Although it seems intuitive that using technology in a drill-and-practice format helps students develop the declarative fact knowledge, evidence suggests that this is not the case. It has been discovered that computerized drill and practice is ineffective in developing declarative fact knowledge in students with mathematics difficulty. The identified problem is that typical drill-and-practice software is designed in such a way that students are practicing procedural counting strategies instead of developing the ability to recall facts from memory. As a result of this, FASTT (Fluency and Automaticity through Systematic Teaching with Technology) model has been designed to assist students in the development of declarative fact knowledge.

**Effectiveness of the FASTT Model**

The FASTT approach has been used successfully to develop mathematical fluency. The principles embodied in FASTT were validated over several years of research with more than 400 students. This research with students with mathematics difficulty has shown that the FASTT
approach can be extremely powerful for developing fluency in the basic mathematical facts. Generally, the findings show that when used daily, for about 10 minutes, most students with mathematics difficulty can develop fluency in a single operation after approximately 100 sessions. The key to success appears to lie in the consistent use of the program.

The effects of using FASTT mathematics can be quite striking. In the first controlled study examining the use of the FASTT model, three groups of students were matched for age, sex, and race. Two of the groups consisted of students with mathematics difficulty and the remaining group consisted of students without mathematics difficulty. In the experiment, one of the mathematics difficulty groups (Math-Disabled Experimental) received an average of 54 ten-minute sessions on the FASTT software for addition, the other two groups (Non Math-Disabled and Math-Disabled Contrast) received only traditional fluency instruction delivered by their classroom teachers. The students with mathematics difficulty receiving instruction with the FASTT approach gained, on the average, 24 new fluent facts while their mathematics-difficulty peers receiving traditional instruction gained no new facts and their non-mathematics-difficulty peers gained only 8 new facts. Perhaps more impressive are the maintenance data. When the experimental students were tested 4 months after the posttest following summer vacation, the students regressed by only 4 facts, indicating that once facts become fluent; they are retained at a high level.

The results of this experiment have been replicated multiple times across all four operations. In all cases, when used consistently, the FASTT approach has a very positive effect on developing mathematical fluency in both students with and without math difficulty. Although the FASTT model is effective for all students needing assistance with developing fact fluency, it appears to be especially effective for students labeled as at risk and as learning disabled.

The result of this work demonstrates that students with mathematics difficulty can be successful in attaining high levels of fluency in basic mathematical operations with the appropriate assistance of technology. However, this assistance must go beyond simple drill and practice if students have not stored the problem and the associated answer in long-term memory. The FASTT model was designed to help students create this network of problems and answers and then strengthen these relationships and increase fluency.

**Building Conceptual Knowledge and Understanding**

Many students do not make direct conceptual links between concrete and tangible mathematical concepts, do not grasp representations of those concepts or relationships, and struggle to make the link from representation to abstractions. An important prerequisite for making these connections is that the declarative and procedural knowledge be taught within the same context(s) where it will be utilized in the future (i.e., the real world). This teaching enables that knowledge to be activated when needed (Bransford, Sherwood, Vye, & Rieser, 1986). Too often, special education students study mathematics by first learning isolated skills. Then they apply these skills by solving narrowly defined mathematics problems that are purported to provide practice for these skills. Unfortunately, this strategy often leads to the practice of rote procedural skills and knowledge without students having a conceptual understanding of why the procedure is being used (i.e. restricted context).

Knowledge that is accessed only in a restricted set of contexts, even though it is applicable to a wide variety of domains, is known as “inert knowledge”. In order for it to be useful, students must understand how to conceptually apply their knowledge and procedures to real-world contexts. This type of learning should result in mathematical knowledge that is organized to trigger the conditions when that knowledge will be needed. The ability to retrieve useful
information from memory appears to be especially challenging for children with learning disabilities or those who are at risk of school failure (Hasselbring et al., 1991).

One approach has been the use of video technology to create scenarios of real-world math problems. This approach to mathematics instruction is called anchored instruction and has been used successfully with regular and special education students. This approach emphasizes the importance of anchoring or situating mathematical knowledge in meaningful / real-world applications. Video is used as the instructional medium because of its engaging characteristics. It can bring mathematics to life for the students.

This approach provides students with an opportunity to use the declarative and procedural knowledge gained in school to develop a conceptual understanding through the real-world application of this knowledge. This format helps students overcome their challenges in perceiving instances in which knowledge they already possess is useful.

**Making Calculations and Creating Mathematical Representations**

In this climate of high-tech software solutions for education, simple and older technologies that provide users with electronic means to make calculations, simplify and solve mathematical expressions and algebraic equations. Often calculators allow the user to focus on the conceptual and problem solving aspects of mathematics (Pomerantz, 1997). Although calculators (graphing and/or scientific) are relatively cost-effective tools and have been widely available for many years, educators have been slow to include their use on a daily basis in part due to misconceptions regarding their use in the educational curricula.

**Organizing Ideas**

Research has shown that individuals who are skilled in mathematics problem solving have something in common; they build a mental representation of the problem they are working (Nathan & Young, 1992). Additionally, skilled mathematics problem solvers tend to classify or group problems by type and then look for known strategies that may be applied to that class of problem. The common elements of a problem that allow classification are known as the “underlying problem model”. Research has found that the more effective students are at identifying the underlying problem model, the more successful they are at problem solving (Hegarty, Mayer, & Monk, 1995).

What this research effectively means is that individuals who are more effective at organizing their ideas about a mathematics problem, in terms of identifying key features and elements, are ultimately more successful at solving problems. A graphic organizer is a visual representation of information. Past research has shown the use of graphic organizers to be an effective tool for mathematics students (Jitendra, 2002). Although the use of graphic organizers is widespread in education and the world of business (e.g., Microsoft PowerPoint presentation), mathematics software that allows students to organize problems and help them identify underlying meaning has been limited. However, a new piece of software called GO Solve Word Problems has been created to help students organize mathematics problems and discover their underlying structure. The software’s interface allows students to organize the component parts of a mathematics problem and then helps student to identify the relationships between the values and component parts of the problem.

**Building Problem Solving and Reasoning**

Students with mathematics difficulty find mathematical problem solving, particularly word problems, challenging. These challenges include:

- misreading the problem,
having difficulty detecting relevant versus irrelevant information,
misidentifying the appropriate mathematical operation,
making calculation errors,
missing steps needed to carry out the problem, and
having trouble organizing the information in the problem.

These challenges can be classified as problems with declarative, procedural, and conceptual knowledge. Students need all three types of knowledge to be able to solve problems. Problem solving requires students to know their basic mathematical facts, to execute the strategies and procedures needed to solve the problem, and to understand conceptually how to apply those facts and procedures (Babbit & Miller, 1996). Without this conceptual understanding, there is no guarantee that the students will be able to apply this knowledge in meaningful ways when confronted with problem situations.

For example, when solving mathematical problems, students may have the mathematical knowledge and procedures they need but may be unable to use them because they lack the conceptual understanding that allows them to match their knowledge to the problem situation. The difficulty arises because their mathematical knowledge is isolated. Without making these connections, students may be unable to detect when this knowledge applies to situations or when a strategy should be used during problem solving. Students who are unable to recognize situations in which their knowledge can be applied will likely be poor problem solvers. Knowledge that remains unused by learners even when it is relevant across several problem situations is wasted knowledge. For knowledge to be useful, it must be activated at the appropriate time. To enable students to become successful problem solvers, they must develop a working and dynamic relationship between declarative, procedural, and conceptual knowledge.

There are several approaches for helping students with mathematical problem solving. Some of these approaches target the declarative and procedural knowledge problems, some focus on students’ difficulty with conceptual understanding, and others concentrate on improving students’ reasoning and critical thinking. These approaches vary depending on the nature and complexity of the problem. For basic problems, some students are taught to search for key words.

**Looking Ahead**

Mathematics is a way of looking at the world that provides people with tools to solve problems (Adelaide, 2002). As well as, mathematics has aesthetic and cultural dimensions that make its study worthwhile in its own right. The first decade of the new millennium is a good time to:

- remember the past,
- consider the present, and
- plan for the future.

The past century brought changes that transformed education. Some of the most drastic changes have come in mathematics education. At the turn of the last century, children studied arithmetic in the elementary grades. They did sums or long division on slates or, later, in lined paper tablets, and they memorized the times tables. Today, the third- and fourth-generation descendents of those school children log onto the Internet for information about fractals and Fibonacci numbers (http://www.prenhall.com/divisions/ect/app/martinez/pages/Chapter%201.pdf). In class they work with manipulatives and study economic concepts such as supply and demand; they even personally interact with astronauts as they conduct experiments on space shuttles. There is, therefore, need to look at the factors that brought about these changes and how the changes are working together to reconstruct or remake mathematics education for the 21st century. Building
a consensus and setting standards for mathematics education have proceeded in the context of international debates over curriculum, evaluation, and professional development—debates, sometimes called the “mathematics wars.”

**Summing Up**

There are differences in mathematics performance between students with and without math difficulty that has been observed over many years. There is, thus, need for commitment to improve outcomes for students with mathematics difficulty. One strategy that needs additional attention involves the use of technology designed to teach mathematical concepts in non-traditional ways. At present, the sheer quantity of educational software and other tools that are available for teachers to use in the classroom is significant. Additionally, the cost of much of this hardware and software is relatively low. One major goal of educators of students with mathematics difficulty should be to conduct ongoing research to determine the best use of existing technology for enhancing mathematical learning. Furthermore, educators and researchers should work closely with developers and publishers of new hardware and software and conduct high-quality research targeted at identifying effective practices that accompany the use of new products.

**References:**

Abstract

Chromosome manipulation produce polyploidy, which improves fish yield in aquaculture. Triploid hatchlings were obtained from the egg and sperm of Clarias anguillarias fertilized artificially and exposed to cold shock at 5°C for 20 minutes, three minutes after fertilization. A total number of 20 juveniles from treatment A: (Diploid) and treatment B: (Triploid) were collected two weeks after hatching. Blood samples for erythrocyte measurements were obtained after cutting the caudal fin of the samples. T-test results was significant (P<0.05) for erythrocyte nucleus volume (where the value for treatment 'A' was 0.64±0.03 and 1.15± 0.18 for treatment 'B') and erythrocyte cell volume, (where treatment 'A' was valued at 13.20±0.13 and treatment 'B' at 15.27±0.66). One way analysis of variance revealed that treatment 'B' produced higher mean weight gain (166.66±53.44g), than treatment 'A' whose value was 50.40±3.03%. However, a higher hatching rate was realized from treatment 'A' having value of 77.53±2.19%, than 50.40±3.03% for treatment 'B'. This study has shown that bigger fish was produced when triploid than diploid catfish were reared. Thus the research has provided a better alternative to bigger and more fish production in aquaculture. It also showed that erythrocyte measurement was reliable for the determination of polyploidy levels.

Keywords: Triploidy, Clarias anguillarias, Erythrocyte measurements, Cold shock, Polyploidy

INTRODUCTION

Polyploidy is an occurrence in which more than two numbers of chromosomes are present in an organism. Chromosomes numbers of 3n are referred to triploids, 4n: are tetraploids, while 5n are pentaploids. Chromosome numbers have been altered through cold, heat, pressure or chemical shocks. Such alterations have been associated with advantageous features such as increased size, hardiness, and resistance to diseases (Lawson and Ishola, 2010). Beyond, the basic goal governing this technology are: to produce sterile fish which prevents early maturation, encourage the production of larger fish, improvement of carcass quality and the utilization of exotic species both in fish farming and fisheries management (Lawson and Ishola, 2010). Triploids have been created in fishes using thermal shocks (Dunham et al., 2003). Eyo et al., (2003), induced triploidy in rainbow trout by raising the temperature in which the newly hatched eggs were incubated at 20°C for 10 minutes beginning from 20-40 minutes after fertilization. Eyo et al., (2003) observed that triploid channel catfish had a better dress out percentage than diploid fish as a result of lack of gonadal development. Hammel et al., (2010), reported that shock duration of 25 minutes at 0°C gave the best results for Clarias gariepinus. Giuliano and Evoy (2006) stated that exposure for five minutes post fertilization was enough to induce 100% triploidy in Rhamdia quelen. Lawson and Ishola (2010) reported that cold shock treatment showed better growth rate and lower survival rate compared to diploid Clarias gariepinus. Normala et al., (2010) reported that triploid catfish had lower hatchability rate and survival rate, but higher growth rate compared to diploid catfish. Gheyas et al., (2001), reported that induce triploidy in newly fertilized eggs of H. fossilis using cold shock duration for 10 minutes at 20°C applied 3 minutes after fertilization was the best. Gima (2009) reported that triploid
grew better than diploid flathead catfish although the diploids were more aggressive than the triploids. Venkatachalam et al., (2012) reported that the extent of triploidy was measured through Erythrocytes Nucleus Volume (ENV). In diploid fish, the ENV was 11.7±1.7μm³ where as in triploid fish it was 17.2±3.2 μm³. Koedprang and Na-Nakron (2000), recorded high hatchability of 72.5% in the production of triploid silver barb when cold shock was applied for a duration of 10 minutes while, Hammad et al., (2010) recorded 55% hatchability in triploid induced eggs using cold shock method for a duration of 25 minutes at 0°C. The present study is aimed at investigating the growth rate of triploid hatchlings as well as ascertain cytogenetically, their ploidy levels through erythrocyte measurement.

**MATERIALS AND METHODS**

**Procurement and Selection of Broodstock:**
A total number of three (3) healthy broodstocks of *Clarias anguillaris* (one male and two females) used in this study were procured from Hotefe farm, Asaba, Delta State, Nigeria. They were eighteen (18) months old, weighing between 3 to 4 kilogram's. Care was exercised when selecting healthy male and female brooders.

**Administration of Ovaprim:**
The female brooder (*Clarias anguillaris*) was injected with Human Gonadotropin Hormone (Trade mark: ovaprim) at a dosage of 0.5 ml per kilogram fish body weight. The injection was done intramuscularly above the lateral line just below the dorsal fin. Injected brood were kept in separate bowls of 1m³ and covered with netting piece to prevent them from jumping out. The temperature of the water holding the fish was measured with mercury in glass thermometer and the corresponding latency period calculated was between eight to ten hours at 28.3°C according to (Herbst, 2002).

**Procurement of Milt:**
The milt used was procured by sacrificing the male. Prior to this action, physiological solution was prepared by dissolving nine grams of salt (NaCl) in one litre of water according to Lawson and Ishola, 2003.

**Stripping of Eggs**
The first step taken during the stripping process was to mop the body of the female brooder with a towel, to prevent the eggs from coming in contact with water which may consequently seal up the micropyle opening and prevent fertilization. Gentle pressure was applied on the abdomen of the female brooder and the ovulated eggs that ooze out freely from the genital opening was collected in a stainless steel bowl where the eggs were subjected to cold shock. Control experiment was also provided according to (Lawson and Ishola, 2003).

**Fertilization of Eggs:**
The incubation bowls and cold shock medium were prepared prior to fertilization. Each of the bowls was filled with 10 litres of clean water. The water was aerated with electric air pumps to which hose and air stones were connected. Mosquito net (kakabans) was also laid in the water so that as the fertilized eggs cross through into the bowl, where they were distributed evenly, the unfertilized eggs were retained/suspended by the net and later discarded. Milt was poured on the eggs and mixed by shaking the containers gently according to (Lawson and Ishola, 2003).

**Post Fertilization Treatments:**
The fertilized eggs were separated into two treatments (A and B). Treatment A was Triploidy, and treatment B was pure strains of *C. anguillaris*. Three (3) minutes old fertilized eggs were subjected to cold shock for treatment A and A1 at 5°C for 20 minutes Cold shock of fertilized eggs was applied in thermostatically controlled water bath (model FDPGH, Techni Cambridge, Ltd UK). Fertilized eggs were removed from the cold medium and placed in the plastic bowls for normal incubation at 27.4°C (Lawson and Ishola, 2003). Water quality was checked and maintained throughout for pH, dissolved oxygen and temperature.

**Hatching of Fertilized Eggs:**
Commencement of hatching was noticed after 22.00 hours and 22.5 hours of incubation in control and cold shock experiments respectively (Lawson and Ishola, 2003).

**Larval Rearing:**
Larval rearing was carried out by placing the hatchlings, each of cold shock and control into nursery tanks. Within the first three days, the larvae were nourished from their yolk sac. After four days, the fry were fed with artemia sp for two weeks according to (Lawson and Ishola, 2003).

**Fry Rearing:**
Two weeks after hatching, twenty fries from cold shock and control experiments were stocked into the culture receptacles (concrete tanks) in duplicates. They were fed on Coppens twice a day at 5% body weight according to (Lawson and Ishola, 2003).

**Nutrient Utilization Parameters**
- The Mean Weight Gain (\(\%\)), was calculated according to Pangni et al., (2008) thus; MWG (\(\%\)) = \(\frac{Final \ mean \ weight \times 100}{Initial \ mean \ weight}\)
- The Mean Length Gain (\(\%\)), was calculated according to Lawson and Ishola, (2003) thus; MLG (\(\%\)) = \(\frac{Final \ mean \ length \times 100}{Initial \ mean \ length}\)
- The Specific Growth Rate (SGR) was calculated according to Lawson and Ishola, (2003): \[SGR(%/day) = 100 \times \frac{In\ (Final \ body \ weight) - In\ (Initial \ body \ weight)}{Rearing \ period \ in \ days}\]

Where “\(In\)” represents natural logarithm
- Survival rate (SR) was calculated according to Pangni et al., (2008)
  \[SR (\%) = \frac{Total \ fish \ number \ harvest}{Total \ fish \ number \ stocked} \times 100\]
- Hatchability rate (HR) was calculated according to Lawson and Ishola, (2003): \[HR (\%) = \frac{Total \ eggs \ number \ fertilized \times 100}{Total \ eggs \ number \ hatched}\]

**Water Quality Monitoring**
Water quality parameters such as dissolved oxygen, pH and water temperature required for growth and other biological processes were monitored weekly. Water in the culture receptacles were changed daily and aerated with air pumps throughout the period of study, to ensure high water quality and to prevent stress (Lawson and Ishola, 2003).

**Polyploidy Optimization through Erythrocyte Measurement**
A comparative measurement of erythrocytes and nuclei from diploid and triploid treatments were carried out to observe the effect of triploidization on cell size. Blood samples were collected from seven triploid and seven control groups post juveniles. Smears were produced on glass slides and fixed for two minutes in absolute methanol (Gheyas et al., 2001). The smears were subsequently stained with Wright’s blood stain for 10 to 15 minutes, washed in distilled water, air dried and finally mounted in DPX (a mixture of Distrene: Dibutyl Phthalate: Xylem). Twenty-five erythrocyte cells from each treatment (major axes A and major axes B) with their nuclei were measured with an eye piece micrometer under 100 times magnification according to (Gheyas et al., 2001). Volumes of the cells and their nuclei were computed using the formulae given by Felip et al., (2001a), as follows:

\[V_{erythrocyte} = \frac{4}{3} \times \pi \times (A/2) \times (B/2)^2\]
\[V_{nucleus} = \frac{4}{3} \times \pi \times (a/2) \times (b/2)^2\]

Where: \(A = \) major axis of erythrocyte, \(B = \) minor axis of erythrocyte, \(a = \) major axis of nucleus and \(b = \) minor axis of nucleus.

**Statistical Analysis**
Data obtained from the production experiment were subjected to one-way Analysis of Variance (ANOVA) using the SPSS software and difference between means were separated using Duncan’s
Multiple Range Tests. Data obtained from erythrocyte measurement were analysed using student T-test at 95% level of significant.

**RESULTS**

The mean production parameters for both treatments as presented in Table 1, revealed that triploid treatments were significantly higher than diploid treatments for all parameters, except for survival rate where equal values were obtained for both treatments. Triploid treatment recorded higher mean weight gain (166.66±53.44g) than diploid treatment, whose value was (105.93±32.23g). The same table showed that triploid treatment recorded higher specific growth rate value of (5.70±2.27%), than diploid (3.14±0.64) treatment. However, survival rate data was not significantly different (P>0.05) for both treatments, although, the hatchability value for both treatments were significantly different (P<0.05). Incidentally, a lower hatching rate was obtained for triploid treatments with a value of 50.40±3.03% whereas a higher hatching rate was obtained for diploid treatment having a value of 77.53±2.19% (Table 1).

Table 1. Show values for mean production parameters of *Clarias anguillaris*

<table>
<thead>
<tr>
<th>Treatments</th>
<th>WG (g)</th>
<th>LG (cm)</th>
<th>SGR (%)</th>
<th>SR (%)</th>
<th>HR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Triploid)</td>
<td>166.66±53.44a</td>
<td>19.43±2.81a</td>
<td>5.70±2.27a</td>
<td>100.00±0.00a</td>
<td>50.40±3.03b</td>
</tr>
<tr>
<td>B (Diploid)</td>
<td>105.93±32.23b</td>
<td>16.27±2.37b</td>
<td>3.14±0.64b</td>
<td>100.00±0.00a</td>
<td>77.53±2.19a</td>
</tr>
</tbody>
</table>

Values with the same superscript on the same column are not significantly different at (P > 0.05) confidence limits. Key: WG = weight gain, LG = length gain, SGR = specific growth rate, SR= survival rate, HR = hatchability rate and ± standard error of the mean.

Ploidy level by cold shock was assessed by erythrocyte measurement, where normal diploid recorded a cell volume of 13.20±0.13 μm³ whereas triploid cell volume was 15.27±0.66 μm³ (Table 2). Plates A and B represents erythrocytes of diploid and triploid individuals respectively. The plates clearly show that nuclei of triploid erythrocytes (plate A) are considerably larger than those for diploids (plate B).

Table 2: Erythrocyte Measurement of Diploid and Triploid *Clarias anguillaris* (cell volumes in cubic micrometer-μm³)

<table>
<thead>
<tr>
<th>TYPES OF CELLS</th>
<th>2n (Diploid)</th>
<th>3n (Triploid)</th>
<th>Ratio 2n/3n</th>
<th>Significant level</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECV (μm³)</td>
<td>13.20±0.13</td>
<td>15.27±0.66</td>
<td>1.16</td>
<td>P&lt;0.95</td>
</tr>
<tr>
<td>ENV (μm³)</td>
<td>0.64±0.03</td>
<td>1.15±0.18</td>
<td>1.92</td>
<td>P&lt;0.95</td>
</tr>
</tbody>
</table>

Where; ECV = erythrocyte cell volume, ENV = erythrocyte nuclear volume and ± = standard error of the mean

Plates A and B shows the nucleus of triploid and diploid blood specimen of *Clarias anguillaris* erythrocytes at x100 magnification.
Atmospheric temperature varied between 23.1 and 27.3°C, while water temperature values ranged from 26.1 to 27.5°C. Values of dissolved oxygen concentration revealed a variation from 2.2 to 6.01 mg/L, while that realized for the control treatments varied between 3.4 to 8.9 mg/L. Hydrogen-ion-concentration (pH) for both treatments ranged between 7.01 to 8.22.

**DISCUSSION**

**Shock Application and Effects**

Cold shock treatment adversely impacted on fertilized egg, resulting in bent trunk observed in fries exposed to such treatment. Similar observation has been reported by Manickam (1991), Aluko et al., (1997) and Lawson and Ishola (2010) in *C. gariepinus*. These authors suggested that the abnormality could be due to chromosome malfunction. It was generally thought that warm water species were more susceptible to cold than heat shock (Gheyas et al., 2001), whereas heat shock was more effective for cold water species. The present experiment supports the contention that because *Clarias* species are inhabitant of warm climate they were more highly susceptible to cold shock treatments. The occurrence of mosaic off springs (having different ploidy levels in the cells of the same individual) is a frequent observation in studies regarding triploidy induction (Gheyas et al., 2001; Herbst, 2002; Eyo et al., 2003 and Lawson and Ishola, 2010). It is most probably the result of exposure of the eggs to shock temperature after fertilization. In our experiment all suboptimal shock showed diploid/triploid mosaicism in the embryos of treated groups.

**Growth Parameters**

Fish growth and their consequent increase in biomass are of major interest to the fish culturist, the fish nutritionist and fishery biologist. Lawson and Ishola (2010) explained that growth of farmed fish was best described in terms of weight rather than length since the ultimate product is usually sold in terms of weight. According to Karlmarx and Sanjeeviraj (2005) chromosome engineering has immediate application in fish farming, because it improves strains of catfish for better growth, assures disease resistance, allows for higher fecundity and increases their tolerance to environmental conditions. The present experiment verified this contention and showed that triploid treatments had higher mean weight gain, than diploid treatment. This observation was in line with those reported by Gheyas et al., (2001); Herbst (2002); Eyo et al., (2003) and Lawson and Ishola (2010). Also, the realization that values for specific growth rate were higher in triploids than diploids agrees with the reports of Lawson and Ishola (2010) who also recorded high specific growth rate for triploid *Clarias gariepinus*.

**Hatching and Survival Rates**

The hatching and survival percentages in cold shock treated groups were considerably lower than those of control group in the present experiment. Such lower hatchability of triploid individuals compared to diploid have been reported by other authors including Chrisman et al., 1983, Krasznai et al., 1984a, Solar et al., 1984, Gheyas et al., 2001; Herbst, 2002; Eyo et al., 2003; Giuliano and Evoy 2006; Lawson and Ishola, 2010 and Normala et al., 2010). Moreover, the hatching, survival and triploidy induction rates varied considerably among different lots of eggs subjected to the same cold shock. Similar results have also been reported in other species and have been attributed to factors such as egg quality differences or the susceptibility of eggs from different origins to shock treatments (Lou and Purdom 1984, Johnstone 1985, Shelton et al. 1986, Ezaz et al.1998). Malison et al., (1993), however, suggested the wide range of ambient water temperature from which brood fish were captured as the probable cause for such variation in perch (*Perca flavescens*). For *C. anguillaris*, such factors in addition to egg quality could have been important. Moreover, the variation in the water temperature during the incubation period under ambient conditions might have also contributed to difference in hatching and survival rates. However, the survival rate data was not significantly different (P>0.05) for each treatments. It was constant all through the experiment with 100.00±0.00% value for both treatments. This finding disagrees with those of Gheyas et al., (2001) who had 95 to 97% survival for triploid Stinging Catfish (*Heteropneustes fossilis*); Lawson and Ishola
(2010) reported 63% survival for triploid *Clarias gariepinus* whereas the study of Herbst (2002) observed 26% both for tetraploid Zebra fish (*Danio rerio*) and Nile Tilapia (*Oreochromis niloticus*).

**Erythrocyte Measurement**

The effect of triploidy on the erythrocyte cellular and nuclear volume dimensions from blood smears were highly significant in the present study. Unlike mammals, erythrocytes in fish species have a nucleus. Erythrocytes and their nucleus are assumed to have an ellipsoidal shape (Felip et al., 2001a). Erythrocyte measurement has been used by many workers (Swarup 1959, Cherfas 1966, Wolters et al., 1982, Kraszna et al., 1984b, Lemoine and Smith 1980, Sezaki et al., 1985, Don and Avtalion 1988, Humayun et al., 1994, Felip et al., 2001a, Felip et al., 2001b, Gheyas et al., 2001, Cal et al., 2005 and Normala et al., 2010) to determine the ploidy level in fish. In respect to increase in chromosome size, the size of the erythrocytes particularly that of their nuclei increased. These workers suggested different variable measures of erythrocytes and their nuclei to be important in ploidy determination. According to Wolters et al., (1982) mean major axis was the best single variable in channel catfish. Penman et al., (1987) also found the same variable useful in distinguishing triploid and diploid fish. Majority of other workers however emphasized on nuclear volume. Triploidization generally increased nuclear volume by 1.5 times (Swarup 1959, Beck and Biggers 1983, Purdom 1972 and Gheyas et al., 2001). In the present investigation, both nuclei and erythrocytes of triploids were larger. Nuclear volume, however, showed a 1.92 times increase in triploids instead of the usual 1.5 times in other species. Significantly greater value (P < 0.95) for all variables (major axis, minor axis and volumes) in triploid *C. anguillaris* indicated that any of the parameters could be used for identification of ploidy in this species. This finding was in line with those of Felip et al., (2001a), Felip et al., (2001b), Gheyas et al., (2001), Cal et al., (2005) and Normala et al., (2010).

**CONCLUSION**

This study has proved that triploidy could be produced in *C. anguillaris* by administering cold shock treatment, 3 minutes after fertilization at 5°C for 20 minutes. This study has also shown that erythrocyte measurement can be used to ascertain ploidy level in *C. anguillaris*.

**REFERENCES**


ARTISANSHIP AND INNOVATION IN THE NIGERIAN TRANSPORT SECTOR: THE ROLE OF NACETEM

O. F. Sanusi*, T.O. Elufisan
National Centre for Technology Management (NACETEM), Ile-Ife, Nigeria

Abstract
The development of any nation is anchored by various factors which are identified as economic drivers; among these factors is technology. According to Hornby (2002), it is defined as a scientific knowledge, used in practical ways, especially in the designing of new machines, machineries and equipment. This improvement in technological activities has been termed innovation. Technological innovation often results in the generation of new process or product or significantly improved process or products. The introduction of these products to artisans in any technological field simply signifies innovation practices; hence the need to train them on the use of the products or process that will make them more innovative and enhance their output. Being an inevitable tool, Nigeria transport sector had witnessed various technology innovation activities which have not been fully harnessed by the artisans in the sectors. This paper therefore seeks to address the role of National Centre for Technology Management (NACETEM) as a policy agency in the adoption and acquisition of various technological innovations available at Nigerian Institute of Transport Technology (NITT) Zaria, for the development of best practices by transport artisans.

Key words: Artisanship, Technology, Innovation, Transport, Sector.

INTRODUCTION
The development of any nation is anchored by various factors which are identified as economic drivers; among these factors is technology. Technology has several definitions; however, it originated from the word “techne” which means activities by which man seeks to adapt to his environment (Olaoye 1990). According to Hornby (2002), it is defined as a scientific knowledge, used in practical ways, especially in the designing of new machines, machineries and equipment.

The growth of technology is an essential tool for the development of a nation. This is because advancement in technology has a way of bringing about changes in various economic sectors. In their definition Olaoye 2008 and Hornby, 2002, Technology development was defined as the transformation of theoretical ideas into practical skill in advanced manners which can bring about total transformation in the ways of doing things or significantly improves the methods involved in doing them; hence yield a new product or an advanced product. Onipede, 2003 however argued that technology development is the sum total of the development witnessed as a result of Industrial activities.

Science and technology represent power instruments of change which can assist in the economic, social, and cultural development of people and a nation. The superiority of the developed nation has been attributed to the priorities given to technological development (Titanyi 1985). Technology is rapidly changing all productive systems and enabling international economic integration (UNCTAD 2001). In a knowledge based society technology alone is not sufficient to transform a nation but the ability to improve technological activities significantly such that it generate new products or process with a market value. This improvement in technological activities has been termed innovation. Innovation is not a new concept and has become a popular term in technological managementstudies. Various sectors of the economy had witnessed innovation activities and had contributed significantly to technology development. The transport sector is one of such technological sector where innovation activities had played important roles. Technological innovation often results in the generation of new process or product or significantly improved
process or products. The introduction of these products to artisans in any technological field simply signifies innovation practises; hence the need to train them on the use of the products or process that will make them more innovative and enhance their output. Being an inevitable tool, Nigeria transport sector had witnessed various technology innovation activities which have not been fully harnessed by the artisans in the sectors. This paper therefore seeks to address the role of National Centre for Technology Management (NACETEM) as a policy agency in the adoption and acquisition of various technological innovations available at Nigerian Institute of Transport Technology (NITT) Zaria, for the development of best practises by transport artisans.

AN OVERVIEW OF NIGERIA’S TRANSPORT SECTOR

Transportation is central to economic development as it entails the movement of people, goods and services from one place to another. Thus, it has impact in every other sectors of the economy whether major or minor, (Rodrigue, 2012) influencing development and the welfare of the populations. This implies that an efficient transport system will provide ample support for other sectors of the economic in the form of employment generation, easier accessibility to market and in effect contributing additional investment to the economy. Current realities in Nigeria’s transport sector (Owolabi and Rafiu, 2010) do not leave much to be desired. Ninety percent of the movement of goods and services in Nigeria is done by road. Presently over 195,500 km of road network is available in Nigeria (Obanikoro, 2009). Only 35, 000 km are constitute federal roads. Fifty percent of federal, 70% of state and 95% of local roads are in bad shape. Most of these roads are overused and lack maintenance. It is difficult to see any significant impact from huge government budgets on roads. Some of the problems associated with execution of road projects stems from flawed contracting processes and fraud in the road construction industry. It is common to see roads supposedly designed to last for decades failing within a mere couple of years of usage. One way out of the roads problem is to decongest traffic on our road networks. The rail transport sector is however comatose. The industry is in almost complete state of neglect. According to the United States Commercial Service (2010), the collapse of the Nigerian rail system and the increasing need to move goods nationwide has made road haulage indispensable. Transportation by road now accounts for more than 80% of all haulage activities.

It has been well documented by many scholars that Transportation could account for a GDP contribution between 6-12% in the developed countries (Rodrigue, 2012; Wells, 2007).

In Nigeria, the contribution of transportation sector to GDP is still relatively low unlike what has been observed in the developed economy of the world. It fluctuates between 2% and 3% since year 2000 though the figure still dominated the services sector in Nigeria after Real Estate and Business services (CBN, 2010). As at 2010, Road Transport accounted for 94% of the entire Transport service, followed by Water and Air (2.2% each), while Rail and Pipeline Transport accounted for the least i.e. less than 1% of the Transport service (CBN, 2010). Budgetary allocation to the transport sector was ₦56 Billion in 2011 (approximately 30% of the 2011 budget).

The gap witnessed between the contributions by Nigeria transport sector and those in the developed countries could be attributed to the various technological innovative activities being carried out by these countries. This could include various innovation strategies adopted by these countries which enables efficient and adequate infrastructure to aid transportation. More so, the continuous emergence of urban settlement from rural ones will increase the transportation volume which the existing capacity for maintenance and stability at both the local and national level may not be able to adequately suffice (Oni, 1999). This therefore calls for various innovation strategies which will be able to assist in the management of transport activities and infrastructures, the need for various innovation strategies which will help to meet up with the upward trend of transport activities and facilities.

INNOVATION IN THE TRANSPORT SECTOR
If the Nigeria transport sector must be efficient and sustainable, innovation is inevitable. This may not be limited to the adoption of various road traffic technologies but will also affect infrastructural development and skill acquisition by stakeholders involved in the repair and maintenance of vehicles and other agents of transportation. Innovation is a major factor in addressing transportation challenges, it also help in improving the performance of a system. Innovation has always been a driving force to create jobs and maximize economic and social benefits, but in today’s knowledge-based economy, the importance of innovation has increased dramatically. Not only does innovation lead to increased productivity and long-term growth, it also lends resilience to industrial sectors through increased flexibility for both anticipated and unforeseen market changes.

NEEDS FOR INNOVATION IN THE TRANSPORT SECTOR

Transport, as a technology, typically follows a path of experimentation, introduction, adoption and diffusion and, finally, obsolescence, each of which has an impact on the rate of economic development. If most innovations in the transport sector are abandoned, many technologies go through what can be called a phase with unrealistic expectations. In addition, transport modes and infrastructures are depreciating assets that constantly require maintenance and upgrades (Todd and Roger 2006), these points out the need and importance of technology innovation in the transport sector. Innovation in the transport sector should not only be associated with the methods and way traffic activities are carried out but it should also include the various ways through which essential facilities for transport activities, such as; vehicle maintenance and repaired are provided are provided in the countries. Oni, 1999 observed that increase in human population will lead to an increase in transportation activities which will demand for more hand and skills that can meet up with the management of the transport sector. The observation clearly point out innovation as a basic tool through which this can be met as artisan will need to be exposed to the new ways or improved ways of ensuring facilities maintenance in the transport sector.

ARTISANSHIP AND INNOVATION

An artisan is one that acquires training through practical and informal or formal means, as an apprentice under a trained craftsman in a specialized workshop or at a specialized craft school or vocational training centre (Federal Ministry of Information and Culture, 1992). Categories of artisans include blacksmiths, goldsmiths, tinkers, plumbers, masons/bricklayers, automobile mechanics, etc. Smith (1969) opined that an artisan is someone who is active and has a lot of ideas. He may or may not possess basic formal education but has the ability and opportunity to develop manual skills. An Artisan does not satisfy his/herself with knowing all there is to know, instead they constantly seek the new and the next. Within the new lies innovation, which involves acquiring new idea, process, design, finishes or uses. In the context of artisan professional services we might look at innovative means of delivery or accessing services. An artisan seeks out how his or her material is produced, what goes into its preparation, how is it shipped and what are the dynamics of that market? The artisan has a very strong affinity with what has gone before. How did her or his trade used to be carried out? What were the challenges then and how were they overcome. It is as though there is a constant resifting and recycling of discarded practice. What ideas, tools and processes are no longer carried out? Is it worth revisiting and re-examining what went before? Might they, upon review, cast some new light on a current practice or challenge? This quest by artisan to acquire new knowledge about their fields made them significant players in the field of managing technological innovation in respect of facilities and other associated accessories. Putting together capital and labour creates the essence of industry but unless a supply of skilled artisans is among the labour force, no combination of capital and labour can achieve technological progress. This thus made it imperative that if innovation activities will be able to be used to meet the maintenance of transport facilities and infrastructure following the rising demand that is gradually emerging, artisan participation in
innovation cannot be neglected. Innovation activities could be shared with the artisan in different ways as stated below.

DIFFERENT WAYS IN WHICH TECHNOLOGY CAN BE HARNESSED TO ARTISANS

1. Technology Capacity Building

According to Sodangi, (2007), Capacity building is a useful method to making people useful to their selves and the society at large, most productive activities in the national economy involve manufacturing and distribution of goods and services. In each of these activities, the role of artisans should not be underplayed. The facilities required for the manufacturing and distribution of these goods and services are designed, fabricated, installed and maintained by engineers/artisans, or technical personnel. In all these activities, manpower is required. The more facilities that are set, the more would be the manpower requirement, since the establishment of these facilities result in very high value addition, with equally very high multiplier effects. This should set a platform to drive skilled manpower trainings and attendant job creation.

However, there is more to our capacity building needs. Major deficiencies in our industrialization policies and economic development are the absence of capacity to produce a better trained population and strong institutional framework within which development can take place (World Bank, 1989; Bamiro, 2007; Alaibe, 2007; Ilaboya and Wara, 2008). Our technological base is weak. According to Wara and Ngubi (2008), competitive advantage is essential to growth of 21st century industries. Presently, the world is on the threshold of a new technological age – driven by rapid advances; new products will emerge that may quickly make conventional processes and products in Africa obsolete (Bamiro, 2007). The world is knowledge intensive and increasingly dominated by emerging technologies. Mere possession of capital or natural resources is no longer pre-condition for national development; future developments will be more and more technologically based. Science is man’s attempt at comprehending the workings of our systems. Scientific capability or “know-why” is acquired through research and its acquisition can take place meaningfully only if there exists a critical mass of scientific manpower in the transport sector of the country – within our firms and in our national R&D institutions. Technology or “know-how” however refers to ways of doing things and technological capability has always existed in any human society. Technology affects human development through innovation, by increasing functionality of existing means and increasing human capabilities, and through enhanced productivity, as seen in increased outputs, heightened efficiency of services and higher incomes. Innovation refers to the application of knowledge in production, knowledge acquired through learning, research or experience is not innovation until it is applied in the production and distribution of goods and services. Creating and sustaining a knowledge-based economy requires an innovative system of policy making which is different from our traditional centralized and rigidly regulated economic decision making.

Key stakeholders that should constitute a national innovation system for the transport sector capacity build-up should include: Firms/Enterprises, Government, Research and Development institutions, Educational and Training institutions, Engineering Consultancy Firms, Financial Institutions, Foreign firms, and International Agencies and artisans in this field.

2. Technology Transfer

Technology Transfer is a method through which technical information and products developed by the Federal Government are provided to potential users in a manner that encourages and accelerates their evaluation and/or use.
More than merely disseminating information, technology transfer techniques feature marketing of federally developed technology and products as well as demonstrating the use of these new technologies when necessary. Technology transfer activities include the proactive identification of Federal research developments or technologies with a high potential for commercialization; the identification of market segments and user groups; ways to advertise and highlight these products; and assistance in commercializing Federal developments.

Traditionally technology transfer is viewed as movement of machinery and knowhow from rich developed countries to poorer developing nations. The rich western countries have the highly educated person power and technically advanced firms which have the capacity to make the technology, both hardware and software. They have been involved in exporting such technology. The challenge for the developing countries such as ours is not only to make the best use of the technology coming to our country but also to ensure the reverse flow.

No nation or firm has the monopoly over the creativity of a person. It is the creativity of individuals working separately or in groups that creates the technology. In many cases we may have the knowledge, but we are not able to make a marketable product out of our knowledge base. It is only when we can change knowledge into products; we can say of having mastered the technology and got out from the “dependency” state of mind.

“Technology transfer” is the process by which commercial technology is disseminated. This takes the form of a technology transfer transaction, which may or may not be covered by a legally binding contract (Blakeney, 1989, p. 136), but which involves the communication, by the transferor, of the relevant knowledge to the recipient.

**Importance of Technology Transfer**

Technology transfer is important for several reasons including the following:

- It encourages use of technology developed to benefit the society.
- It demonstrates research program relevancy and value.
- It permits Federal researchers to partner with the private sector, leverage resources, and share ideas in a protected environment.
- It gives increased visibility to researchers and enables them to generate and earn royalty income.

**BENEFITS OF CAPACITY BUILDING AND TECHNOLOGY TRANSFER**

There are a multitude of benefits to all players in the technology transfer pitch. The Nigerian transport industry will benefit new and better products, processes, and services that lead to increased efficiency and effectiveness, greater market share and increased profits. The transport sector will be strengthened benefiting artisans in the transport sector, including the citizens. Artisans will benefit by becoming more responsive to their needs and the needs of the people that they serve, demonstrating their viability and worth to the Transport sector, and generating non-appropriated funds to aid them in performing their important research and development missions. Individual artisan can benefit by knowledge acquisition. They also can benefit intellectually and professionally through working collaboratively with their peers in the transport sector.

**KEY PLAYERS IN THE NIGERIA’S TRANSPORT TECHNOLOGY SYSTEM**

Nigerian Institute of Transport Technology (NITT) is a major key player in the Nigeria’s Transport Technology System saddled with the responsibility of providing professional training for middle cadre managers on the areas of transport and logistics and also conducts research and offer consultancy services to both public and private transport and logistics organizations. The Institute was established as a Transport Management Development and Research Institute for Nigeria and the West African Sub-region in the year 1986 by Decree No 6 of March 14 (now CAP 309 of the Federal Laws of Nigeria).
ROLE OF NACETEM
Possible Areas NACETEM can come in as Experts in Technology Innovation
NACETEM's mission is to play a leading role in the build-up of expertise for effective management of Science, Technology and Innovation (STI) and to engage in policy research, design, evaluation and review. Her mandates include among others, to:

- Serve as a training Centre for the development of middle-to-high level manpower in Science, Technology and Innovation (STI) management for all tiers of government and the private sector.
- Conduct policy research, evaluation and review with a view to providing sound policy advice/recommendations for dynamic technology-based development.
- Assist the various tiers of government (Federal, State and Local) in the Country in STI policy formulation and strategies for utilizing such for sustainable development.

In view of the above, NACETEM as a research institute can assist in conducting policy research that will help adapt the technology to local conditions, raising awareness on existing technology from which Artisans in the transport sector could immensely benefit. The awareness does not mean the awareness on the need for technological upgrading, but the awareness on recent developments in the technological arena.

NACETEM can also help recommend policy on the importance of training, especially technical training for artisans in the transport sector.

NACETEM can work with the NITT (Transport Technology Centre) in shaping R&D activities and bring their focus to the problems of the transport sector in the real economy.

CONCLUSION/POLICY RECOMMENDATION
It is factual that the upgrading of technological level of Nigerian transport sector and the ability to absorb and improve on existing technology is the key for success and the determining factor of our competitiveness in the global world. Through “technology transfer” and capacity building, technology will reach the designed efficiency level.

Continuous learning within relevant organizations/institutions is required and should be encouraged, as well as information sharing. “Technology transfer” is effective when there is a partnership between “supplier and recipient”. Not only the recipient should see the benefits of acquiring the technology, the supplier should also see the benefits of supplying the technology and be prepared to engage in long-term partnership with the recipient. This is possible when both parties see “technology transfer” not a onetime deal, but a base for a continued long-term relationship.

The country, in order to be technologically advanced, needs to develop its own technological base. This is possible only when we have the appropriate research and infrastructure base.

The academic institutions also need to devote their attention on the needs of the economy rather than to be swayed away by the trends.

REFERENCES


GROWTH PERFORMANCE, SURVIVAL RATE AND NUTRIENT PROFILE OF Clarias gariepinus FINGERLINGS FED RATIONS OF SOYBEAN AS ALTERNATIVE PROTEIN SOURCE

*Olele Nkeonyeasua Florence, **Onyema Mcdonald Ibe and **Odiko, Andress Edowaye

*Fisheries Department, Delta State University, Asaba Campus Nigeria.
**Fisheries Department, University of Benin, Benin City, Edo State, Nigeria.

Abstract

The need to augment fish production from the wild has necessitated increased attention in aquaculture. Such culture encourage the use of cheap and readily available feed which brings about increased size and high yield. Fishmeal was substituted (100%, 65%, 35%, 0%) with soybean (0%, 35%, 65%, 100%) in Clarias gariepinus diet. One hundred and sixty fingerlings having mean body weight of approximately 10g each, were distributed into eight concrete tanks measuring 1×1×1.5m at the rate of twenty fingerlings/tank and fed albition. Analysis of variance revealed that the highest value for final mean body weight (71.5 g), specific growth rate (2.3) and Protein Efficiency Ratios (1.48), were observed in diet 3. Glutamic acid was the major amino acid with the highest concentration (1.5 g) in diet 2. There was a decreasing level of Lysine and Methionine with increasing levels of soy bean inclusion, at various treatments. The study has shown that when 35% fishmeal was substituted with 65% soybean, fish yield was not only at its highest production, but was also nutritionally beneficial.

Key Words: Growth performance, survival rate, nutrient profile, Clarias gariepinus, fingerlings

INTRODUCTION

As the need to augment fish production from the wild heightens due to increasing demand for fish, there is increased global attention on aquaculture (Owodeinde et al., 2010). According to El-Saidy and Gaber (2003); Siddhuraju and Becker (2003); Wu et al., (2004), aquaculture has become the fastest-growing food production sector in which fish meal is a primary protein source in fish diets. In aquaculture, feeding of culture fish is one of the most important factors that must be considered. Fish like other animals have a requirement for essential nutrients in order to grow properly. Nutrient requirements for fish encompasses proteins, lipids, carbohydrates, vitamins and minerals. Protein being a major constituent in fish diet, presumes that a knowledge of its requirement for fish species was essential for the formulation of a balanced diet. Johnston (2004) reported that fishmeal has always been the commonest and most popular source of protein for commercial fish feed production. However, the high cost incurred in the use of fishmeal as raw material has necessitated researches into the use of plants protein in feed formulation. Among the plant protein sources considered in aquaculture diets, soybean meal is the most widely used ingredient. It was used for the replacement of fish meal at various rations due to their high-protein content and relatively well-balanced amino acid profile, (Koumi et al., 2009). Furthermore, it has the advantage of being resistant to oxidation and spoilage and is naturally free from organisms such as fungi, viruses, and bacteria that are harmful to shrimp and fish (Storebakken et al., 2000).
The use of soybean meal as substitute for fishmeal in diets of many fish and marine crustaceans cannot be overemphasized (Davis and Arnold, 2000; Webster and Lim, 2002). This is because the replacement of fish protein with soya protein has not only improved growth but also reduced the cost of fish production. This assertion is in corroboration with those of El Saidy and Gaber, (2002); Wilson et al., (2004), who reported considerable success after the partial replacement of fish meal with soybean meal in the diet of Oreochromis niloticus. Apparent crude protein digestibility of soybean meal by trout, carp and red sea bream was 90-93% (Yamamoto et al., 2000). Again, Chou et al., (2001) reported that incorporating soy protein in cobia (Rachycentron canadum) diets at a modest level of (11.5%) was successful. In a similar study, (Fagbenro and Davies, 2001) reported that the results obtained indicated that 50% of fish meal protein in practical catfish diets was replaced with soybean flour.

However, some challenges exist in using soybean as fishmeal substitute in fish diets. This is because it contains some anti nutritional factors that are known to affect growth and health of the fish (Storebakken et al., 2000) and (Hendricks, 2002). For instance, in Atlantic salmon and rainbow trout, soybean meal was found to cause distinct morphological alterations in the intestine. In addition to impaired growth and protein utilization, the effects escalated with increasing dietary levels (Krogdahl and Bakke-McKellep, 2001). Dietary soybean meal also appear to stimulate immune responses because of inflammation in the distal intestine of some fish species (Krogdahl et al., 2000). However, the concentration of these anti nutrients can be reduced by proper heat processing.

In response to the rising need for more research into fish nutrition that will utilize locally available ingredients without reducing the quality of fish feed, the study was undertaken to establish the optimum replacement ration of fishmeal with soybean meal in the diet of Clarias gariepinus, it will ascertain the survival rate, growth response, and overall performance of Clarias gariepinus fed rations of soybean as well as determine the composition and concentration of Amino and fatty acid present in the carcass of fingerlings receiving various treatments.

**MATERIALS AND METHODS**

**Study Area**

This study was conducted in the experimental tank unit of the Department of Fisheries, University of Benin for a period of twelve (12) weeks, June to August, 2012.

**Tank Preparation And Experimental Set Up**

The experimental set up consists of eight concrete tanks whose dimension was 1×1×1.5m. After the tank was checked for leakage, it was thoroughly washed to ensure the removal of dead algae and other organisms that may adversely affect water quality. Water was appropriately impounded into the tanks.

**Experimental Fish**

Good stock fingerlings were purchased from NIKSEG fish farms in Benin City. One hundred and sixty (160) fingerlings of Clarias gariepinus were randomly selected and distributed into the tanks at the rate of 20 fingerlings per tank. Forty-eight hour period was allowed for acclimatization of the fingerlings. The initial weight of the fingerlings were taken after acclimatization, before feeding commenced. They were fed to apparent satisfaction (ad-libitum) twice daily at 9.00 am and 4.00 pm. The weights of the fingerlings were taken bi-weekly all through the 12 week culture period.

**Experimental Diets**

Four iso-nitrogenous diets comprising of 35% dietary protein levels were formulated. The major source of protein in diet 1, (control) was fishmeal. The fishmeal protein was substituted at a rate of 35 %, 65 %, and 100 % with soybean meal in diets 2, 3 and 4, respectively. Synthetic methionine and lysine were added to the 4th diet at the rate of 0.2kg each in order to make up for their deficiency in that diet. Individual weights of the ingredients were arrived at by Pearson square method. These ingredients were then milled, mixed, produced into pellets and stored in a cool dry place according to Bolorunduro, (2002). The ingredients used and their relative contributions by weight in the diet is shown in Table 1.

<p>| TABLE 1: Relative weight of ingredients used in feed formulations (% FM/SBM) |</p>
<table>
<thead>
<tr>
<th>Ingredients</th>
<th>DIET 1</th>
<th>DIET 2</th>
<th>DIET 3</th>
<th>DIET 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish Meal</td>
<td>100/0</td>
<td>65/35</td>
<td>35/65</td>
<td>0/100</td>
</tr>
<tr>
<td>Soy bean Meal</td>
<td>0</td>
<td>16.93</td>
<td>27.08</td>
<td>31.30</td>
</tr>
<tr>
<td>Corn Meal</td>
<td>21.41</td>
<td>23.47</td>
<td>26.20</td>
<td>30.10</td>
</tr>
<tr>
<td>Wheat Offal</td>
<td>21.41</td>
<td>23.47</td>
<td>26.20</td>
<td>30.10</td>
</tr>
<tr>
<td>Bone Meal</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Vitamin Premix</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Lysine</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>Methionine</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>Starch</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

FM: Fish meal and SBM: Soybean meal

**Amino Acid Analysis**

*Defatting*

About 2.0g of each ingredient was weighed into the extraction thimble and the fat extracted with chloroform/methanol mixture using a soxhlet extraction apparatus (AOAC, 2003). The extraction lasted for 5 to 6 hours.

*Hydrolysis of sample*

Between 30 to 35 mg of each defatted sample was weighed into glass ampoule, 7 ml of 6 N HCl was added and air was expelled by passing nitrogen into the ampoule in order to avoid possible oxidation of some amino acids during hydrolysis. The glass ampoule was sealed with Bunsen flame and put in an oven at 150 ± 5°C for 22 hours. The ampoule was allowed to cool before the content was filtered. The filtrate was evaporated to dryness at 40°C under vacuum in a rotary evaporator. The residue was dissolved with 5 cm³ of acetate buffer and stored in a plastic specimen bottle which was kept in a deep freezer.

*Sample analysis*

The method of analysis used was Ion-Exchange Chromatography (IEC) (FAO/WHO, 1991). The amount loaded for each of the samples was between 5 to 10 μl. This was dispensed into the cartridge of the analyzer designed to separate and analyze free acid, neutral acid, basic acid, and amino acid of the hydrolysates. The period of analysis lasted 76 minutes for each sample. The liquid flow rate in the column was 0.5cm³/min and the column temperature was maintained at 60°C. It has reproducibility consistence within ± 3%.

*Lipid Extraction and Fatty Acid Analysis*

Lipid determination was carried out using the modified Bligh and Dyer procedure (AOAC, 2003). Methanol and chloroform were used as solvents at the ratio of 1:1. The fatty acids were converted to their methyl esters and hexanes. Internal standards were employed for estimation of actual fatty acids in the fat. Identification and quantification of fatty acids was carried out by gas chromatography according to (AOAC, 2003).

**Water Quality Parameters**

Water quality was closely monitored to ensure a suitable environment for the fishes. Parameters measured and recorded include Temperature, Transparency, Dissolved oxygen and Hydrogen-ion-Concentration (pH).

*Temperature:* This was measured in-situ with the aid of mercury in glass thermometer. The measurement was taken morning and evening

*Dissolved Oxygen:* This was measured bi-weekly using the Winkler’s method as proposed by (APHA 2002)

*Hydrogen-Ion- Concentration (pH):* This was measured with a pH metre (Schott-Gerate CG 840)

*Transparency:* This was measured daily and recorded with the aid of a Secchi Disc, following the procedure proposed by (Swann, 2006)

Apart from water quality parameters such as temperature and transparency that were measured in-situ, every other water quality parameter was analyzed at SPLENDID RESEARCH
LABORATORIES, at Kilometer 9, Ugbowo, Lagos Road, opposite Eddy Grace Petrol Station, Isihor, Benin-City, Edo State, Nigeria.

**Growth Parameters**

Determination of parameters such as Specific Growth Rate (SGR), Survival Rate (SR), Food Conversion Ratio (FCR), and Protein Efficiency Ratio (PER), were conducted according to De Silva and Anderson (1995). Parameters measured include:

- Initial body weight of the fingerlings before feeding commenced.
- Final body weight of the fingerlings at the end of the experiment.
- Total weight gained = Final body weight (kg) − Initial body weight (kg)
- Mean weight gained per fingerling (g) = Total Weight Gain / Time
- Specific Growth Rate = \( \frac{\log W_f - \log W_i}{\text{Time}} \) × 100
  
  Where \( W_f \) = Final body weight at time (T)
  \( W_i \) = Initial body weight at time (T)
- Food Conversion Ratio (FCR) = Feed consumed / Body weight gained
- Protein Efficiency Ratio (PER) = Fish weight gain / Protein Fed
- Initial mean length of fingerlings before commencement of feeding
- Final mean length of fingerlings
- Mean daily length gain = Final mean length - Initial mean length / Time

Proximate analysis of fish carcass at harvest was carried out using the procedure in AOAC (2003).

**Statistical Analysis**

The experiment was completely randomized with replicates. Means and standard deviations (±SD/range) were computed. Significance of variations in the growth parameters were tested with one way analysis of variance, ANOVA, while means were separated with the Duncan Multiple Range Test.

**RESULTS**

**Some Water Quality Parameters**

Water quality parameters recorded during the study revealed that they were maintained at optimal levels conducive for the ideal culture of fingerlings. Temperature data, ranged between 27-28°C while dissolved oxygen levels, ranged between 5.67 to 6.17mg/l, Table 2.

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>Wk2</th>
<th>Wk4</th>
<th>Wk6</th>
<th>Wk8</th>
<th>Wk10</th>
<th>Wk12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature °C</td>
<td>28</td>
<td>27</td>
<td>27.6</td>
<td>27</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Transparency (cm)</td>
<td>38</td>
<td>42</td>
<td>42</td>
<td>38</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.04</td>
<td>5.67</td>
<td>6.17</td>
<td>6.08</td>
<td>6</td>
<td>6.14</td>
</tr>
<tr>
<td>PH</td>
<td>6.90</td>
<td>6.83</td>
<td>6.34</td>
<td>6.82</td>
<td>6.7</td>
<td>6.88</td>
</tr>
</tbody>
</table>

**Growth Parameters**

Le 3, shows the initial body weight per fingerlings, which were about the same at the beginning of the experiment. Final body weight on the other hand showed significant differences between treatments. For instance, fingerlings fed diet 3 recorded the highest final mean body weight 71.5g, followed by diet 2 with a record of 68.75g while the least value (52.5g) was recorded in fingerlings fed on diet 1, which incidentally was the control treatment. In terms of Food Conversion Ratio (FCR), the highest value (7.13) was recorded in fingerlings belonging to diet 1, while diet 3 recorded the least value (4.93).

**TABLE 2: Mean values for water quality parameters recorded during the culture period**

**TABLE 3: ANOVA data on growth response of fingerlings fed soybean substituted diets (FM/SBM).**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>DIET1</th>
<th>DIET2</th>
<th>DIET3</th>
<th>DIET4</th>
<th>SEM</th>
</tr>
</thead>
</table>
**Proximate Composition Of Fingerlings**

ANOVA analysis on proximate composition of fingerlings fed various diets is shown in Table 4. The table revealed that the highest crude protein value (60.12) was recorded in fingerlings fed on diet 2. This was closely followed by those fed diet 3 which recorded 60.09 while fingerlings fed on diet 4 had the least crude protein composition 59.88. Moisture content was found to be highest in fingerlings placed on diet 4 which recorded a value of 12.96, while fingerlings fed on diet 3 recorded the least value 12.63, Table 4.

**TABLE 4: Mean composition of fingerlings fed soybean substituted diets**

<table>
<thead>
<tr>
<th>DIETS</th>
<th>FM/SBM</th>
<th>Crude Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fiber</th>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>100/0</td>
<td>59.98c</td>
<td>19.22b</td>
<td>3.36c</td>
<td>1.09b</td>
<td>12.88b</td>
</tr>
<tr>
<td>D2</td>
<td>65/35</td>
<td>60.12a</td>
<td>19.18b</td>
<td>3.44b</td>
<td>1.04c</td>
<td>12.75a</td>
</tr>
<tr>
<td>D3</td>
<td>35/65</td>
<td>60.09b</td>
<td>19.35a</td>
<td>3.52a</td>
<td>1.09b</td>
<td>12.63d</td>
</tr>
<tr>
<td>D4</td>
<td>0/100</td>
<td>59.88d</td>
<td>19.13d</td>
<td>3.29d</td>
<td>1.12a</td>
<td>12.96a</td>
</tr>
<tr>
<td>SEM</td>
<td>0.009</td>
<td>0.009</td>
<td>0.009</td>
<td>0.009</td>
<td>0.009</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Means with the same alphabet on the vertical column are not significantly different at (p>0.05)

**Amino Acid Composition**

ANOVA data for amino acid composition of the fingerlings is shown in Table 5. The table revealed that diet 2 recorded the highest value 0.82 in Alanine content. It was followed closely by diet 3 which had a value of 0.78, with diet 4 recording the least value 0.76. Also diet 4 recorded the highest lysine concentration of 0.93g while diet 1 recorded the lowest value 0.76. Methionine composition was highest in fingerlings fed diet 4 which had a value of (0.54), followed by fingerlings fed on diets 2 and 3 which recorded values of (0.49 and 0.42) respectively. Fingerlings placed on diet 1, recorded the least value (0.38).

**TABLE 5. ANOVA data on amino acid composition of fingerlings fed soybean substituted (FM/SBM) diet.**

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>100/0</th>
<th>65/35</th>
<th>35/65</th>
<th>0/100</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspartic</td>
<td>1.29b</td>
<td>1.33a</td>
<td>1.25c</td>
<td>1.28b</td>
<td>0.02</td>
</tr>
<tr>
<td>Glutamic</td>
<td>1.45a</td>
<td>1.5a</td>
<td>1.44a</td>
<td>1.29b</td>
<td>0.03</td>
</tr>
<tr>
<td>Arginin</td>
<td>0.83a</td>
<td>0.81a</td>
<td>0.76b</td>
<td>0.75b</td>
<td>0.01</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.76d</td>
<td>0.89b</td>
<td>0.8d</td>
<td>0.93d</td>
<td>0.01</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.38d</td>
<td>0.49b</td>
<td>0.42c</td>
<td>0.54a</td>
<td>0.01</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>0.67b</td>
<td>0.72a</td>
<td>0.69b</td>
<td>0.62a</td>
<td>0.01</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.60a</td>
<td>0.53b</td>
<td>0.49c</td>
<td>0.47c</td>
<td>0.03</td>
</tr>
<tr>
<td>Valine</td>
<td>0.93a</td>
<td>0.91b</td>
<td>0.92c</td>
<td>0.89c</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*MDLG=Mean Daily Length Gain (cm/d). Means with the same alphabet on the horizontal rows are not significantly different at (p>0.05)*
Seriine             0.69b  0.87a  0.64c  0.62d  0.01
Proline            0.55a  0.53a  0.52a  0.51b  0.01
Leucine            1.29a  1.22a  1.24a  1.2a   0.03
Triptophan         0.16b  0.18a  0.14c  0.15c  0.01
Histidine          0.33a  0.27c  0.29b  0.25d  0.01
Glycine            0.48b  0.46b  0.42d  0.44d  0.01
Alanine            0.80a  0.82a  0.78b  0.76c  0.02
Tryosine           0.60b  0.62b  0.42d  0.45b  0.03

Means with the same alphabet on the horizontal rows are not significantly different at (p>0.05)

FM= Fishmeal and SBM= Soy bean Meal.

### Fatty Acid Composition

Analysis of variance for fatty acid composition of fingerlings fed various diets is shown in Table 6. It revealed that fingerlings fed diet 2 had the highest concentration of linoleic acid (25.69g), closely followed by those fed diet 1 which recorded a value of 25.55g. Fingerlings on diet 3 recorded the least value: 23.63g. In terms of Palmitic acid, diet 1 had the highest concentration: 26.18g while the least concentration was recorded for diet 4 which had a value of 25.38g.

**TABLE 6: ANOVA data on fatty acid composition of fingerlings fed rations of soybean substituted diet (FM/SBM)**

<table>
<thead>
<tr>
<th>FATTY ACID</th>
<th>100/0</th>
<th>65/35</th>
<th>35/65</th>
<th>0/100</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmitic (C16.0)</td>
<td>26.18a</td>
<td>25.96b</td>
<td>25.44c</td>
<td>25.38d</td>
<td>0.009</td>
</tr>
<tr>
<td>Searctic (C 18.0)</td>
<td>15.33a</td>
<td>15.20b</td>
<td>15.39b</td>
<td>15.37c</td>
<td>0.029</td>
</tr>
<tr>
<td>Oleic (C 18.1)</td>
<td>16.22a</td>
<td>16.55b</td>
<td>16.85c</td>
<td>16.36d</td>
<td>0.009</td>
</tr>
<tr>
<td>Linoleic (C 18.2)</td>
<td>25.55a</td>
<td>25.69a</td>
<td>23.63d</td>
<td>24.18b</td>
<td>0.005</td>
</tr>
<tr>
<td>Linolenic (C 18.3)</td>
<td>12.66a</td>
<td>12.48b</td>
<td>12.18c</td>
<td>12.36b</td>
<td>0.009</td>
</tr>
<tr>
<td>Behenic (C22.0)</td>
<td>2.66b</td>
<td>2.35a</td>
<td>2.29c</td>
<td>2.34b</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Means with the same alphabet on the horizontal rows are not significantly different at (p>0.05)

### DISCUSSION

#### Water Quality Parameters

Water quality parameters were maintained within acceptable ranges for aqua-cultural practice according to Swann (2006).

#### Growth Parameters

Table 3 indicated that soybean inclusion in diets of *Clarias gariepinus* fingerlings resulted in better body weight gain, growth rate, and protein conversion efficiency. Data in Table 3 also show that *Clarias gariepinus* fingerlings performed better, when fed diet in which 65% fishmeal was replaced with 35 % soybean meal. This value exceeds that obtained by (Fagbenro and Davies, 2001) where only 50% fishmeal was replaced by 35 % soybean flour for catfish diet. It is however not surprising to note that the fingerlings placed on diet 4 (100% soybean meal) did better than those fed diet 1 (100% Fishmeal). For instance, while fingerlings placed on diet 1 recorded a final weight and mean weight gain of 52.5g and 42.5g respectively, those placed on diet 4 recorded 66g and 56g for the same parameters. This superior performance, could be attributed to the supplemental Essential Amino Acids (lysine and methionine) that was added in the 4th diet. This further lends credence to the submissions of Chang *et al.,* (2003) who demonstrated that supplementing plant protein with lysine and methionine in low protein diet was beneficial for catfish growth and performance. The lower food conversion ratio of 4.93, recorded by fingerlings fed Diet 3 is an indication that it is of better quality than the other diets. According to Ugwumba and Ugwumba, (2007), lower food conversion ratio indicate higher protein conversion efficiency which results in better growth. Survival rate amongst the treatments was not significantly different. The mortalities recorded could be attributed to handling stress as the mortalities were usually recorded after the occasional sampling of fingerlings.

### Proximate Composition Of Fingerlings
The crude protein content of fingerlings fed different diets show that diets 2 and 3 recorded relatively high values (60.12% and 60.09%) respectively. Treatments 1 and 4 also recorded close values of (59.98% and 59.88%) respectively. These values agree with those reported by Abolude and Abdullahi (2005) on proximate and mineral contents of *Clarias gariepinus*. High values of protein recorded during the study especially with the inclusion of soybean at different levels in the diets, indicate that the fingerlings were reliable sources of good quality protein for man.

Fat content of fingerlings, for all treatments was above 5%, hence *Clarias gariepinus* can be described as a fatty fish (Tocher *et al.*, 2008). However, fat content of fish was highest in fishes fed diet containing 65% soy protein and 35% fishmeal and which recorded a value of 19.35% in Table 4. Moisture content of fingerlings were not only relatively high but statistically significant in all treatments. This observation agrees with that reported by (Adefemi, 2011) who stated that such moisture content enables fish become more susceptible to deterioration if kept unpreserved for long after harvest. Crude Fiber composition of the diets ranged between 1.04g to 1.09g and showed no particular trend relative to increasing levels of soy protein composition.

**Amino Acid Composition**

The data in Table 5 indicate that Glutamic acid whose values ranged from 1.29g to 1.5g had the highest concentration among the amino acid profile. Diet 2 recorded the highest value of 1.5g. This observation is in agreement with similar studies conducted by (Adeyeye and Adamu, 2003). The table also revealed that lysine and Methionine compositions increased with increasing levels of soybean inclusion in the diet, as a result of their inclusion in the diet. Chou *et al.*, (2001), are of the opinion that lysine and Methionine are the limiting amino acids in most plant protein sources. Threonine, which is also an essential amino acid component, slightly decreased with increasing levels of soybean inclusion. This is a clear indication of its essentiality as it cannot be efficiently synthesized in the body of the fish (Yamamoto *et al.*, 2000). The decrease in Threonine level could be as a result of its insufficiency in the soy bean meal. However, irrespective of the soybean inclusion level, *Clarias gariepinus* remains a good source of Essential Amino Acids (EAA) as the values recorded were within the range recommended by FAO/WHO, (1991)

**Fatty Acid Composition**

Fatty acid profile of fingerlings undergoing the various treatments showed that Palmitic acid is the predominant saturated fatty acid. This observation lends credence to the views of Osibona *et al.*, (2006) who conducted a similar study on the proximate and fatty acid composition of *C. gariepinus*. There was a noticeable decrease in palmitic acid concentration with an increasing level of soybean inclusion in the diets. Table 6 revealed that fingerlings fed diet 1 had the highest palmitic acid concentration level of 26.18g, with diets 2, 3 and 4 recording 25.96g, 25.44g, and 25.38g respectively. This trend however does not agree with the views of Osibona *et al.*, (2006) who opined that palmitic acid is a key metabolite in fish whose level is not affected by diet. Oleic acid, which is the major monounsaturated fatty acid in the fingerlings under study, showed no trend, relative to soybean inclusion. This fatty acid according to Osibona *et al.*, (2006) is of exogenous origin and subject to the types of feed consumed by fish. The Poly- Unsaturated Fatty Acids (PUFA) present in the fingerlings include linoleic and linolenic acid. Linolenic acid which as an omega-3 fatty acid, has a range of 23.6g to 25.69g making it the next major fatty acid in the fish, after palmitic acid. It is well-known that essential ω-3 fatty acids has beneficial effect on human health, primarily in prevention and healing of cardiovascular diseases, and are important factors in neurological development (Arts, 2001). The fatty acid composition of fingerlings in the present study, imply that it contains the basic quantity required by man.

**CONCLUSION AND RECOMMENDATION**

The use of a readily available, economically viable plant protein source, enhance the economic sustainability of aquaculture. It is also very important that such protein source should contain very low anti-nutrients, good amino acid profile and various supplements to improve nutritional balance and palatability of the feed. Soy protein has without doubt, met these
requirements. Although the present study did not look into the economics of production, however based on the ease of cultivation and low cost of procuring soybean meal in comparison to fishmeal, it could be recommended that farmers utilize soybean to partially replace fishmeal up to 65% in fish diet. This will enable the farmer cut down on cost of production without compromising the quality of the fish.

REFERENCES


Bolorunduro P.I (2002). Feed formulation and feeding practices in Fish Culture. Fisheries Extension Bulletin vol 152, Fisheries series No.2, pp. 28


INDOLE ACETIC ACID PRODUCTION BY *BACILLUS POPILLAE* ISOLATED FROM FEW LEGUME PLANTS RHIZOSPHERE SOILS

R. Hiranmai Yadav
School of Natural Resources Management and Environmental Sciences,
Haramaya University,
Dire Dawa, Ethiopia

Abstract

Plant rhizosphere soil represents a unique biological niche with diverse micro flora comprised of bacteria, fungi, protozoa and algae. A collection of 185 micro organisms were isolated from the rhizosphere soils of four legume plants (*Vigna angularis, Vigna mungo, Vigna radiata* and *Vigna aconitifolia*) and tested for the production of the plant growth hormone indole-3-acetic acid (IAA). The organism with maximum production was characterized and was mutated. The wild and mutated species were tested for the efficiency in IAA production with different medium such as LB medium, King’s B medium and Czapek dox medium. The media were optimized for the production of IAA. The increased quantity of IAA was produced by *Bacillus popillae* wild (39 µg/ml) and mutant (32 µg/ml) in LB Medium. Production media was prepared with optimized concentrations of carbon source (Bactotryptone 0.40g/25 ml), nitrogen source (Yeast extract 0.18g/25 ml) and mineral source (NaCl 0.30 g/25 ml) for wild and carbon source (Bactotryptone 0.40g g/25 ml), nitrogen source (Yeast extract 0.18g/25 ml) and mineral source (NaCl 0.30 g/25 ml) for mutant strain which produced 65 µg/ml and 40 µg/ml of IAA respectively. The IAA from this strain was extracted, purified and identified by thin layer chromatography and HPLC.

Keywords: *Bacillus popillae*, indole acetic acid, legumes, media optimization, plant rhizosphere

INTRODUCTION

Plant growth promoting rhizobacteria (PGPR) are considered to promote plant growth directly or indirectly. PGPR can exhibit a variety of characteristics responsible for influencing plant growth. The common traits include production of plant growth regulators (auxin, gibberellin, ethylene etc.), siderophores, HCN and antibiotics (Arshad and Frankenberger, 1992). Indole acetic acid (IAA) is one of the most physiologically active auxins. IAA is a common product of L-tryptophan metabolism by several microorganisms including PGPR (Lynch, 1985; Frankenberger and Brunner, 1983).

Microorganisms inhabiting rhizosphere of various plants are likely to synthesize and release auxin as secondary metabolites because of the rich supplies of substrates exuded from the roots compared with non rhizospheric soils (Kampert et al., 1975; Strzelezyk and Pokojka-Burzdziej, 1984). Plant morphogenic effects may also be a result of different ratios of plant hormones produced by roots as well as by rhizosphere bacteria (Muller et al., 1989). Diverse soil microorganisms including bacteria, fungi and algae are capable of producing physiologically active quantities of auxins, which may exert pronounced effects on plant growth and establishment.

Plant growth promoting rhizobacteria (PGPR) are a group of bacteria that can be found in the rhizosphere, in association with roots which can enhance the growth of plant directly or indirectly. A large number of bacteria including species of *Pseudomonas*, *Azospirillum*, *Azotobacter*, *Klebsiella*, *Enterobacter*, *Alcaligenes*, *Arthrobacter*, *Burkholderia*, *Bacillus*, *Rhizobium* and *Serratia* have reported to enhance plant growth (Ajay Kumar et al., 2012). Edi Husen (2003) isolated fourteen soil bacteria from rhizosphere and IAA production was studied among which twelve isolates were
found to be efficient. The present study was an attempt to isolate rhizosphere bacteria from four bacteria that have the ability to produce IAA and find the efficacy of the IAA.

**METHODOLOGY**

**Isolation and biochemical characterization of indigenous isolates**

Rhizospheric soils of different crops (*Vigna angularis, Vigna mungo, Vigna radiata and Vigna aconitifolia*) were collected from agricultural fields of Coimbatore city, Tamil Nadu, India. Bacteria were isolated from the soil on LB medium, King’s B medium and Czapek dox medium. Each isolate showing characteristic growth, pigmentation and biochemical reactions as described in Bergy’s Manual of Determinative Bacteriology for the species was purified and given an isolate number.

**Chemical Mutagenesis**

Thick culture suspension was prepared with normal saline. The suspension was mixed well by means of vortexing. Reaction mixture of 20ml (10ml of culture suspension +9.34ml of acetate buffer having pH of 4.4 ml + 0.66ml of bromouracil) was prepared. The sample was transferred to phosphate buffer at regular intervals of 0, 2, 5, 10, 15 and 20 minutes. Then they were taken from the phosphate buffer and plated by spreading the reaction mixture. The plates were then incubated at 37°C for 48 hours.

**Maintenance of wild and mutant culture**

Nutrient broth was prepared and sterilized. A loop of culture from mother plate was inoculated into the broth and incubated at 37°C for 24-48 hours. After incubation the pure culture was maintained in refrigerated condition and it was used as inoculum for further process.

**Screening of bacterial isolates for indole acetic acid (IAA) production**

All the test strains were screened for IAA production. Briefly, test bacterial culture was inoculated in the respective medium (LB medium, King’s B medium and Czapek dox medium) and incubated at 28 ± 2°C for 1 week. Cultures were centrifuged at 3000 rpm for 30 min. Two milliliters of the supernatant was mixed with 2 drops of orthophosphoric acid and 4 ml of Solawaski’s reagent (50 ml, 35% perchloric acid; 1 ml 0.5 FeCl3). Development of a pink colour indicates IAA production. O.D. was read at 530 nm using Spectronic 20D+. The level of IAA produced was estimated by a standard IAA graph.

**Extraction of crude IAA**

Single bacterial colonies of *Bacillus popillae* were inoculated in 200 ml of nutrient broth amended with 1 and 5 mg/ml of tryptophan and incubated at 28 ± 2°C for 1 week on a shaker incubator. Bacterial cells were separated from the supernatant by centrifugation at 10,000 rpm for 30 min. The supernatant was acidified to pH 2.5 to 3.0 with 1 N HCl and extracted twice with ethyl acetate at double the volume of the supernatant. Extracted ethyl acetate fraction was evaporated to dryness in a rotatory evaporator at 40°C. The extract was dissolved in 300 ml of methanol and kept at -20°C.

**Thin layer chromatography**

TLC plates (Silica gel G f254, thickness 0.25 mm) were developed in chloroform: methanol: acetic acid (85:10:0.5). Spots with Rf values identical to authentic IAA were identified under UV light (254 nm) by spraying the plates with Ehmann’s reagent (Ehmann, 1977).

**Quantification of IAA by HPLC**

Determination of IAA levels in samples extracts was carried out by isocratic reverse-phase liquid chromatography (HPLC) using a Chiral OD column 250X 4.6 mm EcoPack (Sigma Aldrich, India), with post column derivatization involving 119-mg potassium bromide and 350-μL 4M HNO3 (Sigma P- 3179) (Quimica S. A., India) and with fluorescence detector Merck Hitachi; excitation and emission wavelengths were Excitation: 362 nm Emission: 435 nm, respectively. The
flow rates were 1.2 ml/min for mobile phase and 0.30 ml/min for reagent Isocratic: 60:10:30 Water/ACN/MeOH.

RESULTS

A collection of 185 microorganisms were isolated from the rhizosphere soils of 4 legumes (Vigna angularis, Vigna mungo, Vigna radiata and Vigna aconitifolia) plants were found to produce, the plant growth hormone indole-3-acetic acid (IAA). The organism was mutated and the wild and mutated species were observed for the efficiency in IAA production in different medium such as LB medium, King’s B medium and Czapek dox medium were optimized for the production of IAA (Table 1). Among different isolates Bacillus popilliae was studied.

Carbon source utilization by Bacillus popilliae for the production of IAA in fermentation was studied with different concentration of Bactotryptone (0.20, 0.25, 0.30, 0.35 and 0.40g/25ml) in the production medium. The optimization of its cultivation conditions for the IAA production with carbon source showed that the concentration of bactotryptone at 0.40g/25 ml produced 88μg/ml of IAA and mutant with 0.40g/25 ml of bactotryptone produced 68μg/ml of IAA (Table 2).

Nitrogen source utilization by Bacillus popilliae for the production of IAA fermentation was studied with different yeast level (0.10, 0.12, 0.14, 0.16 and 0.18g/25ml) in the cultivation medium. The best concentration of nitrogen source for the production of IAA, for wild and mutant was 0.18 g/25 ml (Table 3).

Mineral source utilization by Bacillus popilliae for the production of IAA in fermentation was studied with different concentration of mineral source NaCl (0.20, 0.25, 0.30, 0.35 and 0.40g/25ml) in the production medium. The best concentration mineral source for the production of IAA was 0.30g/25ml for wild and mutant 0.30g/25ml (Table 4).

Preparation of optimized production medium

Production media was prepared with optimized concentrations of carbon source (Bactotryptone 0.40g/25 ml), nitrogen source (Yeast extract 0.18g/25 ml) and mineral source (NaCl 0.30 g/25 ml) for wild and carbon source (Bactotryptone 0.40g g/25 ml), nitrogen source (Yeast extract 0.18g/25 ml) and mineral source (NaCl 0.30 g/25 ml) for mutant strain (Table 5) which produced 30 μg/ml and 28 μg/ml of IAA respectively.

Production, extraction and purification of IAA

IAA was separated by thin-layer chromatography using a solvent system composed of Chloroform: Methanol: Acetic acid (85:10:0.5). After ascending the plate was taken out dried and then observed under UV light. A pink color band with Rf value of 0.33 (wild) and 0.74 (mutant) was obtained. The concentration of crude extract of Bacillus popilliae wild and mutant were found to be 38 and 22 respectively. After column chromatography the purified IAA quantity was increased to 65μg/ml for Bacillus popilliae and 40μg/ml for mutant (Table 6).

Quantification of IAA by HPLC

Considering that the S/N for G1 is about 30, it is expected that an LOD of 0.2 ppb is quite achievable for all four IAA. In wild and mutant samples chromatogram showed that IAA B1 present at about 0.3 ppb (Table 7).

Table 1 Screening of IAA Production in Different Medium for Wild And Mutant Bacillus Popilliae

<table>
<thead>
<tr>
<th>S.No</th>
<th>Medium</th>
<th>Concentration of IAA(μg/ml) produced by wild</th>
<th>Concentration of IAA(μg/ml) produced by mutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LB medium</td>
<td>39</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>King’s B medium</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>Czapek dox</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2 Optimization of Carbon Source in the Production Medium (Wild and Mutant-Bacillus Popillae)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Bactotryptone (g)</th>
<th>Concentration of IAA (µg/ml) - wild</th>
<th>Concentration of IAA (µg/ml) - mutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.20</td>
<td>72</td>
<td>62</td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td>66</td>
<td>56</td>
</tr>
<tr>
<td>3</td>
<td>0.30</td>
<td>71</td>
<td>61</td>
</tr>
<tr>
<td>4</td>
<td>0.35</td>
<td>63</td>
<td>53</td>
</tr>
<tr>
<td>5</td>
<td>0.40</td>
<td>88</td>
<td>68</td>
</tr>
</tbody>
</table>

Table 3 Optimization of Nitrogen Source in the Production Medium (Wild and Mutant-Bacillus Popillae)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Yeast extract (g)</th>
<th>Concentration of IAA (µg/ml) - wild</th>
<th>Concentration of IAA (µg/ml) - mutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10</td>
<td>76</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>0.12</td>
<td>58</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>0.14</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>0.16</td>
<td>86</td>
<td>76</td>
</tr>
<tr>
<td>5</td>
<td>0.18</td>
<td>94</td>
<td>84</td>
</tr>
</tbody>
</table>

Table 4 Optimization of Mineral Source in the Production Medium (Wild and Mutant-Bacillus Popillae)

<table>
<thead>
<tr>
<th>S.No</th>
<th>NaCl (g)</th>
<th>Concentration of IAA (µg/ml) - wild</th>
<th>Concentration of IAA (µg/ml) - mutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.20</td>
<td>68</td>
<td>58</td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td>54</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>0.30</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>0.35</td>
<td>62</td>
<td>52</td>
</tr>
<tr>
<td>5</td>
<td>0.40</td>
<td>62</td>
<td>52</td>
</tr>
</tbody>
</table>

Table 5 Preparation of Optimized Production Medium

<table>
<thead>
<tr>
<th>S.N.O</th>
<th>Organism (g)</th>
<th>Bactotryptone (g)</th>
<th>Yeast extract (g)</th>
<th>NaCl (g)</th>
<th>Concentration of IAA (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bacillus popillae (wild)</td>
<td>0.40</td>
<td>0.18</td>
<td>0.30</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Bacillus popillae (mutant)</td>
<td>0.40</td>
<td>0.18</td>
<td>0.30</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 6 Purification of IAA

<table>
<thead>
<tr>
<th>S.No</th>
<th>Organisms</th>
<th>Rf value</th>
<th>Crude extract (µg/ml)</th>
<th>Column chromatography (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bacillus popillae wild</td>
<td>0.33</td>
<td>38</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>Bacillus popillae mutant</td>
<td>0.74</td>
<td>22</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 7 Quantification of IAA by HPLC

- **Mobile Phase:** Isocratic: 60:10:30 Water/ACN/MeOH, with 119-mg potassium bromide and 350-µL 4M HNO3
- **Flow:** 1.2 mL/min
- **Temperature:** Ambient
Fluorescence Detector:

<table>
<thead>
<tr>
<th>Excitation: 362 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission: 435 nm</td>
</tr>
</tbody>
</table>

Injection Volume:

| 100 μL               |

Wild and Mutant

| IAA in 0.3 ppb |

DISCUSSION

The stem nodules of the legume *Aeschynomene aspera* contain indoleacetic acid and a high amount of tryptophan. The *Azorhizobium caulinodans* isolated from the stem nodules of the leguminous emergent hydrophyte produced a high amount of IAA (14.8 mg/L) in L-tryptophan-supplemented basal medium. The IAA yields paralleled the culture growth rate and increased up to 52 h. No separate growth and production phase was observed. The IAA production was increased when the medium was supplemented with L-tryptophan, sucrose, FeSO₄·7H₂O, NaNO₃, ascorbic acid and sodium dodecyl sulfate (Ghosh and Basu, 1997). Yeast Extract Mannitol medium supplemented with L-tryptophan was the best general medium for IAA production (Dariush Shokri and Giti Emtiazi, 2010). A total of 21 bacterial isolates (Azotobacter sp., 10 and fluorescent Pseudomonas sp., 11) were isolated from different rhizospheric soils and tested for the production of indole acetic acid (IAA) in a medium with different levels of tryptophan. Production of IAA in fluorescent Pseudomonas isolates increased with an increase in tryptophan concentration from 1 to 5 mg/ml in the majority of isolates. Production of IAA was further confirmed by extraction of crude IAA and subsequent TLC analysis. A specific spot from the extracted IAA preparation was found corresponding with the standard spot of IAA with same Rf value (Farah Ahmad et al., 2005). IAA producing bacteria from local soil could be easily isolated and may be exploited after strain improvement for local use. There are numerous soil microflora involved in the synthesis of auxins in pure culture and soil (Barazani and Friedman, 1999). Some microorganisms produce auxins in the presence of a suitable precursor such as L-tryptophan. The effects of auxins on plant seedlings are concentration dependent, i.e. low concentration may stimulate growth while high concentrations may be inhibitory (Arshad and Frankenberger, 1991). Different plant seedlings respond differently to variable auxin concentrations (Sarwar and Frankenberger, 1994) and type of microorganisms. In the study by Ajay Kumar et al. (2012), six French bean rhizospheric soil samples were collected from different location of Shimla and Solan in H.P (India). IAA production was shown by almost all the bacterial isolates. As PGPR are environmental friendly and offer sustainable approach to increase production of crops and health. Therefore, these isolates can be utilized for biofertilizer formulation under local agro-climatic conditions of Himachal Pradesh.

CONCLUSION

The isolation of rhizosphere microorganisms for production of IAA and utilization will be beneficial for crop production. The present study shows that the *Bacillus papillae* produced more IAA content compared to other species that were isolated. The optimization of medium further improves the production that could be used at industrial production.

REFERENCES


ANALYSIS OF MARGINAL INCOME CONTRIBUTION OF CHILD LABOUR AND ITS DETERMINANTS IN RURAL HOUSEHOLDS: THE CASE OF HARARI REGIONAL STATE, ETHIOPIA

Dejene Jifar

Abstract

This study was initiated with the objectives of analyzing the marginal income contribution of child labor and its determinants in rural households of Harari region using sample households survey data collected from 180 households in the year 2008/09. Results from descriptive statistics show that children are involved in four main activities: school attendance, working, combining school and work, and idle. The econometric results of Cobb-Douglas household production function model identified sex, education, adult working hours, parent employment, demand side characteristics, age, and family size as significant factors influencing the marginal contribution of child labor to family income. The Effective Labor Supply model results show that the marginal contribution of child labor supply was 22.1% (0.84 AE per day per household). The multinomial logit model results showed that the probabilities of children involvement in schooling, working & combining school and work were 57.63%, 10.72%, and 16.85% respectively and the rest were idle. OLS multiple regression results showed that farm size, education, demand side characteristics, and adults working hours per day have statistically significant effects on child labor supply. Generally, the results of this study underline the dependency of the households on child labor to supplement their income. Hence, development policies and strategy should focus on the adult education and youth skill training, supply of labor efficient water harvesting and utilization technology.

Key words: Marginal income contribution, child labor supply, schooling, Harari, Ethiopia.

1. INTRODUCTION

Child labour affects children’s possibilities of becoming productive adults in the future. At the moment, over exploitation and abuse of child labour is a wide spread problem particularly in developing countries despite legislations prohibiting the participation of children in harmful work practices. Children in many developing countries contribute to the household’s income either in cash or in kind; either by working in the labour market or directly contributing to the labour demand of household. All over the world, children continue to work, putting at stake their education, their health, their normal development to adulthood, and even their lives. Millions of them work under hazardous conditions, which present dangers to their health, safety, and welfare. They toil in mines and quarries, are exposed to agro chemicals in agriculture, squat in crippling positions to weave rugs and carpets and scavenge in rubbish collection centers. Many more are enslaved in bonded labour, isolated in domestic service, and traumatized and abused in the commercial sex trade (Asefa, 2002).

According to CSA (2002), about 41% of Ethiopian children aged 10-14 years were participated in child labour. Moreover, in Harari people national regional state in the same year CSA reported that working status of children aged 5-17 was about 49% were participated in domestic and productive activities. About 69% children aged 5-17 in Harari regional state in the year 2001 were attended school (Tassew et.al. 2002).

The above empirical evidence on the child labour indicates that income contribution of child labour is influenced by different factors and affects child physical and moral strengths. Moreover, it affects short-run and/or long-run income of the societies at different extents that can be an extremely expensive phenomenon both for the child and for the society in general. Therefore, giving due attention to combat the problems of child labour will benefit the societies as a whole. Any policy
Intervention on child labour will require research on income contribution of child which benefits all participants in the sector. The basic idea deriving this study is the analysis of marginal income contribution of child labour and factors that influence child labour in rural households of Harari people national regional state.

1.3. Objectives of the Study

The general objective of this study is to analyze the marginal income contribution of child labour and their determinants in the rural households of Harari people National Regional State of Ethiopia.

The specific objectives are:

i. To identify the livelihood activities that children in the study areas are involved in.
ii. To estimate the marginal contribution of child labour to total family labour supply.
iii. To estimate the magnitude of child labour’s contribution to family income.
iv. To analyze the determinants of child labour supply in the study area.

2. METHODOLOGY

2.1. Description of the Study Area

The study was conducted in rural areas of Harari Regional State; Dire Teyara, Erer and Sofi districts and nine Peasant Associations selected from these districts.

2.1.1. Harari people National Regional State

Harari people national regional state is located at 512 km east of the federal capital Addis Ababa. It is surrounded by Oromia national regional State. Harari is located between 9° 11'49" N and 9°24'42" N latitude and 42° 03' 30" E and 42°16' 24" E longitudes. It has an elevation ranging from 1300-2200 meters above sea level (m.a.s.l). It was selected because of its commercial importance as transit centre of domestic commodity export and import of industrial products. It is also a region with wide range of working children.

2.1.1.1. Demographics, Economy and Agriculture

Based on the figures from the Central Statistical Agency (CSA) published in 2008, Harari has an estimated total population of 183,344 of which 92,258 (50.32%) are men and 91,086 (49.68%) are women. About 84,023 (45.83%) of the population are estimated to be rural inhabitants, while 99,321 (54.17%) are urban dwellers. With an estimated area of 311.25 square kilometers, this region has an estimated density of 589 people per square kilometer. It is the third region next to Addis Ababa and Dire Dawa where the majority of its population lives in urban area i.e. 100%, 67.92% and 54.17% respectively. Out of 60,674 children (age 5-18 years), (52.23%) are rural inhabitants.

According to CSA (2007/08), rural households in Harari had a total of 40,780 head of cattle (about 0.086% of Ethiopia’s total cattle), 5,040 sheep (0.019%), 41,230 goats (0.19%), 8,330 asses (0.15%), 36,290 poultry of all species (0.09%), and 1000 beehives (0.02%). The rural inhabitants cultivate crops like chat, sorghum, and vegetables while the urban communities use non-farm activities such as
hiring out labour, providing services including trade of domestic farm products and hand crafts, and imported industrial products as a source of income. To rural households in Harari, agriculture contributes much to food supplies and cash needs. The sector is characterized by its rain-fed and subsistence nature. In rural areas of the region intercropping of food crops with cash crops especially chat is widely practiced. The study area comprises mixed farming where crops are grown for food and cash, and livestock are kept for complementary purposes, as a means of security during food shortage, and to meet farmers’ cash needs. Both crops and livestock productions are equally important for rural households in the region. Food crops and livestock production in the study areas are virtually small-scale, subsistence and crucially dependent on rainfall.

2.1.1.2. Infrastructure

The development of infrastructures such as health services (both human and livestock), education services, communication networks, roads, etc. are important for sustainable agricultural development. Regarding educational establishments, the report of Bureau of Education (BOE) shows that in the study areas there are 17 elementary schools, nine elementary and junior secondary schools, and three farmers’ skill-training centers (FTC). Better rural roads and electric services were networked throughout the districts.

2.2. Sources of Data

For the purpose of this study, both primary and secondary data were used. Secondary data were collected from published and unpublished materials. Primary data was collected through an interview using structured questionnaires. An interview was made for the head of household for all household members who were better informed about the activities of the children. The questionnaires were prepared in English language and translated to Afaan Oromo which is the local language.

2.3. Sample Size and Methods of Sampling

Three stages purposive and random sampling techniques were used to select 180 households from three districts. The special administrative feature of the region is that it has no zone but has a total of 12 districts. In the first stage, a total of three rural districts were purposively selected on the account that they were farming communities which best represent the rural areas of the region. On the second stage, based on the distance from the center of the region access to school a stratified random sampling method was used to select a total of nine PAs (three PAs from each district) among the three districts( Dire Teyara, Sofian and Erer). Finally, a systematic random sampling technique was used to select a total of 180 households from the nine PAs. During the selection, street children’s were not included because the objective of this study is to analyze the income contribution of child labor to rural households. The assumption is that they were not contributing any to the rural households’ income (Table 1).

2.4. Methods of Data Collection

Data collection was conducted from December 2008 to April 2009. Primary data were collected from 180 sample households using a pre-tested structured questionnaire, which was designed to generate data on some socio-economic, institutional, and human capital variables that are related to child labour. Nine enumerators (one from each Peasant Associations) who are fluent in the local language were recruited and trained on the methods of data collection and interview techniques. Field trips were made before the actual survey to observe the overall features of the selected PAs and to pretest the questionnaire. For pretesting purpose, nine farm households were interviewed. After pre-testing, discussions were held with the enumerators on their field experiences, clarity of questions, language used unexpected responses, and additional response options for questions. After
incorporating the comments, the final version of the questionnaire was prepared. Continuous supervision was made by the principal researcher to correct possible errors on the spot.

2.5. Methods of Data Analysis
This study employed both descriptive statistics and econometric methods to analyze the data.

2.5.1. Descriptive analysis
Descriptive statistics give a clear picture of the characteristics of the units under study. By applying descriptive statistics one can describe, compare, and contrast different categories of sample units with respect to the desired characteristics (Sonia, 2001). In this study, descriptive statistics such as mean, standard deviation, percentages, and frequency of occurrence were used to describe the sample units.

2.5.2. Effective labour supply model
The magnitude of the contribution of child labour to family labour was estimated by applying effective labour supply model:

\[ E^S = \sum P_i L_i \]

Where: \( E^S \): Effective labour supply per day per household (adult-equivalent),
\( P_i \): Man-day of the age group (i) which captures specific productivity differentials,
\( L_i \): The number of workers of age (i) per household.

The coefficient of \( P_i \) for adult-equivalent was adopted from Storck et al. (1991).

The difference in average effective labour supply is calculated as:

\[ \Delta E^S = E^S_c - E^S_A \]

Where: \( \Delta E^S \): Change in effective labour supply,
\( E^S_c \): Effective labour supply of child of household in AE and,
\( E^S_A \): Effective labour supply of adults.

The effective labour supply model quantitatively measures the difference in labour supply between the child and adult in the households.

2.5.3. Cobb-Douglas household income function model
The Cobb-Douglas model was used to estimate household's income function with household characteristics (Adult wage market, demand side characteristics of child labour, household head sex, land, education and age of the household head) and labour variables (hours of labour by children, male adults and female adults) as explanatory variables (Cockburn, 2002).

Child work, whether it is enabling or productive, and the marginal product varies with the level of labour participation (law of diminishing returns). In the case of productive labour, we can evaluate the marginal income contribution of child labour by setting it to zero and the child work time in an estimated household production function and measuring the resulting change in predicted total income, assuming that all other variables are unchanged (Cockburn, 2002). Analysis of the marginal income contribution of enabling child labour requires the specification of household model. In Cobb-Douglas production function, household’s income is the function of household labour (L), capital (K) including assets like land and technological influence (A), \( \alpha \) and \( \beta \) = parameter to be tested.

\[ Y = AL^\alpha K^\beta \]
To structure the discussion, a simple two-member (L_A = one adult labour and L_C = one child labour) agricultural household production model was adopted with competitive adult and child labour markets:

2.5.4. Multiple linear regression models

Multiple linear regression model was used to analyze factors that affect child labour supply. This model is selected for its simplicity and practical applicability. It is specified as:

\[ L_C^H = \beta_0 + \beta_1 FMS + \beta_2 AWH + \beta_3 PE + \beta_4 ED + \beta_5 SX + \beta_6 DSC + \beta_7 FS + \beta_8 NSG + e \]

Where: \( L_C^H \) is the amount of household labour supplied by child, \( \beta_i \)'s are parameters to be estimated, FMS is family size, AWH is adults working hours, PE is parents’ employment, ED is household heads education level, SX is household heads sex, DSC is demand side characteristics for child labour, FS is farm size, NSG is non-school going children and e-random term.

2.5.5. The multinomial logit model

The multinomial logit model is used to analyze factors that cause a child to undertake several activities simultaneously.

The probability of a child having activity \( j \) (\( j = 0 \) idle; \( j = 1 \) school only; \( j = 2 \) work only; and \( j = 3 \) school and work) will be estimated by the following multinomial logit model:

\[
Pr(Y_i = j) = \frac{\exp(x_i \beta_j)}{1 + \sum_{j=1}^{3} \exp(\beta_j x_i)}
\]

Where: \( \beta_j \)-parameters to be estimated, \( \exp \)-exponential that captures the explanatory variables, \( x \)-Explanatory variables.

3. RESULTS AND DISCUSSION

This chapter presents the results of descriptive and econometric analyses. Descriptive analyses were used to describe the general characteristics of sample households and child labour supply. Econometric analyses include the estimation of the Cobb-Douglas production function, multinomial logit model, effective labour supply model and multiple linear regression models. (Table 2 and 3).

3.1. General Characteristics of the Sample Households

Of the sampled households, 88.89% are married, 6.11% are widowed, and 5% are divorced. Of the sampled respondents, 8.3% are female headed and 91.67% were male headed households. The average family size of the sample households was 5 persons, the largest family size being 9 and the smallest being 3. The average number of family members in the study area (8-64 ages) was 3.18. The average land holding of the sample households was 0.76 ha, where the largest holdings were 2.25 ha and the smallest was 0.25 ha. Regarding formal education of the sample households, about 24% were illiterate, 17% were between 1-4 grade levels, about 48% were 5-10 grade level and about 11% were above grade 10 levels.

3.1.1. Distribution of non-school going (NSG) children

Of the sample respondents, 33.3% send all their children to school or they have no children out of school or school age child. Results shows that the average working hours per day for these school
attending children is 4.15. About 34% households have one child not attending school and the average working hours per day has increased to 5.4, and 21.6% of the respondent households had two children not attending school with an average working hour of 5.42. Finally 11% of the sample households did not send their three children to school; with the average working hours of 6.85 while the average working hours per day of children in the study area is 5.15.

3.1.2. Primary reasons for children not to attend school
During the survey, sample respondents were asked why some of their children were not attending school. The results show that the majority of the respondents (54.5%) reported that their children were not attending school due to work related reasons. Out of these work related reasons, 23.75% of the sample households reported that their children were not attending school because they require them for different household activities like fetching water and collecting wood, cooking, cleaning, and herding. Even though the result shows that the burden of children in household's activities decreases with age both for boys and girls, which of girls weigh. Moreover, 17.5% of the sample respondents reasoned out that their children are not attending school because they help them in farm related activities like messaging services, cultivation, weeding, harvesting, and transporting of farm inputs/outputs to and from the farm fields. The other reason reported by 6.25% of the households for not sending their children to school were, they require them to care for their baby even though this decreases with age. Moreover, 7% of the respondents reported the reason why their children were not attending school because they require them to work for wage. In the study area, during the survey period child wage was the same with adult’s wage which was 20 Birr per day excluding children aged 5-10 years (Table 4).
This is because in the study area labour shortage was observed at the time of land preparation, cultivation, sowing/ planting, harvesting, and transporting of farm inputs/outputs. The result also shows that 2% of the girls aged 5-10 years work for wage. They take care of baby and the payments were made directly to their parents and the amount depends on the informal agreements between parents.
In the study area, 13.755% of the respondents reported the reason for their children not attending school was because they are unable to cover educational costs. Finally, 13.25% of the sample respondents reported other reasons like drop out.

3.1.3. Children’s main activities
In this study, children included are individuals whose ages are between 5 and 17 years. About 57.63% of the children attend school. In the study area, 10.72% children in the sample households have work as their main activity, 16.85% children have both school and work as their main activities. Finally, 14.8% children do not attend school and do not work (Table 5).

3.1.4. Primary work activities of children
The study results show that fetching wood/water and herding livestock constitute the principal activities for 33.8% and 29.9% of the children respectively. However, there are variations by age and sex. Younger children primarily herd, fetch wood/water, domestic work, and mind other children. About 44% of 11-17 years old boys practice farm work as their main work activity followed by herding and fetching wood/water, while about 45.7% and 29.2% of the 11-17 year old girls participate in fetching wood/water and domestic work respectively. Generally, more girls participate in domestic work and boys in farm work. Moreover, participation increases with age. Almost all work is accomplished within the household although roughly one in five of 11-17 year olds children participate to some degree in family business work, either selling of farm products and animal products or petty trade (Table 6).

3.1.5. Education and child labour supply
Education level of the household head is one of the most important variables that influence child labour. It was hypothesized that education of the parents or the household head decreases the probability of child working and increases the probability of school attendance significantly. In the study areas, 31.67% of sample household heads were illiterate and 27.78% were in the educational level ranges between 1-4 grades, 27.78% were between 5-8 grade and 6.67% were grade 9 and 10 and 6.11% were grade 11 and above. The survey results show that of the sampled respondent large portions were illiterate and children working hours per day for these groups of farmers were 6.61 with a standard deviation of 1.94, which is by far higher than the other groups (Table 7).

3.1.6. Farm size and child labour supply
Inadequate and irregular rainfall, high population density, and small land holding are the major features of the study area. In addition to small land holding, the less productivity of land requires more labour force to produce sufficient amount. The study results show that 29.4% of the sample households were holding a land less than 0.25 hectare and their children were expected to work for an average of 4.69 hours per day. The child working hours per day increases with land holding and it reaches its maximum (6.9 hours per day) for households holding 1.75 hectare (Table 8).

The wealth status of the rural households mainly depends on land holdings. The survey result also shows that 2.2% and 2.7% of the sample respondents holds land of 2 hectares and 2.25 hectares respectively. Moreover, children working hours per day for these households decreases to 4.5 hours per day and 5.8 hours per day because land holding increases the level of income for farming households.

As hypothesized land holding increases the child working hours per day. In this study the increased level of income in turn decreases the child working hours per day. The standard deviation within the households having 2.25 hectares of land is 2.38 which indicates that even though households having 2.25 hectare of land face more labour shortage on the farm they are economically in a better position to hire in labour than using the labour of their children. Generally, average child working hours per day increases with land holding even though the maximum land holdings of the household is limited to 2.25 hectares and average working hours of children is 5.15 hours per day and average land holding in the study area is 0.76 hectare.

3.1.7. Sex and child labour supply
The gender of the head of household is one of the factors hypothesized to influence child labour supply and schooling. It was hypothesized that female headed households usually have higher dependency ratio which may increase the likelihood of sending children to work. So a dummy for male headed household and female headed household is used.

The survey result shows that of the total sample households 91.66% were male headed households in which their children’s’ working hours per day is 3.64 (Table 10). Of the sampled respondents 8.33% were female headed households and their children were expected to work for 6.58 hours per day. That means children participate in different activities that are essential for the households. Generally, child burden in terms of working hours per day is higher for female headed households than male headed households.

3.1.8. Family size and child working hours
It was hypothesized that family size has a negative influence on child working hours per day. The survey result shows that in the study area for 10.55% of the sample households child working hours per day is 8.158. For households having family size of 3 persons is the maximum which decreases with family size and reaches at its minimum which was 2.277 hours per day for households having 9 family members. About 15% of the sample households were having 5 persons per family and their children's working hours per day is 6.518. The result shows that in the households having more family members, the child working hours per day decreases. This is due to large number of
3.2. Households' Labour Utilization

Farmers are engaged in different agricultural activities throughout the year. Labour requirement reaches its peak during the main agricultural periods (land preparation, sawing, cultivation, weeding, and harvesting). Human labour is also required for transporting farm inputs/outputs to and from farm. In the study area, almost all sample households reported labour shortage to effectively undertake their agricultural activities despite the higher average family size of five. This might be due to the extensive involvement in different activities and the low productivity of land. The insufficient water supply and mixed farming system on small scale, livestock, and crop production may require more labour (Table 14).

3.2.1. Mechanisms used by sample households to overcome labour shortage

The result presented in Table 15 shows that those farmers in the study area use different mechanisms to overcome labour shortage. Of the total sample households, 31.7% reported that they cover their labour shortage by their children. About 28.9% of the sample households overcome their labour shortage by hiring in labour and 22.7% cover it through labour exchange, which is the most common and potential labour supply mechanism in the study area. The rest (8.9%) reported that they overcome labour shortages by the assistance they receive from their relatives. Another potential labour supply method during the critical labour shortage period was ‘Dabo’ or ‘Guza’. It is the traditional way of supplying labour by a group of youth and old men from both sex to someone up on his/her request at the time of labour shortage; sawing, cultivation, harvesting and transporting. ‘Dabo’ or ‘Guza’ was also used at the time of construction of houses to accomplish the activities within short period of time. This type of labour supply has no payment for participants.

3.2.2. Activities performed by children to earn income for their families

The survey results show that in the sampled households there are 228 working children aged 5-17 to earn income for their families. Out of this, 67.98% of the children participated in petty trade such as chat, vegetables, root and tubers like potato and sweet potato and animal products like milk in which girls participated more than boys. Moreover, 17.98% children participated in work for wage or daily labourer where boys’ participation is higher. About 9.21% children earn money from selling local products like firewood. Finally, 4.82% children participated in other activities that generate income for their families (Table 13).

3.2.3. Household member's labour contribution in terms of adult equivalent

In the study area there was a continuous demand for labour to undertake farm and domestic activities. All the required labour was supplied either by the household members or hiring in labour and social assistance and assistance from relatives. The main sources of households labour are adults and children. Survey results show that about 16.89% of the total household’s labour was supplied by their children. Adult's supply 82.79% of the total household’s labour. That is, average AE of each sample household per day is 2.76. Though children aged 5-7 work for 3.7 hours per day and contributed labour to the household it was found to be difficult to measure their contribution since the conversion factor used to AE is zero for ages under 7. Children aged 5-17 work for an average of 5.1 hours a day and 4.5 days a week (Table 14).

3.3. Econometric Results

3.3.1. Results of the effective labour supply model

To estimate the magnitude of contribution of household’s labour supply the effective labour supply model was adopted. The study focuses on children with age ranges between 5-17 years and adults, keeping other sources of household labour supply constant. To effectively estimate the magnitude of child and adult labour supply to total household labour supply the base unit used is working hours.
per day and working days per week and the conversion factors into adult equivalent (AE) by Strock et al. (1991).

In the sample households, children were working for 5.15 hours per day and 4.5 days per week, and adults were working for 8.35 hours per day and 5.40 days per week. The working hours per day were the maximum on Saturday and Sunday both for child and adults.

The average child labour contribution per day is 0.67 AE and the average adult labour contribution per day equals to 1.55 AE. The average number of children per household is 1.27 and the total child labour contribution per household is 0.84 AE or 22.10% per day. The average number of adults per household is 1.92 and the total adult labour contribution per household is 2.97 AE or 77.90% per day. The difference in the average effective labour supply is -2.13 AE. The negative sign shows that adult’s labour contribution per day is greater than children’s labour contribution per day. This indicates that households were characterized by labour shortage or deficit. Therefore, they were expected on average to hire in 2 AE per day per household. The total average household labour supply per day in AE for the sample households having 5 family members is 3.81 AE per day per household (Table 15). This means:

\[ \Delta E^S = 0.84AE(E^S_C) - 2.97AE(E^S_A) = -2.13AE : \text{Labour deficit in a household.} \]

**Table 15. Household labour supplies by labour class and age in terms of AE**

<table>
<thead>
<tr>
<th>Labour class</th>
<th>Age group (years)</th>
<th>Average working hr/day</th>
<th>Average AE contributed / day/person</th>
<th>Average AE contributed / week/ person</th>
<th>Average number of active household members</th>
<th>Total average AE contributed / household/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>5-17</td>
<td>5.15</td>
<td>0.67</td>
<td>2.99</td>
<td>1.27</td>
<td>0.84</td>
</tr>
<tr>
<td>Adults</td>
<td>18-64</td>
<td>8.35</td>
<td>1.55</td>
<td>8.37</td>
<td>1.92</td>
<td>2.97</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Own survey result, 2009.

**3.3.2. Results of Cobb-Douglas production function on child labour supply**

The survey results provide information on the determinants of each child’s main activities (work, school, work and school, or inactive). To compute children’s marginal income contribution using a Cobb-Douglas production function the alternative child work was identified. The dependent variable is child working hours per day or child labour supply of households. The coefficients on the household variables are indicating the marginal contribution of variables on child working hours per day. At 1%, 5% and 10% significance level, the model hypothesis that the coefficients on the variables are \( F(9,170) = 18.17 > F_{0.05}(9,170) = 1.93 \). It has an adjusted R\(^2\) = 0.46 that is practically identical to those obtained with logistic regression and the marginal effects of multinomial logit result (Table 16).

The distribution parameters such as household head sex, household head level of education, adult working hours per day, parent employment, age, and family size are the significant variables that affect child working hours.

Among the household’s characteristics household head sex, demand side characteristics for child labour, and family size have significant positive effect on child working hour per day. That is, unit increases in parameters will increases the children marginal contribution by a factor of 0.279, 0.188 and 0.337, respectively.

Parent’s employment, household head’s education level, household head’s age, and adult working hours per day have a significant negative impact on children’s marginal contribution of labour. That
is a unit increase in these four variables each will decrease child’s marginal contribution by 0.513, 0.362, 0.068 and 0.188, respectively.

About 51.3% of change in child working hours per day is due to a unit change in parent employment in formal or public. About 36.2% of change in child working hours per day is due to a unit change in education level of household head. That is as the household head education level increases children get more opportunity to attend school by decreasing their working hours per day. About 18.8% of the change in child working hours per day is due to a unit change in adults working hours per day. That is, in the sample households as adults increases their working hours per day they share more labour supply of the household and children get more free time to attend school.

3.3.3. Results of the multiple regression model

As discussed earlier, the multiple regression models were used to analyze the determinants of the marginal income contribution of child labour supply. In this analysis four statistically significant explanatory variables were identified. Based on the model result, households head education level and adults working hours were found to have a negative significant impact on the child labour supply, while the remaining variables such as demand side characteristics of child labour and farm size have a significant positive impact on the child labour supply in the analysis of determinants of marginal income contribution of child labour supply in rural households of Harari region.

Out of the nine proposed variables, four of them were statistically significant in the model while the rest were not significant at 1%, 5%, and 10% significance level (Table 17).

The significant variables included; households Farm Size, Households heads education level, Adult working hours per day, and Demand side of child labour supply. But the rest were insignificant variables.

**Households Farm Size (FS):** The land holding of a household has a significant positive impact on the child working hours per day. In other words, for the households having relatively large farm size the child working hours per day is high and low for small land holding households. This variable is significant at 10 percent and the slope shows that child working hour’s increases by a factor of 0.117 as the farm size of the household’s increases by one unit while other variables kept constant. As hypothesized large farm size has a significant positive impact on child labour supply. According to Cockburn, (2001), families having relatively large farm size are more likely to look for child labour. This study confirmed that large land holdings increases child working hours per day. In addition to size the low productivity of land in the study area require more labour to produce sufficient amount of products. On top of that, large size of land holdings enhance the burden on household members particularly children. This study identified that parents use their children labour to overcome the labour shortage. Children were very busy in fetching water for household’s consumption including for sanitation and watering of livestock in addition to farm activities.

**Household Heads Education Level (ED):** This variable has a negative significant influence on child working hours per day. In other words, in the sample households where the head of the household was educated their children were not expected to work many hours per day. This variable is significant at 5 percent level. The slope of the variable shows that child working hours decreases by a factor of 0.324 for 1 unit increase in household head education level while other variables kept constant. That is increasing the household head’s education level would initiate their children to attend school than work. The opposite is also true for illiterate families. A study by Jackline, (2000) found that parents’ education affects child labour negatively and school participation decisions positively. This study also confirmed that household heads education has a significant negative impact on child labour supply. The result shows that in the study area children from where head of the household was literate were participated less in work and more in school.

**Adult Working Hours per Day (AWH):** This variable has a statistically significant influence on child working hours in the study area. As hypothesized adult working hours has a significant negative influence on child labour supply. There is a negative relationship between adult wages and
child labour as identified by Basu and Van, (1998) that is higher adult wage would lead to higher supply of adult labour, and lower supply of child labour. The result shows that the variable has a significant negative impact on the child working hours. That is, the child working hours decreases by a factor of 0.167 for a unit increase in adult working hours if all other variables were kept constant. In the households with more adults labour supply, the children working hours was the minimum. The adult labour supply substitute child labour and let free children. In other words, households’ having more supply of adults’ labour, children working hours per day was the minimum and gets more free time to attend school.

**Demand Side of Child Labour (DSC):** This variable has a statistically strong positive significant effect on child working hours per day. As hypothesized the higher the share of adult’s labour supply in the households, the less would be the demand for child labour. The more public sector job in the province, the lower will be the demand for children employment. This is because public sector does not hire children under 17 years old, and second it may reflect the fact that the labour market is more formalized. Finally, the more non-regular-casual and seasonal employment in the study area, the more would be the demand for children work in that market.

According to Jackline, (2000), the higher the share of adults in household labour supply, the less would be the demand for children labour. The higher adult wage would lead to higher supply of adult labour, and lower supply of child labour. The results of the study confirmed that the demand side characteristic has a significant positive impact on child labour supply. As the slope of regression model analysis shows; the child working hours per day increase by a factor of 0.456 for a unit increase of the demand for child labour employment in the study area, while all other variables kept constant.

### 3.3.4. Results of the multinomial logit model

There may be several activities that children may undertake simultaneously. The study assumes that child’s unit-time endowment can be used for four mutually exclusive activities. At a particular time, a child could be only attending school, only working, etc. This gives rise to the polychotomous choice framework. Hence, the multinomial logit model was adopted to identify factors affecting the probability of a child having each activity.

The multinomial probability model assumes that the possible separating states are complete in that they cover all possibilities. The probability of each outcome is a function of the same set of explanatory variables \( X \). In this study four possible decision outcomes have been considered: school attendance only (A), work only (B), combining schooling and work (C) and being inactive (D).

Assuming that the inactive group is chosen as base alternative and considering the fact that the sum of the probabilities of the four alternatives must be one.

By differentiating the log likelihood function given on equation (11) with respect to the parameters \( \beta \), the maximum livelihood estimators can be generated through the model.

For continuous variables the marginal effect is the probability change in response to an increase in the value of the independent variable by one unit evaluated at the mean value. For dummy variables the marginal effect is computed as the difference in probabilities of the dependent variable between the groups with selected value one and the reference group (Asefa, 2002).

The probability identified by the computation of multinomial logit model are school attendance only, work only, combining school and work are 57.63%, 10.72%, and 16.85%, respectively (Table 18, 19, and 20).

The result shows that farm work participation of children in the study area has a negative significant implication on school attendance and positive implication on combining school attendance with work. As the number of hours on farm work increases by one unit children’s likelihood of school attendance decreases by 27 percent. The probability of combining school with work increases by nearly three percent.
The demand side characteristic of child labour supply has strong negative significant implication on school attendance and positive impact on the likelihood of child work. As the demand for child labour increases by one unit, their likelihood of attending school decreases by about three percent. The result also shows that parent’s employment in a formal sector having stable job has a significant positive impact on school attendance and a negative implication on the likelihood of their combining school attendance with work. A unit increase in the probability of parents’ stable regular job will increase the likelihood of their children’s school attendance by more than four percent.

Another significant variable is domestic work of children which has a negative significant implication on children school attendance and has a positive impact on the likelihood of their working. As the domestic work increases by one unit the likelihood of their school attendance decreases by four units. Their likelihood of combining work with school is increased by the same amount.

The result also shows that participation of children in family business has a negative significant impact on school attendance and a positive implication on their likelihood of combining work with school attendance. As the participation of children in to family business increases by one unit their likelihood of attending school decreases by 21 percents. Their likelihood of combining school attendance with work increases by the same amount.

In the study area, respondent households used their children’s labour supply as a coping mechanism of labour shortage. Moreover, they hire out their children’s labour in order to secure the household income. Therefore, the result shows that hiring out labour has a significant negative implication on the likelihood of children school attendance. As hiring out of child labour increases by one unit their likelihood of school attendance decreases by three percent.

Generally the analysis of the results from multinomial logit model confirms the hypothesis that parent employment, demand side characteristics of child labour, farm work, family business, and domestic work has a significant impact on children school attendance and child labour supply. The result also identified the probability of children time endowment to undertake a specific activity at a time, which is school only, is 57.63%, work only is 10.72%, school and work is 16.85% and idle is 14.8%.

4. SUMMARY AND POLICY IMPLICATIONS

4.1. Summary of the Major Findings

In countries like Ethiopia, where subsistence agriculture and smallholder farming dominate the overall national economy, smallholder farmers often face financial shortage. In order to increase their production and productivity they exploit their children’s labour to effectively undertake essential households’ activities and increase their income. However, child labour exploitation and abuse are prohibited by law and has an adverse effect on human capital formation and economy of the country.

Hence identifying the livelihood that children are involved in, estimating their marginal contribution to household labour and income and identifying the main determinants of child labour supply are crucial for policy makers and the society at large.

In this book both purposive and stratified random sampling techniques were used. On the first stage three rural districts (Dire Teyara, Sufi, and Errer) were purposively selected on the account that they were farming household areas which best represent the rural community of the region. On the second stage, a stratified random sampling method was used to select total of 9 PAs (3 PAs from each district) to keep homogeneity among the three districts. Finally, by using systematic random sampling technique a total of 180 respondent households were selected. During the selection households that had at least one child age ranges from 5-17 years were selected. In addition,
secondary data were collected from relevant sources to supplement the data obtained from the survey.

The results show that farm work participation of children in the study area has strong negative significant implication on school attendance and positive implication on combining school attendance with work. The demand side characteristic of child labour supply has a significant negative implication on school attendance and positive implication on the likelihood of children work. Parent’s employment in a formal sector having stable job has a significant positive implication on school attendance and a negative implication on the likelihood of their combining school attendance with work. Another significant variable is domestic work of children which has a negative significant implication on children school attendance and has a positive implication on the likelihood of their working. The result also shows that participation of children in family business has a negative significant implication on school attendance and a positive implication on their likelihood of combining work with school attendance. The result shows that hiring out labour has a significant negative implication on the likelihood of children school attendance.

Regarding the main activities that children are involved in, the study identified four main activities: work only, school only, combine work and school, and idle. The results from Cobb-Douglas household production function show the marginal contributions of child labour in different household activities. Among the household’s characteristics household head sex, demand side characteristics for child labour, and family size have significant positive implication on child working hour per day. Parent’s employment, household head’s education level, household head’s age, and adult working hours per day have a significant negative implication on children’s marginal contribution of labour.

The result of multinomial logit model is the probability of children involvement in the three identified main activities, that is the probability of children to attend school was 57.63%, the probability of children participation in work was 10.72%, and the probability of children attending school and working was 16.85% and the rest 14.8% were base reference or neither work nor attend school. The result of effective labour supply model shows that out of the total 3.81 AE per day per household labour is supplied by household members of which about 22.1% or 0.84 AE was contributed by children of the households.

The significant determinants identified by this study are farm size that is the land holdings of a household has a significant positive impact on the child labour supply, household heads education and adult working hours have significant negative impact on the child labour supply, and demand side characteristic of child labour has a significant positive impact on the child labour supply.

Understanding the determinants of child labour supply would help policy makers to design and implement more effective policies and programs for the child labour abuse and thereby helps to pave way for decreasing the child labour and increasing the child schooling.

4.2. Policy Implications

Based on the findings of this book, the following conclusions and policy implications can be drawn in order to minimize child labour exploitation and enhance child schooling which leads to better human capital formation the following measures need to taken.

1. The study shows that farmers face labour shortage throughout the year. To overcome the labour shortage they use their children’s labour which increases for households having relatively big farm size. In addition, the scarcity of water supply in the area and long distance of the source enhanced the burden on child in fetching. Therefore, the agriculture and rural development strategy should focus on supply of improved farm inputs, water harvesting structure and efficient technology should be scale-up at household level in order to minimize children labour spending on fetching water and on farm activities. Moreover, any
development strategy in the area should focus on the establishment of alternative energy sources so as to minimize child labour spending on collecting fire wood.

2. The findings of the study revealed that educated heads of households are more likely to send their children to school than to work and their children’s working hours per day was relatively found to be the minimum. Thus, education could be an effective instrument for decreasing child labour exploitation. Hence up grading the level of education for the household heads should be given special attention. Moreover, development programs should focus on the establishment of non-formal adult education besides the formal education at the local level.

3. Households having more active adult labor force supply the child working hours per day were the minimum. Therefore, development programs should focus on the establishment of different skill training centers of youth and adults so that youth enter into job and households can utilize their active and legal labour force to earn better income and minimize child labor exploitation.

4. Idle (neither working nor attending school) children is about 14% in the study area. Therefore, any development intervention should focus on those 14.8% of idle children so that they can attend school in order to increase human capital formation of the region.

5. Finally; demand side characteristic of child labour in the study area was high. The results show that the higher the shares of adult labour supply in the households the less would be the demand for child labour. The more public sector job opportunity in the study area, the lower would be the demand for child labour. The more non-regular-casual and seasonal employment in the study area, the more would be the demand for children work in the market. Therefore, the development intervention should focus on the establishment and strengthening of formal sector like bureau of labour and social affairs and child care at local level to minimize child labour and to put corner stone for the future human capital formation of the study area.

5. REFERENCES


GENDER ROLES AND CHALLENGES OF SMALL SCALE PROCESSED CASHEW NUT MARKETERS IN ENUGU NORTH SENATORIAL ZONE OF ENUGU STATE, NIGERIA

Enwelu, I. A*, Ugwu, S. T** and Irohibe, I.***
Department of Agricultural Extension,
University of Nigeria, Nsukka

Abstract
The study examined gender roles and challenges of small scale processed cashew nut marketers in Enugu North senatorial zone of Enugu State. Interview schedule was used to collect data from 72 respondents. The data collected were analysed using descriptive statistics. Small scale processed cashew nut marketers were dominated by female youths with mean age of 31 years and making a monthly income of between ₦10,000.00 - ₦14,999.00 from cashew nut marketing. The marketing strategy mostly used by marketers of processed cashew nut products in the study area was lowering of the product price (73.6%). The roles performed by marketers of small scale processed cashew nut products across gender were effective except selling of the products in which men were not involved at all. None of the extension services received by cashew nut marketers across gender was effective. The major challenges facing small scale processed cashew nut marketing enterprise were lack of institutional support (M=3.86) and poor quality of products (M=3.26). The study therefore recommends that the government critically examines its policy thrust on cashew nut production so as to attract private sector participation.

Key words: Gender roles, challenges, cashew nut, marketers, enterprise

INTRODUCTION

Nigeria’s interest in cashew nut production began in the early 1950’s when the plantations were introduced in Anambra, Imo, Enugu, Oyo and Osun states. These plantations were set up principally for the purpose of controlling erosion and soil protection. However, commercial exploitation began in the late 70’s and early 80’s when south Indian States increased their processing capacity of cashew. Indian processors, traders and their agents travelled round the villages of Nigeria and gave local buying agents (LBAs) and farmers cash advances in order to obtain the product. Over time, purchasing centres were opened to arrange procurement from
the hinterlands through local agents, and the produce exported to processing factories in India (Nugawela, and Oroh, 2005).

Cashews are high in calories (100g of nuts provide 553 calories). They are packed with soluble dietary fibre, vitamins, minerals and numerous health-promoting phyto-chemicals that help protect body from diseases and cancers. They are also rich in many essential vitamins such as pantothenic acid (vitamin B5), pyridoxine (vitamin B-6), riboflavin, and thiamin (vitamin B-1). These vitamins are essential in the sense that our body requires them from external sources to replenish and are also essential for metabolism of protein, fat, and carbohydrates at cellular levels. In addition, the nuts also contain small amount of Zea-xanthin, an important flavonoid antioxidant, which are selectively absorbed into the retinal macular lutea in the eyes. It also provides antioxidant and protective UV ray filtering functions and helps prevent age related macular degeneration (ARMD) in the elderly (www.nutrition-and-you.com/cashew-nut.html).

In Nigeria, cashew is increasing its importance as an export oriented cash crop since 1990s. It is becoming an important source of non-oil export earnings – (estimated to represent about 7 to 8% based on export data of 2003) and also an important source of supplementary on – farm income to thousands of farmers and marketers employed by the sector (Nugawela and Oroh 2005). According to them, the present annual export income estimates stated, tend to suggest that the exports income from raw nuts may vary between US$ 25 to 40 million annually. This represents a significant percentage of non- oil exports of Nigeria.

However, the long term neglect of cashew industry in favour of oil production and exploration left Nigeria behind in competing for the global market worth of $1 billion. Cocoa Research Institute of Nigeria (CRIN), (FAO, 2000) started research into processing, marketing and economy of cashew products in 1972. Presently, in Enugu state especially Enugu North senatorial zone, local cashew nut marketers usually made up of youths, women and men are engaged in small scale cashew nut enterprise as a means of livelihood. Nugawela and Oroh (2005) confirm that this sector (cashew nut enterprise) has a high impact in creating income generating opportunities for women in cultivation, harvesting, post harvest operation and in processing and marketing.

In the boom period of cashew nut enterprise, buying and selling of cashew nut was hot business. But with the dwindling production of cashew nuts and lack of functional modern processing equipment in cashew producing areas, marketing was concentrated on locally processed nuts bought and sold in major towns/cities and local villages (http://www.scribd.com/ozorhyacinth). The start off capital although small but still poses serious challenges to some small scale marketers. The high poverty level in most rural communities which is compounded by unemployment situation compels men, women and youths to engage in small scale processed cashew nut market enterprise.

In view of the foregoing, the study sought to: describe the socio-economic characteristics of small scale processed cashew nut marketers; ascertain marketing strategy of small scale processed cashew nut products; determine gender roles effectiveness of small scale processed cashew nut marketers; determine effectiveness of extension services received by small scale processed cashew nut marketers across gender; and determine challenges of small scale processed cashew nut marketing enterprise in the zone.

**METHODOLOGY**

The study was carried out in Enugu North senatorial zone of Enugu State, Nigeria. The zone is endowed with rich guinea savannah vegetation cover and good climatic condition for cashew nut production. Marketing, food processing, hunting, weaving, arts and crafts among other economic activities are performed by men, women and youths. The population of the study comprised all small scale cashew nut marketers in the zone. Out of seven local government areas
(LGAs) in the zone, three were randomly selected namely Nsukka, Igbo-etiti and Udenu. A preliminary survey was conducted in each of the selected LGA to identify town/village communities engaged in small scale cashew nut marketing. Two town communities involved in small scale cashew nut marketing were purposively selected in each LGA. A list of 20 cashew nut marketers (men, women and youths) was compiled in the village community selected from each town community. From the list compiled, 12 small scale marketers (made up of 4 men, 4 women and 4 youths) were randomly selected which gave a total sample size of 72 respondents for the study. Data were collected through the use of interview schedule. The socio-economic variables such as age, sex, marital status, income etc were measured thus: age (years), sex (male and female), marital status (married, single, divorced and separated), income (₦) etc. Marketing strategy was ascertained by asking the respondents to identify strategies used in marketing of processed cashew nut products from the list of strategies provided. Gender role effectiveness of small scale processed cashew nut marketers was rated on a three point Likert-type scale of very effective (2), effective (1) and not effective (0). The values were summed up to 3 and divided by 3 to give a mean score of 1.0. Therefore, variables with mean score greater or equal to 1.0 were regarded as effective roles while those with mean scores less than 1.0 were regarded as roles not effective. Also, the effectiveness of extension services received across gender was rated on a three point Likert-type scale of very effective (2), effective (1) and not effective (0). The values were summed up to 3 and divided by 3 to give a mean score of 1.0. Therefore, variables with mean score greater or equal to 1.0 were regarded as effective extension services while those with mean scores less than 1.0 were regarded as not effective extension service. On the other hand, challenges of small scale processed cashew nut marketing enterprise were measured on a four point Likert-type scale of major challenge (4), minor challenge (3), very minor challenge (2) and no challenge (1). The values were summed up to 10 and divided by 4 to give a mean score of 2.5. Therefore, variables with mean score greater or equal to 2.5 were regarded as major challenge while those with mean scores less than 2.5 were regarded as minor challenge. The data collected were analysed using percentage and mean scores.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Small Scale Processed Cashew Nut Marketers

Small-scale processed cashew nut marketers were dominated by females (80.4%) (Table 1). The mean age of the marketers was 31 years and a greater proportion (43.1%) was married. The mean age of the respondents implies that they are in their economically active years and as such are energetic to carry out cashew nut marketing. The average household size was six with 54.2% of the respondents making a monthly income of between ₦10,000.00 - ₦14,999.00 from cashew nut marketing. Their economic status though not high in terms of their monthly income from the enterprise but has possibility of improvement if the present Federal Government Transformation Agenda in Agriculture is fully implemented. This will directly and indirectly tackle the problem of unemployment in the country. About 28.0% had no formal education and majority (72.2%) had 1-10 years experience in cashew nut marketing. The respondents are fairly educated as expected from their age and this has the tendency to boost the adoption of any technology or innovation that can be introduced to revamp the entire cashew nut industry in Enugu State with abundant resources for cashew nut enterprise. Greater proportion (47.2%) of the respondents belonged to farmers’ organization while majority (86.1%) used family labour in cashew nut marketing. The use of family labour in marketing of processed cashew nut is an indication of importance attached to the business as part of family strategy for economic survival

<table>
<thead>
<tr>
<th>Socio-economic characteristics</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Mean (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Distribution of socio-economic characteristics of processed cashew nut marketers
<table>
<thead>
<tr>
<th>Age</th>
<th>19</th>
<th>26.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>18</td>
<td>25.0</td>
</tr>
<tr>
<td>40-49</td>
<td>18</td>
<td>25.0</td>
</tr>
<tr>
<td>50 and above</td>
<td>17</td>
<td>23.6</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
<td>19.4</td>
</tr>
<tr>
<td>Female</td>
<td>58</td>
<td>80.6</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>23</td>
<td>31.9</td>
</tr>
<tr>
<td>Married</td>
<td>31</td>
<td>43.1</td>
</tr>
<tr>
<td>Divorced/separated</td>
<td>10</td>
<td>13.9</td>
</tr>
<tr>
<td>Widowed</td>
<td>8</td>
<td>11.1</td>
</tr>
<tr>
<td>Educational qualification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>20</td>
<td>27.8</td>
</tr>
<tr>
<td>Primary</td>
<td>27</td>
<td>37.5</td>
</tr>
<tr>
<td>Secondary</td>
<td>21</td>
<td>29.2</td>
</tr>
<tr>
<td>OND/HND/Degree</td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>Monthly income from cashew</td>
<td></td>
<td></td>
</tr>
<tr>
<td>₦0.00-₦4,999.00</td>
<td>11</td>
<td>15.3</td>
</tr>
<tr>
<td>₦5,000.00 - ₦9,999.00</td>
<td>7</td>
<td>9.7</td>
</tr>
<tr>
<td>₦10,000.00 - ₦14,999.00</td>
<td>39</td>
<td>54.2</td>
</tr>
<tr>
<td>₦15,000.00 and above</td>
<td>15</td>
<td>20.8</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>23</td>
<td>31.9</td>
</tr>
<tr>
<td>5-9</td>
<td>34</td>
<td>47.2</td>
</tr>
<tr>
<td>10-14</td>
<td>15</td>
<td>20.8</td>
</tr>
<tr>
<td>Processing experience (Years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10</td>
<td>52</td>
<td>72.2</td>
</tr>
<tr>
<td>10-20</td>
<td>20</td>
<td>27.8</td>
</tr>
<tr>
<td>Social organization belonged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm organization</td>
<td>34</td>
<td>47.2</td>
</tr>
<tr>
<td>Religious organization</td>
<td>27</td>
<td>37.5</td>
</tr>
<tr>
<td>Social club</td>
<td>9</td>
<td>12.5</td>
</tr>
<tr>
<td>None</td>
<td>2</td>
<td>2.8</td>
</tr>
<tr>
<td>Source of labour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hired labour</td>
<td>10</td>
<td>13.9</td>
</tr>
<tr>
<td>Family labour</td>
<td>62</td>
<td>86.1</td>
</tr>
</tbody>
</table>

**Marketing Strategy of Small Scale Processed Cashew Nut Products**

Entries in Table 2 show that the marketing strategy mostly used by marketers of processed cashew nut products in the study area was lowering of the product price (73.6%). Other strategies utilized by small scale processed cashew nut marketing enterprise were: bonus/extra (34.7%); quantity (22.2%); quality (19.4%) and honesty (16.7%). Low price is an effective strategy for marketing of processed cashew nut products probably because of the high poverty level in the rural communities of Enugu North senatorial zone. Consequently, increase in price of the product may lead to very low sales which can adversely affect the family of marketers who probably depend on income from the product for family upkeep. Also, the marketers may be willing to sell at low prices probably because the raw cashew nut may be collected from their own plantation/wild plantation and processed with local processing
instruments. The traditional marketing strategy of giving bonus/extra to buyers was probably done to encourage them purchase more cashew nut. Marketing of processed cashew nut products may not be based on its quantity because of the small quantity that can be available through local processing. Also, few quantities of cashew nut may be consumed in the area as supplementary food and not as main food. On the other hand, quality may not be a major factor in the marketing strategy of small scale processed cashew nut products considering the processing method at their disposal at this level of enterprise. Surprisingly, honesty was the least marketing strategy employed which may account for dubious packaging of cashew nut products (with chaff and stones) in the rural/urban markets.

<table>
<thead>
<tr>
<th>Marketing strategy*</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low price</td>
<td>53</td>
<td>73.6</td>
</tr>
<tr>
<td>Quantity</td>
<td>16</td>
<td>22.2</td>
</tr>
<tr>
<td>Honesty</td>
<td>12</td>
<td>16.7</td>
</tr>
<tr>
<td>Bonus/extra</td>
<td>25</td>
<td>34.7</td>
</tr>
<tr>
<td>Quality</td>
<td>14</td>
<td>19.4</td>
</tr>
<tr>
<td>*Multiple responses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Distribution of marketing strategy of processed cashew nut products

Gender Role Effectiveness of Small Scale Processed Cashew Nut Marketers

The roles performed by marketers of small scale processed cashew nut products across gender in Table 3 were generally effective except selling of the products in which men were not involved at all. The youths played more effective roles than others in selling (M=2.00), packaging (M=2.00) and grading (M=1.90). They were followed by women in selling (M=1.93), packaging (M=1.72) and grading (M=1.72). Men only played effective roles in packaging (M=1.5) and grading (M=1.0). From these findings, it can be inferred that marketing of processed cashew nut products is a family business enterprise involving all members of the family. This finding contrasts that of Nugawela and Oroh (2005) who emphasized that women mainly played major role in marketing. For all members of the family to be interested in the enterprise implies that the enterprise is lucrative and as such contributes to family livelihood survival. It is also evident that the unemployed youths are engaged in this enterprise to eke a living while waiting for better opportunities.

Table 3: Mean scores of gender role effectiveness of processed small scale cashew nut marketers

<table>
<thead>
<tr>
<th>Operations</th>
<th>Men M</th>
<th>Women M</th>
<th>Youth M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading</td>
<td>1.0</td>
<td>1.72</td>
<td>1.90</td>
</tr>
<tr>
<td>Packaging</td>
<td>1.5</td>
<td>1.72</td>
<td>2.00</td>
</tr>
<tr>
<td>Selling</td>
<td>0.00</td>
<td>1.93</td>
<td>2.00</td>
</tr>
<tr>
<td>Cut off: M=1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effectiveness of Extension Services Received by Small Scale Processed Cashew Nut Marketers across Gender

Table 4 highlights the extension services received by small scale processed cashew nut marketers (including men, women and youths). None of the extension services received by youths namely sharing of market information (M=0.28), help in formation of market association
and training of marketers (M=0.01) were effective. Similarly, those received by women such as sharing of market information (M=0.88), training of marketers (M=0.33) and help in formation of market association (M=0.15) and were also not effective. Also, those of men were not effective like training of marketers (M=0.23), sharing of market information (M=0.20) and help in formation of market association (M=0.05). The implication of this finding is that this category of extension clientele is not effectively covered by extension agents. This may probably be attributed to the low degree of importance placed by extension agents to the area of marketing of cashew nuts. Furthermore, the ability of an extension agent to perform his duties effectively depends on a number of factors. Ogunbameru (2011) stated that lack of funds is responsible for the sliding performance of Nigerian extension service and the resultant effects includes high farmer to extension worker ratio, stagnation of both field and supervisory work, low morale of staff and invariably decreased agricultural production, among others. A motivated extension agent will deliver his assignments creditably.

Table 4: Mean scores of effectiveness of extension services received by cashew nut marketers across gender

<table>
<thead>
<tr>
<th>Extension services</th>
<th>Men</th>
<th>Women</th>
<th>Youth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training of marketers</td>
<td>0.23</td>
<td>0.33</td>
<td>0.01</td>
</tr>
<tr>
<td>Sharing of market information</td>
<td>0.20</td>
<td>0.88</td>
<td>0.28</td>
</tr>
<tr>
<td>Help in formation of market association</td>
<td>0.05</td>
<td>0.15</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Challenges of Small Scale Processed Cashew Nut Marketing Enterprise

Data in Table 5 show that the major challenges facing small scale processed cashew nut marketing enterprise were: lack of institutional support (M=3.86); poor quality of products (M=3.26); low selling prices of the products (M=2.87); and scarcity of cashew nut (M=2.79). The only minor challenge was lack of market information (M=2.43). The challenge of lack of institutional support in the study area stands out as the greatest obstacle to small scale processed cashew nut enterprise. The implication of this finding is that small scale cashew nut marketers apart from family institution do not receive support from government and other non-governmental organizations (NGOs). One government institution that can render support to cashew nut marketers is agricultural extension service through execution of extension programmes geared towards human capital development and mobilization of resources for revitalization of the cashew industry. The challenge of poor quality of products is a reflection of the inability of Enugu State government to maintain modern cashew nut processing plant procured in the state. The continual use of local/traditional cashew processing method is a major set back to small scale processed cashew nut marketers. Supermarkets surveyed in Lagos in a 2003/2004 by New Nigerian Foundation (NNF) study on domestic consumption indicated an increasing demand with consumers having preference for kernels of higher quality going by the increasing number of imported brands appearing on the shelves in the super markets with some of the imported brands reported as products coming from the U.S.A. (Nugawela and Oroh 2005). The challenge of low selling prices is as a result of poor quality which is the outcome of low processing technology. The scarcity of cashew nut for processing is another challenge militating against the growth of small scale cashew nut marketing enterprise. This is in line with Ezeagu (2002) who reported that processing plants were installed on the assumption that raw nuts supply was sufficient. However, after the installation of several plants it was discovered that cashew nuts were not always available when needed. It is only when export prices are low, and exporters of raw cashew nuts are left with unsold stocks, that domestic processors can secure sufficient supplies of raw material.
Table 5: Mean scores of challenges of small scale processed cashew nut marketing enterprise

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Mean (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of market information</td>
<td>2.43</td>
</tr>
<tr>
<td>Low selling prices of the products</td>
<td>2.87*</td>
</tr>
<tr>
<td>Poor quality of products</td>
<td>3.26*</td>
</tr>
<tr>
<td>Lack of institutional support</td>
<td>3.86*</td>
</tr>
<tr>
<td>Scarcity of cashew nuts</td>
<td>2.79*</td>
</tr>
</tbody>
</table>

*Major challenges

CONCLUSION/RECOMMENDATIONS

Findings from the study showed that marketers of small scale processed cashew nut products played effective roles in all aspects of marketing except men who were not involved in actual selling of the products. Also, it was established that youths played more effective roles than others in selling, packaging and grading followed by women. The main strategy adopted by marketers of processed cashew nut products was lowering of the product prices. It was also discovered that none of the extension services received by marketers was effective. Finally, the study highlighted the challenges facing small scale cashew nut enterprise in the zone to include: lack of institutional support, poor quality of products, low prices of the products and scarcity of cashew nuts.

Based on the major findings, the following recommendations were made with a view to revamping the cashew nut enterprises:

1. The Government should critically examine its policy thrust on cashew nut in the agricultural transformation agenda with a view to improving cashew nut production, processing and marketing.
2. The Government and non-governmental organizations should provide institutional support in terms of provision of credit facilities for the purchase of modern cashew nut processing equipment for improved processing and marketing of products.
3. In order to improve the effectiveness of extension services, extension agents should be encouraged in form of provision of incentives so that they can be motivated to provide the needed marketing information for increased marketing of cashew nut, which will translate to increased income for rural people.

REFERENCES


http://www.nutrition-and-you.com

POLICY ISSUES FOR SUSTAINABLE URBAN TRANSPORT IN NIGERIA: CASE STUDY OF ABUJA, FEDERAL CAPITAL TERRITORY (FCT)

O. F. Sanusi*, I.O. Ogundari, B.A. Adebowale and W.O. Siyanbola
National Centre for Technology Management (NACETEM), Ile-Ife, Nigeria

Abstract
This paper qualitatively examines the transport problems in Abuja, the federal capital city of Nigeria and suggests policy options for addressing them. Abuja is the first planned city in Nigeria built from scratch with over 10 billion dollars. The city master plan calls for a phase development of five parts; only phases I & II have been developed. However, the city population has exceeded projected estimate leading to a chaotic housing and transport condition. As at 2009, about 700,000 cars and 9 million passengers entered Abuja city weekly from satellite towns. This paper examines critical perspectives of the transport situation in Abuja and provides suitable policy options for addressing the situation. They include: Introduction of light rail mass transit, introduction of BRT (Bus Rapid Transit) operation, and creation of a segregated bus lane (bus only lane) for smooth operation of buses.

Keywords: light rail, bus rapid transit, dedicated bus lane, Abuja, sustainable transport,

Introduction
Transportation plays an important role in the political, economic and social development of any society; it constitutes the main avenue through which different parts of the society are linked together. As a society grows in terms of population and functions, the need for interaction among its various components also grows, thereby requiring quality and effective transportation systems. In the words of Munby (1968) “there is no escape from transport even in the most remote and least developed of inhabited regions”. Also, Hailey (1957) argued that “there seems to be no other types of development which can effect so speedily a change in the economic and social conditions of backward nations except transport”. Cities have a high level of accumulation and concentration of economic activities and are complex structures that are supported by transport systems. The most important transport problems are often related to urban areas and take place when transport systems, for a variety of reasons, cannot satisfy the numerous requirements of urban mobility. Urban productivity is highly dependent on the efficiency of its transport system to move labor, consumers and freight between multiple origins and destinations. The qualitative purpose of this discussion is to critically examine the current transport situation in Abuja using an observatory method, and suggest possible policy options for a sustainable urban transport system.

History of Abuja
Abuja, the capital city of Nigeria is located within the Federal Capital Territory (FCT) in central Nigeria. Abuja is a planned city and was built mainly in the 1980s. It officially became Nigeria’s capital on 12 December 1991, replacing Lagos which is still regarded as Nigeria’s financial and economic capital. In light of the ethnic and religious divisions of Nigeria, plans had been devised since Nigeria's independence to have its capital in a location deemed neutral to all parties. The location was eventually designated in the centre of the country in the early 1970s as it signified neutrality and national unity. This led to Abuja being the capital city of Nigeria. Another push for Abuja came because of Lagos’ population boom that made that city overcrowded. This master plan defined the general structure and elements of the city that are visible in the city’s current form. Most countries relocated their embassies to Abuja, and many maintain their former embassies as consulates in Lagos, still the commercial capital of Nigeria. Abuja and the FCT have experienced huge population growth; it has been reported that some areas around Abuja have been growing at 20% to 30% per year. According to the 2006 census (Bureau of Statistics 2009), the city of Abuja had a population of 776,298 Squatter settlements and towns have spread rapidly in and outside the city limits.

Abuja Districts
The phase 1 area of the city is divided into five districts: the Central, the Garki, Wuse, Maitama, and Asokoro districts. There are also five districts in Phase 2. They are; Kado, Durumi, Gudu, Utako and Jabi. The Phase 3 districts are Mabuchi, Katampe, Wuye, and Gwarimpa. There are five suburban districts: Nyanya, Karu, Gwagwalada, Kubwa and Jukwoyi. Along the Airport road are clusters of satellite settlements, namely Lugbe, Chika, KuchiGworo and Pyakassa. Other satellite settlements are Idu (the main industrial zone), Mpape, Karimu, Gwagwa, and DeiDei which houses the International Livestock market and the International Building materials market.

FCT and its Area Councils

<table>
<thead>
<tr>
<th>Area Councils</th>
<th>Headquaters</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abaji</td>
<td>Abaji</td>
<td>58,642</td>
</tr>
<tr>
<td>Bwari</td>
<td>Bwari</td>
<td>229,274</td>
</tr>
<tr>
<td>Gwagwalada</td>
<td>Gwagwalada</td>
<td>158,618</td>
</tr>
<tr>
<td>Kuje</td>
<td>Kuje</td>
<td>97,233</td>
</tr>
<tr>
<td>Kwali</td>
<td>Kwali</td>
<td>86,174</td>
</tr>
<tr>
<td>Municipal</td>
<td>Abuja</td>
<td>776,298</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,406,239</td>
</tr>
</tbody>
</table>


Situation of urban transportation in Abuja
Transport is an important element in socio-economic development and it encourages socio-economic and political interaction that most people take for granted (Button and Hensher, 2001). The provision of transport infrastructure has grown extensively across the globe through a range of networks of modes which have undergone technological improvements cutting across the motive power, the tracks as well as the means which serve as compartment for passengers and goods. Following a research carried out by the Nigerian Institute of Transport Technology Zaria, Kaduna state in early 2009, about 700,000 cars and nine million passengers enter Abuja city weekly. Steadily, the population of passengers is fast outpacing the available commercial vehicles within the city and there is commuter crisis. In Abuja, most offices are located within the city centre but houses within the city centre are too expensive for workers. The cost of housing coupled with the eviction of illegal residents from the city in 2005 caused most lower class workers to live in the suburbs and more others in neighboring states like Nasarawa and Niger state; this accounts for the daily influx of people into Abuja to perform their duties. There is an increasing trend of Abuja commuters being stranded at bus stops trying to catch a ride on their way to and from work at peak periods. Daily, people wait endlessly at bus stops to wrestle their
way in to the next available bus or taxi going into the city and some people get injured in the process. Some women bear the brunt of this as stronger people muscled their ways into the vehicles. A Weekly Trust survey revealed that the Abuja urban mass public transport services is fast declining and the fleet of buses engaged is fast depleting due to several factors relating but not limited to policy regulations, infrastructure challenges as well as an unbearable burden on some of the service providers. Simultaneously, as the challenges spring up, public transport demands in the FCT is increasing at a very fast rate for some obvious reasons. One of which is rural-urban migration, which adds to the population density amongst others. It is gathered that the paradox of this transportation problem, if not critically addressed, may lead to an urban mobility crisis feared by some of the commuters.

The Federal Capital Territory Administration (FCTA) under Nasir Ahmad el-Rufai as minister banned commercial motorcyclists (popularly known as “okada”) from operating within the city metropolis and confined them to the less wealthy satellite towns around the city. A lot of residents and commuters thought that the ban on “okadas” was more or less a prelude to the introduction of a regular and sustainable commercial bus services (urban mass transit) around and within the city and its adjoining satellite towns. Presently, the buses plying various routes in the city and its satellites are inadequate in number and quality of service (Turton, 1999). In Abuja, there are three mass transit bus companies established in 2005 with about 650 buses, these companies now have only 60 functional buses (daily trust weekly newspaper). Except for the red ones (Abuja Urban Mass Transit Company Limited) which is owned by the Federal Capital Development Authority (FCDA), it was discovered that there was a recent purchase to beef up the depleted fleet of Urban mass transit buses. However, for the green, Nationwide Unity Transport Company, the fleet has depleted from the initial start –up number of 140 buses to about 50 now. The reasons for the grounded buses are obvious; increasing traffic congestion, deteriorating physical infrastructure and comfort of road-based public transport, sky-rocketing transport fares, absence of effective rail mass transit mode of transportation, among others. The other public transportation challenges that are directly associated with the FCT are the spreading urban growth of Abuja as well as the increase in population size.

Challenges facing urban transportation in Abuja
The following listed problems were identified based on observations, experience and purposive interviews.

1. Traffic congestion
Congestion occurs when transport demand exceeds transport supply at a specific point in time and in a specific section of the transport system. A research carried out by the Nigerian Institute of Transport Technology Zaria, Kaduna state in early 2009, showed that about 700,000 cars and nine million passengers enter Abuja city weekly. Under such circumstances, each vehicle impairs the mobility of others. Congestion can be perceived as an unavoidable consequence of the usage of scarce transport resources, particularly if they are not priced (Adeniji, 2000). Over the last 20 years, there have been extensions of roads in rural and urban areas. These roads were designed for speed and high capacity, but the growth of urban circulation occurred at a rate higher than expected thus leading to high traffic congestion. This has created a vicious circle of congestion which supports the construction of additional road capacity and automobile dependency (Oni, 2000). Congestion is one of the most prevalent transport problems in large urban agglomerations like Abuja. One of the major problems of transportation in the FCT is the stress witnessed on the road system obviously by elongated traffic hold-ups. The rate of traffic jams city- wide is very serious particularly in the morning and evening peak hours. Commuters wait endlessly daily at peak hours to get vehicles to their various destinations in the FCT. Largely, the congestion problem is very serious on the Expressways and major roads like Kubwa, Nyanya, Airport and Gwagwlada, leading to the satellite towns (Sumaila, 2012).
### Traffic congested areas in FCT

<table>
<thead>
<tr>
<th>Congested points</th>
<th>Affected road links</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tipper Junction</td>
<td>Zuba road AYA and Berger Junctions</td>
<td>No bus stop/No Lay- byes</td>
</tr>
<tr>
<td>Berger Junction</td>
<td>Karmo Road, Central area, Area1, and Tipper Garage Roads.</td>
<td>No Lay-byes and bus stops except at Central Area.</td>
</tr>
<tr>
<td>Area 1</td>
<td>Nnamdi Azikiwe way, and roads to Gwawalada, Nyanya, Central Area and Berger Junction.</td>
<td>No lay-byes and bus stops.</td>
</tr>
<tr>
<td>Apo Junction</td>
<td>Central area, Apo District, Area 1 and Nyanya Roads.</td>
<td>No lay-byes/bus stops. Restricted nature of intersections.</td>
</tr>
<tr>
<td>AYA Junction</td>
<td>Central Area and Nyanya roads</td>
<td>No lay-byes/bus stops and high traffic generation from Karmo and Nyanya</td>
</tr>
<tr>
<td>Federal Secretariat and Central Areas</td>
<td>Connecting Roads and Roads to the Satellite towns.</td>
<td>Heavy traffic generation in satellite towns mostly Gwagwalada, Karu, and Nyanya</td>
</tr>
</tbody>
</table>


### Average Daily Traffic Volumes on Selected Routes

<table>
<thead>
<tr>
<th>Route</th>
<th>Average Daily Traffic Volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shehu Shagari Way</td>
<td>23,523</td>
</tr>
<tr>
<td>Ahmadu Bello Way</td>
<td>52,121</td>
</tr>
<tr>
<td>Moshood Abiola Way</td>
<td>28,012</td>
</tr>
<tr>
<td>Tafawa Belewa Way</td>
<td>32,755</td>
</tr>
<tr>
<td>Herbert Macaulay Way</td>
<td>42,585</td>
</tr>
<tr>
<td>Awolowo Way</td>
<td>41,916</td>
</tr>
<tr>
<td>Muhammad Buhari Way</td>
<td>23,409</td>
</tr>
<tr>
<td>Nnamdi Azikiwe Way</td>
<td>27,588</td>
</tr>
<tr>
<td>Nyanya Road</td>
<td>86,147</td>
</tr>
<tr>
<td>Airport Road</td>
<td>87,326</td>
</tr>
<tr>
<td>Kubwa Road</td>
<td>96,425</td>
</tr>
</tbody>
</table>


2. **Public transport inadequacy**

There are three mass transit bus companies in Abuja established in 2005 with about 650 buses; these companies now have only 60 functional buses (Daily trust weekly newspaper).
Most movements within the city and between the satellite towns are by private cars and taxis. Out of the closely 600,000 vehicles plying the Abuja city roads daily, about 520,000 are private. According to Sumaila, 2004, it was observed that a daily volume of 10,686 cars (both taxis and private) as against 155 big buses (High occupancy) and 4,166 Mini-buses move on Awolowo Road. Privately-owned vehicles constitute the most significant means of public transport in greater parts of Abuja metropolis, followed in importance by the use of motorcycles called (Okada) which were banned in the city few years back when their nuisance value became intolerable (Sumaila, 2004).

The number of buses in the public transport system in Abuja is inadequate to meet demand. Furthermore, the condition of these buses is very poor and the quality of service deplorable. (Sumaila, 2004).

3. Difficulties for pedestrians
On day to day bases, pedestrians in Abuja are exposed to road disasters due to the absence of pedestrian bridges across major roads in the territory. A source at Asokoro General Hospital in Abuja told News World magazine that between January and December 2011, 289 victims of road accident cases were recorded as brought in dead, BID and of this number, 130 were male and 159 female. The source also said that in January, 14 of such cases were recorded. The figure increased to 18 in February and then 26 in April. Investigations by NewsWorld magazine showed that there was no provision for pedestrian bridges in major road contracts in the Federal Capital Territory before 2008.

Experts affirmed that about 1.5 million people die in road accidents worldwide while Nigeria contributes a frightening percentage of the figure. Statistic from the Federal Road Safety Commission (FRSC) also shows that over 17,000 persons died in about 3,100 road accidents across Nigeria which occurred between 2007 and 2009. In December 2010 alone the commission said 472 persons died in 500 road accidents in different parts of the country (Mohammed and Uzondu 2012). These difficulties are either the outcome of intense traffic, where the mobility of pedestrians and vehicles is impaired, or as a result of a blatant lack of consideration for pedestrians in the physical design of facilities (Nwanze, 2002).

Many roads in the FCT (Nicon Hilton, and Sheraton hotels, NNPC building, Ahmadu Bello Way) do not have sidewalk. In the CBD of Abuja, importance is given to vehicular traffic without consideration for sidewalk which can be used by pedestrians. There is lack of consideration in the construction of bridges and roads around the Stadium Complex which do not provide for walkways. This is unimaginable since such a complex would generate the greatest level of non-vehicular traffic. Also the general provision of raised central medians around community centres has created difficult access for pedestrians wishing to cross from one side of the street to the other. This is particularly serious in Garki I and II (Sumaila, 2012).

Possible solutions
The possible ways of resolving urban transportation problem in Abuja are:

Introduction of light rail
*Light Rail Transit (LRT)* occurs as various forms of electrically powered rail system. It ranges from low cost trams operating on street ways with other road users to high cost system operating on exclusive rights of way and are readily convertible to metro or heavy rail when demand arises. Passenger-carrying capacity ranges from 6,000-12,000 on one extreme to 36,000 passengers per hour at the other extreme (i.e. in exclusive track). Light rail is distinguishable from heavy-rail by its operation of shorter train units at moderate speed; shared track way; and passenger boarding at road surface or low platforms. Generally, light rails have the advantage of by-passing traffic congestion when based on elevated surface. Its capacity and usefulness are much more enhanced when integrated with other modal options (e.g. Buses and ferries). City residents favor LRT
systems only if they offer relatively high schedule speeds and reliability. Interest in the Light Rail Transit as a viable urban transportation system has been growing worldwide since the late 20th century. Although there is no definite difference between trams and LRT systems, the latter is an evolved tramway system - tracks are often segregated from other traffic, cars run faster, and everyone has easy access due to level boarding. In Germany, where old tramway systems have been strongly upgraded as LRT systems since the 1960s, LRT systems have become the core of urban transport in many cities. New LRT systems have also been constructed in France and the UK some 40 or so years after both countries closed many old tramway systems dating from the Victorian era. LRT systems are also starting to appear in the USA and Canada, two countries known for their love for automobile (Okanlawon 2006).

Good examples of the increasing attractiveness of urban passenger transport through surface light rail may be found in places like Manchester, Karlsruhe and the lesser-known expansion of surface light rail in France, Turkey, Japan, etc. Besides the pioneering events in Manchester and Karlsruhe, new tramways or light-rail systems have started appearing on urban streets in many countries worldwide. More than 100 cities in North America and Europe (especially France, Germany, Spain and Italy) have developed or are planning completely new light-rail systems financed via different public sources (Laconte, 2004). In the UK, there is additional input from the private sector. In some countries like Switzerland and Belgium, the remaining prewar tram systems have been updated and improved. In many cases, building a new light-rail system has been the occasion for revamping citywide public spaces (Okanlawon 2006).

With the light rail, one can really get mass transit because 1,200 people are moved every three minutes. The rail system is expected to be given serious attention as it will enhance transport development and efficiency (Bolade, 1993). Also, government should construct a rail metro line from the neighboring satellite towns and states; like Niger, Nassarawa, Kaduna and Kogi, so that people can dwell in such places and still work in Abuja. All these will reduce transportation as well as housing problems in the FCT.

Figure 2: Picture of a light rail system
Source: Lagos Metropolitan Area Transport Authority

Introduction of Bus Rapid Transit (BRT)
Government should provide effective and sustainable mass transit buses like the BRT (Bus Rapid Transit) buses in Lagos which was introduced by the Lagos state Governor, Mr. Babatunde Raji Fashola, to convey people to their places of work. BRT is a transport option, which relies on the use of dedicated ‘interference’-free segregated lanes to guarantee fast and reliable bus travel. The BRT buses run on physically segregated lanes and thus make them run faster in a situation where there is traffic congestion. It is one of the several options adopted in Lagos State for addressing
public transportation and can be adopted in Abuja. The Bus Rapid Transit (BRT) can help to reduce traffic congestion, improve air quality, and meet mobility needs of the people. The BRT is a roadway-based transport system that looks and behaves like a subway, offering high capacity rapid transit services but on dedicated lanes or city streets (LAMATA 2011). The first phase of the Lagos BRT already running from Mile 12 through Ikorodu Road and Funsho Williams Avenue up to CMS started operations on 17 March 2008. The BRT runs a 16 – hour operations from 6.00 a.m. to 10 p.m. The system uses 220 buses to move more than 200,000 passengers daily. In its first two years of operation, the BRT system moved more than 120 million passengers. The Lagos BRT is the Lite version of the Classic BRT system, with 26 bus shelters, one bus/depot garage which house a maintenance bay and fuel dump, office and other appurtenances for the smooth operation of the system. The operation is guided by a set of regulations approved by the Lagos State House of Assembly and signed into law by the Governor, Mr. Babatunde Raji Fashola. The regulations restrict all yellow buses and other articulated and heavy-duty buses to the service lanes.

Figure 3: LAMATA BRT Buses at the Ojota depot
Source: Lagos Metropolitan Area Transport Authority

**Provision of a dedicated bus lane**

Government should provide a ‘Dedicated Bus Lane’ to be used by public buses. This is also one of the several options adopted in Lagos State to address congestion problems and it has been of much advantage. Lack of such bus lane hampers the operations of buses especially during peak periods between 6.30am and 9.30am and between 4.30 and 7.30pm. If this is taken care of it would solve the issue of stranded passengers, because such is majorly caused by the outcome of heavy traffic hold-ups.
3.4 Adequate Provision for Pedestrian
There is need for Government to put in place adequate provision for pedestrians by constructing pedestrian bridges on Abuja highways and also creating pedestrian ways, signages, Retroreflective paints, bus shelters, flashing cross walk and physically challenged road aids on or along major express roads. These facilities are required in cities in order to reduce the rate of accidents and for the control of road users. For the control of traffic lights, 85 junctions in the city have traffic lights controls, but about 25 more junctions require such facilities for effective coverage. If all these are put in place the safety of pedestrians will be assured and moreover, pedestrians will no longer be exposed to accident on Abuja major highways and express roads.

Conclusion
There is a lot to be done, if public transport is to play an important role in the life of the city. The city cannot afford to cater only to the private cars, and there has to be a general recognition that without public transport cities would be even less viable. Measures need to be taken in the short run to enhance the quality of service provided. In the long term, there needs to be effective land use planning, adequate provision for pedestrians and the introduction of new transit systems to keep the city moving and to assist in making it a pleasant place to live. It must not be overlooked that cities contribute majorly to the economic growth and movement must be made in and between cities as efficient as possible.

Considering the fact that transportation is one of the pillars of the success of economic activities in the FCT, it is necessary that a mass transit system like the light rail transit be constructed for efficient transportation of commuters, or the bus rapid transit (BRT) should be introduced. This type of modes is needed now that the present modes of transportation in FCT cannot cope with the present passengers’ demand (Okanlawon, 2006). To maximize its role, it is necessary for LRT to be integrated within the overall transit system. In order to achieve this, there is need to develop a joint network with existing railways and bus lines, using Transport Demand Management (TDM) strategies that encourage park and ride and other links with motor vehicle traffic, and by creating suitable fare-payment systems. In Europe, such methods have greatly contributed to improving the urban fabric and increasing light rail transit ridership (Okanlawon, 2006).

Policy recommendation
The following policy options are recommended:

- Introduction of Light Rail System
- Introduction of Bus Rapid Transit (BRT) operation
- Provision of a Dedicated Bus lane.
- Adequate provision for pedestrians.

References

Daily Trust Weekly Newspaper


http://www.leadership.ng/nga/features/index.html


Nigerian NEWSWORLD Magazine (Accesses on 7th of February 2012).
http://www.nigeriannewsworld.com/content/agony-abuja-pedestrians


Although HIV/AIDS infection is a global problem, the epicentre of the disease lies in Africa. In fact, about 70 percent of the global HIV/AIDS infected population can be found in sub-Saharan Africa and Ethiopia is one of the hardest hit countries by the pandemic. Hence, this study was initiated with the aim of estimating impact of the pandemic on income, labor force, expenditure, saving and farm production of rural households, and to assess their willingness to participate in HIV/AIDS prevention activities by contributing money and/or labor and further assess their willingness of participation by their sexual practice behavioral changes. The study was carried out in Harari region and data were collected from a total of 160 farm households (80 affected and 80 non affected households). Binary and multinomial logit models were employed to analyse the households’ willingness to participate and the choice (decision) among alternative HIV/AIDS prevention behavioral change groups respectively. The result of the multinomial logit analysis revealed that community support, education, sex of the head of the household, use of family planning, employment, assistance from HIV/AIDS prevention and AIDS knowledge was found to be a significant to affect preference decision at different significance level. Effort in promoting HIV/AIDS prevention activities should recognize the socio-economic and health extension technological characteristics.

1. INTRODUCTION
HIV/AIDS epidemic is one of the most destructive epidemics in the history of humankind, claiming the lives of about 25 million people since HIV had been recognized in 1981. In 2005 alone, 3 million people died of AIDS, more than half a million of them were children. Earlier projections by UNAIDS (2005) had suggested that about 45 million people were infected between 2002 and 2010.
Since two and half decades, HIV/AIDS has been a disease that importantly challenges world agricultural and rural development. Acquired Immunodeficiency Syndrome (AIDS) is a disease caused by Human Immunodeficiency Virus (HIV) and it is not a disease specific to gender, race, religion and/or age. It’s scope and coverage seems to be wider and grave on the young and productive parts of the society (UNAIDS, 2005).
It is widely believed that HIV/AIDS epidemic had substantial socio-economic impacts in Africa, including on the agricultural sector. In Africa the HIV/AIDS epidemic is concentrated in the most economically productive segment of the population (15-49 years old). Deaths in this group lead to the loss of a productive household member, which results in loss of income and productive capacity as well as increased costs and changing expenditure patterns. As HIV/AIDS severely affects the working group of the society, it is obvious that productivity will decrease considerably in areas affected by scourge (David and Cynthia, 2004).
Sub Saharan Africa, with only 10% of the total world population, is carrying the burden of about 70% of the world’s HIV infection and AIDS cases (De Clercq, 2007). The most obvious effect of this crisis has been morbidity and mortality, but the impact of the epidemic has certainly not been confined to the health sector; as households, schools, workplaces and economies have also been badly affected (Lamprey et al., 2006). In 2005 an estimated 25.8 million people in this region were living with HIV, 3.2 million adults and children were newly infected and approximately 2.4 million people were killed by HIV/AIDS in the. The death toll will remain high in the future because about 2.5 million new HIV infections occur each year (UNAIDS, 2007).

Ethiopia is one of the countries in Sub-Saharan Africa faced with poverty, high rate of population growth, insufficient food production, degradation of natural resource base and widespread of HIV/AIDS. Agriculture, as in many other developing countries, is the mainstay of the Ethiopian economy, where nearly 85 percent of the populations earn their livelihood, contributing 45 percent to the GDP and about 85 percent of the foreign exchange earnings (World Bank, 2005; CSA, 2007). Agricultural sector is central to the well-being and self-sufficiency of low and middle-income countries. Agriculture affects food security, the fate of national economy and the sustainability of environmental assets. HIV was first detected in Ethiopia in 1984 and the first two AIDS cases were reported to the Ministry of Health in 1986 (MOH, 2000). The spread of HIV/AIDS started and initially localized in major urban areas of the country located along major roads and commercial routes. The surveillance report by MOH indicates a steady rise in HIV infection rate in the rural setting, while on the other hand the trend in the urban areas seems to be stabilizing (MOH, 2004). Even though Ethiopia is trying to implement poverty reduction strategies, to attain fast economic growth discouraging tasks with 4.4 percent of the Ethiopian working population living with HIV/AIDS (World Bank, 2005).

A number of underlying factors contribute to the spread of HIV/AIDS in Ethiopia including poverty, illiteracy, stigma and discrimination of those infected/affected. The disease contributes to the poverty situation of the individual, family and community at large. It creates a vicious cycle by increasing individual and community vulnerability to infection (INRI, 2004). To address the threats and challenges of HIV epidemic in Ethiopia, the government of Ethiopia has approved a comprehensive HIV/AIDS policy in 1998 (MOH, 2000). The goal of the policy is to reduce the spread of HIV infection and to reduce the social and economic impact of the epidemic. HIV/AIDS Prevention and Control Office (HAPCO) were established in 2002 under the Prime Minister's Office. This office was developing the national strategic framework as a national response to HIV/AIDS. The priority intervention areas implemented in the country were Information Education and Communication (IEC), Behavioral Change Communication (BCC), and condom promotion and distribution (HAPCO and MOH, 2007).

In Ethiopia the major mode of HIV transmission is heterosexual which accounts for 87 percent of infections, another 10 percent of infections occur due to mother to child transmission. In addition, empirical evidences suggest that utilization of unsafe sharp and skin piercing instruments play a role in HIV transmission in the rural setting in particular (MOH, 2004). Main coping strategies appear to be adopted among affected households. Savings are used up or assets sold; assistance is received from other households; and the composition of households tends to change, with fewer adults of prime working age in the households.
1.2 Objectives of the Study

The general objective of the study is to estimate the effect of HIV/AIDS on the socio-economic condition of the rural households and their willingness to participate in epidemic prevention.

The specific objectives of the study are:

1. To estimate the impact of HIV/AIDS on income, expenditure, saving, labor force and farm production of rural households
2. To assess factors affecting households willingness to participate on HIV/AIDS prevention practice by contributing money and/or labor
3. To assess factors affecting use of HIV/AIDS prevention measures as a result of change in behavior and action among rural households

METHODOLOGY

2.1 Description of the Study Area

Harari region is located at 525 km East of the Federal capital city, Addis Ababa. Harari region is surrounded by the Eastern Harerghe Zone of Oromiya regional state (Figure 3). Harari region is located between 9° 11’49” N, 9° 24” 42’ N latitude and 42°3” 30’ E, 42° 16”24’ E longitude and at an elevation range of 1300 - 2200 meters above sea level. The region experiences a mean annual temperature of 17.1°C-25.2°C and annual rainfall of 750-1,000 mm.

Harari has an estimated total population of 183,344 consisting of 92,258 men and 91,086 women and 45.83% of the population are rural inhabitants, while 54.17% are urban dwellers (CSA, 2007). With an estimated area of 311.25 square kilometers, this region has an estimated density of 589 people per square kilometers. It is the third region next to Addis Ababa and Dire Dawa administrative councils where the majority of its population lives in urban area. Harari region health service is estimate to be 98%. In the region, there are five hospitals, 2 private hospitals, 6 health centers, about 27 health stations and a total of 15 private clinics. Moreover, there are 25 pharmaceutical retail outlets, 3 pharmaceutical whole sellers’ and 2 modern laboratories in the region. Every rural PA has its own clinic and rural districts have one health center each (HRHB, 2009). According to HAPCO (2009), VCT and ART services in Ethiopia were increased to 5.8 million and 175 thousand respectively. VCT and pre ART patient’s registration treatment and care were started in all health center and some private health stations in the Harari region. The number of ART and pre ART patients registered in the region were 3459 and 6573 respectively.

2.2 Sampling Procedure

A three stage both purposive and stratified random sampling techniques were used to select 160 respondents from the study areas. On the first stage, Dire-Tiyara and Soffi rural districts were purposively selected on near distance from the centre of the region. On the second stage, Peasant associations (PAs) in the selected districts were further stratified in to high prevalence and low prevalence of HIV/AIDS. PAs that are in close proximity and have easy access to the urban centers are considered to have high prevalence of HIV/AIDS (Hailemariam et al., 2002).

Table 1. Distribution of sample households by PA

<table>
<thead>
<tr>
<th>Districts</th>
<th>Total HHs PAs</th>
<th>HIV non affected HHs</th>
<th>HIV affected HHs</th>
<th>Sample HHs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIV non affected HHs</td>
<td>HIV affected HHs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harari</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Harari    |                |                      |                 |            |
| Dire-Tiyara |                |                      |                 |            |
| Soffi     |                |                      |                 |            |
2.3 Methods of Data Collection
Data collection was conducted from December 2009 to March 2010. Primary data were collected from 160 sample households headed using a pre-tested structured questionnaire, which was designed to generate data on some socio-economic impact of HIV/AIDS, and willingness to participate in HIV/AIDS prevention practice of rural households.

2.3.1 Binary logistic regression model
When any of the explanatory variables in a regression model are binary, one can represent them as dummy variables and proceed with the analysis using linear regression. Binary choice models assume that individuals are faced with a choice between two alternatives and their choice depends on their characteristics.

2.3.2 Multinomial logistic regression model
In the presence of HIV infection risk there is sexual intercourse related behavioral changes. There is no natural ordering in these behavioral changes alternatives. In such conditions unordered choice models can be motivated by a random utility model (Greene, 2000). The most commonly used are multinomial logit and multinomial probit. Following Greene (2000) the multinomial logit model is to determine factors affecting household’s preference among alternatives. The model assumes that the likelihood that a respondent choose one of their most preferred behavioral change indicators from ‘j’ alternatives.

\[ \text{Prob}(Y = j) = \frac{\exp(\beta_j X_j)}{\sum_{k=0}^{J} \exp(\beta_k X_k)} \quad \text{For} \; j=0, \ldots, J \]

\[ Y=0 \quad \text{Stopped sex} \]
\[ Y=1 \quad \text{Restricted sex to one partner} \]
\[ Y=2 \quad \text{Using condom} \]
\[ Y=3 \quad \text{none of these behavioral change approaches} \]

Stop sex in this study was defined as those respondents that abstain from sex or no sex before marriage, widowed/er and divorced that stop sex due to fear of HIV/AIDS infection. Restricted to one partner in this case, those respondents that restrict their sexual intercourse to one partner at least for the past one year. Condom user’s in this study includes those respondents that use condom during sexual intercourse with multi partner to avoid risk of HIV/AIDS. None of these behavioral change respondents that practices polygamy, respondents that avoid condom use while make sex out of his partner, and respondents that inherit widowed/er.

2.4 Variable description and working hypothesis
Several socio-economic and physical factors can influence HIV/AIDS behavioral changes and willingness to participate on HIV/AIDS prevention practice among rural households in various degrees. David and Cynthia (2004), suggests that complex factors affect sexual behaviour in developing countries like, socio-economic status of households, weak state infrastructure and resource scarcity all have been identified as major factors playing an important role.
3. RESULTS AND DISCUSSION
The survey results were analyzed and discussed in this chapter. The first section presents results of the descriptive analysis of household characteristics and impact of HIV/AIDS on income, expenditure, saving, labor force and farm production of rural households. The second section presents the econometric model outputs.

3.1 Household Characteristics
About 92 percent of the total respondents were Muslims while the remaining were followers of Christianity religion. Ninety percent of the affected households were Muslims and the remaining 10 percent were Christians. The corresponding figures for the non-affected household were 94 percent and 6 percent, respectively.
The mean age of sample household heads was 35.84 with standard deviation of 8.01. The average age of the affected household heads was about 35 years while that of the non-affected household heads was about 37 years and there was no statistical difference between the groups (t=0.68). The age of the affected household heads and the non-affected household heads varied from 22 years to 55 years and from 23 years to 60 years, respectively. The average family size of the affected households was smaller (3.99 persons) than the non-affected households (5.19) which is statistically significance at 1 percent probability level (t=3.59).

3.2 Health Condition of Sample Households
All of the affected and 25 percent of the non-affected household heads reported that they had sick family members in the year 2009. The non-affected household heads reported that the sickness in the family member was not as such serious. The affected household heads reported that there were difficulties in getting treatment and after much incurred in to the cost they decided to get HIV/AIDS test.

Two-third (58 percent) of the respondents got tested for HIV because of repeated sickness while about 6 percent decided to get tested for HIV because of repeated sickness and death of their children (Table 3).
Non-affected sample respondents were asked about their willingness to get HIV tested. The results showed that 34 (43 percent) said that they are willingness to go for a test. The remaining 46 (57 percent) of the respondents said that they are not willing to go for a test and that they would not get tested even if the services were offered to them.

3.3 Awareness related to HIV/AIDS
Results of the survey depict that about 54 percent of the affected respondents have good Knowledge regarding the transmission and mode of prevention of HIV, (Table 4). Similarly, 41 percent of the non-affected respondents have good knowledge of both the route of transmission and mode of prevention of HIV/AIDS. However, 46 percent of the affected and 32 percent of non-affected respondents have good attitude towards PLWHA. About 51 percent and 38 percent of the affected and non affected households respectively had comprehensive knowledge about HIV/AIDS. Generally the comprehensive HIV/AIDS knowledge among rural households of study area was about 44 percent. This study also specifies that only 40 percent of women and 53 percent of men have comprehensive knowledge about HIV transmission routes and prevention methods in the study area.

3.4 Impact of HIV/AIDS on Resource Endowments

3.4.1 Livestock ownership
Livestock are also considered as indicators of wealth and prestige in rural areas. The average livestock holding in Tropical Livestock Unit (TLU) was 0.52 for affected and 0.95 for non-affected households (Table 6). This indicates that the non-affected households owned more number of livestock than the affected households. The mean difference for the
two groups of households were found to be significant at 1 percent probability level
(t=4.728). About 69 percent of the affected households did not own an ox, whereas only
about 31 percent of the non-affected households did not own an ox. About 11 percent and
35 percent of the affected and non-affected households owned a pair of oxen, respectively.

3.4.2 Crop production
The average size of total cultivated land was 0.67 hectare for the affected households,
while that of the non-affected households was 0.93 hectares. This implies that the non-
affected households were cultivating more land (0.26 hectares) than the affected
households, mainly through renting/sharing-in arrangements and the affected households in
contrast to this. The mean differences for the two groups of households were found to be
significant at 1 percent probability level.

3.4.3 The impact on household income
The sources of household income were agricultural, non-agricultural and other incomes
such as remittances and gifts received by household members. Agricultural and non-
agricultural income constitutes the largest source of income for rural households in study
area and more focused on two income sources.
Affected households had an average annual income of about Birr 4003.4, while non-
affected household had an average annual income of about Birr 10824. The aggregate
annual income for affected households was about 63 percent lower than average income of
the total households. Crops, livestock and off-farm activities such as handcrafts, Bee
keeping, employment in others farms and selling firewood and charcoal were important
income sources for the sample households of the study area. A typical household earned
annually about Birr 2324.3 and Birr 8814.0 from sale of different agricultural products on
average for affected and non-affected households respectively. Affected households on
average earned more cash from non agricultural sector (Birr 1687.0) than non affected
households (Birr 1608.2).

3.4.4 Household’s labour utilization
In the study area, 72.5 percent of the affected households suffer from labour shortage
during the peak season and also 56.3 percent of the non-affected households report labour
shortage to effectively undertake their agricultural activities (Table 10). This might be due
to the extensive involvement in different activities and the low productivity of labour. The
insufficient water supply and mixed farming system on small scale, livestock and crop
production requires more labour. Labour is also required for transporting farm
inputs/outputs to and from farm. This makes households to force their children out of
school and participate in the farm activity, care giving, and domestic activity. By these
respondent households reported 47.5 percent of the affected and 21.3 percent of the non-
affected household children drop out of the school.

3.4.5 Impact of HIV/AIDS on Households Expenditure
The observed households incurred different categories of medical and agricultural
production expenses. It was found that the mean expenditure per household per year on
agricultural production and medical expenses was 520.7 and 673.3 Birr respectively as
indicated in (Table 12). However, when disaggregated by household categories, the costs
of agricultural production were 323 and 717 Birr for the affected and non-affected
households respectively. Similarly, the annual average medical expenses for the HIV/AIDS
affected and non-affected households were 1154 and 193 Birr respectively. HIV/AIDS has
an impact on depleting the financial resources of households in the form of medical and
funeral expenses.
The high medical expenditure of affected households may force them to spend less on agricultural inputs. This condition will in turn necessitate the use of less intensive production practices, or a shift to crops requiring less fertilizer and other purchased inputs. The affected households have to internally reallocate the financial resources to particularly meet medical expenses as a priority.

### 3.4.6 Impact on household borrowings and savings

Non-affected households had an average annual savings of Birr 693.7 with standard deviation of 205.8 compared to affected household savings Birr 267.20 with standard deviation 144.3. The mean difference of savings between the two groups is statistically significant at 1 percent probability level. Affected households therefore saved approximately 79 percent less than did non-affected households. This difference in household savings can be attributed to the fact that these households had encountered reduced household income or loss of earnings as a consequence of medical related costs or as a result of the death of a household member.

### 3.5 Household's Willingness to Participate (WTP)

Willingness to participate evaluation result that about 66 percent of the respondents were willing to contribute either money or labour or both for HIV/AIDS prevention practices. Of these willing respondents, about 13 percent were willing to contribute only labour about 32 percent were willing to contribute both money and labour and about 55 percent were willing to contribute only money. There was slight variation between affected and non-affected households on their willingness to participate on HIV/AIDS prevention practice. About 71 percent of affected households and 61 percent of non-affected households have willing to participate on prevention practices.

The relationship between selected variables and willingness to participate on HIV/AIDS prevention shows that there are statistical significant differences between the groups at different probability level. AIDS knowledge (AIDK) is significant at 5 percent probability level. Also education level (EDUL) and sex of the head of the household (SEXH) are significant at 10 percent probability level. The significant variables at 1 percent probability level are assistance (ASIST), use of family planning (EVRUS) and stigma and discrimination (STGD).

### 3.6 Preference among HIV/AIDS related behavioural change

Econometric results of the multinomial logit model

All the 9 explanatory variables considered as determinants for the preference decision of sample households among different HIV/AIDS related behavioural change groups, 1 and 2 variables were found to have significant impact on the preference decision for restricted to one partner and condom uses respectively at 1 percent probability level. Two variables for the stop sex, 4 variables for the restricted sex to one partner and 2 variables for the condom use were significant at 5 percent probability level. The effect of some significant variables is not similar for the three structure groups. Some may be highly significant to affect the preference decision for a particular group and may be insignificant for the other groups.

### 6. RECOMMENDATIONS

1. Reinforce the practices of affected households that have positive responses and discourage households from adopting coping responses that compromise the future well-being of the family. With this they have to develop locally initiated HIV/AIDS prevention policy.

2. The households' willingness to participate in HIV/AIDS prevention was also found to be highly associated with their understanding and knowledge level of HIV/AIDS, whether the prevention can be implemented and managed at their knowledge and resource levels. To make participant
accept and implement HIV/AIDS program and to expand AIDS knowledge government and other development cooperative organizations should provide appropriate assistance to the specific socio-economic activities. Moreover, the individuals, groups as well as policy makers should work towards making the people aware of the participant on HIV/AIDS prevention activities to fight against epidemic.

3. One of the most important results of the study was household’s use of family planning which enhances willingness for participation in HIV/AIDS prevention activities. The result was indicating that health sector should integrate with other sector and expand the distribution of family planning with integration of HIV/AIDS related education.

4. The study indicate that stigma and discrimination and dependency ratio influenced negatively and significantly willingness of households in the study area. Therefore, it is very crucial to consider education on HIV/AIDS in any development interventions performed by government and non-government organization that can be achieved by creating sufficient awareness to household.

5. One of the most important results of this study was those households that were not-willing to participate in HIV/AIDS prevention activities by contributing money and/or labor. So, any program work on HIV/AIDS should inform the communities to develop self help locally.

6. Government alone cannot achieve the basic well-being of the entire national population. This calls for meaningful partnership between the communities, governments, donor agencies, international NGOs, local NGOs, private sector, individuals and others in order to address the problems of HIV/AIDS successfully.

5. REFERENCES


Korenrop, E., 2005. Malaria Attributable to the HIV-1 Epidemic Sub-Saharan Africa Emerging Infectious Disease 11(9); 410-9.


EFFECTS OF INOCULATION OF SINORHIZOBIUMCICERI AND PHOSPHATE SOLUBILIZING BACTERIA ON NODULATION, YIELD AND NITROGEN AND PHOSPHORUS UPTAKE OF CHICKPEA (CICERARIETINUM L.) IN SHOAROBIT AREA

Birhanu Messele* and L.M. Pant

Menschen fur Menschen, Agro-Technical and Technology College, Department of Agro-ecology, P.Box: 322, Harar, Ethiopia.

ABSTRACT

A field experiment was conducted during the 2006/07 growing season to assess the effects of inoculation of Sinorhizobium ciceri and phosphate solubilizing bacteria on the performance of chickpea variety "DZ-10-11" in Shoa Robit area, Ethiopia. Three levels of NP fertilizer and four levels of inoculants were used for the experiment. Treatments were laid down in a Randomized Complete Block Design (RCBD) in a factorial combination with three replications. The result of this study revealed that inoculation of Sinorhizobium ciceri alone increased dry matter yield by 156.58% and nodule number by 117.96% over the control whilst the addition of 18/20 kg NP ha⁻¹ as urea and DCB resulted in 149.6% increase of dry matter yield and 143.6% increase in nodule number per plant over the uninoculated control. There was also a marked increase in nodule dry weight (200%), as a result of Sinorhizobium ciceri + 18/20 kg NP ha⁻¹ as urea and DCB, indicating the importance of phosphorus for nodule tissue development. Similarly inoculation of Pseudomonas sp. + 18/20 kg NP ha⁻¹ as urea and DCB also increased nodule dry weight, nodule number, nodule volume and seed yield by 240%, 188.52%, 151.81% 142.95% respectively over the control, indicating the efficiency of the bacteria in solubilizing phosphate in DCB. On the other hand inoculation of Sinorhizobium ciceri + Pseudomonas sp. with 18/20 kg N P ha⁻¹ as urea and DCB increased nodules number per plant by 208.8% and nodule dry weight by 220% and nodule volume by 221.24%, dry matter by 172.09% over uninoculated control at mid flowering stage of chickpea. Similarly inoculation of Sinorhizobium ciceri + Pseudomonas sp. with 18/20 kg NP ha⁻¹ as urea and DAP increased nodule number, nodule dry weight, nodule volume and dry matter by 271.59%, 220%, 241.97%, 181.40% respectively over uninoculated control at mid flowering stage.

INTRODUCTION

Chickpea (Cicerarietinum L.) belongs to the family Fabaceae (earlier Leguminosae) and sub family papilionaceae (Kupich, 1977). It is most probably originated in an area of present day south-eastern Turkey and adjoining Syria where three mild annual species of ciceriz C. bijigum, C. aerbispernum, and C. reticulatum are found (Saxena and Singh, 1987).

Chickpea is one of the most important cool season food legumes in Ethiopia and grown on heavy black soils (Vertisols). It is mainly cultivated between 1400-2300 m.a.s.l where annual rain fall ranges from 700-1200 mm. Chickpea, being a legume, can be used to restore fertility in crop rotation (Baldev, 1988). Hence, the farmers in Ethiopia commonly rotate chickpea with cereals such as wheat, barley and teff. Despite the above fact, chickpea yield in the country is extremely low. The national average yield is 0.8-0.9 t ha⁻¹ (CSA, 2000), whereas at farmer’s field the average yield is 0.6 t ha⁻¹.
Being a legume crop, chickpea can obtain a significant portion of its nitrogen requirement through symbiotic N₂ fixation when grown in association with effective and compatible Rhizobium strains (Stephen et al., 2002). Most Ethiopian soils, similar to the agricultural soils of other countries in the tropics, are generally low in nitrogen (N) and phosphorus (P). These two nutrients are often limiting the crop production in Ethiopia (Asgelil, 2000). For pulse production, P is the major limiting nutrient followed by N. This is because P not only affects legume growth, but also nodule formation and development (Andrew and Jones, 1978; Haque et al., 1986; Yohannes and Richter, 1999). The phosphate solubilizing microorganisms have the capacity to dissolve the insoluble phosphatic compounds present in the soil and also solubilize rock phosphate, bone meal and basic slag (Kucey et al., 1989; Asfaw, 1997). The field experiments done on inoculation of P-solubilizing bacteria in various crops have shown 10-15% increases in crop yields in 10 out of 37 experiments (Tandon, 1987). Various authors reported increased yield responses of pulses to seed inoculation of Rhizobium (Dorosinsky and Kadyrov, 1975; Moawad et al., 1988; Desta, 1988) and phosphate-solubilizing bacteria (PSB) (Gaur, 1985). When inoculated, these organisms colonize the rhizosphere and enhance plant growth by providing it with N and P (Kundu and Gaur, 1980).

In Ethiopia, there is very little information on combined or dual inoculation of Rhizobium and PSB on crop productivity (Wassie, 1999). Hence, it is of great practical importance to study the combined effect of these organisms on nodulation, plant growth and nutrition and legume crop yields. Adoption of such technologies by farmers will help in minimizing production costs and at the same time, avoid the environmental hazards (Galal et al., 2001). Therefore, in view of this a field study on chickpea was carried out at farmers’ field in ShoaRobit with the following specific objective:

To study the effects of inoculation of Sinorhizobium ciceri and Phosphate solubilizing bacteria and their interaction on nodulation, growth, yield, and nitrogen and phosphorus uptake of chickpea.

**Material and Methods**

**Description of the Study Area**

The study was conducted on a farmer’s field under Merye Peasant Association around ShoaRobit, the capital of Kewetworeda located 11° 55’ N and 37° 20’E at 1300 m a.s.l, in North Shoa of the Amhara National Regional Sate. It is located at a distance of about 225 km to the North east of Addis Ababa on the way to Dessie (NMA, 1984). The Kewetworeda is classified under hot to warm moist agro ecological zone. The annual rain fall, from meteorological records of last 14 years, is 1023.8 mm (Koch et al., 1990) and the temperature ranges from 8°C to 37°C with a mean daily minimum and maximum temperatures of 16.6°C and 31.0°C (KewetWoreda BOA, 1995). The soil of the area is typically dark grey when dry and very dark grey-brown when moist with clay texture. The clay is dominant in montmorillonitic, so the soils have high shrinkage capacity when dry and high swellings when wet (Murphy, 1968), for long time. The farmer’s field, where the experiment was conducted, is located around 7 km away from ShoaRobit town.

There are two distinct growing seasons in the area viz., ‘Belg’ (March-July) and ‘Meher’ (August-December). The study was conducted during the Meher 2006/07
cropping season under rainfed condition with supplemental irrigation when required.

Experimental Procedures

Soil Sampling, Preparation and Analysis

Pre-sowing surface soil samples were collected at 0-30 cm diagonally from five spots in the experimental field, then were composited and processed for soil analysis before sowing. Composite soil samples were analysed for soil texture, cation exchange capacity and soil pH were measured using standard laboratory procedures (Yerima et al., 1993). At harvest, soil samples were collected at 0-30 cm from each plot and composited treatment-wise for determination of available P.

Treatments

Urea as a source of nitrogen and two sources of P namely, dried and crushed bone (DCB) and diammonium phosphate (DAP) were used for the field experiment. They were used in combination with inoculants as per the treatment. Lignite-based inoculants of Sinorhizobium ciceri (strain EAL 001) and local isolate of phosphate-solubilizing bacteria, Pseudomonas sp. singly or in combination and with or without N and P sources (urea, DCB and DAP) were used to get the treatments.

Experimental Design

The experiment consisted of 12 treatments with a factorial combination of 3 levels of NP fertilizer (0/0, 18/20 as urea and DAP and 18/20 as urea and DCB kg ha⁻¹), and with four levels of inoculants (Uninoculated, Sinorhizobium ciceri (EAL 001), Pseudomonas sp. and Sinorhizobium ciceri (EAL 001) + Pseudomonas sp.). Treatments were laid down in a Randomized Complete Block Design (RCBD) with three replications making a total number of 36 plots. The full dose of N and P fertilisers were applied using row methods of application at planting time.

As per design of the experiment, field layout was prepared and each treatment was assigned randomly to experimental units within a block. The size of each plot was 2.8 x 4 m (11.2 m²). The spacing between blocks and plots was 1.5 m and 0.5 m, respectively. The chickpea variety ‘DZ-10-11’ was used for planting. This variety was chosen on the basis of its resistance for ascochyta blight disease and better performance for many years in the mid altitudes areas of Ethiopia (DZAR, 1998).

Seed Inoculation

Seeds were inoculated with lignite-based inoculants of Sinorhizobium ciceri (EAL 001, Mojo isolate) and/or phosphate solubilizing bacteria, Pseudomonas sp. (Jimma isolate) at the rate of 7 g/kg of seeds as per the treatment. Carrier based cultures were mixed with small amount of 10% solution of sucrose in cool and clean water to form a thick slurry. The slurry was poured over the dry seeds so as to uniformly coat the seeds with the inoculant. For combined inoculation, inoculants of Sinorhizobium ciceri and phosphate solubilizers were mixed in equal proportions (7 g/kg seed) and applied to the seeds in the similar manner. All inoculations were done just before planting under shade to maintain the viability of microbial cells.

Sowing

The experiment was planted on September 28, 2006. Chickpea seeds of variety DZ-10-11 were sown in seven rows per plot at 40 cm row to row and 10 cm plant to plant distance.

Agronomic Practices

The experimental field was weeded two times during the growing season. The first weeding was done 15-days after planting of chick pea to avoid competition during early stage of crop growth. The second weeding was undertaken one month later. Weeds, in general were not a serious constraints to chickpea. At about the poding stage of the crop, the insecticide Selectron was sprayed at
the rate of 1.04 liter ha⁻¹ to control ball worms.

**Data Collected**

**Nodulation**

The data on nodulation parameters were taken at mid flowering stage of chickpea. Five competitive plants were randomly taken from second border rows from each side of the plot for nodulation parameters (number of nodules, nodule volume and nodule dry weight per plant) and dry weight of plants at mid flowering. In each plot whole root system of a plant was completely exposed and carefully uprooted for nodulation parameters. The roots were gently washed under running tap water over a sieve to avoid loss of detached roots. The nodules from all the plants were removed and separately spread on the sieve for some minutes until the water drained off. The total number of nodules was counted and the mean value of five plants was recorded as the average number of nodules per plant. The color on inside of nodules was observed by cutting with the help of a sharp blade.

The collected nodules were immersed in a previously measured volume of water in a measuring cylinder. The volume of water displaced by nodules from 5 plants was considered as nodule volume and converted to average nodule volume per plant. After determination of nodule volume, the nodules were dried in an oven at 70°C to constant weight to determine nodule dry weight per plant. The average of five plants was taken as nodule dry weight per plant.

**Dry Matter**

Dry matter of plants was determined at mid flowering stage of the crop from plants sampled for nodulation. The sampled plants were placed in labeled perforated paper bags and oven-dried at 70°C to a constant weight. The average dry weight of five plants was measured to determine dry weight per plant.

**Yield and yield components**

At physiological maturity, five competitive plants from net area were sampled for the determination of number of pods per plant. Number of seeds per pod was determined for 20 randomly sampled pods from the same five plants.

One hundred seed weight was also determined by counting 100 seeds and weighing on a sensitive electronic balance. Harvest index was determined as the ratio of grain yield with above ground dry biomass per plot. Yield per plot was determined by harvesting the chickpea from the central three rows of a net size of 1.2 x 3m (3.6m²) leaving the boarder rows and 0.5 m row length on every end of each row. Chickpea plants were harvested from each plot at physiological maturity, the harvested plants was sun-dried in the open air for 3-4 weeks, weighed to determine above ground biomass yield and then threshed and weighed to determine the grain yield of each plot. Finally, yield per plot was converted to per ha basis. Straw yield was calculated by subtracting grain yield from the corresponding above ground biomass yield.

**Plant Tissue Sampling and analysis for N and P**

At physiological maturity, five non-border plants were harvested and partitioned into grain and straw. The grain and straw sample materials was separately air-dried, oven dried at 70°C to a constant weight, ground to pass a 1 mm sieve and saved for laboratory analysis of grain and straw N and P concentration.

Phosphorus in grain and straw sub-samples was determined using metavanadate method (NSL, 1994). Samples were calcinated in the furnace overnight at 450°C and the ash was dissolved in 20% nitric acid (HNO₃) to liberate organic P. The phosphorus in the solution was determined colorimetrically using molybdate and metavanadate for color development. The reading of phosphorus was made at 460 nm in spectro-photometer. Total N in the grain and straw sub-samples were quantitatively determined by a kjeldahl procedure that included a salicylic acid predigest ion step to convert nitrate to ammonium (Nelson and Sommers, 1973).
Phosphorus uptake by grain and straw were determined from the phosphorus content of the respective parts after multiplying with the grain yield and straw yield, respectively. Total phosphorus uptake was then calculated as the summation of grain and straw uptake. Similarly, N uptake in the grain was determined after multiplying nitrogen content of the grain by grain yield, and straw nitrogen uptake was determined by multiplying nitrogen content in the straw by straw yield. Total nitrogen was recorded as the sum of grain N uptake and straw N uptake.

**Statistical Analysis**

All data collected were subjected to the analysis of variance (ANOVA) appropriate to factorial experiments in Randomized complete Block Design using SAS software (SAS Institute, 1989).

The percent organic carbon content of the soil sample is low (1.74%). The organic matter content of the soil sample is computed by multiplying the organic carbon content with a conversion factor 1.724 and the result showed that medium organic matter content of the soil (2.99%). The pH value of soil is 8.3 (in 1:2.5 soil: water suspension) which according to Landon (1984) was rated as high and shows the Thecation exchange capacity of the soil was medium (29.57 cmol (+)/kg). 

### Results

**Some Selected Physical and Chemical Properties of the Soil of Experimental Site before planting.**

Results of the laboratory analysis (Table 1) for the soil sample taken before planting indicated that the textural class of the experimental soil was loam. It had high N, 1.26% while the available P content was 7.64 ppm, the P level of the soil can be rated as low (FAO,1985).

<table>
<thead>
<tr>
<th>Particle size distribution (%)</th>
<th>Textural class</th>
<th>pH (1:2.5 H₂O)</th>
<th>OC (%)</th>
<th>TN (%)</th>
<th>AP (ppm)</th>
<th>CEC (Cmol (+)/kg)</th>
<th>PBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand 42 Silt 32 Clay</td>
<td>Loam</td>
<td>8.3</td>
<td>1.74</td>
<td>1.26</td>
<td>7.64</td>
<td>29.57</td>
<td>89</td>
</tr>
</tbody>
</table>

*OC: Organic carbon; TN: total nitrogen; AP: available phosphorous; CEC: cation exchange capacity; PBS: percent base saturation*

### Number of nodules per plant

As presented in Table 2, the analysis of variance test showed a significant statistical difference among treatments in relation to number of nodules per plant. The highest number of nodules (140.60 nodules plant⁻¹) were recorded with inoculation of *Sinorhizobiumciceri* + *Pseudomonas sp*. along with 18/20kgNP ha⁻¹ as urea and DAP, followed by *Pseudomonas sp* + 18/20kg NP ha⁻¹ as Urea and DAP (108.10 nodules plant⁻¹), *Sinorhizobium ciceri* + *Pseudomonas sp* + 18/20kg NP ha⁻¹ as urea and DCB (108.07 nodules plant⁻¹) and *Pseudomonas sp* alone (104.93 nodules plant⁻¹) which were significantly higher than uninoculated control. Compared to the control all the treatments recorded higher nodule number per plant, however, inoculation of *Sinorhizobium* without urea+DCB/DAP and uninoculated treatment with urea and DCB/DAP gave nodules at par with the control.
Table 2. Nodulation of chickpea and dry matter yield plant$^{-1}$ at mid flowering stage as affected by inoculation of *Sinorhizobium ciceri*+*Pseudomonas sp.*

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of nodule plant$^{-1}$</th>
<th>Nodule dry wt. plant$^{-1}$(g)</th>
<th>Nodule vol. plant$^{-1}$(ml)</th>
<th>Dry matter plant$^{-1}$(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninoculated</td>
<td>51.77f</td>
<td>0.5d</td>
<td>1.93bc</td>
<td>4.30d</td>
</tr>
<tr>
<td>18/20 kg N P ha$^{-1}$ as urea and DAP</td>
<td>64.67def</td>
<td>0.7dc</td>
<td>2.06bc</td>
<td>4.27d</td>
</tr>
<tr>
<td>18/20 kg N P ha$^{-1}$ as urea and DCB</td>
<td>57.23f</td>
<td>0.7dc</td>
<td>2.43bc</td>
<td>5.93abcd</td>
</tr>
<tr>
<td><em>Sinorhizobium</em></td>
<td>61.07ef</td>
<td>0.8bcd</td>
<td>1.97bc</td>
<td>6.73abc</td>
</tr>
<tr>
<td><em>Sinorhizobium</em>+18/20 kg N P ha$^{-1}$ as urea and DAP</td>
<td>90.13bed</td>
<td>1.2a</td>
<td>2.60bc</td>
<td>5.33bcd</td>
</tr>
<tr>
<td><em>Sinorhizobium</em>+18/20 kg N P ha$^{-1}$ as urea and DCB</td>
<td>74.33cdef</td>
<td>1.0abc</td>
<td>1.53c</td>
<td>6.43abcd</td>
</tr>
<tr>
<td><em>Pseudomonas sp.</em></td>
<td>104.93b</td>
<td>1.0abc</td>
<td>2.47bc</td>
<td>5.07cd</td>
</tr>
<tr>
<td><em>Pseudomonas sp.</em>+18/20 kg N P ha$^{-1}$ as urea and DAP</td>
<td>108.10b</td>
<td>1.1ab</td>
<td>2.7bc</td>
<td>5.17bcd</td>
</tr>
<tr>
<td><em>Pseudomonas sp.</em>+18/20 kg N P ha$^{-1}$ as urea and DCB</td>
<td>97.60bc</td>
<td>1.2a</td>
<td>2.93b</td>
<td>5.57abcd</td>
</tr>
<tr>
<td><em>Sinorhizobium</em>+<em>Pseudomonas sp.</em></td>
<td>84.33bcde</td>
<td>0.8bcd</td>
<td>2.53bc</td>
<td>4.20d</td>
</tr>
<tr>
<td><em>Sinorhizobium</em>+Pseudomonas sp.+18/20 kg N P ha$^{-1}$ as urea and DAP</td>
<td>140.60a</td>
<td>1.1ab</td>
<td>467a</td>
<td>7.80a</td>
</tr>
<tr>
<td><em>Sinorhizobium</em>+Pseudomonas sp.+18/20 kg N P ha$^{-1}$ as urea and DCB</td>
<td>108.07b</td>
<td>1.1ab</td>
<td>4.27a</td>
<td>7.40ab</td>
</tr>
</tbody>
</table>

LSD (5%) 27.02 0.3387 1.25 2.31
CV (%) 18.36 21.43 27.53 23.99

CV=coefficient of variance, DCB = Dried and crushed bone, DAP=diammonium phosphate, N=nitrogen and P=phosphorous, Means within a column followed by the same letter(s) are not significantly different.

Nodule dry weight

F-test indicated significant difference (P ≤ 0.01) among treatments with respect to nodule dry weight per plant (Table 2). Maximum nodule dry weight (1.20g plant$^{-1}$) was recorded with inoculation of *Pseudomonas sp.* along with 18/20 kg NP ha$^{-1}$ applied as urea and DCB and *Sinorhizobium ciceri*+18/20 kg NP ha$^{-1}$ as urea and DAP (1.20g plant$^{-1}$) followed by *Pseudomonas sp.*+18/20 kg NP ha$^{-1}$ as urea and DAP (1.1 g plant$^{-1}$) and *Sinorhizobium ciceri*+*Pseudomonas sp.*+18/20 kg NP ha$^{-1}$ as urea and DAP/DCB. Although inoculation of *Sinorhizobium ciceri* alone and combined inoculation of *Sinorhizobium ciceri* and *Pseudomonas sp.* in the absence of P source resulted only in marginal increase in nodule dry weight over the untreated control, but inoculation of *Pseudomonas sp.* alone in the presence or absence of P source showed a considerable increase in nodule dry weight over uninoculated control. In general, the treatments having P solubilizers alone or with *Sinorhizobium ciceri* with phosphorous source recorded higher nodule dry weight as compared to treatments without P solubilizers (Table 2). Therefore, the results have indicated that due to increased availability of phosphorus from soil or DAP/DCB which resulted due to solubilization of P by inoculated phosphate...
solubilizers, the infection of roots by inoculated rhizobia increased and resulted in higher number and mass of nodules. Application of 18/20 kg NP ha\(^{-1}\) as urea and DAP/DCB, inoculation of

**Nodule volume**

Nodule volume was significantly (P \(\leq 0.01\)) affected by application of treatments (Table 2). The highest nodule volume (4.67ml) was recorded with inoculation of (\(\text{Sinorhizobiumciceri} + \text{Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\)as urea and DAP followed by (\(\text{Sinorhizobiumciceri} + \text{Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\)as urea and DCB (4.27ml) and \(\text{Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\) as urea and DAP (2.93ml). However, all other treatments gave nodule volume at par with the control.

**Effect on dry matter yield per plant at mid flowering**

The dry matter production at mid flowering stage of chickpea was significantly (P \(\leq 0.05\)) influenced by different treatments (Table 2). Among the treatments, inoculation of (\(\text{Sinorhizobiumciceri, EAL 001 + Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\) as urea and DAP (7.8g plant\(^{-1}\)) and (\(\text{Sinorhizobiumciceri, EAL 001 + Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\)as urea and DCB (7.4g plant\(^{-1}\)) were significantly (P \(\leq 0.05\)) increased dry matter yield per plant over the uninoculated control. The increase in dry matter yield due to combined inoculation of \(\text{Sinorhizobium}\) and phosphate solubilizing bacteria might be due to synergetic effect, which enhanced nitrogen and phosphorus availability to the plant. In agreement with the present finding, Application of 18/20 kg N P ha\(^{-1}\) as a source urea and DAP gave dry matter yield in par with the control.

Inoculation of \(\text{Sinorhizobiumciceri, EAL 001 alone (6.73 g plant}^{-1}\)increased dry matter yield significantly over the control (4.3 g plant\(^{-1}\)). The increased dry matter yield due to inoculation of \(\text{Sinorhizobiumciceri, EAL 001alone could be the result of increased nitrogen fixation and its supply to chickpea, which enhanced crop growth.**

**Effect on number of pods per plant and seed per pod**

The number of pods per plant was significantly different (P \(\leq 0.01\)) among the treatments (Table 3). All the treatments gave higher number of pods per plant over the control. The highest number of pods per plant (122.63) was recorded with inoculation of (\(\text{Sinorhizobiumciceri, EAL 001 + Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\)as urea and DAP followed by (\(\text{Sinorhizobiumciceri, EAL 001 + Pseudomonas sp.}\) + 18/20 kg N P ha\(^{-1}\)as urea and DCB (119.87) and \(\text{Pseudomonas sp.}\) + 18/20 Kg N P ha\(^{-1}\)as urea and DAP (106.80) as compared to the control.

Uninoculated treatment with 18/20 kg N P ha\(^{-1}\) as urea and DAP or DCB, \(\text{Sinorhizobiumciceri, EAL 001 + 18/20 kg N P ha}^{-1}\) as urea and DCB and \(\text{Pseudomonas sp.}\) alone also gave a marginal increase in number of pods per plant over the control. However, other treatments were at par with the control.

Seeds per pod were not significantly (P \(\geq 0.05\)) affected by inoculation of \(\text{Sinorhizobiumciceri, EAL 001 and Pseudomonas sp.}\) with or without the P source.
Effect on seed yield and hundred-seed weight

Results (Table 3) showed that seed yield was significantly affected by application of different treatments. Inoculation of *Sinorhizobium ciceri*, EAL 001 + *Pseudomonas sp.* in the presence of 18/20 kg N P ha⁻¹ as urea and DAP (1318.53 kg ha⁻¹) was superior to all other treatments followed by inoculation of *Pseudomonas sp.* and *Sinorhizobium ciceri*, EAL 001 in the presence of 18/20 kg N P ha⁻¹ as urea and DAP (1241.73 kg ha⁻¹) and *Pseudomonas sp.* with 18/20 kg N P ha⁻¹ as urea and DAP (1209.43 kg ha⁻¹). These three treatments showed significant (P < 0.01) increase in seed yield over the uninoculated control.

Inoculation of phosphate solubilizing bacterial isolates alone with or without DCB/DAP as P source and uninoculated +18/20 kg N P ha⁻¹ as urea and DAP or DCB also gave a marginal increase over the control, however, the remaining treatments are statistically at par each other and with the control.

As presented in table (3) inoculation of (*Sinorhizobium ciceri*, EAL 001 + *pseudomonas sp.*). +18/20 kg N P ha⁻¹ as urea and with the cheap source of phosphorus as dried and crushed bone resulted 57.02% yield increase over the control. In general, the response to inoculation of phosphate solubilizing bacteria singly or in combination with *Sinorhizobium ciceri*, EAL 001 was found to be greater in the presence or absence of DCB and DAP as phosphorus source compared to inoculation of *Sinorhizobium ciceri*, EAL 001 with or without phosphorous source.

Hundred-seed weight on the other hand was not significantly (P > 0.05) affected by any of the treatments (Table 3).
Table 3. Effects of inoculation of *Sinorhizobium ciceri*, EAL 001 + *Pseudomonas* sp. on number of pods per plant, number of seeds per pod, seed yield, percent yield increase and hundred-seed weight of chickpea

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SY (kg/ha)</th>
<th>HSW (g/p)</th>
<th>Harvest index</th>
<th>Percent yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninoculated</td>
<td>790.83f</td>
<td>12.67bc</td>
<td>0.4c</td>
<td>100</td>
</tr>
<tr>
<td>18/20kg NPha⁻¹ as urea and DAP</td>
<td>1176.47bcd</td>
<td>12.83abc</td>
<td>0.5b</td>
<td>148.76</td>
</tr>
<tr>
<td>18/20kg NPha⁻¹ as urea and DCB</td>
<td>1081.00d</td>
<td>13.40abc</td>
<td>0.5b</td>
<td>136.69</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001</td>
<td>879.63ef</td>
<td>14.73a</td>
<td>0.47b</td>
<td>111.22</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001 + 18/20kg NPha⁻¹ as urea and DAP</td>
<td>790.73f</td>
<td>14.37abc</td>
<td>0.47b</td>
<td>99.98</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001 + 18/20kg NPha⁻¹ as urea and DCB</td>
<td>941.10e</td>
<td>13.47abc</td>
<td>0.47b</td>
<td>119.00</td>
</tr>
<tr>
<td><em>Pseudomonas</em> sp.</td>
<td>1113.00cd</td>
<td>14.60ab</td>
<td>0.5b</td>
<td>140.73</td>
</tr>
<tr>
<td><em>Pseudomonas</em> sp. + 18/20kg NPha⁻¹ as urea + DAP</td>
<td>1209.43abc</td>
<td>12.90abc</td>
<td>0.5b</td>
<td>152.93</td>
</tr>
<tr>
<td><em>Pseudomonas</em> sp. + 18/20kg NPha⁻¹ as urea and DCB</td>
<td>1130.47bcd</td>
<td>12.90abc</td>
<td>0.47b</td>
<td>142.94</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001 + <em>Pseudomonas</em> sp.</td>
<td>856.63ef</td>
<td>12.40c</td>
<td>0.5b</td>
<td>108.32</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001 + <em>Pseudomonas</em> sp. + 18/20kg NPha⁻¹ as urea and DAP</td>
<td>1318.53a</td>
<td>13.03abc</td>
<td>0.57a</td>
<td>166.72</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001 + <em>Pseudomonas</em> sp. + 18/20kg NPha⁻¹ as urea and DCB</td>
<td>1241.73ab</td>
<td>13.47abc</td>
<td>0.6a</td>
<td>157.02</td>
</tr>
</tbody>
</table>

LSD (5%) | 118.81 | 1.98 | 0.07 | — |
CV (%) | 6.72 | 8.75 | 7.80 | — |

Means within a column followed by the same letter(s) are not significantly different. NPP = number of pods per plant, NSP = number of seeds per pod, SY = seed yield, HSW = hundred seed weight, Nr: number, AGW = above ground weight, DCB = dried and crushed bone, DAP = diammonium phosphate, N = nitrogen and P = phosphorus
Harvest index

Harvest index was observed to be significantly (P ≤ 0.01) affected by the treatments (Table 3). The highest value of harvest index (0.60) was recorded with inoculation of Sinorhizobium ciceri, EAL 001 + Pseudomonas sp. in the presence of 18/20 kg NP ha⁻¹ as urea and DCB followed by Sinorhizobium ciceri, EAL 001 + Pseudomonas sp. in the presence of 18/20 kg NP ha⁻¹ as urea and DAP (0.57). The other treatments were at par with each other, however, significantly different from the control.

Total nitrogen uptake

As presented in Table 4, inoculation of Pseudomonas sp. + 18/20 kg N P ha⁻¹ as urea and DAP (10.1 kg N ha⁻¹) resulted the highest total nitrogen uptake of chickpea compared to the control and followed by inoculation of Pseudomonas sp. alone (9.2 kg N ha⁻¹) and inoculation of Sinorhizobium ciceri, EAL 001 + Pseudomonas sp. + 18/20 kg N P ha⁻¹ as urea and DAP (8.8 kg N ha⁻¹), and Sinorhizobium ciceri, EAL 001 + Pseudomonas sp. + 18/20 kg N P ha⁻¹ as urea and DAP (7.9 kg N ha⁻¹). Application of 18/20 kg N Pha-1 as urea and DCB also resulted in the total nitrogen uptake of Chickpea in similar manner with Sinorhizobium ciceri, EAL 001 + Pseudomonas sp. + 18/20 kg N P ha-1 as urea and DAP. However, inoculation of Sinorhizobium ciceri, EAL 001 alone with 18/20 kg N P ha⁻¹ as urea and DCB resulted in the total nitrogen uptake of Chickpea at par with the control.

Total phosphorus uptake

Total phosphorus uptake was markedly affected due to various treatments (Table 4). The maximum total P uptake was observed due to inoculation of Pseudomonas sp. + 18/20 kg N P ha⁻¹ as urea and DAP (6.8 kg P ha⁻¹) followed by Sinorhizobium ciceri, EAL 001 + 18/20 kg N P ha⁻¹ as urea and DAP (6.3 kg P ha⁻¹) and Pseudomonas sp alone (6.2 kg P ha⁻¹). Inoculation of Sinorhizobium ciceri, EAL 001 + Pseudomonas sp. + 18/20 kg N P ha⁻¹ as urea and DAP or urea and DCB also resulted in a higher total phosphorus uptake as compared to the control. The increased total P uptake as a result of inoculation of Sinorhizobium ciceri, EAL 001 and Pseudomonas sp. could be due to increased availability of N and P which enhances crop growth.
Table 4. Uptake of nitrogen, phosphorus and available phosphorus content of the soil after harvest as influenced by inoculation of *Sinorhizobium ciceri*, EAL 001 and phosphate solubilizing bacteria

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total N uptake (kg ha(^{-1}))</th>
<th>Total P uptake (kg P ha(^{-1}))</th>
<th>Olsen P (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninoculated</td>
<td>5.7</td>
<td>4.1</td>
<td>8.6</td>
</tr>
<tr>
<td>18/20 kg N P ha(^{-1}) as urea and DAP</td>
<td>7.2</td>
<td>4.8</td>
<td>9.5</td>
</tr>
<tr>
<td>18/20 kg N P ha(^{-1}) as urea and DCB</td>
<td>7.9</td>
<td>5.8</td>
<td>10.4</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001</td>
<td>6.5</td>
<td>4.2</td>
<td>10</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001+18/20 kg N P ha(^{-1}) as urea and DAP</td>
<td>9.1</td>
<td>6.3</td>
<td>9.2</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001+18/20 kg N P ha(^{-1}) as urea and DCB</td>
<td>6.0</td>
<td>6.3</td>
<td>10.4</td>
</tr>
<tr>
<td><em>Pseudomonas sp.</em></td>
<td>9.2</td>
<td>6.2</td>
<td>8.4</td>
</tr>
<tr>
<td><em>Pseudomonas sp.</em> +18/20 kg N P ha(^{-1}) as urea and DAP</td>
<td>10.1</td>
<td>6.8</td>
<td>9.9</td>
</tr>
<tr>
<td><em>Pseudomonas sp.</em> +18/20 kg N P ha(^{-1}) as urea and DCB</td>
<td>7.7</td>
<td>5.2</td>
<td>8.5</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001+<em>Pseudomonas sp.</em></td>
<td>6.7</td>
<td>4.8</td>
<td>9.0</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001+<em>Pseudomonas sp.</em> +18/20 kg N P ha(^{-1}) as urea and DAP</td>
<td>7.9</td>
<td>5.4</td>
<td>11.5</td>
</tr>
<tr>
<td><em>Sinorhizobium ciceri</em>, EAL 001+<em>Pseudomonas sp.</em> +18/20 kg N P ha(^{-1}) as urea and DCB</td>
<td>8.8</td>
<td>5.7</td>
<td>9.0</td>
</tr>
</tbody>
</table>

**Effect on available phosphorus at harvest**

As presented in Table 4, available phosphorus immediately after harvesting chickpea was found to be highest with inoculation of *Sinorhizobium ciceri*, EAL 001+*Pseudomonas sp.* +18/20 kg N P ha\(^{-1}\) as urea and DAP (11.5 ppm P) followed by *Sinorhizobium ciceri*, EAL 001+18/20 kg N P ha\(^{-1}\) as urea and DCB and application of 18/20 kg N P ha\(^{-1}\) as urea and DCP (10.4 ppm P each).

Application of 18/20 kg N P ha\(^{-1}\) as urea and DAP (9.5 ppm P) resulted higher available phosphorus immediately after harvest as compared to control.

In all treatments the available phosphorus at harvest was higher than the soil P status (7.64 ppm P) before planting. Inoculation of *Pseudomonas sp.* either singly or in combination with *Sinorhizobium ciceri*, EAL 001 in the presence or absence phosphorus source increased the available phosphorus immediately after crop harvest.

**Discussion**

Microbial processes such as biological nitrogen fixation, phosphate solubilization and cellulose degradation etc., could supplement the nutrient requirements of crops. The contributions of these microbial processes are enhanced by introducing efficient microbes in the rhizosphere. For instance, symbiotic nitrogen fixation rates could be markedly increased by introducing highly efficient, competitive and persistent strains of Rhizobia (Materon et al., 1995). Similarly, besides solubilizing the native phosphorus sources in the soil, phosphate solubilizing microorganisms could increase the effectiveness of mineral P fertilization (Mikanova and Novakova, 2002). Inoculation of seeds or soil with efficient nitrogen fixing and phosphate solubilizing microorganisms change the rhizosphere population, consequently affecting plant growth.

The results of field study on the effects of inoculation of *Sinorhizobium ciceri*, EAL 001 and *Pseudomonas sp.* on chickpea in presence or absence of N P sources showed positive response for most of the parameters. The nodulation parameters such as nodule number per plant, nodule volume per plant and nodule dry weight were significantly affected by single or
combined inoculation of *Sinorhizobium ciceri*, EAL 001 and *Pseudomonas sp.* on chickpea. It also increased seed yield (166.7%) compared to the control. This implies that interaction between the two organisms, PSB and *Sinorhizobium ciceri*, EAL 001, benefited the crop in terms of growth and yield.

The response to inoculation was also more when DAP used in combination with *Pseudomonas sp.* and *Sinorhizobium ciceri*, EAL 001. The results indicated that the integrated use of chemical fertilizers and inoculants increase the growth, yield and yield parameters due to solubilization of fixed P in the soil. Therefore, the results of the study indicated that single or combined inoculation of *Sinorhizobium ciceri*, EAL 001 and *Pseudomonas sp.* on chickpea was beneficial for initiating formation of effective nodules under ShoaRobit soil conditions. The dry matter production at mid flowering, yield and yield components were significantly affected by single or combined inoculation of *Sinorhizobium ciceri*, EAL 001 and *Pseudomonas sp.* in the presence of N P sources on chickpea but, hundred seed weight, and seed per pod, were not affected by the treatments. Therefore, it can be concluded that use of effective inoculants is promising under ShoaRobit conditions in relation to growth and yield of chickpea. Total nitrogen uptake, total phosphorous uptake and available phosphorous at harvest increased due to the treatments.

In all treatments the available phosphorus at harvest was higher than the soil P status before planting (7.64 ppm). The increased in available phosphorus because of inoculation with phosphate solubilizing bacteria could be explained by solubilization of native phosphate by these organisms. Therefore the uses of inoculants made from effective strains will not only increase crop yield where fertilizer uses is negligible but it will also help in maintaining and enhancing soil fertility. However, the response to microbial inoculants is dependent on several soil factors including organic matter, temperature, moisture, aeration and nutrient status of the soils. Therefore the results of present study need to be evaluated and re-confirmed by conducting extensive field trials under varying soil fertility conditions with different sources and rates of N P fertilizers in combination with *Sinorhizobium ciceri*, EAL 001 and *Pseudomonas sp.*

**Acknowledgements**

The funding for this study was provided by the HaromayaUniversity, Biofertilizer project. We thank all those who gave us constructive ideas in shaping this manuscript. However, only the authors did participate in the conduction of the study, data collection and interpretation and article preparation.

**References**


SECURITY REQUIREMENTS, ANALYSIS, AND POLICY FORMULATION FOR EDUCATIONAL INSTITUTIONALS

Peter Okpamen
Ambrose Alli University, Ekpoma-Nigeria

Abstract
This project is a design implementation of Security requirements, analysis, and policy formulation of Educational Systems. Security of Information Systems in Educational institutions therefore concentrates on the collective efforts of all institutions to produce markedly secured Information systems to help deal with the threat or problems of Identity management within and outside the institution. Identity Management (IDM)” refers to the analysis of procedures of utilizing technologies, models/methods, standards/mechanisms in order to manage essential information in the institution’s network about the identity of all users, and control access to School’s resources. In this project, apart from the design implementation and analysis, emphasis was also placed on the Identity Management(IDM), which guarantees the Identity and Integrity of every registered users in the Network in order to apply appropriate access policy, deliver visibility into Network activity, and secure the local, centralized, distributed, and web/globalizes management of remote devices, while providing Authentication, Authorization, and Accounting functionality across the institution’s Network devices.

Key words: Security Requirements, Analysis, Policy, Educational Institutions.

1.0 Introduction
This project is focused on a design of a security requirements, analysis, and policy formulation of educational institutions. The essence of this design is to enable school managers to design an appropriate security Network to guarantee the security of Information Systems in their establishments. In the course of the design, the following were taken into consideration: Assets in the school, the operations of each staff and student in terms of authentication and authorization policy; role allocation policy, and threat policy. The confidentiality policy, as well as the availability of the system was also of paramount importance to the design. In the course of the design, the researcher/designer placed emphasis on the threats to the security system in particular, such as access by unauthorised persons either by way of identity theft such as obtaining someone else’s password, and attempting to alter information that could create serious crisis in the institution; as well as the integrity of the designed security system. In view of this development, the design was built on the premise that Identity management is a key to the implementation design.
Challenges of Security Systems
The performance of any security system in any organization depends highly on the level of care put in place during the design. Security of Information Systems has therefore culminated into a tough web of technology concepts and standards. And there seems to be no end in sight in terms of standard or consistency, not even a single organization. At the moment the issue appears to be beyond software and system users. The errors are only discovered only after the damage has been done to the system. “The only true security system is one that is powered off, cast in a block of concrete and sealed in a lead-lined room with armed guards-and even then there are still doubts”-(Gene Spafford 2007 : 291). ISO 27001, an information security management standard and certification program; encompasses a set of information security requirements and it helps to reassures customers, employees, and suppliers that information security is of paramount importance for the organization. The organization on its part owes it a point of duty to establish a standard security system to deal with information security threats and issues. Accordingly, ISO27001 is deeply associated to all classes of organizations, and is generally applied for certification purposes. Once the organization meets the standard of ISO 27001 requirements, the security features is often certified by an external registrar. Broadly speaking, a lot of IT managers do not have the required coherent framework and genuine methodology for achieving enterprise security. A security plan that includes technology, personnel, and policies would be a much better approach to developing an organization security strategy (Hazari, 2005). Essentially, the building of a security model requires a clear understanding of the security functional requirements of the organization, and a standard security policy strategy (FIP Standard, 2004; FIP Standard, 2006). Accordingly, the literature suggests that different levels were adopted by researchers to examine access control requirements. Foremost in their approach is the threat analysis-based approach; and it has been found to be very essential as studied intensively by researchers (Debar et al., 2006; Thomson and Von Solms, 1998; Whitman, 2004). The second approach is the evaluation-criteria based. The emergence of this approach over time gained immense popularity among researchers. And this framework has also been adopted by the US department of defence; as well as the European Union. As a result of this development, it is widely known as the common criteria (ISO/IEC, 20050). Accordingly, this school of thought have recommended that this become a basis for every security model. However, to formally evaluate any security system, an evaluation methodology with a set of security requirements is required in order to define the functionality of the security system. Adequate care for the existing technology expertise may well overwhelm an information company, irrespective of position and size. The bottom line therefore should be a regular assessment of risk in order to ensure that the goal of achieving organizational security is not a mirage.

3.0 Methodology
3.1 Assets in Educational System:
This section contains sample representations of personal details of staff and students, unit registered (u), examination marks (u), financial information and degree registered by the students.

<table>
<thead>
<tr>
<th>Table 1 Personal detail of Students:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student-</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Name</th>
<th>DOB</th>
<th>Gender</th>
<th>Address</th>
<th>Post code</th>
</tr>
</thead>
<tbody>
<tr>
<td>7096</td>
<td>Peter</td>
<td>John</td>
<td>20-03-88</td>
<td>Male</td>
<td>50 Shelly Road</td>
<td>E6 3AL</td>
</tr>
<tr>
<td>7084</td>
<td>Allwin</td>
<td>Dixit</td>
<td>07-03-89</td>
<td>Male</td>
<td>63 Stratford Road</td>
<td>4L CFR</td>
</tr>
<tr>
<td>8124</td>
<td>Lizzy</td>
<td>Harris</td>
<td>14-05-87</td>
<td>Female</td>
<td>75 London Road</td>
<td>SE6 1XX</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Email Address</th>
<th>Year of Entry</th>
<th>Expected Year of Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td><a href="mailto:peter@yahoo.com">peter@yahoo.com</a></td>
<td>2008</td>
<td>2012</td>
</tr>
<tr>
<td>Manchester</td>
<td><a href="mailto:Allin@yahoo.com">Allin@yahoo.com</a></td>
<td>2008</td>
<td>2012</td>
</tr>
<tr>
<td>London</td>
<td><a href="mailto:Liz@yahoo.com">Liz@yahoo.com</a></td>
<td>2007</td>
<td>2011</td>
</tr>
<tr>
<td>Liverpool</td>
<td><a href="mailto:Dani@yahoo.com">Dani@yahoo.com</a></td>
<td>2007</td>
<td>2011</td>
</tr>
</tbody>
</table>

The above table contain records of the full details of the individual student in the school. The attributes are: Name of Student, Student number, Date of Birth, Gender, Permanent home address, E-mail address, Year of entry and Expected year of graduation.

### Table 2: Personal Details of Staff:

<table>
<thead>
<tr>
<th>Staff-ID</th>
<th>First Name</th>
<th>Last Name</th>
<th>DOB</th>
<th>Gender</th>
<th>Address</th>
<th>Post code</th>
</tr>
</thead>
<tbody>
<tr>
<td>24861</td>
<td>Michael</td>
<td>Macaulay</td>
<td>02-07-68</td>
<td>Male</td>
<td>45 Rumford Road</td>
<td>R6 6HG</td>
</tr>
<tr>
<td>244789</td>
<td>George</td>
<td>Ubakaman</td>
<td>18-06-65</td>
<td>Male</td>
<td>65 London Road</td>
<td>BU7 4S</td>
</tr>
<tr>
<td>24623</td>
<td>Ali</td>
<td>Ahmed</td>
<td>24-08-70</td>
<td>Male</td>
<td>75 Shelley Road</td>
<td>E7 8AK</td>
</tr>
<tr>
<td>24794</td>
<td>Paul</td>
<td>David</td>
<td>29-09-60</td>
<td>Male</td>
<td>65 Dixit Road</td>
<td>8DK WN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Email Address</th>
<th>Date of Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td><a href="mailto:Mac@yahoo.com">Mac@yahoo.com</a></td>
<td>2001</td>
</tr>
<tr>
<td>Glasgow</td>
<td><a href="mailto:Geal@yahoo.com">Geal@yahoo.com</a></td>
<td>2000</td>
</tr>
<tr>
<td>Edinburgh</td>
<td><a href="mailto:Ali@yahoo.com">Ali@yahoo.com</a></td>
<td>1997</td>
</tr>
<tr>
<td>Liverpool</td>
<td><a href="mailto:Paul@yahoo.com">Paul@yahoo.com</a></td>
<td>1999</td>
</tr>
</tbody>
</table>

Above is the record containing the details of the individual staff in the institution. The attributes are: Name of Staff, Staff number, Date of Birth, Gender, Permanent home address, Email address, and year of employment.

### Table 3: Unit register table

<table>
<thead>
<tr>
<th>Student Identity</th>
<th>Unit Registered (u)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7076</td>
<td>Security</td>
</tr>
<tr>
<td></td>
<td>Research Method</td>
</tr>
<tr>
<td></td>
<td>Multimedia system</td>
</tr>
</tbody>
</table>

The table above is a sample representation of the various units registered with respect to (u), where (u) represents the different units registered by each student.

### Table 4: Examination Marks

<table>
<thead>
<tr>
<th>Student ID</th>
<th>Examination Marks</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7076</td>
<td>Security</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research Method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multimedia system</td>
<td></td>
</tr>
</tbody>
</table>
The table above is a sample representation of the examination marks of the students showing details of letter grades and their respective remarks; Pass/Fail.

**Table 5  Financial Information**

<table>
<thead>
<tr>
<th>Student Identity (ID)</th>
<th>Fees Paid</th>
<th>Balance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7096</td>
<td>20/09/11 (£5,500), 12/12/11 (£3,400)</td>
<td>£1,300</td>
<td>Debtor</td>
</tr>
<tr>
<td>7195</td>
<td>13/09/11 (£5,200), 13/01/12 (£2,000)</td>
<td>£1,800</td>
<td>Debtor</td>
</tr>
<tr>
<td>8043</td>
<td>12/09/11 (£5,200), 18/01/12 (£2,000)</td>
<td>£600</td>
<td>Debtor</td>
</tr>
<tr>
<td>8124</td>
<td>25/09/11 (£8,900),</td>
<td>--</td>
<td>Paid in full</td>
</tr>
</tbody>
</table>

The table above is a sample representation of financial information with respect to fees payment with dates, balance of fees payment of each student in the school; coupled with the remarks on the financial status of the students.

**Table 6  Degree Registered**

<table>
<thead>
<tr>
<th>Student Identity (ID)</th>
<th>Degree Registered</th>
<th>Duration of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>7027</td>
<td>PhD (Management)</td>
<td>1 Year</td>
</tr>
<tr>
<td>7076</td>
<td>PhD (Business Administration)</td>
<td>2 Year</td>
</tr>
<tr>
<td>8021</td>
<td>PhD (Advanced Information Management)</td>
<td>2 Year</td>
</tr>
<tr>
<td>8043</td>
<td>PhD (Business Administration)</td>
<td>1 Year</td>
</tr>
</tbody>
</table>

The above table is a representation of the degree registered for by each student.

### 3.3 The Operations:

The operations determine the typical permit action(s) to be carried out by the individual in question. This can be seen from the access control matrix (ACM) table displayed below:

**Table 7  Access Control Matrix**

<table>
<thead>
<tr>
<th>Asset Roles</th>
<th>Details (id)</th>
<th>Unit Reg. (u)</th>
<th>Examinations/ Records (u)</th>
<th>Accounts Records</th>
<th>Degree Registered (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOD</td>
<td>{view}</td>
<td>{view}</td>
<td>{view}</td>
<td>{view}</td>
<td>{view, edit}</td>
</tr>
</tbody>
</table>
From the table above, the view operation only permits the user to read through the source document, while the edit operation allows the user to write or make changes in the source document as required. However, while some persons can only perform one operation, some can perform both operations depending on their roles. Below is the sample representation of the operation policy.

### Table 8  Illustration of (“View and Edit”) Operation

<table>
<thead>
<tr>
<th>Role</th>
<th>View Degree Registered (C) (AIT)</th>
<th>Edit Degree Registered (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOD</td>
<td>Cannot make changes</td>
<td>Edit (Examination Marks) for (Security)</td>
</tr>
<tr>
<td>Unit Leader (y)</td>
<td>View (Examination Marks) for security</td>
<td>If y = u, where y is the unit leader of security Unit.</td>
</tr>
<tr>
<td>Student (z)</td>
<td>View (Personal Details)</td>
<td>Edit; if z = id, then (make particular changes)</td>
</tr>
</tbody>
</table>

### Table 9  Roles:

<table>
<thead>
<tr>
<th>User ID</th>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark(s)</td>
<td>Head of Department</td>
<td>Attends to daily memo, preside over DBS meeting and appoints course directors.</td>
</tr>
<tr>
<td>Macaulay</td>
<td>Course Director</td>
<td>Allocates units, compile examination scores of students, attend to matters relating to the courses, etc.</td>
</tr>
<tr>
<td>Paul</td>
<td>Unit Leader</td>
<td>Teaching, Marking, and recording of scores, organize tutorials relating to the units, etc.</td>
</tr>
<tr>
<td>Val</td>
<td>IT Manager</td>
<td>Supervises IT equipments, manage the database of employees, etc.</td>
</tr>
</tbody>
</table>

The role of every individual in the school is clearly spelt out as shown above.

### 4.0  Potential Threats to the Security System

Essentially, threats are those dangers associated to the various Assets, with respect to operations carried out. In dealing with threats, the first thing we do is to identify the various threats. Secondly, we have to find out the vulnerabilities of the system and ways to keep the threats from occurring. Basically, threats could be intentional or unintentional. An intentional threat involves a situation where someone purposely damage asset/property or information in the system. On the other hand, unintentional threats are associated to an unauthorized or accidental modification of software. For instance, someone using the system could accidentally delete an important file, or tripped over a power cord. The potential threats are within and outside the security system. As
part of effort to protect the security system against threat, it was designed to provide confidentiality to every source document in terms of privacy. However, below is of the threats the security system was designed to handle:

- An influx of virus to the disk containing students’ records,
- The incident of fire outbreak,
- Falsification of examination scores/statement of results, and
- Fake admission of students

4.1 Vulnerable Spots in the Security System:
In the security design, the possible vulnerability could either come from the operating system, or from the internet connection. The security system design is being run by an operating system. The consequence of this is that, should anyone have knowledge about the operating system, then he/she could be able to access the system and possibly exploit the weakness within it. In addition, because the security system is also connected to the internet, it is also susceptible to threats in this regard. Since the services are always on the internet, it makes it easy for anyone to find you and take your information and send you a virus.

However, the threat to privacy has been taken care of by the security system because of the in-built of pass-word hashing in the design. For instance, Mark (Head of Department) may be interested in editing a unit leader’s marks in an examination. Obviously this is not possible because Mark does not have access to the hash pass-word of the unit leader. Essentially, integrity involves any unauthorized change to information stored in a system. The integrity of the system is such that it is capable of preventing any attempt by unauthorized person to change examination Marks. For instance, if Head of Department (HOD) has access to (Unit Leader) username and password, it means he can in addition to viewing (Unit Leader”) examination Marks of students; can also edit the scores as required. In terms of availability of the security system, the design makes it possible for individuals to have access to its usage any time of the day.

4.2 Preventive Measures:

i. Making sure that the system is frequently checked for security patches and update of dates in order to keep the system more secure,
ii. Purchasing a firewall and anti-virus programs that will have to keep the information safe from attack when connected to the internet for a long period of time.
iii. Being aware of the threats and vulnerability is a necessity towards making security system safer and secure.
iv. Knowing ahead of time just what could compromise your security information and becoming educated in ways of preventing these will make the system more prepared for any attack.

5.0 Authentication:
“... This is a process of identifying an individual, usually based on a user name and password. In security system, Authentication is distinct from authorization which is the process of giving individuals access to system objects based on their identity. Authentication merely ensures that the individual is who he/she claims to be, but says nothing about the access rights of the individual.” (Webopedia, 2007). Authentication is the process of determining whether someone or something is in fact, who or what it is declared to be. It is also a method of uniquely identifying a user. In private and public
computer networks (including the internet), authentication is commonly done through the user of login passwords. Knowledge of the password is assumed to guarantee that the user is authentic. Each user register initially (or is registered by someone else), using an assigned or self-declared password. On each subsequent use, the user must know and use the previously declared password. The authentication table below contains a description of the username and password of each staff and students in the school. The username is unique in the sense that no two people must have same username to avoid a login error. The password is made up of characters not more than 10 digits. The essence of the authentication is to validate the correct user. The limitation of this is that, any person that has access to another person’s username and password would be validated as the authentic user.

<table>
<thead>
<tr>
<th>Username</th>
<th>Password</th>
<th>Hashed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark</td>
<td>Spoon</td>
<td>@?!;@’&amp;8g</td>
</tr>
<tr>
<td>Ali</td>
<td>Sunlight</td>
<td><em>;&gt;:@!/?</em>&amp;m49w</td>
</tr>
</tbody>
</table>

The above table is used to authenticate the user for login, interact with a personal username and its associated hash password. The purpose of authentication is to validate the identity of the user to ascertain whether he/she is qualified to carry out an operation. The table below is an illustration of authentication. In particular, the password of each student and staff are hashed for protection sake. The design is such that each time a student wants to authenticate, he/she first enters his password; while the system computes the hash password and compares with entry in the password file. If the hash password is the same, then the password is accepted and the user is authenticated.

6.0 Authorization

“This is a process of granting or denying access to network resources. Most computer security systems are based on a two step process. The first stage is authentication, which ensures that a user is who he or she claims to be. The second stage is authorization, which allows the user access to various resources based on the user’s identity” (Webopedia, 2007). Authorization is also the process of giving someone permission to do or have something. In multi-user computer systems, a system administrator defines for the system which users are allowed access to the system and what privileges of use (such as access to which person is allow to view or edit, hours of access, amount of allocated storage space, etc). Assuming that someone has logged-in to a computer operating system or application, the system or application may want to identify what resources the user can be given during the session. Thus, authorization is sometimes seen as both the preliminary setting up of permission by a system administrator and the actual checking of the permission values that have been set up when a user is getting access. As soon as the individual passes through the stage of authentication, the next step is the application of any given operation. The access control matrix presents a representation of each person in the school and the asset(s) he/she can access. The mode of operation here is either a View only or View and Edit happening same time. However, note that the View Operation only enables the user to Read only, and cannot make any changes. On the other hand, View and Edit allows the user to Read and make changes on existing information.
Table 12  Role Allocation
This table is an example of role allocation of two lecturers in the school. The full table containing the roles of individuals in the school is displayed in the appendix section.

<table>
<thead>
<tr>
<th>User Identity</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang</td>
<td>Course Director (ISM)/Unit Leader (JAVA)</td>
</tr>
<tr>
<td>Macaulay</td>
<td>Course Director (AIT)/Unit Leader (Multimedia)</td>
</tr>
</tbody>
</table>

For example, Professor Ali, a lecturer in the faculty of Business and Economics wants to check his roles in view of his course allocation for the semester. What he simply does is to type in his user ID and password. Similarly, same goes for two students in different departments, wishing to check their respective department.

7.0 Confidentiality
Basically, the essence of confidentiality is to protect the system and the user from unauthorized user having access to confidential information. Otherwise, it can go a long way to undermine the efficiency of the system. To prevent this act, the hashing password was designed in the security system. Any user whose hashed password doesn’t have a match with stored password cannot be authenticated, neither can he be authorized. Furthermore, examination scores are kept confidential from the reach of unauthorized persons. Examination question papers are also kept confidential in a place called “strong room”. For example: An attempt to change examination mark of Unit Leader (y); where y = Security Unit lecturer, by a student (z) is practically impossible because student (z) does not know the hash password of Unit Leader (y).

7.1 Availability/Auditing/Integrity
Availability with respect to the security design implies that the security system must be available all the time to every person that has link with the school. Furthermore, information met for authorized persons must not find their way into the hands of unauthorized users because they may prevent others from having access to it. The system runs for 24 hours and can even be accessed through self service mode outside school hours. The Audit facility itemizes all attempted log-on and failed password/IDs. It will also detail the time and duration of every user activity. By and large, the system has been designed in such a way that, it takes into account every operation that takes place. In other words, whenever somebody log-in to make some changes, the changes are kept in the audit file. In the event that there is crisis or fraud that requires investigation, the dealings can be accessed. Below is a table describing the use of an audit facility.

Table 14  Audit Mechanism

<table>
<thead>
<tr>
<th>Student ID</th>
<th>Personal Detail</th>
<th>Date</th>
<th>Log-in Time</th>
<th>Log-out Time</th>
<th>Action</th>
<th>Location</th>
<th>IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>7084</td>
<td>63 Stratford Road, London</td>
<td>20-02-11</td>
<td>19:29</td>
<td>20:05</td>
<td>View</td>
<td>London</td>
<td>185.0.86.9</td>
</tr>
<tr>
<td>7096</td>
<td>50 Shelley Road, London</td>
<td>20-03-12</td>
<td>16:15</td>
<td>16:45</td>
<td>View, Edit</td>
<td>Manchester</td>
<td>208.76.9.75</td>
</tr>
</tbody>
</table>

The above tables represent a practical demonstration of how a typical audit mechanism works in a security system. Anytime a user login into the system to perform any operation, the log file will be generated according to his/her identification. At this point
the time the user login is recorded, as well as the action carried out and the location of the
user at the time when he uses the system. In case of any problem involving a misuse of
the system warranting the presence of law enforcement, the auditing system keeps track
of identity of the user and can always reproduce all the information done by the culprit.
**Integrity** as used in this research implies protecting the system against threat. Such
threat may include changing of examination marks by an unauthorized user, which
invariably can affect the aim of the project. For instance, for there to be integrity in the
system, it must provide for the security of examination marks. The integrity of the system
is guaranteed by the presence of hashed password.

### 8.0 Detection and Reaction

Detection with respect to the system implies how, and when can the system detects
certain things that are not suppose to happen; and when it happens, how do we react?
Furthermore, Closed Circuit Television (CCTV) cameras are also available within the
premises to monitor activities within. This will help to detect fraud users, when and how
the wrong was carried out. The reaction expected is to fish out the culprits through the
help of the CCTV. The appropriate policy on erring persons will be applied to the letter
to serve as a deterrent to others. Also, components or the full assets will be replaced if
necessary. Also, the security system is designed to recover from a complete service
interruption without manual intervention. The durability of the security system makes it
possible for it to withstand a partial or gradual degradation that would occur in the event
of failure of the physical components. Finally, the security system has the ability to
withstand a complete service interruption and invoke subsequent recovery in the event of
the failure of physical components.

### 9.0 Concluding Remark

The security system design for educational system no doubt took into account all the
relevant assets of interest in the school that need to be controlled security-wise. In
particular, the system was developed under the framework of the assets, existing and non
existing threats to the system, authentication/authorization and roles of everyone in the
institution. At the end of the day, the principal focus of the system was based on
confidentiality, availability and integrity because any compromise could undermine the
essence of the project. It is highly recommended for all Educational institutions
especially in Nigeria, to have an effective and efficient Security Network in order to
guarantee the security of Information Systems in the enterprise. If the above measures are
readily in place then the security system can be markedly secure and the threats from
within and outside the institution would be a mirage.

### References

in computer science, 109-128.

Hazari, S (2005) *Perceptions of end-users on the requirements in personal firewall
software: an exploratory study*, Journal of organizational and end user computing, July-
September.

International Organization for Standardization {ISO/IEC} (2005 ;) *Information
technology-Security techniques-Information Security Management Systems
Requirements*. Geneva: ISA.

Internet Reference
REVITALIZING TECHNICAL AND VOCATIONAL EDUCATION (TVET) FOR YOUTH EMPOWERMENT AND SUSTAINABLE DEVELOPMENT.

ALHASAN, NDAGIUSMAN And ABDULLAHI TYABO
Department of Building Technology,
School of Technical Education,
Niger State College of Education, Minna-Nigeria

Abstract

Globally, education is acknowledged as a means for transforming and empowering the youths with skills, knowledge and attitudes to enable them become productive members of the society. Yet Nigeria as a developing country with population of 140 million is battling with poverty and unemployment problems. This paper therefore focused on the contribution of a revitalized technical and vocational education and training with emphasis on youth empowerment to improve the economic status of the country and welfare of the people. Issues pertaining to integrating technical and vocational education and training (TVET) in education curricula, entrepreneurial activities aimed at jobs was discussed, this paper concludes that to solve the problem of widespread poverty and unemployment, priority should be given to revitalizing technical and vocational education and training with the priority given to empowering the youths on vocational education. Six major recommendations were made.

Introduction

Youth as defined by the National Policy on Youth Development, is any Individual who is a citizen of the Federal Republic of Nigeria, between the ages of 18-35. Between 1991 and 2006, the youth population in Nigeria has grown from 22.5 million to over 30 million, young people currently comprise over 25 percent of the Nigerian population (Nigerian Youth Policy, 2001). In absolute numbers there are more young people in Nigeria than ever before.

From the census of 1991, 6.1 million young people between the ages of 12-24 were illiterates (NPC, 2003) and a survey in 2003 shows that 10.4 percent male young people and 12.4 percent of these aged 20-24 had no formal education (NDHS, 2003). Also only 37 percent of youth aged 12-17 attended secondary school. Over the last few years, due to the introduction of the Universal Basic Education (UBE) Programme, school enrolment levels have increased significantly, yet the inclusion of technical and vocational educational training is not adequately addressed (Nigerian EFA Reports, 2004).

Young people make up two thirds of the Nigerian population. These young people are faced with numerous challenges ranging from unemployment and poverty. Many of
those who drop out of secondary schools and those who manage to pass through, lack the skills to compete in the rather weak economy and tight labour market, therefore the loiter around from dawn to dusk while battling with poverty and unemployment

The goals of technical and vocational education according to the Federal Republic of Nigeria (2004) are to:
(a) Provide trained manpower in the applied sciences, technology and business particularly at craft, advanced craft and technical levels.
(b) Provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development.
(c) Give training and impact the necessary skills to individual who shall be self reliant economically.

Though the goals of technical and vocational education as stated above are quite laudable but the implementation of the programme has fallen short of expectation.

The slow pace of unemployment, the increasing rate of unemployment and the inability of the country to provide the good things of life to her citizens are evidences in this direction.

Revitalizing technical and vocational education and training (TVET) in Nigeria
Skill training enhances productivity and sustains competitiveness in the global economy. Worldwide countries are renewing efforts to promote technical and vocational education and training, this is because it is the only way to prepare young people for world of work, which reaches out to the marginalized and excluded groups to engage them in income-generating livelihoods. High unemployment has been leading to increasing poverty and serious social problems in Nigeria: coincidentally there has been a decline in TVET enrolments (EFA, 2000). Less than 1percent of secondary schools was oriented towards technical and vocational skills. Therefore there is the need to revitaliseTVET as the best means to improve economic opportunities for the teaming youths of Nigeria. It is in recognition of this, that government has gone into agreement with the UNESCO’s section for technical and vocational education through the National Board for Technical Education (NBTE). Currently NBTE is implementing a project that aims to better equip large numbers of young Nigerians for a world of work. A cost sharing agreement was therefore signed in 2000, between UNESCO and Nigerian Federal Ministry of Education to revise the curricula for secondary technical colleges and post secondary polytechnics and established a new system of continuing technical staff development and training, (EFA Reports,200). But still the Nigerian government need to do more in view of the enormity of the problem.

The Concept of Vocational Technical Education

Technology education was formerly limited. Technical and vocational education is a form of education designed to equip the learners for gainful employment. Okoro (1993) described vocational technical education as that part of education that provides the skills, knowledge and attitude necessary for effective employment in specific occupation.

According to Dawodu (2006), technical and vocational educations are the most reliable vehicles for self sustenance, economic prosperity and political supremacy of a nation over others.
Technical and vocational education according to Osuala (1981) is a form of education that includes preparation for employment in any industry for specialized education for which there is societal needs and which can most appropriately be acquired in schools.

According to the Federal government of Nigeria (2004), technical and vocational education is a comprehensive term referring to those aspects of the educational process involving in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understandings, and knowledge relating to occupations in various sectors of economic life.

In summary, technical and vocational education could be described as:

(a) An integral part of general education
(b) A means of preparing for occupational fields and effective participation in the world of work.
(c) An aspect of life long learning and preparation for responsible citizenship.
(d) An instrument for promoting environmentally sound sustainable development.
(e) A method of alleviating poverty.

Technical and vocational education is particularly relevant in solving the present economic problems in the country due to the advancement in technology, occupational mobility, high rate of unemployment and increasing number of women in workforce.

It is concerned with producing the manpower who will apply scientific skill towards the improvement and solution of the environmental problems, thus making the environment more conducive and useful for mankind.

According to Olaitan (1990), technical and vocational education is for the following.
Skill and knowledge required in the society
Economic development
For work and economic activity
For job creation and
Self respect, social contact and participation.

From the foregoing, technical and TVE education is a skill development programme which is highly required for the country's guest to be one of the 20st economic nations of the world by the year 2020.

Technical and Vocational Education and the Youth

Technical and vocational education and training plays an essential role in improving the wellbeing of youths and communities. It increases productivity, empowers individual to become self reliant and stimulates entrepreneurship. Businesses are more willing to invest in a community with strong human resources. Chinwe, (2008).

Skills development can therefore contribute to strengthening the social links of a community by promoting employment creativity and sustainable means of subsistence. Vocational education and job training programme has been an integral part of national developments strategies in many societies because of the impact on human resources development, productivity, and economic growth. Despite it’s
proven contribution Nigeria does not seem to give vocational education the attention it deserves; and that appears one of the reasons for the rising unemployment and poverty in the society. Vocational education is therefore the missing link in Nigeria’s development policy.

Although TVET seams deficient in ‘citizenship or leadership training’ (Friedman, 1982), they could provide youths the skills to become productive entrepreneurs and engender creative and innovative ideas that would enlarge the nation’s economic pie and increase personal freedom. Here TVET becomes a handy tool, as it can be both formal and informal. Such skill development of the youth empowerment must take into account:

1) Skills to diversify the youths for self-actualization, rather than reliance on government alone.
2) Equipping the youths to value their handwork.
3) Training in basic literacy, numeracy and life skills should be an integral part of the whole system.
4) The promotion of the growth and profitability of the youths for self-employment to enhance the economy.

Though the neglect of vocational education is socially injurious, as it robs the nation the contribution the youths would make on national development. More importantly, the society needs competent auto mechanics, truck drivers carpenters, plumbers, electricians, medical technicians vocational nurses to function well for sustainable development.

Technical and Vocational Education for Sustainable Development

Education in whatever form, is aimed at modelling a child or the individual into a better person relevant to his immediate environment. Sustainable development cannot be achieved without education. Development is a process where an economy undergoes social and economic transformation leading to a rise in the standard of living, access to basic amenities for all through knowledge. Sachs (2004).

It is in recognition of the above concept of development that TVET in empowering youth for poverty alleviation should be given utmost priority by government, having in mind the future consequence and task ahead for sustainable development. The future prospect and success of TVET would depend on the continuation and expansion of the existing training programmes, and strengthening the existing cooperation both national and international, as well as by starting non-formal training programmes for the unemployed youth and the community at large as part of government poverty alleviation efforts toward sustained welfare of the youth and development.

Youth Empowerment and Sustainable Development

Though TVET can be a decisive instrument for youth to participate in the work force and to improve their living conditions and social status, yet the current preoccupation with the university education in Nigeria reduces economic opportunities of those who are more oriented towards work than academe, not everyone needs a university education, but who would employ them if everyone became a university graduate?
Graduates of vocational and technical institutions are the empowered youths, they are highly skilled entrepreneurs, many of the so called “expatriate engineers” who are being paid huge sum of money in dollars to build roads and bridges in Nigeria are graduates of vocational colleges, yet Nigeria is not taking this sector seriously. Youth empowerment by TVET education is therefore a sure means to aid sustainable development if utmost consideration is given to the sector.

**Integrating Skill Development in Education for All (EFA)**

Ensuring that all learning needs of young people and adults are met through equitable access to appropriate learning and life skills programmes is one of the six education for all (EFA) goals established at the world education forum in Dakar 2000. So the provision of vocational skills training youth empowerment should therefore constitute an important component in national strategies if the EFA goal is to be achieved. But developing countries including Nigeria tend to concentrate on universal primary education and literacy, but do not pay sufficient attention to skill training for youths, even though there are numerous initiatives focusing on providing education and training people. This in most cases are often small in scale and are not always recognized as part of a comprehensive national education strategy. There is the need for government to urgently consider redesigning the curricula with emphasis on skill acquisition, especially on youth empowerment, if the government target of reducing poverty by year 2020 is to be achieved.

In 2003, existing skills training programmes for the disadvantaged groups were reviewed, and policies and institutional environments were analyzed in four countries in Africa and Asia (Mali, Senegal, Laos and Nepal). The experience of these selected countries was shared with other developing countries at an inter-regional seminar held at International institute for education planning (Paris, 22-23 January 2004). Suggestions to a more comprehensive approach to EFA was discussed and all stakeholders to EFA are to implement some of the policies and strategies for efficient result and feedback. Incorporating TVET in the EFA programme is a necessity in all developing countries because it advocates for flexible access to learning and training throughout life while downplaying the shortcoming of the beneficiary in order to accommodate a larger group for sustainable development and improve/ enhance productivity (Hamza, 2005).

**TVET Education and Poverty Eradication**

The way the production forces in the economy are organised, determines the development process of any country, for most countries, the development of industry depend greatly on the private sector, with entrepreneurship playing a major role. Entrepreneurship is the capacity and attitude of a person to undertake venture, with a risk or failure. It demands that the individual be prepared to assume a reasonable degree of risk and a good leader in addition to being highly innovative. Since entrepreneurship involves leadership, leadership abilities determines a person’s or organisation’s effectiveness, the entrepreneurship could become a major avenue to accelerate economic growth create job opportunities, many youths aspire to become a successful entrepreneurs, but their ability to make use of their skills remain constrained if they are not empowered.
At the policy level, TVET plays a critical access and equity role in achieving employment for youth, managing work/life balance, and providing citizenship and parental skills for youth. Therefore, expanding TVET is integral for youth in crisis or post conflict situations, tackling poverty, and promulgating cultural inclusion for tolerant peaceful society. The youths through TVET education are encouraged to assume entrepreneurial position, as there is nothing that can surpass the effectiveness of hands on training. (Alwasi, 2002) Through TVET the youths who are full of fresh ideas ingenuity can build up confidence resourcefulness and experience early in life, so that these youths can begin to change the society into a bloomy economy thereby eradicating poverty.

Conclusion

There is a need to establish a secure and poverty free nation for youth to become influential members of any society. Poverty, hunger, homelessness society, sickness and lack of security are paramount issues that require immediate attention of the Nigerian government, if young people are expected to become leaders of the future. For many youths in Nigeria, this problems are daily challenges, when they cannot feed, clothe or shelter themselves or their immediate family, they surely cannot realize their full potentials, since the need for survival is so overwhelming a good number of young people have fallen victim to the pressures of survival and have ended up as arm-robbers, prostitutes scammers, or militants fighting whatever cause, give them a glimmer of hope.

The failure of the government to revitalise the technical and vocational training(TVET) education with emphasis to empower the youth for self-actualization and employment to satisfy basic social needs, exacerbates these problems. It is therefore imperative to note that, the world needs educated and skilled workers with Nigerian youths at the core, and technical and vocational educational training (TVET) could fill the void.

Recommendation

- To reduce the burden of unemployment and poverty on the youths, the government should improve funding in the TVET sector to increase access to technical and vocational education for the ever growing youths. And the National Board For Technical Education (NBTE) and TVET teachers should take up the campaign for more funds and launder the image of TVET in the society.
- Government should provide strategy and implement plans for increasing TVET opportunities for youths with disabilities.
- TVET should provide a world class skill and knowledge for all youths.
- TVET education should be incorporated at all levels of the educational curricula, youth education centres expanded and equipped properly.
- A flexible learning environment and framework should be provided for the would be beneficiaries.
- Government should focus on poverty eradication through revitalizing TVET education while providing basic literacy for youths.

References

Alwasilah, A. C. (2002). Vocational education must provide students with life skills. The Jakarta post, November 2.


MATHEMATICAL MODELING FOR SIMULATION OF NUCLEAR REACTOR ANALYSIS

Salah Ud-Din Khan
Sustainable Energy Technologies Center
College of Engineering,
King Saud University, Riyadh, 11421,
Kingdom of Saudi Arabia

Shahab Ud-Din Khan
Department of Mathematics and Statistics
Chongqing University, 401331, China

Abstract
In this paper, we have developed a mathematical model for the nuclear reactor analysis to be implemented in the nuclear reactor code. THEATRe is nuclear reactor analysis code which can only work for the cylindrical type fuel reactor and cannot applicable for the plate type fuel nuclear reactor. Therefore, the current studies encompasses on the modification of THEATRe code for the plate type fuel element. This mathematical model is applicable to the thermal analysis of the reactor which is very important to determine the design of the reactor. It can produce desired thermal power without exceeding limitations on core components which may leads to fuel failure and radioactive release into the environment. The result obtained from modified code agrees well with other codes conforming the accuracy of simulation.

Keywords: Mathematical model, Nuclear reactor code, Modification of the code, accuracy of simulation.

1 Introduction
Today global warming and high oil prices intrigued towards the high energy demands of electricity turning the attention of International Community for building up of nuclear power plants. Nuclear power is more efficient, reliable and has extra ordinary advantages compared with other power resources. Such as high energy densities as compared with fossil fuel which in terms reducing the environmental degradation by emission of carbon and much more. Despites of these considerations, developing nuclear power plants would seem to be troublesome for future directions. As they requires a large space, considerable large economic risk which might be impossible for even developing countries. Taken into account these things, trends have been changed to build up small sized nuclear power
plants with passive safety features in accordance with IAEA criteria (Defining small reactor with electric power output is less than 300MWe and medium sized reactor with electric power output in between 300-700MWe). “As reactors having capabilities to operate without refueling and reshuffling of fuel for a reasonably long period, are consistent with the plant economics and energy security, with no fresh and spent fuel being stored at the site outside the reactor during its service life”. For the fledging nuclear power industry Small to Medium sized nuclear Reactors (SMRs) are instrumental for the development and demonstration of nuclear reactor technology. Due to the enhanced and outstanding safety features, these reactors have been considered globally. Moreover, these reactors can be built on less ideal places and can be utilized for hydrogen production, heat supply, electricity generation, fresh water production, sea water desalination etc. Innovative nuclear reactors can solve present and upcoming crises such as global warming, resources shortages, proliferation, security aspects, fuel breeding, high temperature process heat applications etc. Compact reactors also have less hazardous affects due to less contained uranium.

Nuclear reactors were initially started in 1940’s for the research purposes and then afterwards in December 20, 1951 electricity was first generated from the nuclear energy. The first commercial Pressurized Water Reactor (PWR) was the NS Otto Hahn merchant ship, which was commissioned in 1968 and powered as 35MW integral reactor. After that, many innovative reactors had been built with much larger output of electricity. In the late 1980s, the Safe Integral Reactor (SIR) was developed by a consortium including the U.K. Atomic Energy Agency, Combustion Engineering, Stone and Webster, and Rolls Royce. After that, many small and medium sized reactors had been built with reliable features and this trend is increasing day by day.

Table 1 Types of Nuclear Reactors

<table>
<thead>
<tr>
<th>Conventional Nuclear Reactors</th>
<th>Theoretical Nuclear Reactors (Gen IV Concepts)</th>
<th>Advanced Nuclear Reactors (Gen III+concepts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressurized Water Reactor (PWR)</td>
<td>Very High Temperature Reactor (VHTR)</td>
<td>The Integral Fast Reactor (IFR)</td>
</tr>
<tr>
<td>Boiling Water Reactor (BWR)</td>
<td>Supercritical-Water-Cooled Reactor (SCWR)</td>
<td>The Pebble Bed Reactor</td>
</tr>
<tr>
<td>Pressurized Heavy Water Reactor (PHWR)</td>
<td>Molten-Salt Reactor (MSR)</td>
<td>Small, Sealed, Transportable Autonomous Reactor (SSTAR)</td>
</tr>
<tr>
<td>High Power Channel Reactor (RBMK)</td>
<td>Gas-cooled Fast Reactor (GFR)</td>
<td>The Clean And Environmentally Safe and Advanced Reactor (CAESAR)</td>
</tr>
<tr>
<td>Gas Cooled Reactor (GCR)</td>
<td>Sodium-cooled Fast Reactor (SFR)</td>
<td>Sub Critical Reactors</td>
</tr>
<tr>
<td>Advanced Gas Cooled Reactor (AGCR)</td>
<td>Lead-cooled fast reactor (LFR)</td>
<td>Hydrogen Moderated Self-regulating Nuclear Power Module (HPM)</td>
</tr>
<tr>
<td>Liquid Metal Fast Breeder Reactor (LMFBR)</td>
<td></td>
<td>Advanced Heavy Water Reactors (AHWR)</td>
</tr>
<tr>
<td>Aqueous Homogeneous</td>
<td></td>
<td>KAMINI (Reactor using U-233)</td>
</tr>
</tbody>
</table>
Table 2 Comparisons between Large and Medium Sized Nuclear Power Plants

<table>
<thead>
<tr>
<th>Large Sized Nuclear Reactor</th>
<th>Small &amp; Medium Sized Nuclear Reactors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large scale metal forging capabilities needed which requires time and cost</td>
<td>Reduces the need of forging and can be built by utilizing conventional fabrication capabilities</td>
</tr>
<tr>
<td>Large sized make the transportation impossible</td>
<td>Easy to transport</td>
</tr>
<tr>
<td>Scheduled vulnerabilities of large plant construction must be performed onsite</td>
<td>Fabricated in controlled factory environment and then shipped to onsite which reduces the risk</td>
</tr>
<tr>
<td>Plant safety requires</td>
<td>Requires more safety due to reduced inventory of radionuclide's, eliminate design features introduces accidents and passively respond to unexpected accidents</td>
</tr>
<tr>
<td>Total quantity of radio nuclides in reactor core i.e Source term is proportional to power level thus doubling source term increases the power level in same manner</td>
<td>Since power level is less so source term is also reduced.</td>
</tr>
<tr>
<td>Primary coolant system is not integrated into a single vessel contributed transients</td>
<td>Primary coolant system is integrated into a single vessel lessens transients</td>
</tr>
<tr>
<td>Decay heat removal should be improved</td>
<td>Due to low core power, smaller volume decay heat can be compensated</td>
</tr>
</tbody>
</table>

With high energy demand, nuclear power is more efficient, reliable and have extra ordinary advantages compared with other power resources, such as high energy densities as compared with fossil fuel in terms reducing the environmental degradation by emission of carbon and much more. Population growth and economic crises in developing countries with insufficient infrastructure and small electricity grids intrigued towards the production of small reactor. Despites of these considerations, developing nuclear power plants would seems to be troublesome for future directions as it requires a large space and mentionable economic risk which might be impossible for even developing countries. Taken into account these facts, trend has been changed leading to construct compact nuclear power plants because they can be built on less ideal place moreover they can be utilized for hydrogen production, heat supply, electricity generation, fresh water production, sea water desalination etc. In addition to this, Innovative nuclear reactors can solve present and upcoming crises such as global warming, resources shortages, proliferation, security aspects, fuel breeding, high temperature process heat applications etc. Compact reactors also have less hazardous affects due to less contained uranium \([2, 3]\). The main function of nuclear reactor is to generate heat in a controlled nuclear fission reaction process to produce electricity. The thermal analysis of the reactor is very important to determine the design of the reactor so that it can produce desired thermal
power without exceeding limitations on core components which may leads to fuel failure and radioactive release [1].

The most important and noticeable thing is the modification of the THEATRe code according to the plate type fuel element. Since the THEATRe can works only for the pin type fuel element and other kind of fuel geometry is beyond the domain of this code. So in order to carry out the huge amount of impressive work this code has been modified for the plate type fuel element. The modified code would be used for the current studies and it will gives the good results comparatively quite agrees with Relap5 analysis.

THEATRe (Thermal Hydraulic Engineering Analysis Tool in Real Time) is one dimensional Thermal hydraulic code used for modeling the two phase fluid system. It is real time simulation code developed for operator training in nuclear as well as non-nuclear power plants for the best estimate engineering analysis. The code has versatile application including the simulation of thermal non equilibrium, non-homogenous two phase flow systems involving steam water mixture, non-condensable gaseous species and non-volatile solute. Considering its application to the nuclear system, the code is best estimated simulation for the PWR and BWR reactor technologies. Since this code has wide application for the pin type fuel element core but cannot be applicable for the plate type fuel element. Hence the present research encompasses the modification of the codes to make it work for the plate type fuel element.

2 Modification in THEATRe code

THEATRe code was used for the thermal hydraulic analysis of the reactor core. As described in the previous section the code can deals with all kinds of fluid flow problems regarding two phase flow mixture.

This paper is focused on the core thermal hydraulic model utilizing plate type fuel element. Since THEATRe code can be applicable only for the cylindrical fuel element so this code must be modified for the plate type fuel.

In order to tackle this problem, the code has been modified according to plate type fuel element by inserting the plate type fuel module in the source code of the code. For this purpose, the detailed mathematics have been done by considering the plate type fuel and then made the program in FORTRAN language.

Since the source code of the THEATRe code was written in FORTRAN language so first the mathematical studies have been completed and then write the program. This program was then move into the source code of the THEATRe along with some alterations as required.

3 Mathematical Studies

![Fig.1 Schematic diagram of Plate fuel](image)
Let us consider a plate type fuel element as shown in fig.7.1 in which the center part is the fuel meat region and outside it, is the cladding. The heat is generated uniformly throughout the fuel at the rate of $q''$ and also the temperature reaches to a steady state value across the fuel element \(^{[4]}\).

The equation governing the temperature distribution of the fuel element is given as

$$\frac{d^2 T}{d^2 x} + \frac{q''}{K} = 0$$

Where $x$ denotes the fuel meat thickness and $K$ denotes the thermal conductivity of the fuel element.

Solving this equation will give the temperature distribution of the fuel meat region and the cladding.

In the current research our main concern is to setup the THEATRe code for the plate type fuel elements. For this purpose, we have first evaluated the mathematical models which are explained below.

A plate type fuel element consists of fuel plate and the cladding while in case of pin type fuel there must be a gap region between fuel and the clad.

The fig.2 shows the temperature profile of the plate type fuel element

![Fig.2 Mathematical evaluation diagram for plate type fuel](image)

For the evaluation of the mathematical model we have assumed that the temperature profile in the fuel meat region is parabolic while in clad region it has linear profile as shown in above fig.2.

The thermal conductivity and the specific heat in the fuel and the clad region are specified by the function of average temperature. The heat generation term($S$), coolant temperature ($T_c$) and the heat transfer coefficient ($h$) are used in the mathematical calculations. Here, in our case we have considered only the radial conduction heat transfer model. The energy conservation concepts have been utilized for the derivation of numerical difference equations and finally the fuel temperature, the fuel/clad interface temperature and the clad/water interface temperature comes out. The given below is the mathematical model which have been used \(^{[5,6]}\).

The very basic equations that have been used in the heat conduction model are given as

Fuel plate thermal conductivity model:
\[
\frac{\partial}{\partial \tau} \left( \rho_f c_p T_f' \right) = \frac{\partial}{\partial x} \left[ \lambda_f \left( \frac{\partial T_f'}{\partial x} \right) \right] + \Phi \quad (0 \leq x < x_1)
\]

(1)

Fuel cladding heat conduction model:
\[
\frac{\partial}{\partial \tau} \left( \rho_c c_p T_c' \right) = \frac{\partial}{\partial x} \left[ \lambda_c \left( \frac{\partial T_c'}{\partial x} \right) \right] \quad (x_i \leq x < x_2)
\]

(2)

### 4 Boundary conditions

For the homogeneous Neuamm conditions at \( x = 0 \), i.e.,
\[
\frac{\partial T}{\partial x} \bigg|_{x=0} = 0
\]

(3)

At the fuel plate surface temperature the heat flux is continuous i.e.,
\[
T_f' \bigg|_{x=x_1} = T_c' \bigg|_{x=x_1}
\]

(4)

\[
\lambda_f \frac{\partial T_f'}{\partial x} \bigg|_{x=x_1} = \lambda_c \frac{\partial T_c'}{\partial x} \bigg|_{x=x_1}
\]

(5)

At the surface of fuel cladding boundary condition i.e.,
\[
-\lambda_c \frac{\partial T_c'}{\partial x} \bigg|_{x=x_2} = h \left( T_w - T_m \right)
\]

(6)

**Assumptions**

There are some assumptions that have been taken into account,
(1) Ignore the core axial heat conduction, only the transverse thermal conductivity is taken.
(2) Fuel plates depend on the thermal physical properties of the average temperature of plates.
(3) The thermal physical properties of fuel cladding depend on the average temperature.
(4) The temperature profile in the fuel meat region is considered to be parabolic while in clad region it is linear.
(5) There is no air gap in cladding conduction model so no gap conduction model is to be evaluated.
(6) Internal heat source is uniformly distributed across the fuel plates.

### 5 Energy balance in the fuel plate region

The temperature profile is assumed to be parabolic according to the symmetrical conditions at the fuel centerline and at the boundary regions. The governing equation is given as
\[
T_f(x, \tau) = T_0(\tau) + (T_1(\tau) - T_0(\tau)) \left(\frac{x}{x_1}\right)^2 \quad (0 \leq x < x_1)
\]

(7)

Solving this equation, we get the average temperature across the fuel meat which is given as

\[
\bar{T}_f(\tau) = \frac{T_1(\tau) + 2T_0(\tau)}{3}
\]

(8)

As explained earlier linear temperature profile has been assumed in the clad region so the corresponding equation can be written as

\[
T_c(x, \tau) = T_1(\tau) + \frac{T_2(\tau) - T_1(\tau)}{x_2 - x_1}(x - x_1) \quad (x_1 \leq x < x_2)
\]

(9)

Solving the above equation will gives the average temperature profile i.e.

\[
\bar{T}_c(\tau) = \frac{T_1(\tau) + T_2(\tau)}{2}
\]

(10)

The above average temperatures are used to determine the fuel and the cladding thermal properties.

According to heat balance equations for the fuel region which is given as

\[
\left((\rho c_p)_{cf}\right)_f \delta_f \frac{\partial \bar{T}_f}{\partial \tau} = k_f \frac{\partial \bar{T}_f}{\partial x} \bigg|_{\delta_f} + \Phi \delta_f
\]

The above equation can be rearranged and wrote in the following form as

\[
\frac{d \bar{T}_f}{d \tau} = \frac{1}{\left((\rho c_p)_{cf}\right)_f \delta_f} \left(\Phi \delta_f - q_{we}\right)
\]

(11)

According to heat balance equations for the clad region which is given as

\[
\left((\rho c_p)_{ce}\right)_c \delta_c \frac{\partial \bar{T}_c}{\partial \tau} = -k_c \frac{\partial \bar{T}_f}{\partial x} \bigg|_{\delta_c} - h^{(n-1)} \left(T_u - T_f^{(n-1)}\right)
\]

The above equation can be rearranged and wrote in the following form as

\[
\frac{d \bar{T}_c}{d \tau} = \frac{1}{\left((\rho c_p)_{ce}\right)_c \delta_c} \left(q_{we} - q_{cf}\right)
\]

(12)

The heat transfer from the fuel meat to the clad is given as
The heat transfer from the clad to the coolant is given as

\[ q_{cf} = \frac{\overline{T}_c - T_\infty}{R_c + R_m} \]

Where,

Fuel thermal resistance \( R_f = \frac{\delta_f}{3\lambda_f} \);

Cladding thermal resistance \( R_c = \frac{\delta_c}{2\lambda_c} \);

Convective heat resistance \( R_m = \frac{1}{h} \)

Solving eq (11) & (12) by using Euler’s method we get the fuel centerline temperature \( (T_1) \), Fuel/clad interface temperature \( (T_0) \) and the clad/coolant interface temperature \( (T_2) \). The finally solved equations are given as

\[ T_1(\tau) = \frac{R_c \overline{T}_f + R_f \overline{T}_c}{R_f + R_c} \]  

\[ T_0(\tau) = \frac{(3R_f + 2R_c)\overline{T}_f - R_f \overline{T}_c}{2(R_f + R_c)} \]

\[ T_2(\tau) = \frac{R_m \overline{T}_c + R_c T_\infty}{R_c + R_m} \]

These equations are then utilized to develop the program in THEATRe code.

**Summary**

In this paper, the research is focused on the modification of the thermal hydraulic code i.e. THEATRe. For this purpose, description about the modification of the code is included which reveals the extension of the application of the codes for the plate type fuel reactor.

**6 References**


ROLE OF GREEN TEA EXTRACT AND POWDER TO MITIGATE METABOLIC SYNDROMES; SPECIAL REFERENCE TO HYPERGLYCEMIA AND HYPERCHOLESTEROLEMIA

S. Yousaf¹, M. S. Butt¹, H. A. R. Suleria², M. J. Iqbal¹ and M. Sohail¹

¹National Institute of Food Science and Technology, University of Agriculture Faisalabad, Pakistan
²School of Agriculture and Food Science, The University of Queensland, Australia

ABSTRACT
Currently dependence on natural products is gaining popularity to combat various physiological threats. Scientific evidences have been provided that dietary phytochemicals may play important roles as chemopreventive or chemotherapeutic agents in the prevention of many diseases. Green tea has many biologically active moieties like flavanols and polyphenols. Catechins are flavanols that constitute majority of soluble solids of green tea; its major fractions are epigallocatechingallate (EGCG), epigallocatechin (EGC), epicatechingallate (ECG) and epicatechin (EC). Among these, EGCG is the predominant fraction contributing more than 50% of polyphenols. It has many health related characteristics like hypoglycemic, hypocholesterolemic, anticancer, antiviral and antihypertensive. Ethanolic extracts of green tea was subjected to in vivo modeling. Efficacy trial was carried out on normal, hyperglycemic and hypercholesterolemic rats for 8 weeks study. Control, functional and nutraceutical diets were used for each study. Drink & feed intake and body weight increased during the study period. Serum analysis depicted that maximum reduction of cholesterol level was noted in hypercholesterolemic rats up to 15.45% due to nutraceutical diet. It was 21.51% in case of LDL and 12.92% for triglycerides. The serum glucose level was reduced maximum in hyperglycemic rats up to 13.39% as a result of nutraceutical diet. The functional diet resulted in a bit less reduction in the respective traits as compared to nutraceutical diet. Hematological analysis revealed that administration of green tea did not adversely affect the red blood cell, white blood cells and platelets count of the rats. The current research work enables us to conclude that green tea is effective against hypercholesterolemia and hyperglycemia.

Keywords: Green tea, green tea extract, catechins, flavanols, hypercholesterolemia and hyperglycemia

BACKGROUND
Modern sedentary lifestyle includes a diet rich in fat and with lesser proportion of dietary fiber, bioactive ingredients and micronutrients. These eating habits are the reason for an increase in diet-related ailments mainly hypertension, obesity, diabetes, cardiovascular diseases, hyperglycemia, hypercholesterolemia, osteoporosis and cancer. Many scientific investigations have emphasized the association of a diet rich in fruit and vegetables with good health. Intake of certain active ingredients, like flavonoids, carotenoids and
glucosinolates etc. also possess a direct link with reduced risks of hypercholesterolemia, hypertension, cardiovascular and many other chronic illnesses (Lajolo, 2002; Chen et al., 2011).

Tea is a beverage prepared from leaf and bud of the plant Camellia sinensis and is the second most consumed beverage worldwide after water; well to the lead of coffee, beer and carbonated soft drinks (Costa et al., 2002; Rietveld and Wiseman, 2003). It is variably consumed across the globe as green, black, or oolong tea. However, amongst all these, green tea intake is reported to have a remarkable significance on human health (Cabrera et al., 2006). Despite of the economic and social interest, tea is consumed as a fraction of the daily routine of many humans, as an everyday drink and also as a therapeutic abet against many ailments.

Green tea is manufactured in such a manner that eludes the oxidation of all green leaf phenolic compounds. However, oolong tea is a semi-oxidized product whereas oxidation is encouraged during black tea production so that most of these substances are oxidized. As a standard, each year 2.5 million metric tons of dried tea is manufactured across the world. Out of this, green tea comprises only 20% and is mainly consumed in Asian countries like Japan, China, Korea, India and Pakistan (Khan and Mukhtar, 2007). Currently, 90% of green tea comes from China and Chinese strongly believe that green tea consumption is better than medication (Wolfram, 2007).

Catechins constitute a greater part of green tea soluble solids; the major fractions include epigallocatechingallate (EGCG), epigallocatechin (EGC), epicatechingallate (ECG) and epicatechin (EC). Among these, EGCG is the predominant element contributing more than 50% of total polyphenols (Wang et al., 2000). Green tea also contains carotenoids, tocoferols, ascorbic acid and minerals such as Cr, Mn, Se or Zn (McKay and Blumberg, 2002). Other components present in tea include protein, carbohydrates, lipids, sterols, vitamins, xanthic bases (caffeine and theophylline), volatiles compounds, minerals and trace elements (Cabrera et al., 2006).

Additionally, catechins exhibit antimutagenic, hypoglycemic, antiinflammatory, anticarcinogenic, antibacterial and antiviral properties (Cabrera et al., 2006; Wolfram, 2007; Crespy & Williamson, 2004; Henning et al., 2005). The antioxidant properties of polyphenols are the key contributing factors acclaimed to tea and in Japan catechin-rich beverages are available under the label of “Food for Specified Health Use”. More or less 34% of the total polyphenol utilization from beverages in Japan comes from green tea (Hara, 2006; Morita et al., 2009; Muller et al., 2010). However, TPC, a potentially active fraction, is much popular internationally for its antidiabetic and immunomodulatory activities, especially in hyperglycemic mice or rats (Chen et al., 2011). Extract of green tea is known to improve insulin resistance in high-fat-fed and high-fructose-fed rodents and increase insulin sensitivity in male Sprague Dawley rats (Murase et al., 2002; Wu et al., 2004). Studies also revealed that the regular consumption of tea polyphenols may also contribute to the prevention of type-2 diabetes (Kao et al., 2006).

Recent research illustrated the fact that tea contributes a positive effect in consumer health such as reduced cholesterol and glucose levels, control of hypertension etc. whilst EGCG in particular has preventive effects against various chronic diseases (Hara, 2006). Also, green tea may lower the risk of cardiovascular disease and cancer besides other beneficial consequences on health (Cabrera et al., 2006). The therapeutic activities of green tea are associated with its constituents, like tea polysaccharide conjugates (TPC), tea polyphenols (catechins), tea pigments, caffeine and theanine.
MATERIAL AND METHOD

Preparation of raw material

Green tea leaves of Qi-Men variety were obtained from National Tea Research Institute (NTRI), Shinkiari, Mansehra. Reagents (analytical and HPLC grade) and standards were purchased from Merck (Merck KGaA, Darmstadt, Germany) and Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan). Male Sprague Dawley rats used in the efficacy trials were acquired from National Institute of Health (NIH) Islamabad. Diagnostic Kits used were from Sigma-Aldrich, Bioassay (Bioassays Chemical Co. Germany) and Cayman Chemicals (Cayman Europe, Estonia). Green tea dried leaves were cleaned in order to remove dust, stones and straw. Green tea leaves were ground (Renker, Model: GMO 1 grinder) and analyzed for their quality attributes as proximate composition, mineral composition, polyphenols and antioxidant capacity.

Extract preparation of green tea

Ethanolic extract of green tea was prepared using (50% v/v) water and ethanol at 50°C for time interval of 45 min according to the methods described by Rusak et al. (2008) and Aspé&Fernández (2011) with some modification. Later on, extract was filtered and subjected to Rotary evaporator (Eyela, Japan).

Efficacy study

For animal trial modeling sixty male Sprague Dawley rats were procured from National Institute of Health (NIH), Islamabad and housed in Animal Room of National Institute of Food Science and Technology, University of Agriculture Faisalabad, Pakistan. During whole experimental period, temperature (23±2°C) and relative humidity (55±5%) of Animal Room was controlled with 12 hours light-dark period alternatively. At the initiation of study, some rats were sacrificed to get baseline values for each study. Three types of studies were conducted separately using normal diet, high cholesterol diet and high sucrose diet (Figure 1) in order to determine the therapeutic effect of green tea powder and extract on selected parameters of collected sera of rats including lipid profile, glucose & insulin levels. For the purpose each study comprised of fifteen rats, in which each group consisted of five rats.

Place figure 1 here

Feed and water intake

Average feed intake of each group was measured on daily basis by eliminating spilt diet from the total diet given during the whole study period (Wolf and Weidbrode, 2003). The water intake for each group was also recorded on daily basis.

Body weight gain

Increase in body weight of rats from all experimental groups was measured weekly throughout the study period to analyze effect of functional and nutraceutical diet on body weight.

Serum lipid profile

Serum lipid profile of rats including cholesterol, high density lipoproteins (HDL), low density lipoproteins (LDL) and triglycerides were measured by following their respective protocols. Detail for each parameter is given below:

a. Cholesterol

Serum cholesterol level of rats was measured using CHOD–PAP method following the protocol of Kim et al. (2011).

b. High & low density lipoprotein
High density lipoprotein (HDL) and low density lipoproteins (LDL) in serum samples were calculated by method as mentioned by Alshatwi et al. (2010).

c. **Triglycerides**

Triglycerides in serum sample were estimated by liquid triglycerides (GPO–PAP) method as illustrated by Kuo et al. (2005).

d. **Serum glucose and insulin levels**

For each study, the collected sera were evaluated for glucose concentration by GOD-PAP method as described by Kim et al. (2011), whereas insulin level was assessed following the method of Ahn et al. (2011).

**Hematological analysis**

Red blood cell (RBC) and white blood cell (WBC) indices were determined by method of Al Haj et al. (2011). Platelets count estimation was carried out following the method of Kamataniet al. (2010).

**Statistical Analysis**

The data for each parameter was subjected to statistical analysis to determine the level of significance (Steel et al., 1997). Analysis of variance was calculated using Factorial Design whilst means were interpreted by Latin Square Design.

**Results and discussion**

**Efficacy studies**

Efficacy study was carried out in vivo on Sprague Dawley male rats in order to estimate the functional and nutraceutical significance of green tea powder and its prepared extract against hyperglycemia and hypercholesterolemia. The reasons for using rodent experimental modeling instead of human subjects include easy handling, apt supervision, and feasibility of controlled environmental conditions and safety concern of the active ingredient being used.

**RESULT AND DISCUSSION**

**Feed & drink intake**

Mean square values for feed intake explicated significant differences as per trial group and experimental time span; however, means regarding feed intake are presented in Figure 2. In study I, feed intake of control group rats was found to increase successively throughout the trial interval whilst lesser increase was recorded in rats consuming nutraceutical diet. At the end of study, control group persisted with highest feed intake (20.14±0.61 g/rat/day) whereas nutraceutical group showed lowest average feed intake values (19.58±0.48 g/rat/day). Means for diet intake, however, increased consistently during two months in all the groups. At the end of 8th week, mean feed intake values for study II revealed maximum value for control diet group (21.96±0.56 g/rat/day), followed by functional and nutraceutical groups with (21.22±0.59 g/rat/day) and (21.2±0.61 g/rat/day), correspondingly. As regards study interval, feed intake values depicted significant increase from 1st to 8th week for all diet groups. Similarly, study III showed highest mean for control group followed by functional and nutraceutical group; values were recorded as 22.28±0.63, 21.42±0.58 and 21.38±0.52 g/rat/day, correspondingly. Moreover, increasing time favored feed consumption and an overall increasing trend was observed in all groups with highest rate in control groups in all studies.
According to Hininger-Favier et al. (2009), green tea intake led to lesser feed consumption in high fructose-fed rats as compared to the control group. Feed intake in control group after 6 weeks of study was recorded as 21.5±0.6 g/rat/day. Feed intake in fructose-fed rats given 1 g tea solids/kg diet was recorded as 20.5±0.9 g/rat/day while in rats given 2 g tea solids/kg diet was recorded as 20.3±1.5 g/rat/day however, the difference was revealed to be non-significant.

Mean squares for water consumption illustrated a non-significant relation in the measured values as per treatments but a significant increase during the trial interval, in all diet groups. It can be observed from Figure 3 that in study I, highest intake was recorded for control group (27.2±0.77 mL/rat/day) and lowest for nutraceutical group (25.89±0.64 mL/rat/day). Similarly for study II and III, maximum intake was noted for control groups as 28.64±0.81 and 29.18±0.76 mL/rat/day, respectively, whilst minimum for nutraceutical groups as 27.06±0.58 and 27.93±0.62 mL/rat/day. Results showed a significant increase in means for water intake from 1st to 8th week irrespective of the treatments. The obtained data is also comparable to the efficacy results of Haque et al. (2006) who incorporated green tea catechins in rodents and evaluated their impact on learning capacity of subjects. They found insignificant difference among daily water intake values from all study groups i.e. control (27.7±1.7 mL/rat/day), green tea catechins 0.1% (26.0±1.4 mL/rat/day) and green tea catechins 0.5% (26.2±1.0 mL/rat/day).

Body weight

Mean squares for rat body weights show a significant difference in body weights in relation to treatments and trial interval. Body weights of rats were measured once at the initiation of study and then weekly throughout the efficacy trial, data presented as graph (Figure 4). At the start of trial, body weights for study I were noted as 131.28±3.94, 133.72±3.78 and 132.46±2.85 g/rat for control, functional and nutraceutical diet groups, correspondingly. At the termination of study, these values were recorded to be 227.12±5.22, 212.77±5.17 and 208.5±4.32 g/rat, respectively. Means for body weights clearly show a higher weight gain in control group as compared to other two groups. Similar increasing trend was observed for body weights in study II over the trial interval. The values increased from 133.46±2.91, 135.15±3.54 and 134.59±3.87 g/rat for control, functional and nutraceutical group, correspondingly and enhanced to 243.7±6.02, 219.8±5.79 and 218.5±5.94 g/rat for the respective diet groups. Maximum weight gain was observed for control group whilst minimum weight gain was noted for nutraceutical diet group. Similarly for study III (hypercholesterolemic rats), body weights recorded at the start of trial were 132.84±3.86, 134.66±3.54 and 134.59±2.91 g/rat for control, functional and nutraceutical groups, respectively. These values increased to 254.67±6.29, 234.8±5.88 and 230.83±5.62 g/rat, correspondingly at the end of efficacy trial. In all study groups, maximum weight gain was associated with control diet group while nutraceutical diet group showed minimum weight gain after eight weeks of in vivo experimentation.

Data obtained was comparable to previous in vivo biological studies. According to Uchiyama et al. (2010), mice fed on tea polyphenols depicted slower gain in body weight during eight weeks of study. Ingestion of 5% tea polyphenol extract led to a decrease of 32.8% in body weight gain among normal rodents whilst the decrease was 44.2% among high-fat consuming subjects.
Cholesterol

Green tea possesses hypocholesterolemic properties and can lower cholesterol levels in normal as well as hypercholesterolemic rats. Mean squares for serum lipid profile showed a significant difference in cholesterol levels in all three studies as a function of treatments. Results were also found significant with respect to interval and interaction of treatment and interval for study II and III but non-significant for study I. Means for cholesterol levels are presented in Table 1. In study I, highest value for cholesterol (82.50±1.84 mg/dL) was measured in control diet group trailed along by functional (79.06±1.94 mg/dL) and nutraceutical (79.01±1.79 mg/dL) diet groups. During 56 days of trial, an increase in cholesterol level from 81.94±2.56 to 82.89±2.57 mg/dL was observed in control group. Diets containing green tea caused significant decrease in serum cholesterol levels of rats with a decrease from 80.57±2.34 to 77.25±1.84 mg/dL in functional while 81.77±1.89 to 77.21±1.76 mg/dL in nutraceutical group. Results revealed 4.11% reduction in cholesterol levels with functional diet and 5.57% reduction with nutraceutical diet. Likewise, in study II highest value (116.22±3.06 mg/dL) was recorded for hyperglycemic rats from control diet group followed by functional (103.85±2.71 mg/dL) and nutraceutical (103.54±2.89 mg/dL) diet groups. During the study interval, control group showed an increase in cholesterol level from 110.14±3.12 to 121.97±3.16 mg/dL. Functional diet showed a reduction from 98.60±2.64 to 108.77±2.91 mg/dL (9.35%) while nutraceutical from 111.24±2.76 to 98.28±2.55 mg/dL (11.65%) over 2 months. In the same manner, means regarding study III explicated maximum cholesterol level (137.53±2.98 mg/dL) in control group followed by functional (122.14±1.62 mg/dL) and nutraceutical (120.48±2.81 mg/dL) groups. Over the study interval, 12.15% reduction was observed with functional diet from 130.24±3.25 to 114.42±2.76 mg/dL whilst 15.45% reduction was recorded with nutraceutical diet from 131.23±2.96 to 110.95±3.02 mg/dL. Reduction in serum cholesterol recorded in study II and III from 0 to 56 days was highly significant (p<0.01).

Most recently, Onuoha et al. (2012) evaluated the consequence of green tea consumption against hypercholesterolemia and also showed that the values of cholesterol for subject taking green tea were lower (174.2±2.3 mg/dL) than the values for control (183.7±0.7 mg/dL). Earlier, Wu et al. (2004) examined the serum cholesterol levels of male mice dosed with 625, 1250 and 2500 mg/kg/day and observed significant decrease at all dosages. Maximum reduction (27%) was observed at a dose level of 2500 mg/kg/day over 28 days of trial.

High density lipoproteins (HDL)

Mean squares for serum HDL showed a non-significant difference in values for study I and II, however in study III significant difference was observed regarding different treatments. No significant difference was observed with respect to interval and interaction of treatment and interval in all studies. Means for serum HDL levels are presented in Table 2. In study I, highest value for HDL (35.61±0.88 mg/dL) was measured for nutraceutical diet group trailed along by functional (34.68±0.93 mg/dL) and control (34.41±0.62 mg/dL) diet group. During 56 days of trial, diet with green tea caused an increase in HDL levels of rats with an increase from 34.42±0.67 to 34.86±0.91 mg/dL in functional while 35.24±0.91 to 35.93±0.55 mg/dL in nutraceutical group. Likewise, in study II highest value (40.4±0.91 mg/dL) was recorded for hyperglycemic rats from nutraceutical diet group followed by functional (39.43±0.87 mg/dL) and control (39.31±1.05 mg/dL) diet groups. During the study interval, maximum increase was recorded for nutraceutical diets 39.89±1.04 to 40.83±1.12 mg/dL (2.35%) over 2 months.
For study III, means regarding HDL levels explicated maximum (49.02±1.17 mg/dL) in nutraceutical group followed by functional (48.12±1.04 mg/dL) and control (46.22±1.22 mg/dL) groups. Over the study interval, 3.23% increase was observed with nutraceutical diet from 48.2±1.33 to 49.75±0.88 mg/dL whilst only 2.12% increment was recorded with functional diet as 47.58±0.92 to 48.59±1.12 mg/dL. Increase in serum HDL recorded in study III from 0 to 56 days was observed to be significant (p<0.05) whilst control hyperglycemic and control hypercholesterolemic groups showed a decrease in insulin levels indicating ailing conditions.

Moreover, Kasetti et al. (2010) reported a decrease in high density lipoprotein (HDL) cholesterol in streptozotocin induced diabetic rats. Babu et al. (2006) showed that green tea extract given to diabetic rats resulted in reduced cholesterol, triglyceride, free fatty acid and LDL levels, while increased serum HDL levels of rats. Moreover, they affirmed antihyperglycemic and hypolipidemic activity of green tea extract.

**Low density lipoproteins (LDL)**

Green tea can reduce LDL cholesterol levels in normal as well as hypercholesterolemic rats. Mean squares for serum lipid profile showed a significant difference in LDL levels in all three studies as a function of treatment, interval and their interaction. Means for LDL levels are given in Table 3. Study I represented the lowest value (30.82±0.74 mg/dL) in nutraceutical group while highest (33.54±0.42 mg/dL) in control diet group. During 2 months of trial, an increase in LDL level from 33.26±0.81 to 33.89±0.54 mg/dL was observed in control group. Functional and nutraceutical diets resulted in significantly reduced LDL levels, with a decrease from 32.75±0.62 to 30.55±0.24 mg/dL through functional and 32.65±0.76 to 29.63±0.62 mg/dL through nutraceutical diet. Likewise, in study II highest value (59.08±1.67 mg/dL) was recorded for hyperglycemic rats from control diet group while functional (52.64±1.38 mg/dL) and nutraceutical (51.98±0.89 mg/dL) diet groups showed reduced levels. During the study interval, control group showed an increase in LDL level from 55.98±0.93 to 62.07±1.65 mg/dL. Functional diet showed a reduction from 56.49±1.55 to 48.77±0.88 mg/dL (13.67%) while nutraceutical from 57.67±1.24 to 47.61±0.84 mg/dL (17.44%) over 2 months. In the same manner, means regarding study III explicated elevated LDL (68.58±1.78 mg/dL) in untreated hypercholesterolemic rats in contrast to lower levels in functional (59.51±1.21 mg/dL) and nutraceutical (56.39±1.67 mg/dL) groups. Over the study interval, 16.91% reduction was observed with functional diet from 65.68±1.49 to 54.57±1.43 mg/dL whilst an appreciable 21.53% reduction was recorded with nutraceutical diet from 63.82±1.55 to 50.09±1.20 mg/dL.

Results of present project are comparable to earlier findings. Kim and fellows (2011) carried out a systematic review of various research findings and affirmed the link of green tea intake with reduced cholesterol and LDL levels. Nantz et al. (2009) reported significant decrease in LDL levels in men, during 3 weeks of green tea ingestion in the form of encapsulated tea components of defined composition.

**Triglyceride**

Mean squares for serum lipid profile showed momentous effect of treatments and interval on triglycerides level in all three studies while variable effect for interaction. Means presented in Table 4 indicate that for study I, represented maximum value (71.76±2.17 mg/dL) in control group while lower values in functional (70.47±2.06 mg/dL) and nutraceutical (69.7±1.94 mg/dL) diet groups. 56 days of trial, led to increased triglycerides level from 71.15±2.09 to 72.21±1.62 mg/dL in control group. Green tea containing diets
resulted in significantly reduced levels, as 71.53±2.12 to 68.98±1.89 mg/dL with functional and 71.75±2.18 to 68.11±2.02 mg/dL with nutraceutical diet. Results revealed 3.56 and 5.07% reduction with functional and nutraceutical diets, respectively. Likewise, in study II highest value (80.69±2.19 mg/dL) was recorded for hyperglycemic rats from control diet group while functional (72.78±2.08 mg/dL) and nutraceutical (72.65±2.14 mg/dL) diet groups showed reduced levels. During trial interval, control group showed an increase in triglycerides from 77.42±1.54 to 83.46±2.08 mg/dL. Functional diet showed a reduction from 75.58±2.33 to 70.12±1.77 mg/dL (7.23%) while nutraceutical gave best results with a reduction from 76.75±2.18 to 69.11±1.98 mg/dL (9.96%) over 2 months. Means regarding study III explicated same trend with elevated level (98.26±1.62 mg/dL) in control hypercholesterolemic rats but lower levels in functional (90.67±2.05 mg/dL) and nutraceutical (88.06±2.16 mg/dL) groups. Over the study interval, 9.36% reduction was observed with functional diet from 95.42±2.61 to 86.48±1.96 mg/dL whilst greater reduction (12.92%) was recorded with nutraceutical diet from 94.63±2.41 to 82.40±2.04 mg/dL.

Current data is in corroboration with previous research work as Li et al. (2006) expressed that green tea extract caused significant reduction in triglycerides level not only in plasma but also in liver and heart tissues in fructose-fed rodents. They reported triglyceride accumulation reduced by 42% in liver and 32.5% in heart tissues at high dose of green tea supplementation versus control, incorporated in rats for 4 weeks.

**Place table 3 and 4here**

**SERUM GLUCOSE & INSULIN ANALYSIS**

**Glucose**

Green tea possesses anti-hyperglycemic properties and can help maintain elevated glucose levels in hyperglycemic rats. Mean squares for serum glucose & insulin levels showed a significant difference in glucose levels in all studies as a function of treatment. However, results showed variable effect observed with respect to interval and interaction of treatment and interval. Means for serum glucose are presented in Table 5. In study I, highest value for glucose (93.51±2.45 mg/dL) was measured in control diet group while functional and nutraceutical diet groups showed lower levels, 90.81±2.62 mg/dL and 90.78±2.48 mg/dL, respectively. Two months of study led to an increase in glucose level of control group subjects as 92.29±2.67 to 94.54±2.64 mg/dL. Functional diet showed a reduction from 91.76±2.56 to 89.58±2.67 mg/dL (2.37%) while nutraceutical from 93.42±2.52 to 89.04±2.54 mg/dL (4.69%) over 2 months. Similarly, in study II hyperglycemic control diet group showed elevated glucose level (125.28±3.55 mg/dL) while lower levels were observed in functional (112.10±3.32 mg/dL) and nutraceutical (110.73±3.18 mg/dL) diet groups. During the study interval, control group showed increased serum glucose as 119.63±3.12 mg/dL on 0 day to 131.64±3.58 mg/dL after 56 days. Functional diet showed a reduction from 118.32±3.26 to 106.62±2.86 mg/dL (9.89%) while nutraceutical from 119.32±3.48 to 103.34±3.05 mg/dL (13.39%) over 2 months. Means regarding study III explicated increased glucose level (102.28±2.49 mg/dL) in control hypercholesterolemic group followed by functional diet group (97.5±2.65 mg/dL) while minimum value was recorded for nutraceutical (95.37±2.53 mg/dL) groups. Over the study interval, 3.85% reduction was observed with functional diet from 99.54±2.72 to 95.71±2.54 mg/dL whilst 6.03% reduction was recorded with nutraceutical diet from 98.72±2.64 to 92.76±2.61 mg/dL giving best results.

Current results highly correlate with earlier research findings affirming a decline in serum glucose levels with green tea intake. Tsunekiet al. (2004) reported better glucose
metabolism and significantly reduced blood glucose with the administration a suspension of green tea powder in human subjects. Moreover, they evaluated antihyperglycemic properties of green tea in diabetic mice and observed significant decrease from 235 ± 15 mg/dL to 116 ± 12 mg/dL and 201 ± 10 mg/dL to 106 ± 8 mg/dL after 6 hours with two different green tea cultivars having 16.3 and 10.5 g total catechins/100g tea powder, respectively.

**Insulin**

Mean squares for serum insulin showed significant difference in insulin levels for study I, II and III as a function of treatment. No significant difference was observed with respect to interval and interaction of treatment and interval in all studies. It can be observed from means for serum insulin (Table 6) that in study I, maximum value for insulin (9.83±0.16 µU/mL) was measured for nutraceutical diet group trailed along by functional (9.64±0.19 µU/mL) and control (9.06±0.18 µU/mL) diet group. During trial interval, diet with green tea caused non-momentous elevation in insulin levels of rats with an increase from 9.52±0.25 µU/mL to 9.74±0.22 µU/mL in functional while 9.68±0.28 µU/mL to 10.03±0.27 µU/mL in nutraceutical group. Results revealed 2.19% increment with functional diet whilst 3.61% increase with nutraceutical diet, higher than 1.95% increase in control group.

In study II highest value (11.12±0.18 µU/mL) was recorded for hyperglycemic rats from nutraceutical diet group, trailed along by functional (10.58±0.23 µU/mL) and control (10.02±0.19 µU/mL) diet groups. During the study interval, maximum increase was recorded for nutraceutical diet as 10.72±0.26 µU/mL to 11.47±0.23 µU/mL (7.06%) while functional showed lesser increment from 10.33±0.21 µU/mL to 10.79±0.19 µU/mL (4.47%) over 2 months. Means regarding serum insulin for study III showed maximum value (10.24±0.17 µU/mL) in nutraceutical group followed by functional (9.43±0.18 µU/mL) and control (9.22±0.21 µU/mL) groups. Over the study interval, 4.89% increase was observed with nutraceutical diet from 9.97±0.18 µU/mL to 10.46±0.23 µU/mL whilst only 3.67% increment was recorded with functional diet as 9.25±0.25 µU/mL to 9.59±0.18 µU/mL. Control hyperglycemic and control hypercholesterolemic groups showed a decrease in insulin levels indicating diseased conditions.

Recently, Li and co-researchers (2012) carried out an experimental trial on rats to evaluate the effect of maternal green tea supplementation on alleviation of insulin resistance in male offsprings. They reported 57% reduction in insulin resistance along with improved glucose metabolism in offsprings born to obese female rats administrated with green tea extract.

**Hematological study**

Blood hematological analysis was performed to get an estimation of green tea intake on red blood cell- (RBC), white blood cell- (WBC) and platelet count. Mean squares regarding these parameters showed non-significant difference throughout the efficacy trial as a function of treatment, interval and their interaction except for effect of treatment in study I. Similarly, it can be well observed that there was non-momentous effect of green tea on WBC and platelet count of rats with treatment and interval as well as their interaction.

Means for RBC count (Table 7) explicated a decrease with green tea administration in study I, II and III while non-significant increase was observed in control group subjects. For study I, a lower RBC count (7.65±0.21 106/µL) was estimated in nutraceutical group as compared with functional (7.78±0.21 106/µL) and control (8.13±0.19 106/µL) groups. Study II showed the same trend with increase in RBC count for control and reduction for green tea treated groups. Nutraceutical diet attained an RBC count of 8.75±0.21 106/µL.
comparatively lower than functional and control diet as $8.77\pm0.24$ and $8.89\pm0.22$ 10^6/µL, correspondingly. Likewise, study III showed values for nutraceutical, functional and control groups as $9.53\pm0.21$, $9.55\pm0.24$ and $9.64\pm0.19$ 10^6/µL, respectively.

Means for WBC count are presented in Table 8, showing non-monumentous difference in all values. However in green tea treated diet groups (functional & nutraceutical), WBC count increased slightly as a function of time over 56 days, in all studies. Study I showed means for control, functional and nutraceutical groups as $10.53\pm0.24$, $10.67\pm0.29$ and $10.89\pm0.23$ 10^3/µL, respectively. In study II, maximum count ($11.28\pm0.27$ 10^3/µL) was observed in nutraceutical group followed by functional ($11.23\pm0.29$ 10^3/µL) and control ($10.86\pm0.24$ 10^3/µL) group. Study III presented similar results with nutraceutical, functional and control groups showing values as $11.47\pm0.31$, $11.29\pm0.24$, $11.12\pm0.29$ 10^3/µL, respectively. Time interval showed non-momentous effect on the values observed in all studies.

Platelet count showed slight increase with green tea treatments, means shown in Table 9. In study I, nutraceutical group showed highest count ($1079.66\pm29$ 10^3/µL) followed by functional ($1062\pm32$ 10^3/µL) and control ($1036.33\pm21$ 10^3/µL) group. Likewise, in study II, maximum count ($1112\pm31$ 10^3/µL) was observed in nutraceutical group followed by functional ($1096.66\pm33$ 10^3/µL) and control ($1084\pm28$ 10^3/µL) group. Study III presented similar results with nutraceutical, functional and control groups showing values as $1103\pm25$, $1091\pm27$, $1073.33\pm21$ 10^3/µL, respectively. All study groups showed non-momentous difference on the platelets count during two months of trial.

Current data with non-momentous effect of green tea on hematological parameters is highly consistent with previous findings. Isbruckeret al. (2006) observed non-momentous effect of EGCG on WBC and platelets count, however, some significant results were observed with RBC count at lower dosage. However, the phenomenon of reduction in RBC count is not fully understood and needs further investigations (Leider et al., 2009). Takami and coworkers (2008) evaluated the toxicity of green tea catechins and carried out complete hematological analysis for the purpose. They found slight decrease in RBC while an increase in WBC and platelets count in catechins-fed rats over a period of 90 days. However, all the differences were statistically non-significant. Hsu et al. (2011) studied toxicity evaluation of green tea extract in normal mice and demonstrated no significant effects of green tea extract on the values of RBC, WBC and platelets count.

CONCLUSION

Cultivated across more than 30 states with 2.7 million hectares globally, green tea has engrossed significant attention, both in scientific and consumer communities owing to its health benefits against variety of maladies ranging from weight loss to cancer. The present project was an attempt to explore the functional/nutraceutical role of green tea against hyperglycemia and hypercholesterolemia. For the purpose, three types of studies were carried out on the basis of diets i.e. study I (normal diet), study II (high sucrose diet), study III (high cholesterol diet), in Sprague Dawley rats. A decline was observed in the level cholesterol, LDL, triglycerides and glucose as compared to control after consumption of functional and nutraceutical diets. It was observed that reduction of cholesterol, LDL, triglycerides and glucose was more in groups fed on nutraceutical diets while it was lower in functional diet group followed by normal group. It was also depicted that level of insulin and HDL increased in functional and nutraceutical diet groups. Regarding hematological analysis, treatment has non-significant effected on all hematological parameters however with passage
of time red blood cells and white blood cells changed momentously in study I and II. Conclusively, green tea has proved to hold functional/nutraceutical worth against various lifestyle related threats. The secret of green tea health effects lies in its rich polyphenol profile, mainly catechins. Diets containing green tea active ingredients as an adjunct, not only attenuated hyperglycemia and hypercholesterolemia in rodent subjects but also improved antioxidant status when used in food products.

REFERENCES


Table 1. Means for cholesterol (mg/dL) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>81.94±2.56</td>
<td>82.67±2.64</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>80.57±2.34</td>
<td>79.36±1.92</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>81.77±1.89</td>
<td>78.05±2.04</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>81.42±2.14</td>
<td>80.02±2.06</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>110.14±3.12c</td>
<td>116.56±2.86b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>108.77±2.91c</td>
<td>104.18±2.25d</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>111.24±2.76c</td>
<td>101.09±1.95de</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>110.05±2.42a</td>
<td>107.27±2.14b</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>129.14±3.21c</td>
<td>137.24±3.78b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>130.24±3.25c</td>
<td>121.77±3.16d</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>131.23±2.96c</td>
<td>119.27±2.62de</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>130.20±3.07a</td>
<td>126.09±2.19b</td>
</tr>
</tbody>
</table>

Table 2. Means for HDL (mg/dL) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>34.47±0.83</td>
<td>34.12±0.78</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>34.42±0.67</td>
<td>34.76±0.46</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>35.24±0.91</td>
<td>35.66±0.61</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>34.71±0.81</td>
<td>34.84±0.33</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>39.76±1.01</td>
<td>39.31±0.87</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>39.14±0.98</td>
<td>39.44±1.17</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>39.89±1.04</td>
<td>40.48±0.92</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>39.59±0.94</td>
<td>39.74±1.08</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>46.77±1.04</td>
<td>46.21±1.18</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>47.58±0.92</td>
<td>48.19±1.05</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>48.2±1.33</td>
<td>49.11±1.21</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>47.52±1.28</td>
<td>47.83±1.31</td>
</tr>
</tbody>
</table>

Table 3. Means for LDL (mg/dL) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>33.26±0.81cd</td>
<td>33.48±0.93bc</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>32.75±0.62a</td>
<td>31.02±0.74cde</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>32.65±0.76a</td>
<td>30.18±0.55dc</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>32.88±0.68a</td>
<td>31.56±0.91b</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>55.98±0.93c</td>
<td>59.21±1.34b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>56.49±1.55c</td>
<td>52.65±1.28d</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>57.67±1.24bc</td>
<td>50.66±1.19e</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>56.71±0.91a</td>
<td>54.17±1.16b</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>63.96±1.62a</td>
<td>68.92±1.71b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>65.68±1.49bc</td>
<td>58.28±0.99d</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>63.82±1.55c</td>
<td>55.24±1.15d</td>
</tr>
</tbody>
</table>
Table 4. Means for triglycerides (mg/dL) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>71.15±2.09</td>
<td>71.92±2.05</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>71.53±2.12</td>
<td>70.92±2.18</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>71.75±2.18</td>
<td>69.24±1.92</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>71.47±1.88a</td>
<td>70.69±2.05a</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>77.42±1.54c</td>
<td>81.2±2.36b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>75.58±2.33d</td>
<td>72.65±2.19c</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>76.75±2.18cd</td>
<td>72.09±1.96c</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>76.58±1.66a</td>
<td>75.31±2.12ab</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>93.12±2.56</td>
<td>97.32±2.73</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>95.42±2.61</td>
<td>90.11±2.26</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>94.63±2.41</td>
<td>86.56±1.92</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>94.39±1.78a</td>
<td>91.52±2.15b</td>
</tr>
</tbody>
</table>

Table 5. Means for glucose level (mg/dL) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>92.29±2.67</td>
<td>93.71±2.71</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>91.76±2.56</td>
<td>91.11±2.68</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>93.42±2.52</td>
<td>89.88±2.44</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>92.49±2.63</td>
<td>91.57±2.71</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>119.63±3.12c</td>
<td>124.59±3.62b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>118.32±3.26c</td>
<td>111.35±3.56d</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>119.32±3.48c</td>
<td>109.54±2.78de</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>119.09±3.51a</td>
<td>115.16±3.16ab</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>97.72±2.56cd</td>
<td>101.9±2.78b</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>99.54±2.72bc</td>
<td>97.25±2.66cd</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>98.72±2.64c</td>
<td>94.64±2.42de</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>98.66±2.53</td>
<td>97.93±2.51</td>
</tr>
</tbody>
</table>

Table 6. Means for insulin level (µU/mL) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>9.03±0.26</td>
<td>8.94±0.19</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>9.52±0.25</td>
<td>9.66±0.21</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>9.68±0.28</td>
<td>9.78±0.26</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>9.41±0.21</td>
<td>9.46±0.23</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>10.26±0.24</td>
<td>10.04±0.22</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>10.33±0.21</td>
<td>10.62±0.27</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>10.72±0.26</td>
<td>11.17±0.25</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>10.44±0.22</td>
<td>10.61±0.19</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>9.37±0.23</td>
<td>9.21±0.21</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>9.25±0.25</td>
<td>9.45±0.24</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>9.97±0.18</td>
<td>10.29±0.21</td>
</tr>
</tbody>
</table>
### Table 7. Means for red blood cells (10^6/µl) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>7.97±0.22</td>
<td>8.15±0.19</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>7.84±0.19</td>
<td>7.78±0.18</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>7.71±0.21</td>
<td>7.65±0.23</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>7.84±0.19</td>
<td>7.86±0.21</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>8.76±0.23</td>
<td>8.89±0.18</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>8.88±0.21</td>
<td>8.76±0.22</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>8.94±0.23</td>
<td>8.74±0.19</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>8.86±0.19</td>
<td>8.79±0.21</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>9.55±0.22</td>
<td>9.67±0.21</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>9.61±0.24</td>
<td>9.56±0.24</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>9.64±0.24</td>
<td>9.52±0.23</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>9.6±0.19</td>
<td>9.58±0.19</td>
</tr>
</tbody>
</table>

### Table 8. Means for white blood cells (10^3/µl) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>10.18±0.21</td>
<td>10.58±0.24</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>10.31±0.27</td>
<td>10.59±0.31</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>10.54±0.23</td>
<td>10.87±0.27</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>10.34±0.22</td>
<td>10.68±0.25</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>10.67±0.25</td>
<td>10.86±0.26</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>10.97±0.26</td>
<td>11.28±0.33</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>11.05±0.25</td>
<td>11.32±0.29</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>10.89±0.22</td>
<td>11.15±0.27</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>10.93±0.21</td>
<td>11.14±0.24</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>10.64±0.19</td>
<td>11.27±0.22</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>10.73±0.33</td>
<td>11.61±0.31</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>10.76±0.22</td>
<td>11.34±0.19</td>
</tr>
</tbody>
</table>

### Table 9. Means for platelets (10^3/µl) of rats in different studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Diet</th>
<th>Study intervals (Days)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Study I</td>
<td>Control</td>
<td>1033±28</td>
<td>1026±32</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>1037±22</td>
<td>1065±23</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>1041±26</td>
<td>1082±29</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>1037±25</td>
<td>1057.66±24</td>
</tr>
<tr>
<td>Study II</td>
<td>Control</td>
<td>1068±31</td>
<td>1075±26</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>1036±25</td>
<td>1098±33</td>
</tr>
<tr>
<td></td>
<td>Nutraceutical</td>
<td>1041±27</td>
<td>1104±21</td>
</tr>
<tr>
<td></td>
<td>Means</td>
<td>1048.33±25</td>
<td>1092.33±28</td>
</tr>
<tr>
<td>Study III</td>
<td>Control</td>
<td>1054±23</td>
<td>1076±29</td>
</tr>
<tr>
<td></td>
<td>Functional</td>
<td>1057±27</td>
<td>1094±26</td>
</tr>
</tbody>
</table>
**Table 1: Nutraceutical Means**

<table>
<thead>
<tr>
<th>Study</th>
<th>Control</th>
<th>Functional diet</th>
<th>Nutraceutical diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I</td>
<td>1062±31</td>
<td>1105±32</td>
<td>1142±26</td>
</tr>
<tr>
<td>Study II</td>
<td>1057.66±24</td>
<td>1091.66±28</td>
<td>1118±24</td>
</tr>
<tr>
<td>Study III</td>
<td>1103±25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1: Efficacy Plan**

Control : Normal diet  
Functional diet : Diet containing green tea powder  
Nutraceuticals diet : Diet containing green tea extracts
Figure 2. Feed intake in different studies (g/rat/day)
Figure 3. Water intake in different studies (ml/rat/day)
Figure 4. Body weight in different studies (g/rat)
MANAGING SCIENCE TEACHERS’ PRODUCTIVITY
CHALLENGES FOR QUALITY SCIENCE EDUCATION

Melody N. Modebelu and Nnennaya Kalu-Uche
College of Agriculture and Science Education
Michael Okpara University of Agriculture, Umudike-Abia State, Nigeria

Abstract
Teachers are individuals trained to possess the technical know-how and the elements of what it takes to inculcate the expected national education goals through various curriculum subjects at various levels of education. The ability of these teachers to produce graduates with the expected goals indicates teacher’s productivity or effectiveness. Majority of secondary education graduates in Nigeria and other third world-nations do not adequately manifest the expected goals of secondary education and national education goals at large. This ugly situation negates the current emphasis on achieving quality science and technology driven economy in the nation. The study therefore examined issues in managing Science Teachers’ productivity challenges for quality science education in Anambra State of Nigeria. Descriptive survey design was adopted for the study. A sample size of 708 science teachers (i.e. 342 Biology, 218 Chemistry, 113 Physics and 35 Basic science teachers), were selected through proportionate stratified sampling. A thirty-item-researchers-made questionnaire built on a 4 point scale was used for data collection. Mean and grand mean were used to answer the research questions. Findings revealed a low extent provision of supportive services for enhancement of teachers productivity in implementing science education reforms. Eight strategies for enhancing science teachers productivity were identified. Based on the findings, sponsoring science teachers to conferences on education reforms and challenges to teachers productivity by ministry of education and corporate organizations were recommended.

Keywords:
Managing, productivity, science teachers, science education and challenges.

INTRODUCTION

Nigerian education system recognizes the vital role of science, technology and mathematics in effecting quality national sustainable development. The Nigerian system of education places strong emphasis on achieving quality science education. This appear to be response to the rapid advancement in science and technology to enable Nigerian nation surge ahead in moving with trends and keeping pace with the process of
modernization and globalization in line with the globe. Teaching and learning of science has become crucial not only for the well-being of the citizens but also for the advancement of socio-political, economic, technological and knowledge-based development of the society as a whole (Masheng, 2004). New reforms in science education have led to increased students’ enrolment in the sciences. Some of such reforms are: renewed use of practical and hand-on-activities in science classes. The issue is that the reforms tend to promote management of classroom interactions that foster environment of friendly teaching and learning. Bajah (2006) observes that emphasis in the classroom is usually placed on the application of student-centered approach which requires innovations in the development of schemes of work, using new teaching and learning strategies, employment of assessment methods for classroom activities that develop critical skepticism, open mindedness, thoroughness in rational inquiry and desire to learn science.

Science teaching in line with the reforms should be based on the integration of knowledge of systematic study of nature, (Science), learning, pedagogy and creative inquiry originality, innovativeness and hand-on-learning (Bello, 2008 & Onwuachu, 2010). One of the implications is that meaningful teaching of science is partly dependent on the clear understanding of the meaning and nature of science which the teacher holds. The foundation of scientifically oriented career cannot effectively be laid in the classroom without the teacher. The teacher remains the major factor in students learning of science. Science teachers cannot miraculously produce students that are of higher quality than the teachers. This agrees with Ukeje (1992) that no one teach what he knows not. He also observes that education system can rise above its teachers. The importance of science education and its reforms in achieving the role of science, technology and mathematics (STM) in effective quality national sustainable development cannot be over-emphasized. Quality science education in Nigerian secondary schools has been a proposed response to achieving rapid advancement in STM to enable Nigerian nation surge ahead in moving with trends as well as keeping pace with the process of modernization and globalization. Teaching and learning of science become crucial not only for the well-being of the citizens but also for the advancement of the socio-political technological and knowledge-based development of the society as a whole (Mansheng, 2004). The overall essence of science education to stimulate development has called for various reforms emphasis on science, technology and mathematics education (STME).

A reform effort designed to enhance access to science education in secondary school has invariably led to astronomical increase in students involvement in the sciences, renewed use of practice of hands-on activities in science classes and encouragement of classroom interactiveness that could normally foster efficiency and effectiveness in science learning. In support of the above, Bajah (2006) and Onwuachu (2007) advocate teachers’ application of a student-centered approach. He emphasizes the need for management of innovations in developing schemes of work, utilization of new teaching and learning strategies, employing assessment methods for classroom activities that develop critical skepticism, open-mindedness, thoroughness in rational inquiry and desire to learn science. Science teachers teaching in line with the above expected classroom practices must be based on the following:

- Integration of knowledge of science
- Integration of learning of science
• Integration of pedagogy and
• Integration of creativity inquiry skills.

The implication of these is that unless the meaningful teaching of science is partly based on a clear understanding of the meaning and nature of science that the teacher holds, the foundation of a scientifically oriented career cannot effectively be laid in the classroom. Hence, teachers to a great extent determine students’ learning of science. Teachers to become effective must be versatile with the goals of science education.

Goals of science education in Nigeria
There are six major goals of science education in Nigeria. They represent the actual as well as the expected behavior of products as science education. These goals are:

1. Having a deep understanding of natural forces, being aware of their environment and acquiring the necessary science concepts and skills for every day life.
2. Inculcating the habit of ethical observation and drawing conclusions only on available data.
3. Developing scientific attitudes and values including open-mindedness, honesty and curiosity.
4. Developing the necessary process skills for the acquisition and application of scientific concepts, principles, Laws and theories.
5. Making effective use of a variety of scientific resources and tools (ICT tools) in the learning and application of science.
6. Produce imaginative and creative work arising from scientific ideas and develop the abilities to reason logically, communicate in a more reasonable and scientifically correct manner for cooperatively and independently learning (Chibuogwu, 2010).

Possession of these goals as characteristics by the secondary school products is an indication of teachers high productivity or effectiveness.

Science Teachers Productivity for Quality Science Education
Science teachers are individuals trained to possess a worthwhile knowledge needed to inculcate right science values, attitudes, knowledge and skills into the science students at secondary school for individual integration into the society and stimulation of science and technology (Modebelu, 2007). No wonder Bajah (2006) maintains that the teacher is the most crucial single element in education process. Science teachers are therefore the key factors in the achievement of education reforms for quality science education. Science teachers are organizers of learning experiences, for students, the selectors of instructional units, methods designers, directors of activities and evaluator of students’ performances and achievement productivity. The major role of science teachers in achieving quality science education requires teachers display of a high level productivity in the job of teaching. This teacher productivity could be described in terms of compliance with reform initiatives. Onwuachu (2007) sees productivity as a dedicated conduct of staff in the performance of their teaching roles. A productive teacher is a researcher, receiver, disseminator of knowledge, a helper, facilitator, guide, counselor, motivator, leader, a model, manager, a humanist, catalyst etc. A productive teacher is also judicious in preparing lesson notes, maintaining orderly classroom, using cooperative learning techniques, participating in team work in improving materials, managing students, evaluating pupils leaning outcomes, attending and contributing to staff meetings.
including PTA’s. Such productive teacher would not lose sight of co-curricular activities as well as school administration.

Base on the expectation of a productive teacher, Odeli (2010) identifies ten categories of support needed by teachers for effective implementation of educational reforms to include:

- System information
- Use of internet connectivity
- Instructional strategies
- Emotional support
- Classroom management support
- Discipline management support

Chibuogwu (2010) recognizes constructive criticism and guidance as very important support to development of proficiency and enhanced productivity in assuring quality science education reforms.

The problem of the study indicates poor performance of students in science subjects. Science teachers in Anambra State as well as other states in Nigeria have not been able to manifest the above enumerated characteristics of a productive teacher due to various manifold challenges facing them, (Ezeliora, 2003). Science educators have shown that students perform poorly in science subjects due to the following challenges:

- Poor quality science teachers whose methods of teaching are mainly teacher, copying of notes, rote learning of textbooks materials, etc.
- Prevalent expository method of instruction as against inquiry, with minimal students involvement in the experiments
- Inability of students to understand adequately teachers explanations, lesson notes, practical instructions and materials in science textbooks (Onwuachu, 2007 and Chibuogwu, 2010).

Other challenges include:
- increasing poor instructional delivery,
- incompetence in classroom management,
- inadequate teaching skills, inadequate application of innovative teaching methods,
- lateness to classes and near absence of practical lesson, poor teacher motivation and rewards for excellence (Modebelu & Durie, 2012).

The problem of the study is that students in secondary schools in of Nigeria have continue to record poor performance in science subjects. It also appear that science teachers in these schools are handicapped in terms of quantity and quality. These inadequacy seem to have increased these teachers low productivity or effectiveness. In what ways could science teachers productivity be enhanced?

The study examined managing science teachers productivity challenges for quality science in school in Anambra State of Nigeria

Research Questions/Hypothesis

What is the extent of productivity of science teacher in secondary schools in Anambra State?

To what extent have supportive service provided enhanced science teachers productivity in secondary schools.

To what extent would the designated strategies been used to enhance science teachers productivity for improved students’ performance.
There is no significance between the extent of science teachers’ productivity and extent supportive services provided could enhance the productivity of these teachers.

**METHODOLOGY**

The study adopted a descriptive survey design. A sample size of 736 science teachers (307 Biology, 224 Chemistry and 205 Physics) where selected through simple random sampling from a population of 1,840 (768 Biology, 560 Chemistry and 512 Physics) teachers. This was done by selecting 40% of the teachers from the population strata. Three research questions and a null hypothesis guided the study. A four-point-Likert-type scale researchers-self-made questionnaire was used for data collection. The reliability coefficient value of 0.88 was obtained using test-test method with two week interval for 30 science teachers from secondary schools in Delta State using Pearson Product Movement Correlation Coefficient technique. The data obtained were analysed using mean and t-test statistic tool at 0.05 level of significance.

**RESULTS**

Research Question I: What is the extent of productivity of science teachers in Anambra State?

Table 1: Mean score responses of science teachers on the science teachers’ extent of productivity

<table>
<thead>
<tr>
<th>S/n</th>
<th>Science teachers</th>
<th>X</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>are committed to the planning of science innovations in their schools</td>
<td>2.21</td>
<td>Low extent</td>
</tr>
<tr>
<td>2.</td>
<td>give students assignments that require the use of internet</td>
<td>2.02</td>
<td>Low extent</td>
</tr>
<tr>
<td>3.</td>
<td>are committed to the use of instructional aids</td>
<td>2.24</td>
<td>Low extent</td>
</tr>
<tr>
<td>4.</td>
<td>improvise materials and specimens</td>
<td>2.15</td>
<td>Low extent</td>
</tr>
<tr>
<td>5.</td>
<td>engage their students in co-operative</td>
<td>2.21</td>
<td>Low extent</td>
</tr>
<tr>
<td>6.</td>
<td>organize extra classes for coverage of science scheme of work</td>
<td>3.22</td>
<td>High extent</td>
</tr>
<tr>
<td>7.</td>
<td>give students projects regularly</td>
<td>3.03</td>
<td>High extent</td>
</tr>
<tr>
<td>8.</td>
<td>engage students in hands-on-experience (e.g. hitting iron against a stone to produce fire)</td>
<td>1.80</td>
<td>Low extent</td>
</tr>
<tr>
<td>9.</td>
<td>encourage students to ask questions for injury and creativity</td>
<td>3.75</td>
<td>High extent</td>
</tr>
<tr>
<td>10.</td>
<td>discuss children’s progress and problems with their parents</td>
<td>2.14</td>
<td>Low extent</td>
</tr>
</tbody>
</table>

Table 1 shows that the mean scores of science teachers on ten items indicating extent of productivity in their work. It shows that3 out of the 10 items scored above the weighted mean of 2.50. This indicates that science teachers in the secondary schools in Anambra state are general productive to a low extent. The only three areas of high productivity are in organizing extra time to cover scheme, in involving students in project works and in the good use of questions to evoke inquiry and creativity.

Research Question 2: To what extent to which have supportive services provided for enhancement of productivity?

Table 2: Mean scores of science teachers on the extent supportive services provided enhances productivity.
<table>
<thead>
<tr>
<th>S/n</th>
<th>Items</th>
<th>X</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Seminars are often organized</td>
<td>2.76</td>
<td>High extent</td>
</tr>
<tr>
<td>12</td>
<td>Teachers often reinforced for effective classroom interaction</td>
<td>2.00</td>
<td>Low extent</td>
</tr>
<tr>
<td>13</td>
<td>Principals often observed classroom instruction and give feedback on appropriate classroom interaction</td>
<td>1.71</td>
<td>Low extent</td>
</tr>
<tr>
<td>14</td>
<td>Supervisors often counsel and guide</td>
<td>1.73</td>
<td>Low extent</td>
</tr>
<tr>
<td>15</td>
<td>Principal often provide teachers with clear and detailed updates</td>
<td>2.22</td>
<td>Low extent</td>
</tr>
<tr>
<td>16</td>
<td>Principals/Supervisors employ appropriate supervisory behavior to improve self-concept of teachers.</td>
<td>1.89</td>
<td>Low extent</td>
</tr>
<tr>
<td>17</td>
<td>Principals often employ inquiry approach to solicit teacher’s advice</td>
<td>2.48</td>
<td>Low extent</td>
</tr>
<tr>
<td>18</td>
<td>PTA contribute towards sponsoring teachers STAN conference</td>
<td>2.32</td>
<td>Low extent</td>
</tr>
<tr>
<td>19</td>
<td>Principal encourage teachers to test new materials/strategies for managing classroom of mixed ability</td>
<td>2.47</td>
<td>Low extent</td>
</tr>
<tr>
<td>20</td>
<td>Supervisory behaviors teachers received are democratic</td>
<td>2.41</td>
<td>Low extent</td>
</tr>
</tbody>
</table>

Result in table 2 reveals that only item I scored above 2.50. The indication is that only seminars that are often organized to assist these teachers as a means of acquiring needed skill for enhancing their productivity. The other nine expected supportive services are provided to a low extent because they scored below 2.50.

Research 3: To what extent would the designated strategies be used to enhance science teachers productivity?

**Table 3: Mean score responses of science teachers on science teachers’ productivity.**

<table>
<thead>
<tr>
<th>S/n</th>
<th>Item</th>
<th>X</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>A good representation of science teachers should participate in the planning of science education reforms and policies</td>
<td>3.52</td>
<td>High extent</td>
</tr>
<tr>
<td>22</td>
<td>Ministry of education and other interested bodies should furnish schools with adequate reference books, journals on new trends in science</td>
<td>3.58</td>
<td>High extent</td>
</tr>
<tr>
<td>23</td>
<td>Regular workshops should organize for science teachers in line with any reform introduction.</td>
<td>3.25</td>
<td>High extent</td>
</tr>
<tr>
<td>24</td>
<td>Science teachers should be sponsored to exchange programmes in other countries to learn global trends in science education</td>
<td>3.61</td>
<td>High extent</td>
</tr>
<tr>
<td>25</td>
<td>Computers with internet facilities should be provided in science laboratories for teachers’ use in online learning</td>
<td>3.88</td>
<td>High extent</td>
</tr>
<tr>
<td>26</td>
<td>Special hazard allowances should be approved for science teachers for science teachers</td>
<td>3.95</td>
<td>High extent</td>
</tr>
<tr>
<td>30</td>
<td>Science teachers should be encouraged to write proposals on science education for reforms and innovation and submit same to MDE for consideration</td>
<td>3.49</td>
<td>High extent</td>
</tr>
</tbody>
</table>
Results in table 3 shows that all the ten items scored above 2.50. The conclusion drawn from these mean ratings is that the entire ten itemized strategies should be utilize to enhance science teachers’ productivity for enhanced students’ performance and learning.

DISCUSSION OF RESULTS

The findings of the study indicate that science teachers in secondary schools in Anambra state of Nigeria manifest low extent level of productivity in implementation of science reform as a means achieving quality science education. Science teachers rarely use innovative teaching methods such as cooperative learning, science reform books, hand-on-experiences, internet/online learning etc. In confirmation of the above, Bello (2008 and Bajah, 2006) reports of low level of productivity among secondary school staff in Lagos State. Onwuachu (2007) also observe that teachers in secondary schools in Enugu State show low productivity. This, Onwuachu believes results in poor students’ performance, learning hence low standard of science education in Nigeria at large.

Findings that supportive services are provided of low extent to science teachers may be attributed to principals’ inadequate knowledge and creativity skills in varying supervisory processes as observed in Bajah (2006). Onwuachu (2007) in support of the findings, discovers that PTA rarely sponsor science teachers to conference/workshop because they are not well educated on the importance of teachers attendance to workshops on the academic performance and learning of their children/wards. One of the major challenges in achieving quality science education in Nigeria is the issue of science education reform implementation. The finding indicates that teachers are not usually made aware of new reforms policies. They need training on a new reforms or innovation in terms of technical proficiency and utilization skills. Modebelu and Okeke (2009) report that one of the major aim of science education reforms is to enhance teachers’ ability to manage learners, their needs and interests and also their difficulties. The implication is that if teachers in any way lacked supportive services, such teachers will continue to manifest or display low extent productivity.

This also implies low quality education. This is so because no teacher can give what he does not have. Teachers are not well supported implies that students would not be adequately supported by their teachers. Great deal of support services are therefore recommended. This should be at the joint effort of the MOE and other stakeholders.

Ten items on strategies of enhancing science teachers productivity were identified and accepted by science teachers in secondary schools in Anambra State. The strategies include provision of adequately equipped laboratories and learning resources, exchange of programmes for teachers, payment of hazard allowances etc. This in line with Modebelu and Okeke (2009) that identify five items for enhancing teacher commitment and good work behavior to include: Incentives to teachers, adequate teaching and learning facilities well equipped laboratories, seminars and conferences free sponsorship. Onwuachu (2007) and Mansheng (2004) are of the opinion that teachers adequate participation in affairs of education reforms and transformation will go a long way to improve curriculum and its implementation.

Conclusion
The study examined issues in managing challenges to science teachers’ productivity for quality science education. The status-quo in science teachers’ productivity supportive services needed to manage their challenges as a means of reducing impediment to quality science education were studied. Extent of teachers productivity was determined, the extent the supportive services provided have enhanced their productivity was examined and the ten strategies for managing their challenges for enhanced productivity were identified.

**Recommendations**

The following recommendations are made

1. Science teachers’ preparation institutions should be adequately equipped to ensure adequate teacher development in terms of skills creativity, originality and improvisation.

2. Since we are on age of computer, secondary schools should be adequately connected to internet facilities. This will provide easy and free access to new trends on pedagogy, content reform policies and implementation strategies.

3. Science teachers should adequately be represented in decisions that concern science education quality assurance.

**REFERENCES**


DESIGNING OF WIRELESS DISTRIBUTION SYSTEM NETWORK (WDSN) MODEL

Babangida Zubairu

Computer Science Department

Federal College of Education, Katsina-Nigeria

Abstract

Wireless network offers convenience, cost effectiveness, and easiness of integration with other networks and network components without coursing much technical hitches, hence is easier to setup and maintain, in this paper Wireless Distribution System Network (WDSN) has been developed using Wireless Distribution System (WDS) to demonstrate bridging of Wireless Local Area Networks (WLANs). Optimized Network Engineering Tool (OPNET) was used to develop and simulate the model; the network was set to run web browsing, E-mail, audio streaming, and FTP (File Transfer Protocol). Simulation was run and the results obtain shows significant web page response time, media access delay and higher throughput that correspond with International Telecommunication Union (ITU) standard of 0 to 150 (ms)

1.0 Introduction

Wireless networking is quickly becoming the "de facto" standard in home and small business networking. There are more than a few reasons for this, but for the most part it is done because it is cheaper and easier to setup and maintain. The problem arises when you cannot cover the entire area you need to with a single wireless device. This requires setup a repeater in line from your source wireless device. With WDS you put multiple wireless devices into bridge mode, but without the need for wired connections between them, it was first introduced around 2005-2006 as an alternative to the standard repeater modes. [3]

In telecommunication networks, a bridge is a product that connects a local area network (LAN) to another local area network that uses the same protocol (for example, Ethernet or token ring). You can envision a bridge as being a device that decides whether a message from you to someone else is going to the local area network in your building or to someone on the local area network in the building across the street. A bridge examines each message on a LAN, "passing" those known to be within the same LAN, and forwarding those known to be on the other interconnected LAN (or LANs) [1], you can build large bridged wireless networks using Wireless Distribution System (WDS). WDS allows access points to communicate with one another wirelessly in a standardized way [2].

WDS works well and require the use of MAC (Media Access Control) to establish the links in the WDS group. This brings the connectivity down to the Data link layer of the OSI
model, which is one layer below traditional IP based connectivity (IP based communication is layer 3) [3]

OPNET’s IT Guru provides a Virtual Network Environment that models the behavior of networks, including its routers, switches, protocols, servers, and individual applications. The Virtual Network Environment allows IT managers, network and system planners, and operation’s staff to more effectively diagnose difficult problems, validate changes before they are implemented, and plan for future scenarios such as traffic growth and network failures [5].

You can do “what if” analyses (called scenarios in IT Guru) on network designs, just as you can on spreadsheet models with financial business models. However, instead of looking at “bottom line” financial numbers, you will be looking at how response times, latency (delays) and other network performance measures will change under different network design approaches.

EOC5611P is a powerful, enhanced, enterprise scale product with 4+1 multi-functions Access Point, Access Point with WDS function, Client Bridge, WDS Bridge, and Client Router. EOC5611P is easily to install almost anywhere with Power over Ethernet for quick outdoor installation. EOC5611P can manage power level control, Narrow bandwidth selection, Traffic shaping and Real-time RSSI indicator. EOC5611P is fully support of security encryption including WI-Fi Protected Access (WPA-PSK/WPA2-PSK), 64/128/152-bit WEP Encryption and IEEE 802.1x with RADIUS accounting [4]

2.0 METHODOLOGY

To build a network model Optimized Network Engineering Tool (OPNET) has a workflow which is used to create network models, the workflow is in sequence as follows: create network model and configure, collect statistics, run simulation, view result and analyze

The WDS wireless model was designed using Engenius device (EOC5611P)

2.1 Preparation

Start OPNET IT Guru Academic Edition

Guru Academic Edition, where x.x is the software version (e.g., 9.1).

2.2 WDSN Model

To create a network model, you specify the nodes (computers, switches, routers, etc.)
The model consists of seven different wireless LANs (WLANs) located apart from each other, the WLANs were linked using WDS with Engenius devices (EOC5611P).
Wireless Local Area Network (WLAN)
The WLAN is made up of access point (AP) connected to EOC5611P, WIFI devices in turn connect to the AP. The model was set to run, web browsing, E-mail, audio streaming, and FTP (file transfer protocol).

With WDS Bridge Mode, the EOC5611P can wirelessly connect different LANs by just simply configure each other’s MAC Address and Security Settings. This mode is used when two wired LANs locate in small distance and want to communicate each other. WDS Bridge Mode can establish 16 WDS links [9].

The connection diagram is like a Star.

Source: http://www.senao.com

2.3 Statistics
The following statistics were collected on the model: pages respond time (sec), the throughput that is (bites/sec), to determine how many bytes-per-sec can be transferred from one node on the wireless network to another, HTTP response time (sec)

### 2.4 Simulation

The simulation was run with respect to the statistics mentioned above, below is the simulation sequence dialog box showing the simulation progress of the model:

![Simulation Sequence Dialog Box]

### 3.0 RESPONSE TIME BENCHMARK

When you design networks that transport voice over packet, frame, or cell infrastructures, it is important to understand and account for the response time delay in the network. If you account correctly for all potential delays, it ensures that overall network performance is acceptable. The International Telecommunication Union (ITU) considers network response time delay in Recommendation G.114. This recommendation defines three bands of one-way delay shown in Table 5.1 (Cisco, 2006) [6].

<table>
<thead>
<tr>
<th>Range in Milliseconds</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-150</td>
<td>Acceptable for most user applications.</td>
</tr>
<tr>
<td>150-400</td>
<td>Acceptable provided that administrators are aware of the transmission time and the impact it has on the transmission quality of user applications.</td>
</tr>
<tr>
<td>Above 400</td>
<td>Unacceptable for general network planning purposes. However, it is recognized that in some exceptional cases this limit is exceeded.</td>
</tr>
</tbody>
</table>

Table 1 Delay Specifications
4.0 RESULTS AND DISCUSSION

4.1 Page Response Time Results

The average page response time obtained is 46.4 (ms) and this shows a significant response time, hence is within the International Telecommunication Union (ITU) standard of 0-150 (ms)
4.2 Wireless LAN throughput

The average throughput obtained is 12.21 (bit/sec), this gives a throughput that is significant WDS devices.

4.3 Media Access delay

The average media access delay of the model obtained was 0.001348 (ms), the result shows marginal media access delay on the network.
5.0 Conclusion

In this paper Wireless Distribution System Network (WDSN) has been developed using Wireless Distribution System (WDS), the paper discuss the benefits of wireless Distributed System technology and demonstrated the methodology of bridging Wireless Local Area Networks (WLANs). The WDSN network was designed and simulated using OPNET IT Guru and was set to run web browsing, E-mail, audio streaming, and FTP (File Transfer Protocol). The results obtained shows significant web page response time, media access delay and higher throughput.

5.0 References


Website: http://support.dlink.com/emulators/dwl2210ap/help/wds.help.html, date accessed 16/6/13

Website: http://www.tweaktown.com/articles/3085/wireless_distribution_system_is_Wireless_ready_to_replace_the_wired_network/index.html, date accessed 16/6/13


EFFECT OF POLYA GEORGE’S PROBLEM SOLVING MODEL ON STUDENTS’ ACHIEVEMENT AND RETENTION IN ALGEBRA

Samuel Onyinyechi Nneji
Department Of Physical Sciences, Evangel University, Akaeze, Ebonyi State, Nigeria.

Abstract
Quasi-experimental design was adopted in this study. Pretest-posttest, non equivalent control group was used. Eight intact classes, four of which were randomly assigned to experimental and the other four to control groups are used for the study. Sample of the study consisted of 220 SSII students from Ishielu Local Government Area of Ebonyi State. Four research questions and four hypotheses guided the study. Algebra Achievement Test (ALAT) was used for data collection. ALAT was constructed by the researcher and validated by three research experts. Mean and standard deviation were used to answer the research questions while the hypotheses were tested at .05 level of significance using Analysis of Covariance (ANCOVA). Experimental groups were taught using Polya George’s Problem Solving Model (POGPROSMO) while control groups were taught the same topics using expository method. Major findings of the study revealed that students taught Algebra with POGPROSMO achieved higher and retained more than those taught with expository method. There was no significant difference between the mean achievement and retention scores of male and female students in the study. It was recommended that Mathematics teachers should adopt POGPROSMO in teaching Algebra.

Keywords: Achievement, Retention, Problem solving, Algebra, Education

Introduction
Obviously mathematics is a veritable tool for facilitating functional education needed to empower a person. It is therefore worrisome seeing students’ consistent poor achievement and retention in this all important subject. According to Jacos (2008), academic achievement depicts students’ performance on a standard of measurement such as performance test, skill test, analytical thinking test. It is therefore, not out of place to describe academic achievement as the gain in knowledge of students as a result of taking part in a learning activity or programme. Learning here refers to changes in a person’s behavioural repertoire rather than just a change in behavior. Academic achievement is a result-oriented construct that encapsulates the extent of performance of a desired task. (Rix, 2010).

Retention is the noun form of the verb “Retain”. Hornby (2003) defined retain as “keep”; “continue to have or hold” or “keep in place”. In the same vein, Rix (2010) defined retain as “keep possession of. Retention, which is the act of retaining, maybe defined as the act of “absorbing and holding” or “or continue having or holding”. In the context of this work, retention refers to the act of absorbing, holding, or continuing to hold or have facts or things learned. On problems of retention, Dulton (1975) in Ezeamenyi (2004) asserted that failure to provide enough applications to real life activity and social usage cum poor teaching techniques are strong limiting factors to students’ retention in mathematics. Similarly, Gagne (1977) in Ezeamenyi (2004) contended that for improvement of retention
of learned materials in mathematics, activity-based learning is indispensable. Retention, thus, depends mainly of teaching strategy adopted by the teacher.

Research evidence have consistently indicated teaching method as a major factor determining the achievement and retention of students in mathematics. Hence the search for better methods and newer innovations is a great challenge facing science educators. This study therefore investigated the effect of a modern innovation, the problem solving technique on students’ achievement and retention in algebra. According to Obodo (2004) problem solving technique comprises of identifying and choosing mathematical problems which grow out of the experiences of individual students, placing these problems before the students and guiding them in their solutions. It follows the steps of scientific method as well as those of reflective thinking. The teacher guides the class in solving the mathematical problem as a group. This technique allows students to learn from their successes and failures and culminates into real comprehension of facts since it permits the students to participate in their learning. The techniques also tends to force students to arrange and classify facts or data. The aim of this techniques is to inculcate in the children the habit of seeking logical answers or finding adequate pattern which solve the problem. This may imply that the technique encourages students to think for themselves and to arrive at a deeper understanding of what they have. In other words, the technique guides and stimulates the learner into discovering the solutions to certain problems which arise in their course of study by himself and to encourage the learner to reason and pass judgement in order to arrive at a reasonable solution to his problem.

Many scholars have outlined the sequence of problem solving technique and one of them is Polya George a professor of mathematics. Polya in his problem solving model in 1973 identified four stages viz; Understanding the problem, Devising a plan to solve the problem, carrying out the plan and looking back.

As good as this technique may sound, research evidence still have no definitive answer to how effective it is in teaching mathematics, especially in topics like algebra which constitutes greater percentage of the secondary school Mathematics curriculum. This study therefore is, to say the least, most timely.

**Purpose of the Study**

The main purpose of this study was to investigate the effect of Polya George’s Problem Solving Model (POGPROSMO) on secondary school students’ achievement and retention in algebra. Specifically, the study investigated the effect of POGPROSMO on senior secondary School II (SSII) students

1. achievement in algebra
2. retention in algebra
3. achievement in algebra with regards to their gender and
4. retention in algebra with regards to their gender.

**Research questions**

The following research questions guided the study;

1. What are the mean achievement scores of students in the experimental and control groups in both pretest and posttest?
2. What are the mean retention scores of students in the experimental and control groups?
3. What are the mean achievement scores of male and female students in Experimental and Control groups in both pretest and posttest?
4. What are the mean retention scores of male and female students in experimental and control group?

**Hypotheses**
The following research hypotheses were tested at .05 level of significance.

1. There is no significant difference between the mean achievement scores of students in the experimental and control groups in the posttest.
2. There is no significant difference between the mean retention scores of students in the experimental and control groups.
3. There is no significant difference between the mean achievement scores of male and female students in the experimental and control groups in the posttest.
4. There is no significant difference between the mean retention scores of male and female students in the experimental and control groups.

**Methodology**
The research design adopted in the conduct of this investigation was quasi-experimental design, thus, a pretest posttest, non equivalent groups was used. Eight intact classes randomly assigned to experimental and control groups were used. The area covered in this study was Ishienu Local Government Area, of Ebonyi State. The population for the study consisted of all senior secondary two (SSII) students in the area numbering three thousand and twelve (3,012) as at the time of the study. Purposive sampling technique was used to draw four secondary schools, two male (boys only) and two female (girls only). Furthermore, in each of the four secondary schools two SS II intact classes were sampled randomly and assigned to experimental and control groups randomly also. The total number of 220 students in the eight SS II intact classes made up the sample of the study. The sample consisted of 118 students in the experimental group and 102 students in the control group. Similarly, the sample was made up of 104 male and 116 female students. Instrument used for data collection was Algebra Achievement Test (ALAT). This instrument was developed by the researcher. It is made up of twenty (20) multiple choice questions. The items were drawn using a table of specification to ensure adequate coverage of the content area covered in the study as well as maintain even spread across the different levels of the cognitive domain.

ALAT was validated by three research experts, one of whom was a specialist in measurement and evaluation and the other two specialists in mathematics education. ALAT was also trial – tested and the result obtained was used to calculate the reliability coefficient of .66 using Kuder-Richardson’s formula 20 (KR-20).

**Experimental procedures**
The researcher trained the four regular mathematics teachers in the four secondary schools used in the study for a period of two weeks on the use of POGPROSMO. Foremost, the ALAT was administered to all the subjects of the study as pretest. Thereafter, the treatment was administered for a period of six weeks. The experimental group in each school was taught algebra using POGPROSMO while the control group in each school was taught the same topics expository method. After six weeks of treatment, the ALAT was re-arranged and administered to all the subjects as posttest. After two weeks of posttest ALAT was further re-arranged and re-administered to the subject for retention scores. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at .05 level of significance.
Results

Research question one:
1. What are the mean achievement scores of students in the experimental and control groups in both pretest and posttest?

Table 1: Mean achievement scores and Standard Deviations of experimental and control groups in both pretest and posttest.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>32</td>
<td>14.8</td>
<td>72</td>
<td>15.31</td>
<td>118</td>
</tr>
<tr>
<td>Control</td>
<td>34</td>
<td>13.1</td>
<td>50.6</td>
<td>15.31</td>
<td>102</td>
</tr>
</tbody>
</table>

Table 1 shows that there was no major difference between the mean achievement scores of experimental and control group in the pretest. However, experimental group apparently obtained a higher mean score of 72 than their control counterparts that achieved 50.6 as their mean achievement scores. Also the experimental group had a lower standard deviation value showing that there were less extreme scores in that group.

Research question two:
2. What are the mean retention scores of students in the experimental and control groups?

Table 2: Mean retention scores and Standard Deviations of experimental and control groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>66.1</td>
<td>12.8</td>
<td>118</td>
</tr>
<tr>
<td>Control</td>
<td>44.6</td>
<td>14.6</td>
<td>102</td>
</tr>
</tbody>
</table>

The mean retention score and standard deviations were 66.1 and 12.8 respectively for experimental group. Also the mean retention score and standard deviations were 44.6 and 14.6 respectively for control group. Obviously, the experimental group retained better also the lower standard deviation of the experimental group showed that the mean was more reliable than that of control group.

Research question three:
3. What are the mean achievement scores of male and female students in Experimental and Control groups in both pretest and posttest?

Table 3: Pretest and Posttest achievement scores of male and female students.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest Mean</th>
<th>Std.Dev.</th>
<th>Posttest Mean</th>
<th>Std.Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (Experimental)</td>
<td>50</td>
<td>18.6</td>
<td>6.11</td>
<td>72.5</td>
<td>4.01</td>
</tr>
<tr>
<td>Male (Control)</td>
<td>54</td>
<td>19.1</td>
<td>5.07</td>
<td>42.3</td>
<td>18.44</td>
</tr>
<tr>
<td>Female (Experimental)</td>
<td>68</td>
<td>18.1</td>
<td>6.06</td>
<td>73.1</td>
<td>4.20</td>
</tr>
<tr>
<td>Female (Control)</td>
<td>48</td>
<td>18.42</td>
<td>6.14</td>
<td>40.11</td>
<td>14.32</td>
</tr>
</tbody>
</table>
In the experimental group, the pretest mean achievement scores and standard deviations were 18.6 and 6.11 for male students and 18.1 and 6.06 for female students respectively. Similarly, the posttest mean achievement scores and standard deviations were 72.5 and 4.01 for male students and 73.1 and 4.20 for female students. Apparently there was no tangible difference, the standard deviations were very low for both groups, and hence both means were reliable.

However, in the control group, the pretest mean achievement scores and standard deviations were 19.1 and 5.07 for male students and 18.42 and 6.14 for female students respectively. The posttest mean achievement scores and standard deviations were 42.3 and 18.44 for male students and 40.11 and 14.32 for female students. Apparently there was no tangible difference in their performances.

**Research Question Four:**

4. What are the mean retention scores of male and female students in experimental and control groups?

<table>
<thead>
<tr>
<th>Table 4: Mean retention scores and standard deviation scores of male and female students in the experimental and control group.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>Male (Experimental)</td>
</tr>
<tr>
<td>Male (Control)</td>
</tr>
<tr>
<td>Female (Experimental)</td>
</tr>
<tr>
<td>Female (Control)</td>
</tr>
</tbody>
</table>

The mean retention scores and standard deviations were 63.1 and 7.12 for urban students and from the table above there is no significant difference between the mean retention scores and standard division of both groups.

**Hypotheses Testing**

<table>
<thead>
<tr>
<th>Table 4: ANCOVA Analysis of students’ achievement scores.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scores of variation</strong></td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Covariates</td>
</tr>
<tr>
<td>Pretest</td>
</tr>
<tr>
<td>Main effect</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>2-way</td>
</tr>
<tr>
<td>Interactions</td>
</tr>
<tr>
<td>Method, Gender</td>
</tr>
<tr>
<td>Explained</td>
</tr>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Results in table four above shows that there is significant difference between the achievement of students in the experimental and control groups in favour of the experimental group. Thus, hypothesis one is rejected as stated because students taught Algebra with POGPROSMO outperformed their counterpart in the expository class. However, there was no significant difference between the achievement of male and female student in the experimental and control groups. Hence, hypothesis three is not rejected as stated, because the treatment applied on the subject affected both gender equally.

Table 5 ANCOVA Analysis of the students mean retention scores.

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-calc.</th>
<th>Level of significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-variates</td>
<td>514.982</td>
<td>1</td>
<td>514.982</td>
<td>39.714</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Pretest</td>
<td>514.982</td>
<td>1</td>
<td>514.982</td>
<td>39.714</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Main effects</td>
<td>26943.814</td>
<td>2</td>
<td>13471.907</td>
<td>811.401</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Methods</td>
<td>26481.417</td>
<td>1</td>
<td>26481.417</td>
<td>2419.845</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Gender</td>
<td>22944</td>
<td>1</td>
<td>22944</td>
<td>706.312</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>2-Way interaction</td>
<td>152.433</td>
<td>1</td>
<td>152.433</td>
<td>0.141</td>
<td>0.768</td>
<td>NS</td>
</tr>
<tr>
<td>Methods*Gender</td>
<td>152.433</td>
<td>1</td>
<td>152.433</td>
<td>0.141</td>
<td>0.768</td>
<td>NS</td>
</tr>
<tr>
<td>Explained</td>
<td>28335.488</td>
<td>4</td>
<td>7083.872</td>
<td>432.201</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Residual</td>
<td>2003.111</td>
<td>261</td>
<td>7.675</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30338.599</td>
<td>265</td>
<td>114.485</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = Significant, NS = Not significant at 0.05 level of probability

Table 5 displays a result that shows significant effect in the mean retention scores as indicated by the F-calculated obtained. Hence, hypothesis two is rejected as stated because the experimental group retained more than their counterpart in the control group. Conversely, the F – calculated for 2-way interaction between methods and gender shows no significant effect. Thus, hypothesis three is not rejected as stated because the treatment had equal effect in both gender.

Summary of Findings
Here is the summary of the findings made in this study:
1. The students taught algebra with POGPROSMO achieved higher than their counterpart in the expository class.
2. The students taught algebra with POGPROSMO retained more than those in the expository class.
3. There is no significant difference between the mean achievement and retention scores of male and female students taught algebra with POGPROSMO.

Discussion
Results of data analysis shows that both groups of students had close mean and standard deviation scores in the pretest, apparently showing that they had chances of achieving equally. However, after treatment, the experimental group achieved far higher, with a lower standard deviation. These results implicated method of teaching as a major factor affecting students’ achievement in mathematics.

Similarly, there was a significant difference between the retention ability of both groups in favour of the experimental group. The experimental group retained far better than the control group. This shows that POGPROSMO enhanced the retention ability of the
students better than the expository method. These results further agree with the famous Chinese proverb which stated “what I hear I forget, what I see I remember, what I do I understand.”

Moreover, this result further authenticates the findings of Umar, et al (2006) and that of Eze and Egbo (2007) whose reports revealed that students taught through students-centered method retained better than those taught with the traditional lecture method. Ukeje and Obioma (2002); Ezeamenyi (2004); Obodo (2004) and Azuka (2009) all made case for the adoption of instructional methods that promote students’ involvement and activity in the teaching of secondary school mathematics so as to enhance students’ retentiveness.

**Recommendations**

Based on the findings of this study, the following recommendations are made;

1. Polya George Problem Solving Model (POGPROSMO) should be used in teaching algebra in senior secondary schools.
2. Secondary school mathematics and science teachers should be trained through intensive seminars, workshops and in-service trainings on the use of POGPROSMO for teaching and learning of mathematics.

**References**


AUXIN PRODUCING BACILLI: POTENTIAL CANDIDATES IN GROWTH STIMULATION OF VIGNA RADIATA (L.)

Atia Iqbal and Shahida Hasnain

Department of Microbiology and Molecular Genetics, University of the Punjab, Lahore, Pakistan

Abstract

While screening the best candidate for plant growth promoting attributes, gram positive bacilli get the special attention due to good survival rate under unfavorable conditions. Three bacilli strains, isolated from the rhizospheric region of different crops, were evaluated for their auxin production potential and their plant growth promoting capability for Vigna radiata (L.) plant. All strains were found to synthesize auxin when grown in LB broth emended with L-tryptophan in vitro condition that was further confirmed by high performance liquid chromatography HPLC. Model plant Arabidopsis thaliana was used to check the effect of bacilli in root morphogenesis of this plant. Strains led the increase in primary root length and lateral root density significantly (P=0.05) over control. Bacterization of Vigna radiata seeds with bacilli isolates resulted in the increase of the root length, shoot length, fresh and dry biomass of the seedlings significantly (P=0.05) over uninoculated control under laboratory conditions. Similar effects were observed under natural conditions in which shoot biomass and yield were increased significantly as compared to non-inoculated ones. Rhizospheric isolated strains showed the best results in growth enhancement of the plant growth and considered as good addition as a best biological candidate in the selection of plant phytostimulator.

Keywords: auxin, bacilli, Vigna radiata, Arabidopsis, tryptophan.

INTRODUCTION

Due to increase in human population worldwide, the demand for food is increasing globally day by day that leads to explore new methods of increasing the crop yield without any hazardous impact both on plants and human population. The use of microbes as biofertilizers, an alternative of chemical fertilizers, opened the new horizon for searching and exploiting microbes with maximum beneficial effects upon the crop productivity and yield (Djuric et al. 2011). Rhizospheric microbes attain special attention due to their close proximity with plant roots (Saharan and Nehra, 2011). Their interaction with the plants could be beneficial, harmful or neutral for the plant growth development. Beneficial aspect of the plant microbe interaction has been investigated by many researchers for high crop production (Hussain and Hasnain, 2011). Various microorganisms have been reported as PGPR but Bacillus and Paenibacillus genera have advantages due to its maximum survival rate in adverse environmental conditions by producing spores (Brain et al. 2004), that increase its shelve life for use in commercial formulations as an agriculture input (Sehiser et al. 2004), therefore, used as the most common PGPR (Compant et al. 2005). Plant hormones play a vital role in the growth and development of plant throughout the life. Auxin is the most important and widely studied phytohormone (Davies, 2010). Apart from endogenous auxins, plants are also influenced by exogenous auxin produced by microorganisms (Khalid et al. 2004). Bacterial auxin production, especially in the rhizosphere region, has the pronounced effect on the plant growth and development even in the small amount. The
auxin production both in plants and microbes is increased by the precursor L-tryptophan. (Ali et al. 2009). Studied showed that some bacteria have the ability to synthesize auxin without L-tryptophan but the production was increased by the amendment of L-tryptophan (Asghar et al. 2002). Auxin production by rhizobacteria involved in plant microbe signaling that can lead to the change in root morphology by proliferation and elongation of adventitious and lateral roots to the plant (Iqbal and Hasnain). Therefore, facilitation of plant growth by rhizobacteria has been ascribed to the auxin production (Akhtar et al. 2011). Beans are considered as an important legumes as a food supplement as a rich source of proteins, vitamins and minerals (iron and zinc) (White and Broadley, 2009). The present study involved the screening of beneficial bacillus strains based on auxin production. Strains were checked for their potential to modulate the root system of Arabidopsis thaliana and to enhance the Vigna radiata growth under laboratory and natural conditions.

MATERIAL AND METHODS
Isolation and Identification
In order to isolate the auxin producing rhizobacteria, soil samples were collected from the rhizospheric region of different plants in sterile bags. Soil samples were diluted and plated on L-agar plates and incubated at 28ºC for 24 hours. The morphologically different colonies were selected and further purified by streaking method and checked the purity by gram staining procedure. For 16S rRNA gene sequencing, genomic DNA was isolated from 24 hours old bacterial culture using QIAGEN kit according to the manufacturer's instructions. The amplification of the DNA fragment (1.5kb) was done by using the universal primers27f (5'AGAGTTTTGATCCTGGCTCAG3') and reverse primer 1522r (5'AAGGAGATGATCCAGCC3'). The obtained sequence was edited, and relatedness of the resulted sequence was checked with already submitted entries by using the BLAST programme and finally submitted the sequences in GENBANK for accession numbers.

In Vitro Auxin Production and Identification by HPLC
The auxin producing ability of Bacillus strains was checked by the Salkowski’s method with and without the addition of L-tryptophan (Glickman and Dessaux, 1995). The auxin was extracted from bacterial cells and identified by HPLC with the comparison of standard IAA (sigma).

Root Morphogenesis by Arabidopsis thaliana
The seeds of Col-0 were sterilized by commercial bleach and tween 20 followed by distilled water. The sterilized seeds were dipped in bacterial inoculum for 30 minutes and implanted on plates contain MS media. After 15 days the root morphology of seedlings was measured.

Sterilization of Seeds and Bacterial Inoculum Preparation
Certified Seeds of Vigna radiata were provided by Punjab seed corporation Lahore Pakistan. Healthy seeds were sterilized with 0.1% HgCl₂ for 5 minutes with continuous shaking. Seeds were washed three times with autoclaved water to remove the hazardous effect of HgCl₂. For inoculum preparation, bacterial cells were harvested from 24 old cultures by centrifugation at 15,000g for 15 minutes and washed the pellet with saline buffer (0.85% NaCl). The suspension of all bacterial cells was made (10⁶ to 10⁷ CFU ml⁻¹) by measuring the optical density at 600 nm by spectrophotometer.

Plant Microbe Experiment under Laboratory Conditions
The seeds were sown in the plastic pots that contained the 200gm soil to the depth of 2 cm. The soil was moistened with autoclaved distilled water and placed in the growth chamber with 16 to eight hours dark: light. The growth parameters (root length, number of roots,
shoot length and plant biomass) were observed after fifteen days of the seedling growth (Ali et al. 2009).

**Plant Microbe Experiment under Natural Conditions**

To check the effect of bacterial auxin on the growth and yield of the *Vigna radiata* plant under natural condition. Seed bacterization was done by incubation the sterilized seeds in the bacterial suspension for 30 min and then sown 3cm deep in the pots contains 12 kilograms of the non-sterilized garden soil in November, 2010. Initially, 10 seeds were sown but thinning was done up to 5 after six weeks. Yield parameters were measured after harvesting the plants at full maturity. All experiments of plant microbe interaction in laboratory and field conditions were repeated three times to confirm the validity of the results.

**Statistical Analysis**

All the data were analyzed by using the software SPSS 16 program (SPSS Inc. Chicago, IL). Mean values of all replicate, and the controls were compared by using the Duncan’s multiple test (P < 0.05).

**RESULTS AND DISCUSSION**

**Identification**

The soil region around the plant roots gained special attention in selecting potential candidates due to plentiful microbes and their interaction with plant roots. A variety of microbes (*Bacillus* and *Pseudomonas*) have been investigated for their beneficial effects on the cereal and legume plants (Ali et al. 2009; Akhtar et al. 2011). The 16S rRNA gene sequences revealed the resemblance of isolated strains with genera *Bacillus* and *Paenibacillus* (more than 98%). Sequences were submitted in the GenBank under the accession numbers of JF700524.1 (PNS-12), JQ218448 (PNS-20), JQ218449 (PNS-22) (Table-1).

**Auxin Production In Vitro Condition**

The present study was aimed to explore the beneficial bacilli strains on the basis of auxin production that has been considered a direct mechanism for plant growth promotion. The beneficial effect of the bacilli strains could be attributed by the production of auxin, the most common and widely studied hormone with the potential to change the root morphogenesis and in turn the efficient uptake of nutrients (Iqbal and Hasnian, 2012). All strains showed the auxin production potential without amendment of L-tryptophan but the production was enhanced several folds with the increasing amount of the L-tryptophan. PNS-12 yielded maximum auxin production (9µg/ml) followed by PNS-22 (2.4µg/ml), PNS-20 (2.3µg/ml) without L-tryptophan and increased up to 79.6, 43 and 34.6µg/ml respectively in PNS-12, PNS-22 and PNS-20 strains with the amendment of L-tryptophan (Fig-1).

**Root Morphogenesis in Arabidopsis thaliana**

All strains modulated the root morphology of Arabidopsis seedlings by increasing primary root length and lateral root density significantly (P=0.05) when compared to the non-inoculated seedlings. The strain PNS-12 was found the most efficient in changing the root architecture of seedlings beneficially as compared to other strains (Fig-2).

**Impact on growth of Vigna radiata (L.) seedlings under laboratory conditions.**

Impact of seed bacterization on the growth parameters of *Vigna radiata* plant was depicted in Table-3. All strains exhibited significant increase (P=0.05) in percentage germination and all growth parameters of seedlings as compared to non-inoculated seedlings. Generally PNS-12 showed the 30.9, 6.6 % increase in the root and shoot length followed by PNS-22 which showed the 45, 17.1% increase in root and shoot length over control respectively. Similarly fresh weight and dry weight also increased significantly (P=0.05) by the seed bacterization. Maximum increase in the fresh and dry weight of plant was observed by PNS-12 (22 and
28.7%), PNS-22 (20 and 25%) and PNS-22 (14.1 and 26.9%) inoculated seedlings over water treated control (Table-3). Biochemical parameters were also positively influenced by bacilli seed inoculation. All strains showed significant increase in seedlings auxin and soluble protein content in inoculated plants as compared to non-inoculated ones (Fig-3). The pot experiments in the laboratory were done to investigate the role of bacterial auxin in plant growth enhancement while interacting with plant roots. The data revealed the fact that bacteria lead the plant growth promotion by increasing root and shoot lengths, root proliferation and plant biomass. Other researchers (Ali et al. 2009) also explored the same phenomenon of increasing plant growth promotion by bacterial interaction with plants.

Natural Conditions
To attain the fruitful results, we further confirmed the impact of strains in the non-sterile soil under natural conditions. Because it is considered important to evaluate the PGP candidates under natural condition in addition to laboratory environment as there are several environmental factors such as soil ecology and indigenous microbial flora also effect in the plant growth promoting ability of the selected strains. Majority of the strains were enhanced the overall plant growth promotion by increasing the vegetative and yield parameters under natural conditions (Ali et al. 2009). Seed bacterization by bacilli strains was resulted in enhancement of yield parameter significantly ($P=0.05$). Inoculation with PNS-12 showed the 15.6% increase in shoot length followed by PNS-20(6.25%) and PNS-22(6.25%) respectively as compared to water treated control. Bacillus strains showed the similar increasing effect on the number of pods and weight of seeds as well. Bacterization with PNS-12 showed the maximum increase in the number of pods (17.6%) and weight of the seeds (3.1%) over non inoculated control significantly ($P=0.05$) (Table-4). Seed bacterization caused the increase in seed weight and number of pods while significant increase was observed in shoot length and shoot fresh weight and dry weight. Our results were in accordance with Prashanth and Mathivanan (2010) who also observed the positive results of auxin producing bacillus strains on growth of groundnut plant. Manjula and Podile (2001) reported that Bacillus subtilis AF1 improved the plant growth as compared to control while coating the seed. Same results were reported by Chang et al (2007) and Ng et al (2012) who found the enhancement of Chinese cabbage and rice growth by the metabolites of B. cereus QQ308 and B. amyloliquefaciens respectively.

CONCLUSION
These results have significant importance as the selected strains, most important PNS-12, could be used as biofertilizers to increase the productivity of the Vigna radiata plant growth promotion.

REFERENCES


### Table 1. Molecular identification of the bacilli strains isolated from different plants.

<table>
<thead>
<tr>
<th>Strain</th>
<th>Plant Source</th>
<th>Sequence Length</th>
<th>%age homology</th>
<th>Identified organism</th>
<th>Accession number</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNS-12</td>
<td><em>Gossypium hirsutum</em></td>
<td>1028</td>
<td>99</td>
<td><em>Paenibacillus</em> sp. PNS-12</td>
<td>JF700524.1</td>
</tr>
<tr>
<td>PNS-20</td>
<td><em>Hordeum vulgare</em></td>
<td>1361</td>
<td>98</td>
<td><em>Bacillus</em> sp. PNS-20</td>
<td>JQ218448</td>
</tr>
<tr>
<td>PNS-22</td>
<td><em>Zea mays</em></td>
<td>1485</td>
<td>99</td>
<td><em>Bacillus subtilis</em> PNS-22</td>
<td>JQ218449</td>
</tr>
</tbody>
</table>

**Fig-1** Auxin quantification of most effective strains by colorimetric method with and without the presence of L-tryptophan.
Fig-2 Effect of rhizobacterial inoculation on primary root length and lateral root density of Arabidopsis thaliana (Col -0) (n=20) in MS medium. Data was expressed as mean values ± standard error of the mean. The significant difference among different rhizobacterial inoculated and uninoculated seedlings was designated as different letters above bars by using Duncan’s multiple range test (P=0.05).

Fig-3 Effect of Bacilli inoculation on the auxin and total soluble protein content of plants under laboratory conditions. Results were represented as mean of five replicates. Different letters indicated the significant difference among different treatments by using the Duncan’s multiple range tests (P<0.05).

Table 3. Effect of auxin producing bacilli strains on the growth promotion of the Vigna radiata seedlings under laboratory conditions.

<table>
<thead>
<tr>
<th>Bacterial strains</th>
<th>% Germination</th>
<th>Soot length (cm)</th>
<th>Root length (cm)</th>
<th>Fresh Weight (mg plant⁻¹)</th>
<th>Dry Weight (mg plant⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>80±6.12 (a)</td>
<td>10.5±0.17 (a)</td>
<td>7.1±0.23 (a)</td>
<td>1700±0.12 (a)</td>
<td>0520±0.09 (a)</td>
</tr>
<tr>
<td>PNS-12</td>
<td>90±0 (c)</td>
<td>11.2±0.23 (b)</td>
<td>9.3±0.14 (b)</td>
<td>2160±0.13 (c)</td>
<td>0670±0.07 (b)</td>
</tr>
<tr>
<td>PNS-20</td>
<td>86.6±5.5 (b)</td>
<td>12.5±0.28 (c)</td>
<td>9.4±0.28 (b)</td>
<td>2020±0.07 (b)</td>
<td>0660±0.03 (bc)</td>
</tr>
<tr>
<td>PNS-22</td>
<td>90±5.1(c)</td>
<td>12.3±0.14 (c)</td>
<td>10.3±0.13 (c)</td>
<td>2130±0.12 (cd)</td>
<td>0650±0.02 (cd)</td>
</tr>
</tbody>
</table>

Data has been presented as mean ± SE of twenty plants. The significant difference among control and different treatments were shown by different letters by applying Duncan’s multiple range test (P=0.05).

Table 4. Effect of auxin producing bacilli on the plant growth promotion of the Vigna radiata plant under natural condition.

<table>
<thead>
<tr>
<th>Bacterial strains</th>
<th>% Germination</th>
<th>Shoot length (cm)</th>
<th>Number of Pods/plant</th>
<th>Pod length (cm)</th>
<th>Weight of 100 seeds/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>87.7±5.83(a)</td>
<td>32.2±1.32 (a)</td>
<td>17± 0.95 (a)</td>
<td>7.6±0.17 (a)</td>
<td>3.83±0.02 (a)</td>
</tr>
<tr>
<td>PNS-12</td>
<td>93.3±3.33(c)</td>
<td>37.2±1.32 (c)</td>
<td>20±1.28 (c)</td>
<td>8.3±0.19 (b)</td>
<td>3.95±0.03 (b)</td>
</tr>
<tr>
<td>PNS-20</td>
<td>88.8±4.16(ab)</td>
<td>34.7±0.86 (b)</td>
<td>19±0.78 (b)</td>
<td>9.3±0.32 (c)</td>
<td>3.94±0.01 (b)</td>
</tr>
<tr>
<td>PNS-22</td>
<td>94.4±3.81(c)</td>
<td>34.4±1.56(b)</td>
<td>20±0.92 (c)</td>
<td>8.2±0.26 (b)</td>
<td>4.07±0.05 (c)</td>
</tr>
</tbody>
</table>

Significant difference among control and different treatments were shown by different letters by applying Duncan's multiple range test (P=0.05).
THE CHALLENGE OF EFFECTIVE SCIENCE TEACHING IN NIGERIAN SECONDARY SCHOOLS

Omorogbe, E  
Department Of Biology  
and  

Ewansiha, J. Clestine  
Department Of Chemistry  
College Of Education, Igueben

Abstract

This paper attempts to highlight the performance of students in science in Nigeria, and some of the factors that affect performance in science. These include, Quality Science teaching, Teacher quality and the five indicators of teacher quality. These include; academic and professional qualification, In-service refresher courses and trainings, teacher experience and teacher salary and quality teaching –learning resources. All these factors affect largely the way science is taught in schools. Regrettably the teaching and learning of science in Nigerian schools cannot be said to be effective because of the poor performance of students resulting from inappropriate teaching methodologies, lack of adequate knowledge of subject matter, competencies, skills, inadequate teacher training and lack of in-service training and refresher courses, and lack of basic teaching-learning resources. The way forward to improving science education in Nigeria is also discussed and recommendations and conclusions made.

Keywords: Performance, Quality, Teaching, Teacher, Resources

INTRODUCTION

The 21st century is characterized by advancement in science and technology. For Nigeria to realize accelerated development in the 21st century, she needs qualitative science education in our schools especially in senior secondary schools. Over the last two decades, there have been repeated calls for reforms and innovations aimed at improving Science Education in Nigeria. This suggests that there are issues in science Education in Nigeria that needs to be improved upon. 

Science is an organized body of knowledge in form of concepts, laws, theories and generalizations. Urevbu (2001) defines science as a study of nature and natural phenomena in order to discover their principles and laws. Science has three interrelated aspects: content, process and attitude. Content can be separated into physical, life and earth sciences. Process involves the fifteen inquiring skills proposed by the American Association for the Advancement of Science (AAAS) which include
observing, classifying, experimenting, measuring, inferring, organizing data etc. Attitude concerns openness and objectivities (Omoifo, 2012)

Education is “The total process of human learning by which knowledge is impacted, faculties trained and skills developed” (Urevbu, 2001). Science Education is a field of study concerned with producing a scientifically literate society. It acquaints students with certain basic knowledge, skills and attitudes needed for future work in science and science related fields. Although there are several issues in science education in Nigeria, the following areas of emphasis have been identified for discussion: students performance in science and some factors influencing poor performance which include Quality of Teaching, Teacher Quality and its indicators and Quality teaching learning resources.

**PERFORMANCE OF STUDENTS IN SCIENCE**

Table 1: School certificate examination results for sciences subjects

<table>
<thead>
<tr>
<th>Year</th>
<th>Subjects</th>
<th>Total students</th>
<th>Total pass</th>
<th>% pass</th>
<th>Total Failure</th>
<th>% Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Physics</td>
<td>120,768</td>
<td>64,185</td>
<td>53.3</td>
<td>56,383</td>
<td>46.7</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>133,188</td>
<td>87,262</td>
<td>66.6</td>
<td>45,926</td>
<td>34.5</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>453,353</td>
<td>222,891</td>
<td>49.2</td>
<td>230,462</td>
<td>50.8</td>
</tr>
<tr>
<td>1996</td>
<td>Physics</td>
<td>132,768</td>
<td>57,321</td>
<td>43.2</td>
<td>75,446</td>
<td>56.8</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>144,990</td>
<td>87,676</td>
<td>69.5</td>
<td>57,314</td>
<td>39.5</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>506,628</td>
<td>208,231</td>
<td>41.2</td>
<td>297,789</td>
<td>58.8</td>
</tr>
<tr>
<td>1997</td>
<td>Physics</td>
<td>127,486</td>
<td>56,352</td>
<td>44.1</td>
<td>71,234</td>
<td>55.9</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>138,572</td>
<td>64,923</td>
<td>46.9</td>
<td>73,649</td>
<td>53.1</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>492,429</td>
<td>203,205</td>
<td>41.3</td>
<td>289,224</td>
<td>58.7</td>
</tr>
<tr>
<td>1998</td>
<td>Physics</td>
<td>169657</td>
<td>7356</td>
<td>43.36</td>
<td>93639</td>
<td>55.19</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>182659</td>
<td>7973</td>
<td>43.64</td>
<td>95498</td>
<td>52.28</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>626894</td>
<td>374779</td>
<td>59.77</td>
<td>243581</td>
<td>38.85</td>
</tr>
<tr>
<td>1999</td>
<td>Physics</td>
<td>210271</td>
<td>126055</td>
<td>59.94</td>
<td>777.09</td>
<td>36.95</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>223307</td>
<td>121076</td>
<td>54.21</td>
<td>94347</td>
<td>42.24</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>745102</td>
<td>411446</td>
<td>55.21</td>
<td>315919</td>
<td>41.97</td>
</tr>
<tr>
<td>2000</td>
<td>Physics</td>
<td>188312</td>
<td>129075</td>
<td>68.54</td>
<td>59237</td>
<td>31.45</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>193810</td>
<td>114745</td>
<td>58.60</td>
<td>81056</td>
<td>41.39</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>620291</td>
<td>3043372</td>
<td>49.06</td>
<td>315919</td>
<td>50.93</td>
</tr>
<tr>
<td>2001</td>
<td>Physics</td>
<td>287993</td>
<td>209506</td>
<td>72.74</td>
<td>78487</td>
<td>27.25</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>310740</td>
<td>191076</td>
<td>63.32</td>
<td>110664</td>
<td>36.67</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>995345</td>
<td>527129</td>
<td>52.95</td>
<td>468216</td>
<td>47.04</td>
</tr>
<tr>
<td>2002</td>
<td>Physics</td>
<td>254188</td>
<td>20282</td>
<td>79.69</td>
<td>51606</td>
<td>20.30</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
<td>262824</td>
<td>167968</td>
<td>63.90</td>
<td>94856</td>
<td>36.09</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>882119</td>
<td>548423</td>
<td>62.17</td>
<td>333696</td>
<td>37.82</td>
</tr>
</tbody>
</table>

By implication less than 50 percent of students pass their science examinations. This is further illustrated with the percentage of students who passed at credit level and above in 2000 to 2004 as shown in figure 1.
Table 2: Performance level for SSCE and JSSCE in Mathematics and Science in Ondo and Ekiti States (2005-2009)

<table>
<thead>
<tr>
<th>State</th>
<th>Years</th>
<th>SSCE</th>
<th></th>
<th>JSSCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mathematics</td>
<td>Physics</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Ondo</td>
<td>2005</td>
<td>17</td>
<td>14</td>
<td>32</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>24</td>
<td>39</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>19</td>
<td>35</td>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>2008</td>
<td>20</td>
<td>33</td>
<td>48</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>26</td>
<td>36</td>
<td>50</td>
<td>43</td>
</tr>
<tr>
<td>Ekiti</td>
<td>2005</td>
<td>10</td>
<td>8</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>14</td>
<td>25</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>11</td>
<td>19</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>2008</td>
<td>13</td>
<td>18</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>16</td>
<td>19</td>
<td>27</td>
<td>25</td>
</tr>
</tbody>
</table>

Source: Adeyemi (2011).

For the five years the highest percentage pass was in biology in 2005. In the same year only 8 percent of the students passed in Physics. Although the picture seems better as the JSSC, it is disappointing that the highest percentage pass for integrated science is 52% in 2009. The situation is not better with National Examination Council (NECO) results. The summary of NECO results released for November/December 2011 examination is presented in figure 2.
The November/December examination is for external candidates. Of the total number of students who sat for Physics 43,504 or 90.05% failed. Even though 9.95% of the students passed, only 24 candidates or 0.05% passed at credit level and above. In Biology, of the 97,595 that sat for the paper, only 29.52% passed out of which only 8109 or 7.57% passed at credit level and above, while 75486 or 70.48% failed. In Chemistry of the 44,950 that sat for the paper 2,577 or 5.32% had credit and above, 3,432 or 7.09% had passed, while 37,973 or 70.39% failed. The Tables, paints alarming downward trend and indicates poor performance. This downward trend in students’ performance in external examination in science has become a source of worry to all.

FACTORs INFLUENCING STUDENTS PERFORMANCE IN SCIENCE

Quality of Teaching.
Inadequate teaching has been advanced as one of the problems of science education in Nigerian secondary schools. Quality science teaching is effective science teaching. Effective teaching occurs when students learn and achieve many scientific goals and not just being able to repeat scientific knowledge (Omoifo 2012). During effective learning, student learn how to learn, students develop conceptual understanding and thinking skills, thus helping students change their intuitive, everyday ways of explaining the world around them to incorporate scientific concepts and ways of thinking into their personal frameworks. Therefore students’ ability to solve problems and perhaps enhanced learning occurs.

According to Okafor, (2007), quality teaching lies at the teacher’s capacity to transform written knowledge into forms that are pedagogically powerful and yet adaptive to the students’ abilities and backgrounds. Ayodele (2006) identified the use of inappropriate non-effective teaching methodology as a major factor hindering students understanding and achievement in science. The teaching and learning of science do not require theoretical and lecture approaches. Onose (2009), posited that
many in experience teachers teach science in abstraction, thereby making science lessons boring and the students finding it difficult to grasp some scientific concepts, skills and principles. Abdulahi (2007), and Ogbeba (2010) observed that most teachers emphasis theory rather than practical aspects of science subjects and most of them lack adequate knowledge of subject matter and the competence to deliver. In addition, they stressed that the teaching of science has been reduced to a descriptive exercises through the use of lecture method and very little inquiry. Although, the National Policy on Education (1998), emphasized the activity based and child-centered learning, most science lessons are of the traditional lecture. There are few classrooms with demonstrations, and when in use it is often teacher demonstration which makes students passive. There are also few traditional hands- on (practical) classes. Our science lessons are yet to be structured, guided and students directed. (Omoifo, 2012).

**Quality of Teachers:**

Poor quality of science teachers in terms of adequate knowledge base and pedagogic skills is another factor identified to influence students performance. The teacher’s academic qualifications and knowledge of subject matter, competencies and skills, and the commitment of teacher have a great impact on the teaching learning process. A science teacher is anyone who teaches science. Science teachers in Nigeria are prepared mainly at colleges of Education and faculties of Education of different universities.

Achieving the goals of science education requires qualified and highly scientifically literate teachers. Okureme (2003) posited that: An effective science teacher should be a master of his subject, as well as grounded in methods of teaching and be able to relate the science concepts to real life experience. Abd–El-phallic and Boulaoude (1997) conceived such teachers as those who understand the concepts, principles, theories and processes of science and are aware of the complex relationship between science, technology and society. Such teachers more importantly must develop an understanding of the Nature of Science. This is important because the portion of scientific knowledge science teachers choose to teach and how they carryout the instruction presents a particular view of the nature of science to their students. (Omoifo, 2012).

The teacher knowledge base for effective science teaching is very important in that they are to help the students completely understand the content and underlying philosophy of science. This has long been stressed and culminated in recent emphasis on teacher preparation programmes that will produce sound and effective scientifically literate teachers. Different studies showed that the most important resource input in the school that predicts student achievement is Teacher Quality and effective teacher will have students with good test score (Dahar, Dahar, Dahar and Faize, 2011). The five indicators of teacher quality according to Dahar et al (2011) are academic qualification, professional qualification, in-service refresher courses and trainings, teacher experience and teacher salary.

**Academic Qualification:**

Academic qualification is a very important quality of a teacher. Academically qualified teacher has move authentic knowledge about the relevant subject than the academically less qualified teacher has Nigerian Science Teachers. Molnar (2002), reported some studies in which students taught by certified teachers consistently outscored those taught by uncertified teachers. He posited that a poorly trained teacher will likely produce a poor doctor, engineer, architect, fellow teacher and the like.
Professional Qualification:

Professional qualification can be termed as the preparation for a life-long journey into the teaching profession. The basic skills and abilities of the teaching-learning process are developed in a teacher through professional qualification. Professional qualification can be categorized into pre-service and in-service professional qualification. The National Policy on Education (2004) in section 6:70b states that the qualification for entry into the teaching profession shall be the Nigeria certificate in education (NCE)”. Omayuli and Omayuli, (2009) posited that most of the science teachers are also not professionally trained. To the extent that an engineer is recruited to teach Mathematics, Physics and Chemistry, rather than specialists actually trained to teach the subjects.

Teaching experience:

Teaching experience is the time spent by a teacher in the teaching profession. With the passage of time, teachers get command of their subjects and become competent in the art of teaching through experience. In other words, teaching experience improves the teaching skills and methodologies adopted.

Teacher Salary:

Teacher salary is very important as a predictor of students' achievement because it has a capacity to uplift the other aspects of teacher quality. If a teacher gets a suitable salary that covers the basic living costs, he may be able to live comfortably and thus be more effective as he is motivated to use his abilities, competencies and skills. Poor remuneration affects the morale of teachers, distracts and hinders their commitment and effectiveness.

In-service Refresher courses and Training:

Over the years, the interplay of politics and economics on teacher training policies led to some degree of compromise in admission requirements. Consequently, a large proportion of what we have today as trained science teachers are professionally incompetent. This fact prompted Aluede (2003) to say that the general deterioration and collapse of the educational system have resulted in a guild of teachers who are unqualified and even uncommitted to leading the learners to expected destination. Odia and Omonfonmwan (2007) opined that the teacher training institutions have tended to produce teachers that are inadequate in terms of knowledge of subject matter and pedagogic skills. The quality of teachers is dependent on the nature of their preparation and training. In-service education and training is a continuous on-going process for teachers throughout their professional life. It may be provided at any time between joining the service until retirement. Okhiku, (2005) summarized in-service training as all the activities, planned and structured engaged in by professionals (teachers) during their service aimed at helping the teacher to acquire basic skills for the efficient execution of the functions for which he was employed. As noted by Ajayi (1998) in Okhiku (2005), teachers are not finished products even after the completion of a preparation or pre-service programme. Science teachers are faced with the challenge of meeting with new innovations in science. It was in recognition of this fact, that it was stated in section 6:70b of the NPE that “Teachers shall be regularly exposed to innovations in their profession. Also In-service training shall be developed as an integral part of continuing teacher education and also take care of all inadequacies (6:75).

Quality Teaching Learning Resource.
Lack of ideal resources for science teaching and learning in Nigerian schools has been a major issue of concern. It is a well known fact that the quality of education a student receives largely depends on the quality of teaching/learning resources provided. Teaching learning resources are all the things used by the teacher during teaching to aid understanding and make teaching successful and effective. They include, modern textbooks, equipments, consumables like chemicals and reagents, models, charts e.t.c. and the physical learning environments which include the science classrooms and laboratories.

One of the major objective of science education is to teach students the scientific process. Students need some investigative skills such as observing, measuring, classifying recording experimenting, analyzing inferring, e.t.c. To achieve this, science classrooms, laboratories and the general learning environment must be adequate and conducive. Inquiry focused science teaching demands a lot of activities on the part of the learner that require scientific materials and equipments. Due to the fact that majority of schools lack the essential resources for imparting the knowledge of science concepts to students, many students learn little science, learning tends to be by rote and many students find science not interesting and boring (Ogunmade, 2006). The teacher student interactions in many science classrooms are not healthy because of lack of adequate resources. In most of our schools, there are no facilities for the teachers to demonstrate phenomena, let alone allow the students to have opportunities for finding out things for themselves (Audu and Oghogho, 2006).

The situation in many science classrooms in Nigeria is nothing to write home about. In many schools there are no laboratories. Some schools merely have empty rooms labeled laboratories. Students rarely have hands-on, minds-on experiences. Few days to science practical examinations, most schools acquire science equipments for teacher demonstration to students. This cannot make for effective learning and eventually results in poor achievement (Omoifo, 2012). To worsen the problem of lack of or inadequate resources, the few available ones are not properly maintained, protected and cared for. Ogunmade (2006) stated that “Majority of students do not have textbooks and most of the schools do not have libraries and where they have one, the textbooks in the libraries are outdated.

**IMPROVING SCIENCE EDUCATION IN NIGERIA FOR EFFECTIVENESS: THE WAY FORWARD.**

**Science Education can be improved if the Teacher Quality is Improved.**

Concerted efforts should be made by authorities in our higher institutions of learning to establish and sustain non compromised high admission standard (Odia and Omofonwman 2007). Also, the right caliber of teachers should be recruited and making of the teaching profession a dumping ground for those who cannot get employment elsewhere must be discouraged.

**Teachers’ Training and Retraining Issues.**

Regrettably today in Nigeria, Science teaching cannot be said to be effective due to observed low performance of science students. The competence, effectiveness and efficiency of a teacher is a function of his training. Therefore training and retraining of science teachers should be given greater emphasis and implementation. Such training should take cognizance of effective teaching strategies, acquisition of adequate concept of the nature of science and adequate knowledge base/ content for effective science teaching. However if teachers are properly trained, it is expected that
they will be effective. Therefore it is strongly recommended to improve the existing science teachers training programme with respect to admission criteria, curriculum, teaching practice and measurement and evaluation process. Proper training of teacher may strengthen the causal-relationship between the various qualities of teachers and academic achievement. (Dahar, Dahar, Dahar and Faize, 2011).

Quality of Teaching Issues.

Central to the calls for a new approach to science education, educators have suggested that special attention be given to teaching about science, i.e developing an understanding of the nature and methods of science. Quality Science teaching has three major aspects as pointed out by Ayodele (2006): These are:

a. Learning Science (i.e acquiring and developing conceptual and theoretical knowledge).

b. Learning about science (i.e developing an understanding of the nature and methods of science and an awareness of the complex interactions between science and society).

c. Doing Science (i.e engaging in and developing the expertise in scientific inquiry by using the methods and procedures of science to investigate phenomena and solve problems).

Akinyemi (2006) posited that “if we want performance of students in science to improve, they should be encouraged to use appropriate thinking strategies through innovative intervention by teachers. The emphasis now is on inquiry teaching because this will develop better understanding of the nature of science.

Resources for Science Teaching and Learning Issue

Since effective teaching and learning of science requires adequate resources such as classrooms, laboratories, textbooks, charts, models and consumables like chemicals and reagents for the teachers to engage students in practical and activity work, the stakeholders in science education should provide enough funds to build more classrooms, laboratories and provide the equipments and resources for the teaching and learning of science. Libraries should be provided with modern quality science textbooks for teachers and students.

CONCLUSION

The attainment of the goals of science education is largely dependent on the quality of teachers. Therefore there should be quality teacher development. Opportunities to enrich teachers’ practices and competencies through in-service training, conferences, seminars and workshops should be provided on a regular basis to help them keep abreast with recent developments in the field of science and broaden their knowledge of subject matter.

There should be proper staffing of schools in terms of quality and quantity. Good practices for effective implementation of inquiry based science education must be identified and properly implemented. There should also be provision of modern teaching –learning resources in terms of quality and quantity as students need a variety of science materials to engage in inquiry-centered science learning. Libraries and laboratories should be provided and well equipped. The school administrators, managers, teachers, laboratory assistants, and students should develop good maintenance culture. If science is properly taught from the lower level, this will lay a sound foundation for science at higher levels.
REFERENCES


Okhiku, I. I (2005) In-Service Training and Professional Development of Secondary School Teachers. I. 8: (1 & 2)


Omayuli, M. O. and Omayuli, V. O (2009) Reforms and Innovation in Science Education; The Way Forward. Journal of Teacher Perspective 3(2)


ASSESSMENT OF LOST OF AGRICULTURAL FARMLAND USING REMOTE SENSING TECHNIQUES IN GUDU LOCAL GOVERNMENT AREA OF SOKOTO STATE

Muhammad, Mansur Aliyu
Department of Geography
Shehu Shagari College of Education, Sokoto-Nigeria

Abstract

Assessment of loss of Agricultural farmland using Remote Sensing Techniques is an area of significance that has been attracting swelling attention. This paper is an attempt to assess the changes in Agricultural farmland in Gudu town of Sokoto State over a 13 year period. The study made use of LandSat imageries of 1986 and 1999. The images were classified using Maximum Likelihood Classification method after which the land use land cover Maps produced for the periods are overlaid. The results show that loss of Agricultural farmland to bare soil constituted the most extensive type of land use/land cover in the study area. The increasing population and economic activities were noted to be putting pressure on the available land. This paper highlights the importance of Remote Sensing and GIS Techniques in apprehending the situation in order to save the environment for our future generation in Gudu Local Government area of Sokoto State and the nation as a whole.

KEYWORDS: Remote Sensing, Agricultural Farmland, LandSat Images, Techniques, Maximum Likelihood.

INTRODUCTION

Land use is only one such aspect, but knowledge about the land cover/land use has become increasingly important as the nations plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, and destruction of important wetlands.

Increase in population, destruction of environmental resources, environmental pollution, as well as human activities have been recognized as a major force shaping the biosphere those are the various issues threatening the environment today Vernon, (2002).

Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels UN-habitat, (2003).

Globally, urban centres over a half century ago have continued to witness unprecedented growth in its population in most developing countries. This growth is premised on the perceived improvement in living conditions and the environment Kombe and Kreibich, (2000), thereby triggering high level migration usually one way from the rural areas to the urban areas. This phenomenon comes with high level population increase in the urban areas as well as consistent decline in economic opportunities in rural areas (Gardner, 2001; UN-Habitat, 2003).

Thematic Committee (2001) opines that in Nigeria the growth and complexity of human settlements and in particular the process of urbanization has been phenomenal. 1950, the percentage of the total Nigerian population living in urban centres was less than 15 per cent; by 1975, this proportion had risen to some 23.4 per cent. By year 2000,
the proportion had gone up to more than 43.5 per cent and it is been projected to be more than 50 per cent by the year 2010.

The conversion of agricultural farmland land to urban use, settlement expansion desert encroachment, wetland in the rural environment is inevitable for many developing countries. However, there is a need to minimize the impacts of agricultural land loss through sustainable land allocation: that is, to create a balance between land development and conservation, so that the needs of both present and future generations can be met.

Sokoto State is one of the states in Nigeria that has been faced with environmental threat for years, it should be noted however that, Gudu is one of the area in the state that is faced with challenges of losing potentialities in farmland, hence the need for geospatial technologies such as Remote Sensing in enhancing monitoring and management efforts for agricultural farmland in the study area.

METHODS AND PROCEDURES

To study land use change dynamics at a regional level with a comparable level of confidence, land-use and socio-economic data of the study area were needed. Data collection and ground truthing necessitated visits to Gudu town.

Data Sourcing, Acquisitions and Processing

The Landsat TM data covering Sokoto State for 1986 and Landsat ETM data for 1999 were obtain from the Sokoto State office of the Surveyor General, to add to this data other relevant documents were also obtained from the Sokoto State Ministry for Agriculture, Ministry for Environment and Ministry for Forestry and Animal Health respectively. However, the paper entailed gathering relevant information to the assessment of loss of Agricultural Farmland in Gudu Town, the geo-referencing and sub-mapping of the image imageries used as data for the purpose of the paper was carried out using ILWIS 3.3 Software, the figure 1 below summarized the work flow process adopted in carrying out the paper.
Image Sub-Mapping and Image Classification

During the image sub-mapping the study area was sub-mapped and enhanced using the contrast stretching techniques of the global contrast enhancement method, the spectral band were combined to obtain a colour composite by formation of bands 4, 3 and 2 for both 1986 and 1999 respectively, the result of the colour composite is shown below in figure 2 and 3 respectively. However, image classification is a conventional change detection method which provides an avenue to create series of Land cover maps, and in order to produce land use land cover maps after classification that will the various changes that occur due to loss of Agricultural farmland in the study area, the satellite imageries of Landsat TM of 1986 and Landsat ETM of 1999 was classified using maximum likelihood classification algorithm, and the results are shown in figure 4 and 5, for the purpose of this paper predefined classes depicting the various land use within the study area was identified thus include: Bare soil, Built up area, Farmland, Vegetation, Wetland and Water bodies.
Figure 2: Submap colour composite of the study area of LandSatTM 1986

Figure 3: Submap colour composite of the study area of LandSat ETM 1999
Map Overlay

One basic way to create or identify spatial relationships is through the process of overlay. Spatial overlay is accomplished by joining and viewing together separates datasets that share all or part of the same area. The results of this combination will give new data set that in no small measure identifies the spatial relationships this will allow the user to view and analyze those portions of the various layers which cover the same place on the earth surface. However, for the purpose of this paper the intersect overlay analysis was carried out in order to analysed the changes that occurs within the study area.
REULTS AND ANALYSIS

The result obtained in the analysis has shown the potentialities of Remote Sensing in assessing the loss of Agricultural farmland. After the two images of the study have been overlaid the result revealed that, Farmland areas covering an area 1108Km² which accounted for 20% was lost due to increase of built up in 1999, out of the 29769.3 Km² in 1986. This attributed to the fact there is increase demand for shelter which is as a result of increase in population in the study area. Similarly, bare soil extent in the Agricultural farmland in the study area as of 1999 has been increase tremendously covering virtually an area of 3975 Km² that accounted for 72% as indicated in Table 1 and figure 4.6 respectively, out of the initial 29769.3 Km² of agricultural farmland in Gudu. This is unconnected with the fact the action of climate change has already manifested in the area, equally the action of desert encroachment has also prevailed which is as a result of the fact that Gudu is neighbouring Republic of Niger to the North West and there is always the prevalence of trade wind which is associated with dryness encroaching in to the area and this has lead to the loss of agricultural farmland to that extent in Gudu Local Government area.

<table>
<thead>
<tr>
<th>Changes</th>
<th>Area (Km²)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmland to Built up area</td>
<td>1108</td>
<td>20</td>
</tr>
<tr>
<td>Farmland to Bare soil</td>
<td>3975</td>
<td>72</td>
</tr>
<tr>
<td>Farmland to Farmland</td>
<td>437</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>5520</td>
<td>100</td>
</tr>
</tbody>
</table>
CONCLUSION

The result of this study indicated that, Gudu Local Government area experienced an increase of 72% in the loss of Agricultural farmland to bare soil between 1986 to 1999 and increase of 20% to Built up area. Going by this trend it is an illustration that the area is virtually a desert environment and it is a clear indication that from 1999 to date the area might have been seriously lost so many potentialities and may be at risk of food insecurity. From the preceding it can be firmly stated that assessment of loss of agricultural farmland is essential in order to trounce the effect of desertification and food insecurity and above all the consequences of climate change in our environment which will eventually help us to save our environment for our future generation.

Furthermore the output of the various analyses shows that the application of Geoinformation technology is an influential tool for emergent pronouncement support system based on the availability of spatially referenced data.

Recommendations

In rounding up this paper it is important to stated out some recommendations that will help the Sokoto State Government and all stakeholders in this industry in order to undertake necessary measure in controlling the rate at which Agricultural farmland are loss in the State and to protect the menace of affecting our environment in the future. These recommendations are;

1. Establish a land information system for effective monitoring, supervision and control of desert encroachment in the State.
2. There is the need to have a passionate public enlightenment campaign on the dangers associated with human activities such as overgrazing and deforestation which eventually lead loss of agricultural farmland.
3. The need to have an appropriate and ample programme to improve on the reduction of impact of climate change in the area and the State as a whole.
4. There the need to institute policies and convention that will save from harm further loss of agricultural farmland bearing in mind the penalty that may arise.
5. There is the need for versatile usage of land all the time in order to make the farmland fully utilize as this may reduce the rate at which farmland are waste in the study area and the State in general.
6. There is the need for a comprehensive monitoring and assessment of human activities in the area so that to check the level at which these activities impinge on the agricultural farmland.

References

Thematic Committee, (2001). Sustainable urban development and good governance in Nigeria- Istanbul
CULTURAL IMPERATIVES IN DIFFERENTIAL ITEM FUNCTIONING (DIF) IN MATHEMATICS

Ebisine, Sylvester Sele
Department of Mathematics, College of Education, Warri, Delta State, Nigeria

Abstract
DIF is said to occur if different subgroups, who have equal standing on the construct the test is designed to measure, display different probabilities of passing an item (in test of typical performance). DIF as a condition in which given examinees of equal ability in the trait being measured, the probability of answering an item correctly is related to group membership. There are evidences of DIF among testees from different subgroups (cultural group, gender and socioeconomic background). Therefore, any test used to measure students’ ability must be fair among different cultures. Because of the different cultural setting tests may not be functioning in the same way in all cultures, which is also called that test may be equivalent or tests may not be fair among different culture. This paper therefore discusses the concepts of DIF, culture and the theoretical perspective of cultural imperative in DIF. Furthermore, the paper examined the sources of DIF in multicultural assessment and how to deal with inequivalent items. Finally, it attempts the use of culturally responsive instructional technique to reduce students’ differential performance in mathematics.

Keywords: Culture, Mathematics, Differential Item Functioning (DIF), Inequivalent Items, Differential Performance

Introduction
Learning is a basic attribute of every human being. No learning is complete until what is learnt is assessed. The process of determining the extent of possession of what was learnt in a concrete and measurable term is called assessment. A basic component of assessment is measurement. Measurement is the transformation of attributes to numeric values. Gronlund (1976) describe measurement as the quantitative description of learner’s behavior. In psychological measures, because the attribute being measured is not directly observable it is given a special name “construct”. Then, the equivalence of the attribute measured can be re-specified as: the construct to be measured must possess the same properties and meaning in different culture, which is referred to as construct equivalence (Hui & Triandis, 1983). In addition, the scale representing this construct must also be the same. Such an identical scale is referred to as comparison scale. In other words, comparison scale can be regarded as a measurement scale on which equivalence is assured.

However, the problem due to the lack of equivalence in the construct being measured is called construct bias or item bias. Item bias may be due to various reasons, such as partial correspondence of the construct over culture. If the construct being measured does not possess the same set of behaviours in different culture, presence of irrelevant, non-target constructs which are related to gender, ethnicity, race, linguistic background, socio-economic status or handicapping condition (Flores, 2000; Lam, 1995), differences in upbringing environment, culture (Flores, 2000) and daily life experiences (Fortune, 1985). The general concept is termed Differential Item Functioning (DIF). DIF is said to occur if different subgroups, who have equal standing on the construct the
test is designed to measure, display different probabilities of passing an item (in test of typical performance).

Therefore, any test used to measure students’ ability must be fair among different cultures (Poortinga, 1989; Kleime & Baumert, 2001). In other words, it must be assured that the tests measure some common construct in different cultures. Because of the different cultural setting tests may not be functioning in the same way in all cultures, which is also called that test may be equivalent or tests may not be fair among different culture (Allalouff, Hambleton & Sireci, 1999; Ercikan, 1998). For example, cultural differences may lead to different response styles or response patterns in examination. Presence of these factors with the potential of affecting item equivalence can cause problems in comparability of items (Sireci & Berberoglu, 2000; Arim & Ercikan, 2005). For example, the Ijaw cultural environment favour spatial component of mathematics as reflected in geometry, whereas the Hausa cultural environment allied with the numerical component of mathematics which is arithmetic in nature. For instance, in NECO (2011) multiple choice test on mathematics, 33% of the items were phrased in cultural environment. Questions 3, 4, 11, 15, 53, 54, 58 favour the Hausa culture which is trading in nature. While questions 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 48 and 49 favour the spatial component of mathematics as reflected in the Ijaw cultural environment where activities are spatial in nature. As such test items in this aspect of mathematics may be simpler to an individual from such cultural environment. Specifically, question 3 which states as follows: find the compound interest on ₦225.00 invested for 20 years at 4% per annum favour the Hausa trade culture, while question 34 which states as follows: a right circular cylinder of base radius 8cm has a height of 14cm. find the volume of the cylinder favour the Ijaw spatial culture. Thus, if a test aims at measuring ability across different cultures, it has to assure that the scale on which the score are expressed has the same zero-point and the same scale units. This is to assume completely bias-free measurement. Item bias can seriously threaten the scalar equivalence.

Based on this background, this paper attempt to examine the concept of DIF, culture, sources of DIF in multi-cultural assessment and how to deal with inequivalent items. Finally, the paper examine how culturally responsive instructional technique can reduce students differential performance in mathematics.

**Concept of Differential Item Functioning (DIF)**

DIF occurs when a test item measure an ability which is alien to the subject matter, such that performance on the item is now sustained by abilities which are alien to the subject matter. According to Zumbo (1999) DIF is a condition in which examinees from different groups show differential probabilities of endorsing an item after matching on the underlying ability that the item is intended to measure. Put in a similar way Doolittle & Cleary (1987) defined DIF as a condition in which given examinees of equal ability in the trait being measured, the probability of answering an item correctly is related to group membership. In probability term, Warm (1978) defined DIF with the equation below:

\[
P_A(\Theta = K) \neq P_B(\Theta = K)
\]

In the equation above, A and B represent two subgroups, \(\Theta\) represents ability which is equal to K in each group membership. The equation means that an item is said to be differentially functioning if probability of members of group A ability (K) getting an item correct is not equal to the probabilities of group B with ability K also getting the item correct. DIF comes about when different subgroups that are matched in terms of the primary dimension differ in their standing on a secondary dimension, such as
familiarity with the content in terms of which the items are formulated. DIF analysis are directed at identifying items that are affected by secondary dimensions or, stated differently, that measure different, additional aspects in different subgroups. Nowadays, this term is invoked only if items have been identified, by statistical means, as differentially functioning, and if the reason for this can be attributed to construct-irrelevant properties of the item (Lam, 1995).

Similarly, Differential Person Function (DPF) indicates the differential person functioning between items and classes of persons. Another type of DIF is Differential Group Functioning (DGF), which indicates the differential functioning between classes of items and classes of persons, DIF and DPF.

**What is Culture?**

Culture comprises the distinctive habit of a people; it performs both a unifying and, more importantly a directive role. Culture referred specifically to those habits which bind a people together into a single group for a common end. According to Guillerman & Sharon (2001) culture and society shape an individual’s mind and thinking. In effect the socio-cultural context in which people live influences the way in which they make sense of issues and the way in which they solve them. These socio-cultural influences include the values, beliefs, experiences, communication patterns, teaching and learning styles, and epistemologies inherent in the individual’s cultural backgroups, as well as, the socio-economic conditions prevailing in cultural groups.

Reflecting on a cognitive orientation, Greenfield (1997) defined culture as the collective programming of the mind which distinguishes the members of one human group from another. Also focusing on cognition, Flores (2000) referred to the human constructed intangible in the environment as the subjective culture, defining it as a shared meaning system, founding among those who speak a particular language dialect, during a specific historic period and in definable geographic region. In essence, culture determines what individuals sense and perceive within their environment. It determines the importance of competing external and internal stimuli, the interpretation of the stimuli, and the consequential responses to the interpretations. Therefore, culture is an essential variable to consider when attempting to explain, alter, or predict behavior, as well as, performance difference between two groups of comparable ability or performance.

**Theoretical Framework**

This paper focus is on the interactionist view. The interactionist view focus is not the individual but interaction between individuals within a culture (Brunner, 1984). In essence for an interactionist mathematics educator, learning is not just an endeavor of the individual mind trying to adapt to an environment, nor can it be reduced to a process of enculturation into a pre-established culture. In mathematics, the individual construction of meanings takes place in interaction with the culture of environment (Cobb & Bauersfeld, 1995). Therefore, people learn indirectly, through participating in a culture and its discursive practices. For example, the process of construction of knowledge is based on interpretations that have their sources not in the individual alone but in his/her interpretation with others within a culture. For Bauersfeld (1995) meanings are generated neither by the individual mind nor are they attributed to some historically founded collective mind of a society, but they are continually constituted in the interactions whose pattered character accounts for the relative stability of cultures. Thus, the quality of the culture in which one lives play a dominant role in performance and development of mathematics knowledge.
The perspective focused on the fact that there are mathematical thinking used by students to solve problems that arise in customary activity such as their play, trade, farm activities and work (Schliemann, Carraher & Ceci, 1997). For the interactionist, mathematical thinking used by children to solve problems, could by the intellectual tools children acquire from their culture, and other support parents and teachers provide that help children develop mathematical knowledge (Radziszewska & Rogoff, 1991). This perspective indicates that variables associated with culture play a role in mathematical development. Although, it remains an open question whether or how culture per se play a role in mathematical development.

Source of DIF in Multi-Cultural Assessment

For almost past quarter of a century it has been recognized that DIF is caused by multi-dimensionality in an item (Linn, Levine, Harstings & Wardrop, 1980), that is, the performance on items depends not only on the construct that the test is designed to measure, referred to as primary (or target) dimension, but also on one or more dimensions, known as secondary dimension. Allalouf, Hambleton & Sireci (1999) provided one of the most comprehensive classification of causes of DIF in translated verbal items. They reported four main causes for DIF in translated instruments: (1) changes in difficulty of words or sentences specifies the situation in which some words become easier or more difficult after translation, (2) changes in contest may be due to an incorrect translation changing the meaning of an item. Gierl & Khalig’s (2000) category of “omission or addition that affect meaning” also deals with same issues, (3) changes in format are the cases, for example when a sentence become much longer after the translation. Gierl & Khalig (2000) also include the changes in punctuation, capitalization in this category, (4) differences in cultural relevance is the last category. In this case the items remain same, however it is the cultural content of items that causes DIF. For example, content of a sentence completion item may be more familiar for one of the groups. Gierl & Khalig define this category as “differences in words or expressions inherent to a language”. Scheuneman & Grima (1997), on the other hand provides an additional cognitive perspective to the classification of possible sources of group performance differences in mathematics items. They specify three categories, mainly (1) the cognitive nature of the task presented to the examinee, (2) mathematical content of the item, and (3) the surface properties of the items such as item format among others.

How to Deal with Inequivalent Items

Biased items are eliminated through the reduction of equivalence. For example, Hulin (1987) explained a method of eliminating the non-equivalent items and then reestimating their abilities with the rest of the items and again testing all items for equivalence and eliminating non-equivalent items and so on until no non-equivalent items are found. On the other hand, Roznowski & Reith (1999) provide an interesting perspective with result of their study that is not supporting the assumption of differentially functioning items should be deleted in order to get a fair measurement. They suggest that after determining the differentially functioning item it must be the following concern to test whether elimination of these items contributed to the quality of the test, because differential item functioning is an item level analysis whereas individuals are usually compared at the test level. Also, biased items may be pointing out some cross-cultural differences that may require further investigations. In the case of these items, this potential source of information will be lost. In addition, this elimination method may deform the content validity of the instruments.
Also, to ensure that tests are fair for all examinees, most large testing programmes have a formal review, which is part of the test development process where items are screened by content specialists for test that might be inappropriate or unfair to relevant subgroups in the test-taking population including female examinees. These reviews are conducted before the tests are administered. Statistical measures of DIF can also help test developers identify item that are biased against examinees since the ultimate criterion of item equivalence must come from an analysis of the examinee responses (Gierl, Khaliq & Boughton, 1999). According to them, the purpose of review is to examine the tests for content validity, curricular validity, item appropriateness (e.g. wording, length, interest), bias (e.g. gender, cultural, disability), balance to the test blueprint and tone.

Consequently, if characteristics that an item measures are relevant to the trait in the source but not in the target culture, such culturally specific characteristics or concepts are referred to as emic, and in contrast culturally general concepts are called as etic concepts (Hui &Traindis, 1985; Hulin & Mayer, 1986; Hulin, 1987). The general aim in cross-cultural studies is increasing the sensitivity and cultural relevance of the instrument for both cultures, but at the same time retaining the psychomotor equivalence. For this aim, etic items can be used as anchor items in linking the two language forms of a test to generate scales that only reflect cultural uniqueness but at the same time satisfying the psychomotor equivalence (Sireci, 1997).

The Use of Culturally Responsive Instructional Technique to Reduce Students’ Differential Performance in Mathematics

Cultural psychologist and child development researchers and theoreticians have acknowledged that culture and society play a critical role in cognitive development (Vygotsky, 1979; Wertsch, Del Rio & Alvarez, 1995). Thus, culture influences the way in which people construct knowledge and create meaning from experience (how they think about things, reason and solve problems) (Greenfield, 1997), which relates directly to the ways in which individuals learn and teach informal and school settings (Lipka, 1991). The implication is that the child’s culture can be used to teach him mathematics and this may make mathematics teaching and learning meaningful. According to Enukoha, the “Okoso” game or “Top” could be used to gain insight into geometry and physics therefore affording the child and teacher an opportunity for interdisciplinary discussion (Enukoha, 1995).

The Top or Okoso Game

An interesting and mathematical aspect of spinning the top (okoso) is the controversy which is often generated about the winning position of a top which is not completely covered at certain angle of inclination to the ground (horizontal). For example A and B below are two positions of a top which was covered by two players. “A” has attained neutral equilibrium while “B” has attained unstable equilibrium. The position of B generates a lot of arguments as to whether it should be accepted as a winning position or not. The basis for detecting the acceptability is the size of the angle of inclination x. The smaller the x, the more likely that the position will be accepted as a winning position (Enukoha, 1997). The children could convert these arguments into geometry class involving measurement of the various sizes of X and the relationship between x, b and w in the meaning of complementary and supplementary angles where:

\[ x + w = 90^\circ \] (Complementary angles)
\[ x + b = 180^\circ \] (Supplementary angles)
This game also give the teacher an opportunity for an interdisciplinary lesson in physics by relating the various equilibrium position (neutral and unstable) to the mathematical concepts of complementary and supplementary angles (Enukoha, 1997). For instance the bigger the $x$, the smaller the $b$ and the more stable the top become until it approaches a neutral equilibrium position when $x = 0$.

$$\text{As } x \to 0 \quad b \to 180^\circ$$

Neutral Equilibrium  Unstable Equilibrium
(Top completely covered)  (Top partially covered)

**The Teacher’s Role**

This game could be easily adapted in the class with the teacher facilitating the decision as regards acceptable winning positions. After the children have played the game on a sand tray, a number of measurements of $x$ are made. The children and the teacher then decide what the largest $x$ that could be accepted as a winning should be. Once this decided, the argument about winning positions is settled and the game could then become more educational having rules and standards for winning (Enukoha, 1997). According to him, there are number of these traditional games, puzzles and rhymes which could be used to teach certain mathematical concepts and process and if these are developed they may help to make mathematics teaching and learning culturally relevant.

**Nomadic and Migrant Fishermen Activity**

An illustration of the type of a mathematics problem that is culturally relevant in nomadic evaluation appeared in Pythagoras of April 1995. The title of the problem is “the heritage of fractions” and is presented below:

A cattle breeder owned 17 cows. His last will said: the eldest son will have $\frac{1}{2}$ of them, the second $\frac{1}{3}$ and the youngest $\frac{1}{9}$ of them. After his death the cows had to be divided. The sons could not solve the problem without killing the cows, which according to the will was forbidden, so they started quarrelling. A wise man came along, asked what was wrong, heard the problem and asked them to wait. “I will be back in a few minutes”, shortly after that, the man came back with a cow and added it to the little herd. “Well” he said, “each of you can now take your share”. The eldest son took $\frac{1}{2}$ of 18 = 9 cows, the second son took $\frac{1}{3}$ of 18 = 6 cows and the youngest son took $\frac{1}{9}$ of 18 = 2 cows. The wise man took the cow, which he borrowed from a neighbor and brought it back, leaving each of the sons satisfied.

The problem above according to Enukoha (1997) illustrates an ingenious method of solving a problem in fraction. The problem itself is culturally very relevant to the nomad whose daily living revolve on cattle. The solution to the problem, he observed, also gives an insight into the meaning of approximation in mathematics problem solving. For instance, the problem has been solved by the use of approximations and the same result will be got but the solution would have remained at the abstract level.

$\frac{1}{2}$ of 17 = 8.5 = 9 cows
$\frac{1}{3}$ of 17 = 5.7 = 6 cows
$\frac{1}{9}$ of 17 = 1.9 = 2 cows
The lives of the nomad revolve around cows in the same way that the lives of fishermen revolve around fishes. Some mathematical concepts that could be developed with migrant fishermen may include: shapes, for example the conical shape of the fishing traps; patterns on the fishing nets; weight and volume of the fishing boats as well as the relationship between weight, volume, density and flotation (Enukoha, 1997). In fact, research has gingered great response of scholars to the emergence of mathematical thinking in the local parlance, using local examples of things that can be seen, recognized in their quantities as well as their similarities in shapes and cultural applications and remembered as many times as they need to be recalled. The teacher of mathematics will find it very useful as a means of motivation to let his pupils see the value of native history and past history of mathematics that can open the door to enrichment of mathematics (Odili & Okpobiri, 2011).

Cultural Mathematics of the Igbo Boys

Here, the boys who are already apprenticed to various trades, such topics as interest rates, simple interest, profit and loss, fractions, percentages and exchange rates of different currencies of the world, may enhance their knowledge of such topics in mathematics. The use of mathematics in the form will meet the cultural needs of these boys. It is therefore, strongly hoped that the use of these cultural materials in teaching the regular school mathematics programme will counteract with euro-centric bias recently encountered in mathematics (Enukoha, 1997). Cultural mathematics helps link past experiences to classroom experiences, links home background to the classroom activities thereby making mathematics concrete and a reality due to its processes. As such, it is pertinent that a thorough understanding of any cultural group’s worldview can expose elements of teaching within their worldview which can be applied creditably in the teaching and learning of mathematics in that group (Odili & Okpobiri, 2011).

Conclusion

An attempt has been made in this paper to discuss the cultural imperatives of DIF. In this paper, the writer examines the concept of DIF and culture, as well as sources of DIF in multi-cultural assessment and how to deal with inequivalent items. Furthermore, the cultural responsive techniques to reduce students’ differential performance in mathematics were examined.

References


EXTENT OF AVAILABILITY OF SAFETY INSTRUMENTS/EQUIPMENT IN SCIENCE LABORATORIES IN SECONDARY SCHOOLS IN EBONYI STATE OF NIGERIA

Celestine N. Nwele
Department of Chemistry
Ebonyi State College Of Education, Ikwo-Nigeria

ABSTRACT
The study examined the extent of availability of safety instruments in science laboratories in secondary schools in Ebonyi State of Nigeria. The researcher used 45 secondary schools and 180 science teachers and laboratory attendants for the study. Descriptive survey design was adopted. 11-item four-point scale structured questionnaire was used to collect data. The data collected were analysed using mean and standard deviation for the research question while t-test was used to test the hypothesis at 0.05 alpha level of significance. Result of the data analysis revealed that the extent of availability of safety instruments is very low in secondary schools in Ebonyi state of Nigeria. The implication of this is that sustainable development of science laboratory skills in the state will be hampered. The researcher recommends that the government of Ebonyi State should ensure that safety instruments are provided to a very high extent in secondary schools in the state.

Keywords: Safety instrument, Science Laboratory, Availability, Laboratory Skill, Accident.

INTRODUCTION
Science is a study of nature and natural phenomenon. Mbajiorgu, (2003) stated that this study of nature and natural phenomenon relies on hypothetical-deductive experimental approach and operates on physical, measurable and observable realm. The study of science involves a systematic process of investigation that employs observation and experimentation as tools (Okeke, 2007). The field of investigation in science according to Mbajiorgu, (2003) and Igwe, (2003) is the natural environment and may involve going outside the classroom to look at flowers, insects, rocks rivers, sky, or activities (experiments) in the formal school science laboratories.

A great deal of importance is attached to science and technology education for Nigeria to achieve accelerated national development. FRN, (2004) stipulates a ratio of 6:4 of science and technology to art courses in admission of students in tertiary institutions in the country. Nwana, Baja and Obioha, (2000) opined that without science education, it is impossible to develop such professions as agriculture, dentistry, medicine, engineering, astronomy, space exploration, geology, pharmacy. To accelerate national development, a method of teaching science which ensures a high degree of student’s participation is advocated. Adigun, (1999) emphasized that students have to be actively involved in the science and technology lessons to acquire skills in their various field of study. These science lessons (activities) take place in normal school science laboratories. These laboratory activities are usually prone to
risks, hazards, and accidents, hence the need to provide safety instruments/equipments in the laboratories.

Laboratory activities or experiments are very important and essential in the teaching and learning of science in secondary schools. The laboratory activities are carried out using materials and equipment and following laid down procedures that require care and precaution, (Nwanuma 2005). Ali (1998:84) defined laboratory as a “place where experiments in science are carried out with chemicals, specimens, materials and equipment” According to Ibia and Idoko, (2008), laboratories are most often prone to hazards due to the presence of dangerous chemicals and equipment not carefully handled by the users. Igwe, (2003) reported that cases of accidents abound during experiments in secondary school science laboratories in Nigeria. Nkwegu, (2008) outlined causes of accidents in the laboratory to include carelessness, improper storage of materials and equipment, ignorance of the use of protective items for safety. Adigun (1999) reported that most fatal accidents in the history of scientific and technological development occurred as a result of hazards associated with experiments being carried out, ignorance of necessary precautionary measures and lack of safety instruments and skill in their operations.

Aniodoh, (2001), Ezeliora, (2001) and Igwe, (2003) stressed that safety instruments such as fire extinguishers, first aid box, hand gloves, fume cupboards, laboratory coats, fire blankets, gas masks, eyewashers, acid cabinets, safety glasses, face shields, protective foot wear, respirators should be available in science laboratories. These are used to prevent and control accidents and emergency situations in the laboratories. Archenhold, Jenkins and Robinson, (1978) and Ezeliora, (2001) emphasized that students should know the locations and how to use these instruments in the laboratory.

Science laboratories appear to be most prone to risks, hazards and accidents because of the presence of dangerous chemicals in them. The science laboratory of Ikwo high School of Ebonyi State was once partially burnt because of carelessness and improper lighting of the Bunsen burner and absence of a functioning fire extinguishers and fire blankets to quench the fire, (Nwanuma, 2005). According to Nkwegu, (2008), students of Community School Ekpomaka also in Ebonyi State in similar vein carry out experiments in the science laboratory without wearing laboratory coats, safety goggles and hand gloves. It appears that there are no safety instruments such as fume cupboards, fire blankets, spill kits, vacuum desiccators, gas mask in most of the laboratories in the state. The first aid boxes available in some of laboratories appear to be worn out with no functioning materials in them. The carbon dioxide fire extinguishers available in some of the laboratories seem to be empty of the gas. It is possible that students and teachers in some of the laboratories carry out experiments without wearing laboratory coats, hand gloves or safety goggles.

These presumptions all point to fact that science laboratories in secondary school in Ebonyi State may not have safety instruments to a desirable extent. The users of these laboratories, materials in the laboratories and the laboratories themselves could therefore be exposed to the danger, risks and accidents. This has the grave implication of hampering the sustainable development of science laboratory skills. It is uncertain whether there are empirical data on the extent of availability of safety instruments/equipment in science laboratories in secondary schools in Ebonyi State. It is in the light of this, that this research is set out to assess the extent of availability of safety instruments in science laboratories in secondary schools in Ebonyi State of Nigeria.
STATEMENT OF THE PROBLEM

Material Safety Data Sheet (MSDS), a document on safety handling of various laboratories materials, contain a wealth of information on flammability, poison nature of each chemical, health hazard, safety instruments needed, first aids and other precautionary measures required in science laboratories. It is uncertain the extent to which requisite safety instruments/equipment necessary to prevent and control accidents are available in secondary school science laboratories in Ebonyi State of Nigeria. Thus, this study is designed to assess the extent of availability of safety instruments/equipment in secondary school science laboratories in Ebonyi State of Nigeria.

PURPOSE OF THE STUDY

The study is designed to investigate the extent of availability of safety instruments/equipment in science laboratories in secondary schools in Ebonyi State of Nigeria.

RESEARCH QUESTION

To guide the study, the following research question was posed:
To what extent are safety instruments/equipment available in science laboratories in secondary schools in Ebonyi State?

HYPOTHESIS

There is no significant difference in the mean responses of science teachers and laboratory attendants on the extent of availability of safety instruments/equipment in science laboratories in secondary schools in Ebonyi State of Nigeria.

RESEARCH METHODOLOGY

The study was a descriptive survey, which sought to ascertain the mean responses of science teachers and laboratory attendants on the extent of availability of safety instruments/equipment in secondary school science laboratories in Ebonyi State of Nigeria. The study was carried out in the three education zones of Ebonyi State. The zones are Abakaliki, Onueke and Afikpo. The population of the study consisted of senior secondary school science teachers and laboratory attendants in 213 government owned secondary schools in Ebonyi State. Stratified random sampling was used to select 15 secondary schools from each of the three education zones in the State. Purposive random sampling technique was used to select 135 science teachers and 45 laboratory attendants. The use of purposive sampling technique was to ensure that science teachers and laboratory attendants who are most experienced in laboratory activities and thus are most likely to know the requisite safety instruments in science laboratories, were used for the study.

The instrument for data collection was a four-point scale structured questionnaire developed by the researcher. The weighting of the responses was: very high extent VHE = 4, high extent HE = 3, low extent LE = 2 and very low extent VLE = 1. Three experts from Science Education Department, Ebonyi State University Abakaliki, validated the instruments. The researcher administered copies of the instrument to a sample of 15 science teachers and 15 laboratory attendants that were not part of the sample of the study. Cronbach alpha statistics was used to compute the reliability coefficient. A reliability coefficient of 0.80 was obtained indicating that the instrument was very reliable.

The researcher was assisted by two research assistants to distribute copies of the questionnaire. In this way, all the copies distributed were recovered. Mean and standard deviation were used in answering the research question while t-test was used to test the null hypothesis at 0.05 level of significance. A mean value of 1.00–1.49 was regarded as VLE, 1.50–2.49 as LE, 2.50-3.49 as HE and 3.50–4.00 as VHE.
RESULTS

The results were presented according to the research question and the null hypothesis in table 1 and 2 respectively.

Table 1: mean result based on the extent of availability safety instruments.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Safety Instruments</th>
<th>VHE</th>
<th>HE</th>
<th>LE</th>
<th>VLE</th>
<th>Mean</th>
<th>SD</th>
<th>interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fire extinguishers</td>
<td>2</td>
<td>44</td>
<td>54</td>
<td>80</td>
<td>1.82</td>
<td>0.82</td>
<td>LE</td>
</tr>
<tr>
<td>2</td>
<td>First aid kits</td>
<td>8</td>
<td>38</td>
<td>48</td>
<td>86</td>
<td>1.82</td>
<td>0.81</td>
<td>LE</td>
</tr>
<tr>
<td>3</td>
<td>Eye washers/Safety showers</td>
<td>0</td>
<td>2</td>
<td>18</td>
<td>160</td>
<td>1.11</td>
<td>0.33</td>
<td>VLE</td>
</tr>
<tr>
<td>4</td>
<td>Fume Cupboard</td>
<td>0</td>
<td>2</td>
<td>20</td>
<td>158</td>
<td>1.13</td>
<td>0.37</td>
<td>VLE</td>
</tr>
<tr>
<td>5</td>
<td>Acid cabinets</td>
<td>8</td>
<td>38</td>
<td>48</td>
<td>86</td>
<td>1.82</td>
<td>0.81</td>
<td>LE</td>
</tr>
<tr>
<td>6</td>
<td>Fire blankets</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>162</td>
<td>1.11</td>
<td>0.33</td>
<td>VLE</td>
</tr>
<tr>
<td>7</td>
<td>Safety goggles</td>
<td>0</td>
<td>24</td>
<td>60</td>
<td>96</td>
<td>1.58</td>
<td>0.70</td>
<td>LE</td>
</tr>
<tr>
<td>8</td>
<td>Laboratory coats</td>
<td>0</td>
<td>30</td>
<td>50</td>
<td>100</td>
<td>1.56</td>
<td>0.76</td>
<td>VLE</td>
</tr>
<tr>
<td>9</td>
<td>Hand gloves</td>
<td>18</td>
<td>20</td>
<td>46</td>
<td>96</td>
<td>1.78</td>
<td>1.00</td>
<td>LE</td>
</tr>
<tr>
<td>10</td>
<td>Gas masks</td>
<td>0</td>
<td>2</td>
<td>22</td>
<td>156</td>
<td>1.15</td>
<td>0.43</td>
<td>VLE</td>
</tr>
<tr>
<td>11</td>
<td>Fire proof Cupboards</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>168</td>
<td>1.08</td>
<td>0.34</td>
<td>VLE</td>
</tr>
</tbody>
</table>

Based on the result of data analysis shown in table 1, items 1, 2, 5, 7, 8 and 9 were available at a low extent (LE) while items 3, 4, 6, 10 and 11 are available at very low extent (VLE) in secondary schools in Ebonyi State. The grand mean of 1.45 and SD of 0.62 also show that the extent of availability of safety instruments in the laboratory is very low.

Table 2: t-test result based on extent of availability of safety instruments.

<table>
<thead>
<tr>
<th>SN</th>
<th>Variables</th>
<th>No.</th>
<th>X</th>
<th>SD</th>
<th>DF</th>
<th>T-cal</th>
<th>T-crit</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.87</td>
<td>100</td>
<td>178</td>
<td>0.30</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>2</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.87</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.85</td>
<td>0.82</td>
<td>178</td>
<td>1.04</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>4</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.7</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.14</td>
<td>0.37</td>
<td>178</td>
<td>2.63</td>
<td>1.96</td>
<td>Reject</td>
</tr>
<tr>
<td>6</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.00</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.17</td>
<td>0.42</td>
<td>178</td>
<td>2.83</td>
<td>1.96</td>
<td>Reject</td>
</tr>
<tr>
<td>8</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.00</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.84</td>
<td>0.82</td>
<td>178</td>
<td>1.03</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>10</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.71</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.89</td>
<td>0.94</td>
<td>178</td>
<td>1.89</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>12</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.60</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.59</td>
<td>0.68</td>
<td>178</td>
<td>0.12</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>14</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.57</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.68</td>
<td>0.78</td>
<td>178</td>
<td>0.82</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>16</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.44</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.77</td>
<td>1.00</td>
<td>178</td>
<td>0.30</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>18</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.48</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.20</td>
<td>0.48</td>
<td>178</td>
<td>2.41</td>
<td>1.96</td>
<td>Reject</td>
</tr>
<tr>
<td>20</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.02</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Science Teachers</td>
<td>135</td>
<td>1.11</td>
<td>0.39</td>
<td>178</td>
<td>1.86</td>
<td>1.96</td>
<td>Accept</td>
</tr>
<tr>
<td>22</td>
<td>Laboratory attendants</td>
<td>45</td>
<td>1.00</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-test value</td>
<td></td>
<td>1.65</td>
<td>1.96</td>
<td></td>
<td></td>
<td></td>
<td>Accept</td>
</tr>
</tbody>
</table>

Summary of data analysis in table 2 indicates that Ho for items 1, 2, 5, 6, 7, 8, 9, and 11 were accepted because their t-calculated values were less than t-critical value of 1.96. Items 3, 4 and 10 have t-calculated values greater than t-critical and were therefore rejected. The grand t-calculated value of 1.65 is less than t-critical of 1.96. This means that Ho is accepted implying that the mean responses of science teachers and laboratory attendants do not differ significantly at 0.05 level of
significance with respect to availability of safety instruments/equipment in the science laboratories.

**DISCUSSION**

Summary of the data analysis on table 1 indicates that the extent of availability of safety instruments in science laboratories in secondary schools in Ebonyi State of Nigeria is very low. The summary indicates that the extent of availability of safety showers/eye washers, fume cupboards, gas masks, fire blankets and fire proof cupboards is very low. On the other hand, the extent of availability of first aid kits, acid cabinets, safety goggles, laboratory coats and hand gloves is low in secondary school science laboratories in Ebonyi State of Nigeria. This result shows that most secondary school science laboratories in Ebonyi State do not have safety equipment to a desirable extent. The finding is in line with the finding of Adigun, (1999) that most science laboratories in secondary schools in Lagos State of Nigeria do not have adequate safety equipment. It is also in line with the finding of Ibiam, Ibrahim and Idoko, (2008) that there are inadequate safety gadgets and protective wears in science laboratories in secondary schools in Nsukka Local Government Area of Enugu State of Nigeria.

Result of t-test on the table 2 showed that t-value of 1.65 was obtained. This is less than t-critical of 1.96. H0 is therefore accepted implying that the responses of science teachers and laboratory attendants do not differ significantly with respect to the availability safety instruments in the science laboratories in the secondary schools in Ebonyi State of Nigeria. The lack of significant difference in the mean responses could be explained by the fact that science teachers and laboratory attendants are both users of the laboratories. Both would therefore likely know whether any equipment is available or not and the extent of their availability.

**CONCLUSION AND RECOMMENDATION**

Based on the result of the study, it was found that safety instruments/equipment are not available to a desirable extent in science laboratories in secondary schools in Ebonyi State of Nigeria. Some safety instruments are available at a very low extent (VLE) while others are available at low extent (LE). There is no safety instrument that is available at a high or very high extent. This situation makes the laboratory unsafe for users, materials in the laboratories and the laboratories themselves. The implication is that sustainable development of science laboratory skills will likely be hampered. The science graduates of the secondary schools will only know the theories without the accompanying practical skills. The researcher therefore recommends that the government of Ebonyi State should ensure that safety instruments are provided to a very high extend (VHE) in science laboratories in secondary school in the state. Science Teachers Association of Nigeria, (STAN) Ebonyi State chapter, should insist that necessary safety instruments/equipment are installed in the secondary school laboratories in the state. In this way, a good foundation for science laboratory activities devoid of fear, and engenders sustainable development of science laboratory skills by the students would be laid. This is a way of enhancing the development of a culture of scientific researches, which will in turn propel the sustainable technological development of the society.

**REFERENCES**


ANALYSIS OF TEACHERS PERCEPTION OF THEIR PUBLIC IMAGE AND IT INFLUENCE ON STUDENTS PERFORMANCE IN PHYSICS: A KEY TO IMPROVING THE QUALITY OF EDUCATION IN NIGERIA.

Mallo Yohanna Iliya & Akila Simdet
Physics Department
Federal College of Education, Pankshin-Nigeria

ABSTRACT
The study examined teachers’ perception of their public image and its influence on students’ performance in physics in Pankshin Local Government Area of Plateau State. A survey research design was employed for the study; the study population was all secondary school in Pankshin L.G.A of Plateau State. 100 teachers and students were used as sample using simple random sampling techniques. The study was guided by three research hypothesis. A 16 items questionnaire was the instrument used to collected data from the sample and students’ performance was also collected. The instrument was validated by experts and a reliability coefficient of 0.90 was established using test-retest method. Pearson Product Correlation Coefficient was used to test the research hypothesis. From the findings, Government and students attitude towards the teacher contributes to teachers public image in turn have a negative effect on students performance. The paper recommended that Government/employers of labour should show regards for teacher by meeting their demands to encourage them in their job. Also parents, teachers and government should put heads together to ensure that student attitudes towards teachers change positively to achieve improved performance.

Keywords: teachers, image, perception, students’ performance, physics.

INTRODUCTION
Academic success is a function of the teacher who is the key, the students who are the focus, the environment and the parents who have a great role to play. The role of the teacher in any learning environment is to ensure that the learners acquire the knowledge expected of them. In both formal and informal education, the teacher is at the forefront of curriculum implementation hence he is considered capable of performing the job. An ideal teacher provides instruction in such a way that will lead to high level of student achievement in terms of students outcome such as learning gains and work readiness.

Students on their own part, have a task of listening and paying attention to the teacher, carrying activities and responsibilities assign to them by the teacher. Cogan (1975) stressed that students who share and amplify their elders disparagement of the teacher will tend to learn less, forget faster, transfer and apply their learning less readily than if these learning had been gained in pervading atmosphere of high esteem for teacher. From the forgoing, it is imperative that the teachers image is a significant factor in students, learning. The way the students perceive the teacher determines their attitude to the subject and in turn their interest and readiness to learn.

Parents have the responsibility of supporting the teacher effort by providing the necessary things required of them from the students. An ideal learning environment therefore requires a smooth relationship between teacher, student, parents and the society at large. Emengu (2005) affirmed that poor conditions of services, heavy work load, remuneration, low social and public image ingratitude by other officer and
continued ingratitude shown to teacher by parents and public in general have frustrated many teachers and have forced them to develop low morale.

One does not look to closely at teaching to know that one of the causes of poor academic achievement of students is low regard for to teachers. What most affect the students performance is the quality of the teacher in the classroom and also the respect he receives from the society as a whole.

To improve on the quality of education, there is need to put heads together with the teacher for affection learning to be achieved. Geo, Belly and Kittle’s (2008) said effective teachers collaborate with other teachers, administrator, parents and educational professionals to ensure students success particularly the success of the students with special needs and those at high a risk for failure.

The teacher being a helper, a mentor, a planner, a mornitor, and evaluator, a developer and a collaborator of educational system needs to be motivated by the society through cooperating with him, appreciating his effort, protecting his, image, financing his programme and above all putting heads together with the teacher to ensure success in the teaching learning program.

TEACHER’S PUBLIC IMAGE. THE STATE OF THE ART

The recent industrial strike action embark upon by teachers of various institutions of learning is an evidence of an existing problem between the teachers and employers of labour/government. The negligence of government to the teacher's demand have demonstrated high level of disregard of teachers in the society. For instance Academic Staff Union of Universities (ASUU) on going strike action which started on the first of July 2013, (1-7-2013) to date for lack of implementation of the agreement reached between them and the government since 2009. Okoroafor (2006) noted that the teacher can be said to be all and end all of all situations but ironically he is not instead he is in Nigeria today a laughing stock of all professions. Olabisi (2005) observed that the public population generally regard teaching as an undesirable occupation in Nigeria. the resultant effect is that, the self image of the teacher appears touch of apology. The findings of Oladije (2009) and Okeye (2010) revealed that the perception a student has on the teacher is the same as that he has on the subject.

STATEMENT OF THE PROBLEM

In spite of the importance of the teacher as the engine that pulls educational system along to the land of knowledge. Evidence of teachers disregard in the society is pointed by Emengu (2005) and Olabisi (2005). Teachers being human are sometimes conscious of their rating in the society and their feelings may become attitude to work on their students. This in turn affect students performance as stressed by Ada (2002) and Okeye (2010). It therefore becomes necessary to monitor what the teacher thinks about his/her job and his/her students in the light of confusion from the society about the image of the teachers.

The problem of this study therefore, is what teachers perceive their public image to influence their duty performance with regard to the academic achievement of their students.

PURPOSE OF THE STUDY

The purpose of the study is to examine the teacher’s perception of their public image and its influence on the academic achievement of physics students, the research work looks at the following objectives.

1. To find out the perception of physics teachers in Pankshin Local Government of their public image.
2. To find out the perception of physics teachers in Pankshin Local Government whether their public image has impact on the academic achievement of their students.

3. To find out the causes of the teachers public image in Pankshin Local Government.

4. To determine the strategies for improving teachers public image.

HYPOTHESIS
1. There is no significant relationship between parents perception of the teacher and students performance in physics.

2. There is no significant relationship between government/employer’s attitudes towards teachers and students performance in physics.

3. There is no significant relationship between student’s attitude towards teachers and their performance in physics.

METHODOLOGY
The researcher adopted a descriptive survey research in carrying out this research. The population consists of all secondary schools in Pankshin local government area of Plateau Stat. The size of the population was 180 science teachers and 983 students. Random sampling techniques was used to select 10 schools (100 teachers and 100 students). A researcher made instrument four point liked scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) questionnaire which covered all information regard the topic was used. The content validity of the instrument was determined by an instruments and the reliability value of 0.94 was obtained using test-retest method and Pearson product moment correlation coefficients. The copies of the questionnaire were administered to the sample workers an interval of 10 minutes was given to respond to the items as stipulated in the questionnaire after which the performance of the students was also collected.

METHOD OF DATA ANALYSIS
The data collected were analyzed using pearson product moment correlation (r) and t-test ratio. All hypotheses were tested at 0.05 level of significant (x).

TESTING THE RESEARCH HYPOTHESIS
The analysis of data presented below follow the sequence in which the null hypothesis were initially stated

HYPOTHESIS ONE (HO)
There is no significance relationship between parents perception of the teacher and students performance.

Table 1: Showing the analysis of the relationship between parents perception and students performance using the Pearson product moment method.

<table>
<thead>
<tr>
<th>Of r</th>
<th>T_cal</th>
<th>T_crit</th>
<th>Degree of freedom</th>
<th>Level of significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.54</td>
<td>2.132</td>
<td>4</td>
<td>0.05</td>
<td>Rejected Ho</td>
<td></td>
</tr>
</tbody>
</table>

In table 1 the calculated value of t is 6.54 and its greater than the critical value of t 2.132 at 0.05 level of significance. This implies that the parents perception of teacher affect students performance. Which means null hypothesis is accepted since t_cal > t_crit.

HYPOTHESIS TWO (HO)
There is no significance relationship between government/employers attitudes toward teachers and student performance.
Table 2: Showing the analysis of the relationship between government/employers attitude towards teachers and students performance using the Pearson moment method.

<table>
<thead>
<tr>
<th>( T_{\text{cal}} )</th>
<th>( T_{\text{crit}} )</th>
<th>Degree of freedom</th>
<th>Level of significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3449</td>
<td>2.015</td>
<td>5</td>
<td>0.05</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

In table 2 calculated value of t is 2.345 and its greater than critical of \( t = 2.015 \) at 0.05 level of significance which implies that Government/employers attitude and the teacher affect students performance. Which implies that hypothesis is rejected and alternative hypothesis is accepted the \( t_{\text{cal}} > t_{\text{crit}} \).

HYPOTHESIS THREE

There is no significance relationship between students attitude towards teachers and their performances.

Table 3: Showing analysis of students attitudes towards teachers using Pearson product moment correlation coefficients method.

<table>
<thead>
<tr>
<th>Value of r</th>
<th>( T_{\text{cal}} )</th>
<th>( T_{\text{crit}} )</th>
<th>Degree of freedom</th>
<th>Level of significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4034</td>
<td>2.469</td>
<td>2.132</td>
<td>4</td>
<td>0.05</td>
<td>Reject Ho</td>
</tr>
</tbody>
</table>

In table 3 the calculated value of t is 2.469 and its greater than the critical value of t, 2.132 at 0.05 level of significance which implies that students attitude towards their teachers has great influence on their performance. Which means null hypothesis is rejected since \( t_{\text{cal}} > t_{\text{crit}} \).

CONCLUSION

On the basis of this research finding the following conclusion were drawn.

1. Parents perception of teachers affect student performance.

2. Government/employers attitude towards the teachers affect students performance.

3. Students attitude towards their teacher has great influence on their performance.

RECOMMENDATIONS

Based on the results of this study the following recommendations were made:

1. Government/employers should show regards for the teachers by meeting their demands to encouraged them in their job.

2. Both parents, teachers and government/employers of labour should put heads together to ensure that students attitude towards teachers/studies change positively as follows;
   - Parents should play their advisory role as well as make available what is required of the learners for their study.
   - Teachers should create good teachers students relationship by way of apply teaching method that will captivate students interest towards learning.
   - Government on their own part makes provision for conducive learning environment for both teachers and students.
REFERENCES
CONTEXT – BASED TEACHING STRATEGY (CBTS) FOR EFFECTIVE LEARNING OF SIMPLE ALTERNATING CURRENT (A.C) CIRCUITS IN SENIOR SECONDARY SCHOOL PHYSICS

Eyenaka, F.D; Ekanem, C.H and Uwak, S.O.
Department of Physics,
Akwa Ibom State College of Education,
Afaha Nsit,Akwa Ibom State, Nigeria

ABSTRACT
The paper investigates the context-based strategy of teaching Senior Secondary School Alternating Currents (A.C) Circuits in Physics. A quasi-experimental design was adopted for the study of 450 SSS II Physics students (250 males and 190 females) drawn from 10 out of 85 secondary schools in Ikot Ekpen Education Zone. Three null hypotheses were formulated and tested at 0.05 levels of significance. Simple Alternating Current Circuits in Physics Achievement Tests (SACPATs) was employed in the data collection. The instrument was validated (reliability coefficient=0.56) and administered both as pre- and post- tests. The data were statistically analyzed. Results were that context-based teaching strategy was significantly better than the expository method in enhancing students’ transfer of learning in simple alternating current (A.C) circuits in Physics with respect to gender and school location. Recommendation made, among others, was that context-based teaching strategy be adopted in teaching and learning of Physics concepts in Nigerian schools.

Keywords: Context-based teaching strategy (CBTS), Academic achievement, Simple Alternating Current (AC) Circuits, Transfer of learning, Physics concepts.

INTRODUCTION
Physics is a branch of Physical Science that concerns mainly with matter in relation to energy (Olumuyiwa and Okunola, 1992). Physics, as a fundamental science provides a basis for creative work in various fields of modern science and technology and offers excellent background for various professional studies and competence in effectively relating what is learnt in school to real life situations outside of school (Ekanem, 2000b). It has been acknowledged as a pre-requisite for the study of several courses in the universities. For example, Engineering, Medicine and other applied science courses need physics. Physics Education is generally aimed at equipping the individual learner with such knowledge, skills and attitudes that will enable him live a meaningful and fulfilled life and contribute positively to the development of the society from which he can derive maximum social, economic and cultural benefits (NERDC, 2004). Yet, in spite of the great importance of Physics in our national development and the efforts being made by the government, researchers, Science Teacher’s Association of Nigeria (STAN) and other agencies, students’ achievements
in Physics have been poor and unsatisfactory. Enabling the learner acquire functional skills in Physics calls for well-planned academic programmes being put in place to address some issues that adversely militate against effective teaching and learning of Physics-based concepts and principles in school and to stem the low ebb with which the learners of this academic discipline effectively transfer what they learn while in school to real life situations outside of school (Ekanem, 2000b). And, in view of the obvious importance of Physics in the scientific and technological advancement of any nation, and its usefulness in most fields of human endeavour, there is need to develop effective strategies in the teaching of this course in our schools, colleges and universities.

However, various studies have shown that students find it difficult to learn certain Physics concepts (Onwioduokit, 1996; Ekanem, 1998; Ogunleye, 2000; Okonkwo, 2002; Nnadi, 2002; Azim, 2002; Ajeyalemi, 2003; Ezeudu, 2003). In a study, “Issues and Problems of Teaching and Learning Physics in Nigeria”, Ekanem (1998) cites some Physics concepts that senior secondary school students in Nigeria find difficult to learn and discusses some causes of poor performance of the learners of the subject in external examinations. For example, poor teaching methods have been predominantly in use for a long time in the teaching of Physics concepts (Okonkwo, 2002; Ajeyalemi, 2003). These include the traditionally based lecture and expository methods. These methods are said to be didactic, stereotyped, dull, and therefore, not result oriented (Azim, 2002; Ezeudu, 2003). Some methods such as demonstration, guided inquiry and discovery methods could be result-oriented but have been reported to have made students fail to see the inter-dependent relationship that exist between academic contents of Physics courses offered while in school and their real life applications (Ekanem, 2000b). The tide now seems to be more critical in the assimilation/comprehension and subsequent transfer of the learning of Alternating Current (A.C) circuit concepts in terms of appreciating the various A.C. circuits concepts and the conducting paths along which alternating electrical current (which periodically reverses its direction as it flows through the conductor) flows (Mkpanang, 2010). Onwioduokit (1996) and Mkpanang (2010) have independently shown that the Peak and the Root Mean Squared (RMS) values of A.C. Resistance, Capacitance, Inductance and Power in A.C circuits as well as Resonance in Resistance-Inductance-Capacitance (RLC) series circuits are all aspects of simple A.C circuits which pose some levels of difficulties to comprehend by Senior Secondary School Physics students. Furthermore, NERDC (2004) confirms that many teachers of Alternating Current (A.C) circuits in Physics believe that their students find this sub-discipline of Physics difficult to learn. One of the reasons adduced for students’ poor performance in certain areas of the SSCE simple A.C circuits in Physics is its method of teaching which most of the students find uninteresting (Mkpanang, 2010). Based on the shortcomings of the already existing methods of teaching certain “difficult” physics-based concepts, Okonkwo (2002), for example, proposed the need for a search for better instructional methods that would enhance the attainment of better learning outcomes. Notable among such innovative approaches is the Context-Based Teaching Strategy (CBTS) (Bennett, 2003).
Bennett (2003) defines context-based teaching strategy as an approach adopted in science teaching where contexts and application of science are used as the starting point for the development of scientific ideas, concepts and principles. This contrasts with the more traditional approaches that present scientific ideas, concepts and principles first before considering the applications. Context-based teaching strategy (CBTS) thus involves the connection of the teaching of a particular concept within its context as a science-based discipline or concept as well as its connection to students’ lives in the real world.

However, some evidence abound in the literature (Ekanem, 1998; 2000b; Ogunleye, 2000) that has shown that some factors, either singly or in combination with instructional methods used in disseminating Physics-based lessons, influence students’ achievement in the subject. Specifically, some studies have been carried out to find out the influence of gender (Azim, 2002; Anidu, 2007) and location (Azim, 2002) on students’ achievement in science generally and on the students’ achievements in Physics in particular. Unfortunately, the findings seem to be contradictory and inconsistent. For example, Azim (2002) finds that there is no significant difference in the achievement of male and female students in Physics while Ogunleye (2000) observes a significant difference in achievement with respect to gender. Also, influence of school location on students’ achievement in science is equally contradictory (Daluba, 2011; Obinne, 2007). According to Daluba (2011), urban students out-performed their rural counterparts in science achievement test. This finding is contrary to that of Obinne (2007) that students in rural schools perform significantly better than their counterparts in urban schools. These studies may have failed to consider other variables such as the influence the teaching method used may have on the subjects before administering the respective instruments. Moreover, the combined effect of each of the factors of gender and school location in Physics achievement hitherto shown to be contradictory with the CBTS has not been explored. In consideration, therefore, of the inconclusiveness of these previous studies with respect to gender and location in science achievement, there is need to carry out the present study to determine how the CBTS would affect students’ academic achievement in simple A.C circuits in Physics with respect to gender and location.

STATEMENT OF THE PROBLEM AND PURPOSE OF STUDY

Over the years, the achievements of students in Physics in Nigerian secondary schools have been very poor. This is because these students fail to see the interdependent relationship that exists between the academic contents of Physics subjects offered in school and their applicability in real life. As a result there is low transfer of what is learnt in the school to the real-world. This is the gap that this study is construed to fill.

The purpose of this study is, therefore, to determine the effects of context-based teaching strategy on senior secondary schools students’ achievement in simple A.C. circuits in Physics. The study was specifically designed to:
Determine the difference in students’ achievements when taught simple A.C. circuits in Physics with context-based teaching strategy (CBTS) and when expository method of teaching (EMOT) is used;

(ii) Determine difference in achievement of male and female students taught simple A.C. circuits in Physics with CBTS;

(iii) Determine difference in achievement of contemporary students of urban and rural schools taught simple A.C. circuits in Physics with CBTS.

RESEARCH HYPOTHESES
In this study, three null hypotheses (Ho1, Ho2 and Ho3) were formulated and tested for significance at 0.05 error margin. They are:

Ho1: There is no significant difference in the achievements of Senior Secondary School students taught simple A.C. circuits Physics concept using context-based teaching strategy and those taught with expository method.

Ho2: There is no significant difference between the academic achievements of the Senior Secondary School male students and their female counterparts taught simple A.C. circuits Physics concept using context-based teaching strategy.

Ho3: There is no significant difference between the academic achievements of the contemporary rural and urban Senior Secondary School students taught simple A.C. circuits Physics concept using context-based teaching strategy.

METHODOLOGY
A quasi-experimental (the non-equivalent pre-test- post-test control group) design was adopted for the study. All the senior secondary school II (SSS 2) Physics students in the Ikot Ekpene education zone of Akwa Ibom State, Nigeria formed the population of the study. Stratified random sampling technique across gender and school location was used to select ten (10) out of eighty-five (85) schools in this Education Zone. Simple Alternating Current (AC) Circuits in Physics Achievement Tests (SACPATs) were employed in the data collection. The instrument was face- and content- validated by three experts in Science Education Department of the University of Uyo, Uyo, Nigeria. The comments and suggestions of the experts were incorporated in building up the final draft of the instrument. The instrument was trial-tested on 40 SSS II students drawn from secondary schools that were not involved in the main study. The result was used to determine the reliability of the instrument using Kuder-Richardson formula 20 and the consistency index obtained for the SACPATs was 0.56. The SACPAT instrument was administered as both the pre-test and post-test by the substantive Physics teachers of the sampled schools. The data obtained were analyzed using mean, standard deviation and t-test statistical tools.

RESULTS
Table 1: t-test analysis of academic achievement of Physics students in SACPATs using Context – Based Teaching Strategy (CBTS)

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>X</th>
<th>S.D</th>
<th>Df</th>
<th>t-cal</th>
<th>t-crit</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment (CBTS)</td>
<td>300</td>
<td>39.3</td>
<td>25.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results as shown in table 1 indicate that the calculated t-value (8.05) exceeds the critical t-value (1.96) at 0.05 alpha levels of significance. This implies that hypothesis one is rejected in favour of the alternative hypothesis that there is a significant difference in the achievements of Senior Secondary School students taught simple A.C. circuits Physics concept using context-based teaching strategy and those taught with expository method. This means that there are significant differences in the achievements of students taught simple A.C circuit in Physics using context-based teaching strategy and those taught with expository method of teaching.

Table 2: t-test Analysis of the influence of gender on Physics achievement using CBTS

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>X</th>
<th>S.D</th>
<th>Df</th>
<th>t-cal</th>
<th>t-crit</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>260</td>
<td>48.3</td>
<td>18.2</td>
<td>448</td>
<td>9.4</td>
<td>1.96</td>
<td>*</td>
</tr>
<tr>
<td>Female</td>
<td>190</td>
<td>33.4</td>
<td>13.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>450</td>
<td>40.85</td>
<td>15.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Significant at P<0.05

The results in table 2 show that the t-calculated (9.4) exceeds the critical t-value (1.96) at 0.05 levels of significance. This implies that hypothesis two is rejected. The conclusion on this result is that gender has significant effect on Physics achievement of Senior Secondary students using CBTS.

Table 3: t-test analysis of the effect of the school location on Physics achievement using CBTS

<table>
<thead>
<tr>
<th>School Location</th>
<th>N</th>
<th>X</th>
<th>S.D</th>
<th>Df</th>
<th>t-cal</th>
<th>t-crit</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>225</td>
<td>14.37</td>
<td>5.86</td>
<td>448</td>
<td>0.32</td>
<td>1.96</td>
<td>**</td>
</tr>
<tr>
<td>Rural</td>
<td>225</td>
<td>14.54</td>
<td>5.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>450</td>
<td>14.455</td>
<td>5.565</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** = Not Significant at P<0.05

From table 3, the t-calculated (0.32) is less than t-critical value (1.96) at 0.05 alpha levels of significance. This means that hypothesis three is accepted. This implies that the achievements of physics students in rural secondary schools are generally comparable to (that is, neither better nor worse than) that of their contemporaries in urban schools all with respect to the teaching and learning of simple A.C circuits using CBTS.
DISCUSSION

The tests mean scores of the subjects with respect to the teaching method used as well as the statistical analyses/results of this study show that the method of presenting Physics-based concepts and principles in general and particularly simple alternating current (A.C.) circuits in physics is a significant contributing factor to failure of, or, the low ebb with which the learners of this academic discipline effectively transfer what they learn while in school to real life situations outside of school. The findings of this study show that context-based teaching strategy is significantly better than expository method of teaching. The results of testing the first hypothesis thus reveal the efficacy of CBTS on academic achievement of secondary school students in Physics (that is, the subjects taught using the experimental method achieved better than their counterparts who were taught using the control method). These results are in line with Ekanem’s (2000b) and Azim’s (2002) position that some traditionally used method of teaching Physics such as demonstration, guided inquiry, discovery methods could be result-oriented but have made students fail to see the inter-dependent relationship that exist between academic contents of Physics courses offered while in school and their real life applications. This finding further buttresses the earlier position of Bennett (2003) and Ogunleye (2000) that some factors have been shown to either singly or in combination with instructional methods used in disseminating Physics-based lessons influence students’ achievements in the subject. Based on these findings, the current researchers posit that students taught using innovative teaching methods such as CBTS perform better than those taught using the expository method respectively in terms of achievement.

The result of testing the second hypothesis shows that secondary school students differ significantly in their academic achievement using gender as a variable of interest. This implies that gender is a significant factor in students’ achievements in simple (A.C) circuits in Physics. This finding appears to support the views of Eziobu (2005) and Nnadi (2002). Similarly, Azim (2002) in his study of the relative effectiveness of guided-inquiry and expository instructional methods on students’ achievements in Physics found that there is a significant difference in the transfer of learning between male and female students. In particular, the current study found that the Senior Secondary School male students performed significantly better in the achievement tests than their female counterparts when taught simple A.C. circuits Physics concept using the context-based teaching strategy. However, the findings of the present study differ from the findings of Nnadi (2002) who reported that female students performed better than their male counterparts, in favour of Esiobu (2005) who reported that male students are better than female students all with respect to academic achievement.

The results of the present study further show that location is not a significant factor in students’ achievements in the learning of simple Alternating Current (A.C) circuit concepts in Physics with respect to the teaching method used on the subjects. This assertion was arrived at by testing the third hypothesis formulated for this study which, in recap, states that there is no significant difference between the academic
achievements of the contemporary rural and urban senior secondary school students taught simple A.C. circuits Physics concept using context-based teaching strategy. In other words, students in the urban area are not found to perform better in SACPATs than their contemporaries in the rural schools given the same extraneous conditions. These results are in agreement with Akpan (2009) who found no significant difference between urban and rural students’ acquisition of Physics process skills. They are, however, in disagreement with Nworgu and Madu (1996) who found significant differences between urban and rural students in their achievement in science teaching and learning.

**RECOMMENDATIONS**

Based on the findings of the current study, the following recommendations are made:

- The Government through the Federal and State Ministries of Education should organize and sponsor physics workshops, exhibitions, quizzes, seminars and conferences on a regular basis aimed at upgrading the knowledge status of the teachers.
- Physics teachers should endeavour to use the context-based teaching strategy in teaching simple Alternating Current (A.C) Circuit and some other Physics-based concepts that are tagged “difficult” since this method enhances achievement and has the potentials of developing critical thinking and creative abilities in the students.
- Students should be serious, hardworking, initiative and creative to enable them carryout independent or group work, such as assignments or project given to them by the Physics teachers. These are necessary in CBTS teaching – learning processes.

**CONCLUSION**

Considering the great importance of Physics in our national development, which coincide with one of the objectives of Physics curriculum by the Federal Ministry of Education to show physics and its link with industry, everyday life, benefits and hazards, and efforts being made by government, Science Teachers’ Association of Nigeria (STAN) and other agencies in promoting achievement in the subject, it is construed that context-based teaching strategy will help in making the above laudable objective and those efforts feasible. One way of ensuring an improved performance of the learners during the external examination is by making them appreciate the inter-dependent relationship that exists between academic contents of Physics concepts presented in the teaching-learning situations while in school and their real life applications. If we are able to achieve this transfer of what is learnt in school to the real-world then improved achievement in external examination, irrespective of gender or school location, can be achieved.
REFERENCES


and Science Education, River State University of Science and Technology, Port Harcourt, 14(1,2): 25-34.


FUNCTIONAL AND NUTRITIONAL CHARACTERISTICS OF CASSAVA FLOUR (LAFUN) FORTIFIED WITH SOYBEANS

*Bankole1, Y.O., Tanimola1, A.O., Odunukan1, R.O. and Samuel2, D.O.
1Department of Agricultural & Bio-Environmental Engineering;
Lagos State Polytechnic, Ikorodu-Nigeria
2Department of Food Technology; School of Technology,
Lagos State Polytechnic, Ikorodu-Nigeria
*Correspondence Author

ABSTRACT
This study was designed for nutrition fortification of cassava flour lafun with soya beans. Five different samples of lafun to soya beans were (100:0, 90:10, 80:20, 70:30, and 60:40). The following proximate analysis of these samples were carried out: ash determination, crude fiber, protein, moisture and fat. The results ranges were 0.84-2.46%, 1.63-2.12%, 1.16-12.54%, 13.01-11.28% and 0.44-2.62% respectively. Functional properties of the formulation were also evaluated and the result obtained showed that loose and packed bulk density were 0.2-0.3% and 0.5-0.55%, the water absorption and oil capacity were 163-127% and 167-113.5% respectively. Swelling capacity and disposability were also 6.2-2.95% and 93.7-81.4% while the regulation and solubility are 24.5-18.99 and 6.7-4.95 respectively. The pasting properties results were also revealed that at a peak of 244.17-112.33 r/vu, the trough was 129.17-58.83 r/vu, and the breakdown was 115.00-52.50 r/vu, the final viscosity was between 164.33-81.92 r/vu, set back 35.17-23.08 r/vu, peak time 4.46-3.91 and pasting temperature 63.15-63.85°C.

Keywords: Functional-characteristics, nutritional-characteristics, cassava flour, fortified, soya-beans.

INTRODUCTION
Food security remain an unfulfilled dream for more than 800 million people (Anuonye, 2011) who are unable to leave healthy and active lives because they lack access to safe and nutritious food. More than 840 million people lack access to enough food to meet their daily basic needs, while more than one third of the world’s children are stunted due to diets inadequate in quantity and quality (WHO, 2001). Cassava Manihot esculanta spp. is one of the perennial crops grown throughout the lowland tropics. It is a major staple food crop in Nigeria supplying about 70% of the daily calorie to over 50 million Nigerians. World consumption of cassava for food is concentrated in the developing countries. For instance, in Africa about 70% of cassava production is used as food and most popular processed products are garri, lafun, fufu, kpokpo gari and a dry granular meal made from moist and fermented cassava is most commonly used in West Africa (Sanni, et al 2009). Processing of cassava to flour is one of the food means of utilizing this important food crop. Processing of cassava roots also serve as an important means of preserving food crop.

Aside processing the cassava to lafun, its root can be cooked and eaten while the fermented and ground tubers could be baked into different processes. Lafun is one of
the local names given to flour made from cassava in Nigeria. It is produced through the submerged soaking of cassava roots in water for about 2-3 days in order for fermentation process to take place, the product will be sun dry before milling of dried fermented roots to flour. The fermented cassava flour could then be mixed with boiled water to form dough and consumed with soup. It is carbohydrate food that can be eaten with soup. The protein source is the fish or meat in the soup. During fermentation of cassava to lafun various microorganisms were involved and these include Bacillus substilis, Klebsiela spp., Candida tropicals (Oyewole, 1990). The major limitation in lafun like other cassava product includes low protein content, low minerals, and vitamins and present of cyanide toxicity. Cassava is protein(1-2%) deficient, though it contains low amount of methionine, lysine, and tyrosine ( Akubor and Ukwuru, 2003). Cassava cause toxicity through hydrolytic breakdown and release hydrocyanic acid. However glycosides present are reduced to safe levels by traditional method of processing. Efforts have been made to address the protein deficiencies of cassava product including lafun. One possible solution has been the incorporation of soya beans to cassava products.

The incorporation of soybeans, groundnut and other seed protein into cassava meal has been shown to yield fortified products of high protein values. Jishaa, Sheriff and Padmajaa (2010) revealed that low protein and poor functionality limit the use of cassava flour in snack foods, which were modified using blends with cereal and/or legume flours. Some food products have been incorporated with soybeans; like traditional fermented maize foods with soybeans weaning foods with soybeans for baby, development of non-wheat soybean fortified biscuit, performance of extruded maize, cassava, sorghum wheat, soybean flour for bread production, etc. Daniel and Osho (2005) revealed that fortification of lafun will increase the nutritive value of consumer that takes in the food. This also reduces the kwashiorkor which is a major disease of people that lack protein. This purpose of this study was to investigate the nutritive attributes of lafun fortified with soybean. Specifically, it will investigate the following:

1. The functional attributes of lafun fortified with soybean
2. The nutritional attributes of lafun fortified with soybean.
3. Consumer acceptability of lafun fortified with soybean.

METHODS AND PROCEDURE

Matured cassava root (Odongbo) used in this research was obtained from Alabata farm settlement in Abeokuta Ogun state. Soybeans were purchased from Ikorodu market in Lagos state. The soybeans were processed into soybeans full fat. Mature cassava root were sorted, peeled and washed after peeling. It was latter cut into smaller sizes and soaked for twenty-two days. This was sieved to remove the fibers and was sun dried for two days. It was then milled into flour and sieved with 0.25mm mesh to remove the coarse fiber particle present. Unfermented cassava Lafun fortified with soybeans was analyzed for moisture content, protein, ash, crude fiber, carbohydrate and amylase in the ratio of 100:0 for the control, 90:10, 80:20, 70:30 and 60:40 (Cassava :Soybean).

Proximate Analysis of Soybean-lafun

Determination of the moisture content
About five grams of each sample were accurately weighed into a pre-weighed aluminum dry dish. The samples were dried to constant weight in an oven at 105°C for 3 hrs (AOAC, 1990).

% moisture content was obtained as shown below.

\[ \% \text{ moisture content} = \frac{M_2 - M_0}{M_1 - M_0} \times 100 \]

- \( M_0 \) = weight of the aluminum dish
- \( M_1 \) = weight of fresh sample of dish
- \( M_2 \) = weight of dry sample of dish

**Determination of crude protein**

1g of each sample was introduced into the digestion flask. Kjehadi catalyst (5 selenium table) was added to the sample. 20millitre of concentrated acid was added and allowed to stay for 8hrs until a clear solution was obtained. The cooled digestion was transferred into 100ml volumetric flask and made up to mark with distilled water. The distillation apparatus was rinsed and set up. 20ml of 4% borc acid was pipetted into conical flasks and 5 drops of methyl-red added to each flask as indicator. Samples were later diluted with 75m/distilled water; 10ml of the digest was made alkaline with 20ml of sodium hydroxide (20%) and distilled. The steam exhaust of the distillation apparatus was closed and the change of color of boric acid solution to green was fixed. The mixture was distilled for 15mins (AOAS) and the filtrated were titrated against 0.1m, HCL.

The percentage total Nitrogen was calculated as shown below

\[ \% \text{ Total Nitrogen} = \frac{\text{Titre value x normality}}{\text{Weight of sample}} \times 0.014 \times 100 \]

\% crude protein= %total Nitrogen x conversion factor= 6.25

**Determination of crude fibre**

The fat in the sample was removed 5g of fat free sample was weighed into 600ml beaker and 100ml of trichloroacetic acid (TAC) was added. The sample was boiled and refluxed for 4mins, cooled and thereafter filtered with what man No4 filter paper. The residue was washed with hot distilled water and methylated spirit. The filter paper together with the sample was transferred into a crucible in an oven overnight at 100°C for 6hrs, and weighed again after cooling weight during incineration. The loss in equivalent to amount of crude fibre.

\[ \% \text{ crude fibre} = \frac{(W+A)-(W+B)}{\text{Sample weighed}} \times 100 \]

- Weight A = weight after drying
- Weight B = weight of sample after Aching

**Determination of crude fat**

5 grams of the sample was weighed and put in thimbles and plugged with cotton wool. The thimble was dried and inserted into a soxlet system HT (a) the extraction cup was inserted into the soxlet extractor and extracted for 15mins in the boiling and 30-45mins in the rinsing position.

The % fat in the sample was calculated as follows

\[ \% \text{ Fat} = \frac{W_1 - W_2}{W_1} \times 100 \]

- \( W_1 \) = weight of the sample
- \( W_2 \) = weight of the empty cup
- \( W_3 \) = weight of the cup with the extracted oil

**Determination of the ash content**
5 grams of the sample was weighed into porcelain crucibles previously ignited and weighed. Organic matter was charred by igniting the material on a hot plate in the fume cupboard. The crucibles were placed in the muffle furnace and maintained at 600°C for 6 hrs. They were later cooled in desiccators and weighed, immediately. The percentage Ash content was shown below.

\[
\% \text{ Ash} = \left( \frac{\text{Weight of crucible+Ash} - \text{Weight of empty crucible}}{\text{Sample weight}} \right) \times 100
\]

**Functional Properties Determination**

**Solubility index determination**
Solubility was done by weighing 1g of sample in 20ml distilled water in test tube. This was subjected to heating in a water bath at a temperature of 60°C for 30 mins because there was no appreciable heating, it was subjected to configuration at 1200-ppm for 20 mins and 10ml of the supernatant was decanted and dried to constant weight. The solubility was expressed as the percentage by weight of the dissolved starch from a heated solution.

**Swelling capacity determination**
0.1g of sample was weighed into a test tube containing 10ml distilled water and then heated in a water bath at temperature of 60°C for 30 mins. This was continually shaken within the heating period. The test tube was centrifuged at high speed for 15 mins after heating in order to facilitate the removal of supernatant water which was then carefully decanted and the weight of starch paste taken.

\[
\text{Swelling capacity} = \frac{\text{weight of starch paste}}{\text{Weight of dry starch sample}}
\]

**Emulsion capacity**
1g of sample was made into slurry in 20ml of distilled water in a Greenberger flask by stirring at 100rpm for 15 mins and edible oil was added and stirring continued another. The system was then transferred into a centrifugal tube to separate into two layers.

\[
\text{EMULSION CAPACITY} \% = \left( \frac{\text{Height of emulsified layer}}{\text{Height of whole layer}} \right) \times 100
\]

**Oil absorption capacity**
2g of the sample was added to 20ml of oil and a graduated centrifugal tube. The mixture was stirred to dispense the samples in oil. Sample was then allowed to stand for 30 mins, at 30°C after which it was centrifuged at 350rpm for 30 mins as water absorption capacity. The excess oil absorbed was expressed as the percentage oil bound by sample after the mixture has been pinioned into a measuring cylinder.

\[
10\% = \left( \frac{\text{Volume of bound water}}{\text{Weight of sample}} \right)
\]

**Bunk density determination**
10g of the sample were weighed into a weighed 25ml of graduated cylinder. The cylinder was gently tapped ten times against the palm of the hand; the bulk density was expressed as the weight of the sample per volume occupied by the sample (g/ml).

**Foaming capacity determination**
2g of the sample was whipped with 50ml of water for 30 mins in a blender at a speed “soft” and “mine” and was poured into a 100ml graduated measuring cylinder to know the volume.
Foaming capacity = \( \frac{\text{Volume after whipping} - \text{Volume before whipping}}{\text{Volume before whipping}} \times 100 \)

**Foaming stability determination**

0.5g of the sample was blended 30mins in distilled water at top speed in a moulinex blender. The whipped mixture was transferred into a graduated cylinder. The blender was rinsed with 10ml of distilled water which was then greatly added to the graduated cylinder. The foam volume in the cylinder was recorded per sample after 30mins standing.

**Water absorption capacity**

About 2g of the sample was mixed with 20ml of distilled water in a graduated centrifugal tube. The mixtures were stirred to dispense the sample in distilled water. Samples were then allowed to stand for 30mins at 30°C after which it was centrifuged at very high speed (between 3500rpm to 1000rpm) for 30mins. The volume was noted in a graduated cylinder after having been poured into it. Density of water was taken to be 1g/ml excess water absorbed was expressed as the percentage water bound by 100g of sample and the absorption capacity calculated thus,

\[
10\% = \frac{\text{Volume of bound water}}{\text{Weight of sample}} \times 100
\]

**Dispensability**

10g of sample was placed in 10ml measuring cylinder and distilled water was added to reach the graduated volume 100ml. The mixture was stirred vigorously and allowed to settle for 3hrs. The volume of the settled particles was recorded and deducted from 100 and the difference reported as percentage dispensability

**Determination of amylase**

0.1g of flour sample was weighed into 100ml volumetric flask and 1ml of 95% Ethanol was added to wet the sample. 10ml of 0.5MKOH was added and the mixture was held overnight at room temperature. The mixture was diluted to 100ml with distilled water and again held overnight at a room temperature. 5ml aliquot of the diluted solutions was pipette out of the mixture into another 100ml / volumetric flask and three drops of 0.1% phenolphthalein solutions were added. The resulting solution was neutralized using IMACHLIMHCL droproise until neutral pH was achieved. 2ml of 0.2 Iodine solutions was added to the neutralized solutions and made to volume with distilled water. Standard solutions of amylase of range 0-10ppm were prepared from 100ppm stock amylase solution and treated similarly like sample above. The absorbance or optical density of samples as well as standard solutions of different concentrations range were taken after 30mins of addition of 0.2% iodine solution on a spectronic 12D spectrophotometer at a wavelength of 630nm.

% Amylase was calculated using:

\[
\frac{\text{Absorbance of sample} \times \text{Gradient factor} \times \text{dilution factor}}{10000}
\]

**HCN–Determination of HCN Content**

About 10g of each sample were diluted with 20ml distilled water and Ogawasaki cyanide ion selective electrode was used after the instrument have been calibrated with oil and 10ppm standard solution of potassium cyanide.
**Pasting properties of HCN content**
Pasting properties were determined according to the Newport (1998) procedure. The pasting properties of the sample based on 100% dry matter were determined by mixing the sample with 25ml distilled water and placed into canister. The paddle was placed into the canister which in turn was inserted into the instrument. The measurement cycle was initiated by depressing the motor tower of the instrument. The RVA machine was loaded and was set at 40°C and allowed to run for 20mins. The canister was removed on the completion of the test.

**Sensory evaluation**
Sensory Evaluation for soy-lafun from each of the proportion was performed by 30 panelists. 5 samples of soy-lafun flour were presented to the panelists who determine the sample based on the following attributes; taste, color, texture, drawness, and overall acceptability of the sample using the following hedonic scale.

Like extremely (9); Like very much (8); Like moderately (7); Like slightly (6);
Neither like nor dislike (5); Dislike slightly (4); Dislike moderately (3);
Dislike very much (2) and Dislike extremely (1)
The samples were labeled as follows: SSF-01 (100% cassava); SSF-02 (90:10%); SSF-03 (80:20%); SSF-04 (70:30%); SSF-05 (60:40%)

**RESULTS**

**Proximate Composition of Soy-lafun**
Table 1: Proximate Compositions of soybeans sample

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>SSF01</th>
<th>SSF02</th>
<th>SSF03</th>
<th>SSF04</th>
<th>SSF05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>13.01</td>
<td>12.04</td>
<td>11.6</td>
<td>11.52</td>
<td>11.28</td>
</tr>
<tr>
<td>Ash</td>
<td>0.84</td>
<td>1.71</td>
<td>2.08</td>
<td>2.39</td>
<td>2.46</td>
</tr>
<tr>
<td>Protein</td>
<td>1.16</td>
<td>4.63</td>
<td>7.87</td>
<td>11.7</td>
<td>12.54</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>1.63</td>
<td>1.81</td>
<td>1.94</td>
<td>2.07</td>
<td>2.12</td>
</tr>
<tr>
<td>Fat</td>
<td>0.44</td>
<td>1.85</td>
<td>2.47</td>
<td>2.55</td>
<td>2.62</td>
</tr>
</tbody>
</table>

The raw flour without fortification has 1.2% protein, 1.6% of crude fibre, 0.4% fat, 0.8% ash and 13.01% of moisture content which is almost the same as the chemical composition of cassava as reported by several studies. Table 1 also shows the chemical composition of soybeans full fat at various levels of fortification. The crude fat, protein, Ash, crude fibre and moisture content decrease in levels of supplementations. Although, there is an overall higher value with soybean full fat fortification. Generally, from the observation it could be deduce that there was an appreciable increased in the chemical composition of soy-lafun fortification with increase in addition with soybeans on lafun.

**Table 2: Functional Properties of Soybeans Samples**

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>SSF01</th>
<th>SSF02</th>
<th>SSF03</th>
<th>SSF04</th>
<th>SSF05</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOOSED</td>
<td>0.2897</td>
<td>0.2896</td>
<td>0.3622</td>
<td>0.2818</td>
<td>0.32765</td>
</tr>
<tr>
<td>BULK Mean</td>
<td>0.000283</td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0002</td>
<td>0.32765</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.01</td>
<td>0.0015</td>
<td>0.0001</td>
<td>0.0002</td>
<td>0.00025</td>
</tr>
<tr>
<td>PACKED</td>
<td>0.5283</td>
<td>0.58836</td>
<td>0.5716</td>
<td>0.51305</td>
<td>0.55535</td>
</tr>
<tr>
<td>DENSITY Mean</td>
<td>0.01</td>
<td>0.00015</td>
<td>0.0001</td>
<td>0.00025</td>
<td>0.00025</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.01</td>
<td>2.5</td>
<td>1.5</td>
<td>140</td>
<td>1.27</td>
</tr>
<tr>
<td>WAC</td>
<td>1.63</td>
<td>156.5</td>
<td>149.5</td>
<td>140</td>
<td>113.5</td>
</tr>
<tr>
<td>Mean</td>
<td>1.414214</td>
<td>2.5</td>
<td>1.5</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>OAC</td>
<td>167</td>
<td>129.5</td>
<td>129.0</td>
<td>121.5</td>
<td>113.5</td>
</tr>
<tr>
<td>Mean</td>
<td>2.8284827</td>
<td>1.5</td>
<td>0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1</td>
<td>1.5</td>
</tr>
</tbody>
</table>
The water absorption capacity on raw flour without fortification is 163g/100g. The foaming capacity range of SSF 01 is 6.2% while SSF 05 with highest fortification has 2.95%. Solubility index is an indication of how soluble the sample is and its ability to gelatinize with much residual particles. Gelatin indicates that the energy requirements and cost of providing energy for gel formation will be relatively high which is economically advisable. The sample with highest fortification has the lowest value which is 18.99% while sample with no fortification has the highest value which is 24.5%.

Table 3: pasting properties

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>SSF 01</th>
<th>SSF 02</th>
<th>SSF 03</th>
<th>SSF 04</th>
<th>SSF 05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak 1</td>
<td>244.17</td>
<td>183.83</td>
<td>148.83</td>
<td>119.25</td>
<td>112.33</td>
</tr>
<tr>
<td>Trough 1</td>
<td>129.17</td>
<td>85.50</td>
<td>73.08</td>
<td>76.17</td>
<td>58.83</td>
</tr>
<tr>
<td>Breakdown</td>
<td>115.00</td>
<td>98.33</td>
<td>75.75</td>
<td>43.08</td>
<td>52.50</td>
</tr>
<tr>
<td>Final viscosity</td>
<td>164.33</td>
<td>119.42</td>
<td>101.92</td>
<td>98.7581.92</td>
<td></td>
</tr>
<tr>
<td>Set back</td>
<td>35.17</td>
<td>33.92</td>
<td>28.83</td>
<td>22.58</td>
<td>23.58</td>
</tr>
<tr>
<td>Peak time</td>
<td>4.46</td>
<td>4.14</td>
<td>4.01</td>
<td>4.53</td>
<td>3.91</td>
</tr>
<tr>
<td>Pasting temp.</td>
<td>63.15</td>
<td>63.15</td>
<td>64.35</td>
<td>63.70</td>
<td>63.85</td>
</tr>
</tbody>
</table>

The results obtain for the pasting properties is as shown in Table 3. The result showed that, there was increase in the sample SSF01 for the peak viscosity due to the no fortification which was in the range of 244.17 while there is a decrease in the other sample as the introduction of soybeans being introduced. A singular observation was made for tough, breakdown, viscosity, setback, peak time and pasting temperature. The pasting temperatures of the entire sample were in the range of 63-63.85°C. Peak time for the samples was also in the range of 4-4.6. Breakdown was in the range of 115.00-52.50. Trough was 129-58.8, set back also decrease from 35.17-23.08. Final viscosity ranges from 164-81.92. It also observed that most of the starchy products also showed the progressive rise in the viscosity with increase in the concentration.

**CONCLUSION**

From the result of this study, *lafun* can be fortified and well accepted at 10% of levels of fortification with soybeans flour. The least preferred sample was 60:40 levels of fortification. Therefore, soybeans flour is relatively high in protein contents with the levels of Lysine, Tryptophan and certain minerals which provide a sound basis for using soy flour to supplement Cassava flour.
REFERENCES


AN ASSESSMENT OF THE FUNCTIONAL PROPERTIES, PROXIMATE COMPOSITION, SENSORY EVALUATION AND RHEOLOGICAL VALUE OF GARI FORTIFIED WITH BAMBARA GROUNDNUT FLOUR (VOANDZEIA SUBTERRANEAN THOUARS)

*Bankole¹, Y.O., Tanimola¹, O.A., Odunukan¹, R.O. and Samuel², D.O.
¹Department of Agricultural Engineering; Lagos State Polytechnic, Ikorodu-Nigeria
²Department of Food Technology; School of Technology, Lagos State Polytechnic, Ikorodu-Nigeria
*Correspondence Author

ABSTRACT
Gari fortified with Bambara Groundnut Flour (BGF) was assessed for its proximate composition, functional properties, sensory evaluation and Rheological properties. Four samples; 100% gari (coded SLY), 90% gari with 10% BGF (coded ATS), 85% gari with 15% BGF (coded FEA), and 80% gari with 20% BGF (coded ROT) were examined for the parameters listed above. The proximate analysis showed that the protein content ranges between 0.98% - 4.68%, fat content 1.10 – 2.60%, ash content 1.82 – 2.90%, crude fibre 2.30 – 2.42%. This showed an increase on addition of BGF while the carbohydrate content ranges between 78.20% - 83.5%, moisture 11.60% - 12.60% and acidity 0.40 – 0.60, all showed a decrease in value on adding BGF. Rheological value showed that the peak viscosity ranges between 106.17 – 177.17, trough viscosity 98.33 – 161.00, breakdown 7.83 - 16.71, final viscosity 150.50 – 251.67, set back 52.17 – 90.67 and pasting time between 6.87 – 6.93. All these varied inversely with the quantity of BGF added. Pasting temperature showed slight variation which was not dependent on the amount of BGF added. It ranges from 79.2 - 80.02°C. Sensory evaluation showed that there were significant differences in the samples examined.

Keywords: Gari, Bambara-groundnut, proximate composition, sensory evaluation, Rheological value.

INTRODUCTION
Cassava (Manihot esculenta crantz) provides energy as a dominant staple food crop of great importance for the nutrition of over 500 million people in the tropical world most especially in Africa and in many developing countries. Irtwange and Achimba (2009) viewed that cassava appears to be the major staple food that matches the population growth in Nigeria. It is an important raw material for the non-food industries as well. The low amylase, high amylopectin content of the cassava starch gives it necessary viscosity for high quality adhesive and for use in paper and textile industries. Cassava also finds application in the production of dextrin utilized in glues and in the production of ethyl alcohol. There are two varieties of cassava, the bitter cassava and sweet cassava. The sweet cassava Manihot palamata can be boiled, pounded and eaten with soup. It is recognized by its red leaf and purplish outer cortical layer. The bitter cassava contains more bitter juice in its roots. The root is poisonous when eaten raw, so, it has to be fermented before use.
Gari is one of the numerous products derived from cassava tubers; the products derived from cassava include *Fufu*, *Lafun*, Starch, Tapioca, Cassava chips. The cassava roots are peeled, washed, grated, fermented, press, fry, sieved and bagged. If the process of hydrogen cyanides extraction in cassava is ensured. During fermentation, some micro-organisms such as *Corynebacterium* and *Lactobacillus spp* would breakdown the cyanohydrins produced during the hydrolysis to ketone and hydrogen cyanide. Consequently, in aerobic fermentation, pyruvic acid is broken down by a large number of steps into carbon dioxide and water, a process which yields a lot of energy. In anaerobic fermentation, few steps are involved and only pyruvic acid is incompletely broken down yielding the end product which is carbon dioxide, alcohol, lactic acid with other organic acids and a small amount of energy. Irtwange and Achimba (2009) stated that fermentation is carried out to detoxify the cassava and to develop the characteristics flavor.

Bambara groundnut crops are mostly herbaceous plants from the family of legume. It is an important item in the diet of West African. It is a source of plant protein. It can be consumed boiled after freshly harvested roasted and eaten with palm kernel as a snack or dry (Alozie, et al 2009). Ijarotimi and Keshinro (2012) revealed that protein-energy malnutrition among children is the major health challenges in developing countries particularly Nigeria. BGF is eaten in various ways, either alone or mixed with maize, rice, fish or gari. Bambara groundnuts are sometimes grown as cover crops because it is valuable for improving soil fertility. Bambara contain 7.3% moisture, 18 to 24% protein, 6.0 to 6.5% fat and 60 to 63% carbohydrates (Eltayeb, et al 2012). The immature seeds are boiled and eaten as an early harvested source of food and the fully matured seeds are cooked or made into flour. It is cultivated both as an intercrop with maize, cowpea, melon or as a sole crop.

Gari has a very low level of protein probably because of this; kwashiorkor is believed to be prevalent in the area where cassava is the staple items of diet. With the prevalence of malnutrition in the society, there is need to fortified our diets with protein using a cheap source of protein that is found in legume family. The purpose of this study is to reduce kwashiorkor; a prominent diseases of people that lack protein and also allow for maximum utilization of local raw materials. It will also aid the sensitization of Millennium Development Goals and aid Federal Government policy on food fortification campaign. Therefore, specific objectives are:

1. To produce fortified gari with bambara groundnut flour.
2. To evaluate the effects of fortification on the nutritional composition of the product.
3. To determine the functional properties and rheological properties of the product.

**METHODS AND PROCEDURE**

Bambara Groundnut was purchased at mile 12 market in Lagos state and the cassava was purchased from a farm at Ogijo, Ogun State. Cassava tubers were washed, to remove the surface dirt and surface micro-organisms. Tubers were then peeled and grated to reduce the size and to determine the size of the end products. Pulp formed was fermented for 5/days for proper lactic acid fermentation to take place and reduce the toxic level and serve as a means of preservation due to reduction in pH. Fermented pulp was then dewatered to remove excess water, sieved and fried to reduce water
content and give good taste and also to remove the Hydrogen Cyanide which is volatile in nature.

**Flow Chart for the Production of Fortified Gari with Bambara Groundnut**

```
Cassava Tuber
  ↓
Washing
  ↓
Peeling
  ↓
Washing
  ↓
Grating
  ↓
Fermenting
  ↓
Mixing at different Ratio of Blend
  ↓
Dewatering
  ↓
Breaking of lumps
  ↓
Sieving
  ↓
Garification/Frying
  ↓
Cooling
  ↓
Packaging and Sealing
```

```
Bambara Groundnut
  ↓
Cleaning / Sorting
  ↓
Roasting
  ↓
Cooling
  ↓
Drying
  ↓
Millling
```

**Functional /Physical Properties Determination**

Functional properties were carried out to determine the behavioral and physical characteristics of the fortified gari. The parameter used include: Water absorption capacity, bulk density, swelling index.

**Water Absorption Capacity Determination (WAC)**

3 grams of each sample were weighed into different centrifugal tube of known weight. 10ml of distilled water was added and samples were stirred. Tubes were then placed in water bath at room temperature 32°C for 30/minutes and they were stirred at 10 minutes intervals. Tubes were centrifuge at 250rpm for 15/minutes. Supernatant was decanted and the tubes containing the samples were reweighed.
Calculation:

\[
\text{WAC} = \frac{\text{weight of sample + test tube after experiment}}{\text{test tube before experiment}} - \frac{\text{weight of sample + test tube after experiment}}{\text{test tube before experiment}}
\]

**Bulk Density**

2 grams of each sample were weighed and poured into 100ml measuring cylinder. The cylinder was tapped constantly against a table until there was no further change in volume. The level of the sample was then traced.

**Calculation:**

Bulk density = \( \frac{\text{Mass}}{\text{Volume}} \) (g/cm\(^3\))

**Swelling Index Determination**

2 grams of each sample were weighed and placed in 100ml of distilled water at 50\(^\circ\)C in a graduated measuring cylinder. It was tapped gently to eliminate air and the volume was noted in Cylinder. The mixture was allowed to swell and then swirl round and then it was allowed to stand for 1 hour and final volume was noted.

**Calculation**

Swelling index = \( \frac{\text{final volume} - \text{initial volume}}{\text{sample}} \)

**Chemical or Proximate Analysis**

Chemical or proximate analysis was used to determine chemical composition of each of the food formula. The analyses according to Eltayeb et al (2012) include the determination of Moisture content, pH value, Total titration acidity, Ash determination, Protein, Crude fiber and carbohydrate content.

**Moisture Content Determination**

Moisture meter as used. The device mechanism is based on drying of the sample at 100\(^\circ\)C for 10 minutes.

**Procedure:**

The device (moisture analyzer) was connected to switch, when the switch was on, the device indicated ready on its screen, sample was added on the foil plate in it, and the cover lid was closed. At 10 minutes, the device indicated the end of the analysis by displaying the moisture content in percentage on its screen.

**Carbohydrate Determination**

Total carbohydrate content of each samples were determined by difference. These were done by subtracting the percentage of moisture, ash, protein and fat obtained from 100\(^\circ\) (Bryant et al, 1988).

**Calculation:**

\( \% \text{ Carbohydrate} = 100\% - (\text{moisture} + \text{ash} + \% \text{ protein} + \text{fat}) \)

**Ash Content Determination**

Ash content determination was based on principle of complete incineration of organic component of food and the left behind component is called inorganic component or ash.

**Apparatus**

Crucibles to be used were cleaned, dried by being ignited and cooled in desiccators and weighed 5g of samples were introduced into the crucibles and the initial weight was taken. The crucible and its content were placed over a burner flame until the samples in it turns brown. The crucibles and their contents were then transferred, using a pair of cleaned tongs into a muffle furnace at 600\(^\circ\)C for 1 hour or until fully ash.
The crucibles and their contents (residue) were placed in the desiccators for cooling and weighed.

**Calculation:**
\[
\% \text{ Ash weight of residue} \times 100
\]

**pH Determination**
5grams of each sample were dissolved in 100ml distilled water. The samples were centrifuged for 15minutes. The pH of the decanted resulting solution was determined with the aid of a previously standardized PH meter (Unicans 945 model). Already calibrated pH meter with pH of 4.0 and 7.0 buffers. The pH electrodes were then introduced into the sample and the readings indicated on the screen.

**Total Acidity**
Acidity of each sample was determined by the titration of 25ml of the decanted homogenate used for pH determination against 0.1m NaOH to pH 8.3.

The relative amount of lactic acid was calculated as percentage lactic acid on dry matter basis as follows.

**Calculation**
\[
\% \text{ lactic acid} = \frac{\text{Titer value} \times \text{Nomality of alkalis}}{\text{weight of sample}} \times 100
\]

**Crude Fibre Determination**
10g of each samples were weighed into a 250ml conical flask, 50ml of 0.3m H\textsubscript{2}SO\textsubscript{4} was added and the mixture reflux for half an hour using reflux condenser 0.5m Sodium hydroxide was added after the half hour and refluxing was carried out for another half an hour. (Defatted sample obtained). Content in the flask was filtered using filter paper. Residue was rinsed with hot water and this followed with addition of 50ml acetone to remove any fat present. Fibre was then scrap into a crucible using a jet of acetone from the filter paper into a cleaned, weighed crucible. Acetone was evaporated by heating crucible over a boiling water bath. The sample was dried in a convectional oven for 1 hour at 140°C. The fibre was further ash in furnace at 600°C – 650°C for 3hours. Sample was cooled in desiccators and weighed after cooling. Same procedure was repeated for other samples.

**Protein Determination**
Protein content in food samples is determined mainly or usually by the conventional Kedjhal method. However, various modifications are available and one of them is *Nessler’s Reagent Method* where 5g of the sample was weighed and transferred into a digestion flask. 5ml of the concentrated H\textsubscript{2}SO\textsubscript{4} was added. The sample and the acid were heated gently until digestion is completed. This was determined when the solution became clear. The digest is finally clarified by adding another strong oxidizing agent, hydrogen peroxide (H\textsubscript{2}SO\textsubscript{4}). The solution becomes very clear signifying total digestion. Digest was then transferred into a 100ml volumetric flask and made to volume with ammonia free water to form a stock solution. 10ml of the aliquot was transferred into another 25ml volumetric flask and 2ml of Nessler’s reagent was added. The mixture was made up to volume with ammonia free water. Change in colour from yellow to brown was observed, which shows the presence of Nitrogen. The intensity of the colour is directly proportional to the amount of Nitrogen in the sample which is also related to the quality of protein in the sample. Color developed was measured using spectrophotometer at about 460 – 462 nanometer, from which the amount of protein was determined.
**Fat Content Determination**

10g of each sample was put into cleaned, dried conical flask. Samples were heated with 10ml alcohol for 10 minutes on a water bath at a temperature 62°C. Samples were allowed to cool using desiccators.

12ml diethyl ether was added into sample in each flask, samples and the reagent were shake properly. 0.5ml dilute ammonia was added to the samples in each flask. 4.5ml water and 12.5ml light petroleum was added and were mixed together gently. Upper layer of each sample was siphoned off into a cleaned weighed beaker. Extract were then heated to remove solvent by evaporation and were then weighed and values were recorded.

**Calculation**

\[
\% \text{ fat content} = \frac{\text{weight of extract}}{\text{weight of sample}} \times 100
\]

**Sensory Evaluation**

Sensory evaluation was performed on each of the formulation to evaluate their organoleptics qualities. The samples were reconstituted with boiled water. A sensory panelist of 9 people was used. The formulations were assessed in term of color, taste, aroma and general acceptability using a nine (9) point hedonic scale as shown below.

Like extremely; Like very much; Like moderately; Like slightly; Neither like nor dislike; Dislike slightly; Dislike moderately; Dislike very much; Dislike extremely.

Samples were presented to each panelist in a clean saucer in warm form. Coded name was placed below each saucer used to serve the panelist.

**Rheological Properties**

Rapid Visco Analyser model RVA-3D was used to determine the peak viscosity peak time, pasting temperature, peak temperature, holding strength, Breakdown, final viscosity, set back from peak and pasting time of the samples.

**Operation and General Principle**

The Rapid Visco Analyser was designed as a simple – to – use viscometer. Sample preparation requirement have been minimized and the test procedure is highly automated. Proper operation of the instrument depends on the actual application required. Successful analysis generally depends on proper application of a few general principles and following a few simple steps. Generally, method employed for testing depends on the nature of the sample being analyzed; diversity of the samples and application makes it impractical to detail a method for every sample. However, a few general principles can be applied to majority of the cases. The types of test employed can vary widely depending on whether it is for process emulation, rapid screening, quality control, basic research and so on.

**Procedure**

The device was switched to on position. 3g of each samples was transferred into the water surface in the canister. The paddle was placed into a canister and the blade was vigorously jogged through the sample up and down ten times, or until the flour was no longer found on the surface of the water. The device automatedly recorded on the chat the value of the gelatilization temperature and viscosity at different stages of heating. The device automatedly plotted a chart which was shown on the computer screen.

**Definition of Terms Used in Rheological Value**

a. **PEAK VISOCITY:** Maximum viscosity developed during or soon after the heating portion of the test, in RVU

b. **PEAK TIME:** Time at which the peak viscosity occurred, in minutes.
c. **PEAK TEMPERATURE:** Temperature at which the peak viscosity occurred in °C.

d. **PASTING TEMPERATURE:** Temperature where viscosity first increases by at least 2RVU over a 20 seconds. Period using profile STD 1, in °C.

e. **HOLDING STRENGTH:** Minimum viscosity after the peak, normally occurring around the commencement of sample cooling, in RVU.

f. **BREAKDOWN:** Peak viscosity minus trough viscosity in RVU

g. **FINAL VISCOSITY:** Viscosity at the end of the test, in RVU

h. **SETBACK FROM PEAK:** Final viscosity minus peak viscosity in RVU

i. **SETBACK FROM TOUGH:** Final viscosity minus trough viscosity in RVU

These values can conveniently be determined by using the software provided with the instrument.

**RESULTS**

The results obtained were as presented in tables 1, 2, 3 and 4

Table: 1 Result for functional properties.

<table>
<thead>
<tr>
<th>Functional Properties</th>
<th>SLY</th>
<th>ATS</th>
<th>FEA</th>
<th>ROT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (g/cm³)</td>
<td>0.625</td>
<td>0.606</td>
<td>0.615</td>
<td>0.625</td>
</tr>
<tr>
<td>Swelling index</td>
<td>5.00</td>
<td>3.00</td>
<td>4.20</td>
<td>4.50</td>
</tr>
<tr>
<td>Water Absorption Capacity</td>
<td>6.53</td>
<td>5.53</td>
<td>5.10</td>
<td>4.83</td>
</tr>
</tbody>
</table>

Table: 2 result for proximate composition

<table>
<thead>
<tr>
<th>Proximate Composition</th>
<th>SLY</th>
<th>ATS</th>
<th>FEA</th>
<th>ROT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content (%)</td>
<td>12.60</td>
<td>12.20</td>
<td>11.38</td>
<td>11.60</td>
</tr>
<tr>
<td>Protein content (%)</td>
<td>0.98</td>
<td>2.98</td>
<td>3.39</td>
<td>4.68</td>
</tr>
<tr>
<td>Fat content (%)</td>
<td>1.10</td>
<td>1.32</td>
<td>1.88</td>
<td>2.60</td>
</tr>
<tr>
<td>Ash content (%)</td>
<td>1.82</td>
<td>2.20</td>
<td>2.60</td>
<td>2.80</td>
</tr>
<tr>
<td>Carbohydrate content (%)</td>
<td>83.5</td>
<td>81.30</td>
<td>79.86</td>
<td>78.20</td>
</tr>
<tr>
<td>Crude fibre (%)</td>
<td>2.30</td>
<td>2.26</td>
<td>2.42</td>
<td>2.31</td>
</tr>
<tr>
<td>pH</td>
<td>4.30</td>
<td>4.50</td>
<td>4.93</td>
<td>4.90</td>
</tr>
<tr>
<td>Acidity</td>
<td>0.64</td>
<td>0.43</td>
<td>0.43</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Table 3 results for sensory evaluation

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>ss</th>
<th>mss</th>
<th>Fcal</th>
<th>@5% level</th>
<th>@ 1% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>35</td>
<td>32.89</td>
<td>4.44</td>
<td>7.71</td>
<td>9.03</td>
<td>14.16</td>
</tr>
<tr>
<td>Taste</td>
<td>35</td>
<td>137.11</td>
<td>20.54</td>
<td>14.55</td>
<td>9.03</td>
<td>14.16</td>
</tr>
<tr>
<td>Texture</td>
<td>35</td>
<td>87.94</td>
<td>12.16</td>
<td>12.45</td>
<td>9.03</td>
<td>14.16</td>
</tr>
<tr>
<td>Flavor</td>
<td>35</td>
<td>184.00</td>
<td>28.24</td>
<td>15.27</td>
<td>9.03</td>
<td>14.16</td>
</tr>
<tr>
<td>General acceptance</td>
<td>35</td>
<td>208.67</td>
<td>29.04</td>
<td>50.34</td>
<td>9.03</td>
<td>14.16</td>
</tr>
</tbody>
</table>

**Table 4 result for rheological value**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Peak Viscosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLY</td>
<td>177.17</td>
</tr>
<tr>
<td>ATS</td>
<td>136.50</td>
</tr>
<tr>
<td>FEA</td>
<td>135.42</td>
</tr>
<tr>
<td>ROT</td>
<td>106.17</td>
</tr>
<tr>
<td></td>
<td>SLY</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Trough Viscosity</td>
<td>161.00</td>
</tr>
<tr>
<td>Breakdown</td>
<td>16.17</td>
</tr>
<tr>
<td>Final Viscosity</td>
<td>251.67</td>
</tr>
<tr>
<td>Set Back</td>
<td>90.67</td>
</tr>
<tr>
<td>Peak time (minute)</td>
<td>6.93</td>
</tr>
<tr>
<td>Pasting Temperature</td>
<td>79.20</td>
</tr>
</tbody>
</table>

**DISCUSSION**

**Function Properties**
Sample SLY had the highest water absorption capacity (WAC) and Swelling index. Water absorption capacity (WAC) is an important parameter which can be used to determine cooking time. Sample SLY will therefore be expected to give the shortest cooking time which implies less fuel and energy. Sample SLY and ROT had the highest bulk density while sample ATS had the lowest.

**Proximate Composition**
The results of the chemical composition of all the fortified gari using bambara groundnut were as shown. Protein content is one of the most important parameters determined. Protein content of the fortified gari ranged from SLY sample 0.98% (Gari 100%, Bambara groundnut 0%) to ATS sample 2.98% (Gari 85%, Bambara groundnut 15%) and to ROT sample 4.68% (Gari 80%, Bambara groundnut 20%) Ash content, which is an estimation of mineral content of the fortified sample ranged from (1.82%-2.8%). This is an indication that the samples contain a fair source of mineral element required by the body. Fat content of the samples ranged from 1.10% - 2.60%. The result revealed that fortification of each samples helped to enhance the fat content of the sample.

Moisture content ranges from 11.60% - 12.60%. Low moisture content ensures longer shelf life.
Carbohydrate content decreases as the Bambara Groundnut flour was being increased. Sample SLY has 83.5% (Gari 100%, Bambara 0%) to sample FEA 79.86% (Gari 85%, Bambara 15%) and to sample ROT 78.20% (Gari 80%, Bambara 20%). pH of the samples were relatively low, which ranges from (4.30 – 4.90). Low PH ensures good keeping quality of any sample (Akapo et al, 1995). Acidity of the four samples were relatively low. Low acidity ensures long shelf life of the product

**Sensory Evaluation**
Results of the sensory evaluation carried out on the samples were as shown in Table 4. The raw data was analyzed using Analysis of variance (ANOVA) to determine any significant difference among the samples. The result showed significant difference at 5% level and 1% level in taste, color, flavor and general appearance. But there is no significant difference in the texture at 1% significant level.

**Rheological Value**
The results of the rheological study using Rapid viscous Analyzer – 3D showed that the value for peak viscosity, Trough viscosity, Breakdown, final viscosity, set back, and pasting time was inversely proportional to the quantity of bambara groundnut flour added, that is, the values obtained reduce with increase in the quantity of bambara groundnut contained in the sample. This is evident with sample SLY (100% gari and 0% Bambara groundnut) having the highest value, followed by sample ATS (90% Gari and 10% bambara groundnut), FEA (85% Gari and 15% Bambara
Groundnut) and ROT (80% Gari and 20% Bambara Groundnut) having the least value. The result showed that the water binding capacity and swelling ability of the sample reduce as the value of bambara groundnut increases. However, the pasting temperature showed slight variation which was not dependent on the amount of bambara groundnut flour added.

**CONCLUSION**

The study has shown that protein can be included in gari production using bambara groundnut flour. The nutritional content of the fortified Bambara gari is improved, as there is an increase in protein content, fat content, and ash content, but decrease in carbohydrate content on addition of bambara groundnut flour to the gari at different percentage. Result of the sensory evaluation carried out on the samples shows an average acceptability of the samples. The preference for the sample decreases as the incorporation of the bambara groundnut flour increases.

It is, however, noted from the study that protein fortification of gari with bambara flour affect significantly the colour, taste, flavour and general appearance of the sample. Therefore, the production of bambara-garri production is much easier to produce because it is less labour intensive and with very low cost of production.

**RECOMMENDATION**

Incorporation of bambara groundnut flour in gari production for protein inclusion should not be more than 5% as increase in this will affect the color, taste flavor and general appearance of the garri. It should, however, be included that another source of protein such as fish and meat be consumed with fortified garri using Bambara groundnut to ensure proper amount of protein required in the diet to prevent kwashiorkor in the society.

**REFERENCES**


