FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

TRAINING AND TECHNOLOGY ADOPTION: ROADMAP TO A HUNGER-FREE NATION

By

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B.Sc. (Ed) (Benin), M.Sc. (Ilorin), PhD (FUTM)

Professor of Agricultural Extension & Rural Development

INAUGURAL LECTURE SERIES 101

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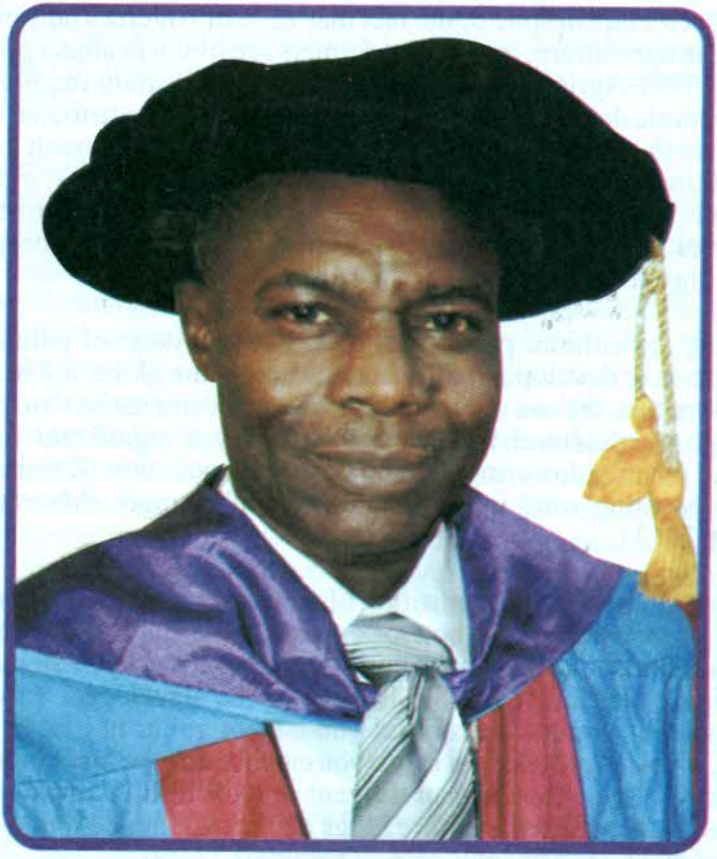

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1.0 Introduction

Agricultural development is the foundation for economic development, and the agricultural sector is undoubtedly the prime area of concentration for economic progress. Despite the importance of this sector and in spite of the fact that 72 % of Nigeria's households engage in agriculture, most of the farmers are living in abject poverty (FOS, 1999). Agricultural development is an important requirement for economic development. One of the major reasons attributed to the low growth of the Nigerian economy is the slow growth of the agricultural sector, which has resulted in rising food prices, increase in food import and inadequate raw materials for agro-based industries, which is attributed especially to the use of inappropriate technology (CBN, 1999).

Boosting agricultural productivity has been an issue of paramount importance to development institutions across the globe and in order to achieve this, the use of technological improvements have to play a key role. Agricultural innovations also play a significant role in fighting poverty, lowering per unit costs of production (Kassie *et al.* 2011), boosting rural incomes and reducing hunger (Maertens & Barrett, 2013).

Training has to do with acquisition of abilities and skills. Skill means ability or technical know-how or expertise in a field. Before a man becomes skillful he must have gone through the regour of all manner of training and exercise. Skills have to be developed. In every profession, if you are not skillful you cannot go far in life. In other words, if you are not skillful in life you cannot stand before kings. The Bible says "seest thou a man diligent or skillful in his business or profession, he will serve before kings and he will not be found in the midst of mean or despicable men." (*Proverbs 22:29*)

The training of farmers and the adoption of improved technologies can lead to increase in productivity and higher income to farmers. This could consequently lower the prices of agricultural products and generate greater economic efficiency and overall growth in the national economy (Benin & Pender 2001; Oyebanji,1997). In the same vein, Falusi (1997) emphasizes that increase in availability and adoptions of improved packages of production technology are two of

the factors which favour the growth of food production in Nigeria. The relative contribution of the agricultural sector to the Gross Domestic Product (GDP) declined steadily to the point where the country's agricultural production has all but stagnated, and food prices risen dramatically (Olayide, Eweka & Bello-Osagie, 1980; Dayo, 2010).However, training and adoption has some potential to support Nigeria smallholder farms to produce more than enough food to curb the increasing incidence of hunger and improve farmers' livelihood.

2.0 Agricultural Extension Education

Extension is a non-formal education that applies to any institution that disseminates information and advice with the intention of diffusing and promoting knowledge, attitudes, skills and aspirations through training. "Extension is rural vacuum filler". Extension is an educational programming to adults in communities. Therefore, extension must be committed to offering excellent training to its own clients (farmers). It is useful to review extension's role in a functioning technology development, transfer and adoption system. Most people would agree that extension should be involved in a two-way process of transmitting problem solving information to farmers and information on farmer problems back to agricultural research (See Figures1&2). However, it proves difficult to translate this theoretical conviction into actual practice. Therefore, the technology transfer function is frequently stressed, with little or no concern with extension's role in farmer feedback.

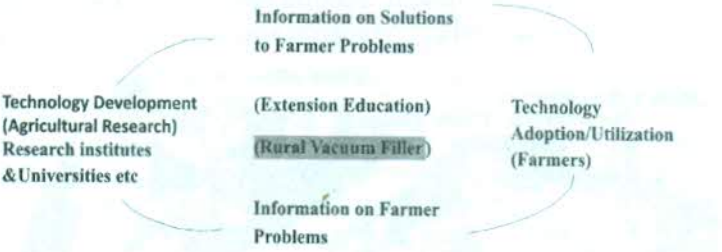


Figure 1: A sample conception of a technology development, transfer and utilization system

Source: Adopted from Havelock (1976) and Tsado (2013)

According to Ekumankama and Anyanwu (2008) in Ogunwale (2012), effective agricultural extension service depends on the effectiveness of the frontline extension staff members, who have the mandate to train farmers. For any extension service to be effective it has to abide with the following basic principles: (i) Principles of cultural difference. (ii) Grass roots principle. (iii) Principle of indigenous knowledge. (iv) Principle of interest and needs. (v) Principle of learning by doing, and (vi) principle of participation

An extension service that is to function as part of an interdependent technology development, transfer and utilization system must achieve a two-way flow of information. Therefore, strengthening extension is not just a process of training and deploying more extension workers; rather, it is a process of strengthening the whole system. For example, in cases where field extension workers are poorly trained, it may be overly optimist to expect them to clearly identify and then articulate farmers' problems back to researchers. An alternative approach, depicted in (Figure 3), might be to have agricultural researchers become directly involved in identifying farmer problems and then working to solve them through a farming systems research approach. Under these circumstances, potential solutions to farmer problems (which result from farming systems research) could be considered by a technical committee involving farmers, researchers and extension specialists (as well as representatives from agri-service firms or agencies and agricultural banks) to formulate technical recommendations that would be subsequently disseminated by extension and utilized by farmers.

Figure 2: Extension bridging the gap between research and the farmer
Source: Adapted from by Havelock(1976) and Tsado, (2013)

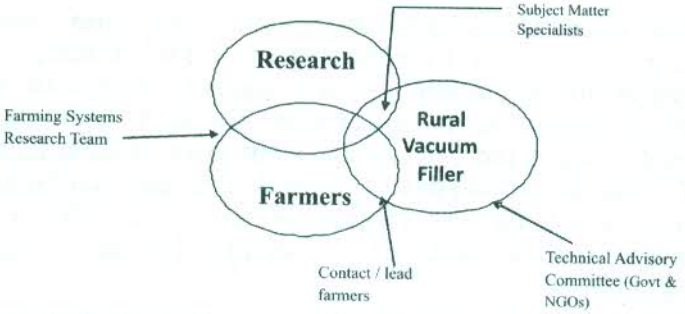


Figure 3: An alternative conception of a technology development, transfer and adoption system
Source: Adapted from Havelock (1976) and Tsado (2013)

Extension services help in improving the flow of information about farmer problems either directly to research, or indirectly and assisting farmers to improve their organizational and leadership skills so they can effectively articulate their problems and needs which are essential features of an effective technology development, transfer and utilization system as illustrated in Figure 3.

3.0 Training

Training is described by Okwu and Ejembi (2005) as a process of acquiring knowledge and skill required by an individual to use technology appropriately. Agricultural training is defined as the educational process involving the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in agriculture, in addition to general education (Jones, 2013). Training can also be described as the act of increasing the knowledge and skills of an employee in doing a particular job. Training is mostly directed at improving the ability of individuals to do their vocation more effectively and efficiently. Generally, it involves acquiring information and developing abilities or attitudes, which will result in greater competence in the performance of a work. There are two main agents in training – the trainee and trainer. The active participation of both agents at every stage of the training programmes is very important (Broad, 2007; Tsado, 2013). There are five basic steps to be followed in organizing a successful training programme: (i)

Assessment of needs, (ii) design of relevant means to meet them, (iii) selection of trainees, (iv) conducting the actual training and (v) evaluating the training session. A good understanding of the need is therefore fundamental to successful training. Training need assessment is one of the most crucial steps towards identification of farmers' intent, design and development that can best suit the existing real condition of farmers (Sajeeu *et al.*, 2012). The German development agency (GIZ, 2015) explains the various types of training as follows:

Formal training: Provided by the state education system and leading to a recognized qualification. The learning processes are intentional and systematic.

Non-formal training: Delivered by education and training providers, companies, social partnership organizations and public-benefit bodies outside of the state-initiated education and training system. The learning processes are intentional and systematic and may lead to a recognized qualification.

Informal learning: Non-structured, non-intentional learning processes that take place at work or through other everyday activities. It does not typically lead to certification and recognition.

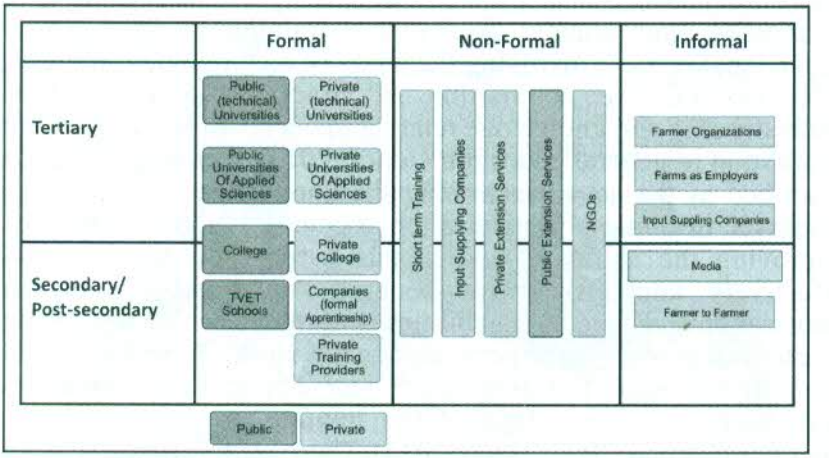


Figure 4: Actors in Technical Vocational Education and Training in Africa
Source: Adapted from Walker and Hofstetter (2016)

Figure 4 presents all the actors involved in training and classifies them into formal, non-formal and informal training categories by level of education, distinguishing between private and public agents. The type of training provision generally falls into the following categories: (i) Public school-based vocational education and training, (ii) vocational training centres, and (iii) private for-profit institutions (NGOs).

The link between poverty reduction and skills training and increased growth, productivity and innovation, is particularly strong in the informal sector (Fluitman, 2002). Training plays a vital role in developing the skills that are needed to improve output, quality, variety and occupational safety, which in turn improve health outcomes, thereby increasing the incomes and livelihoods of the poor. Also training helps the trainees to strengthen knowledge about the informal sector, rural organizations and good governance. Access to training and relevant skills is important in many ways; it leads to increased productivity in agriculture-related sectors, links the poor rural population to profitable income generating activities, and attracts young people to agricultural and rural futures. Effective training systems that build linkages between education, technical training, labour market entry, and lifelong learning are necessary for sustainable productivity growth and for generating better paying jobs in rural areas and beyond.

Yields in the developing countries could be more than doubled rapidly through training, in conjunction with improved technology adoption. For this to succeed there is need for appropriate production and cropping methods that are environmentally sound and conserve natural resources. Agriculture must not become, as it has in some parts of the world, a driver of the problems of climate change, species loss, soil degradation, deforestation, and water consumption. Agriculture should become a problem solver by adopting new technologies that are ecologically friendly with economic wide facts (Awotide *et al.*, 2016) as indicated in Figure 5.

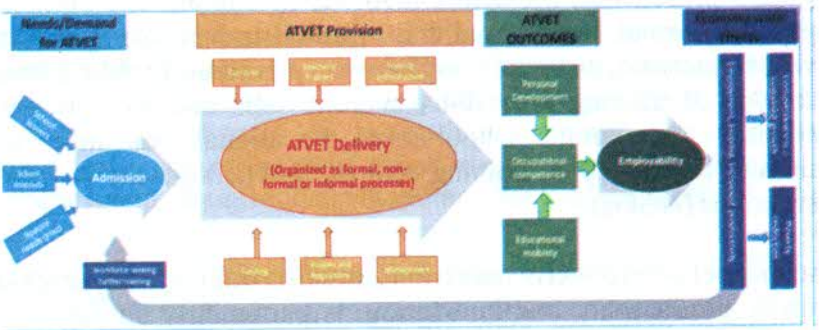


Figure 5: Impacts of training on individual, agro-food sector and the whole economy
Source: Adapted from Kehl et al. (2013)

3.1 Types of Training

According to USAID/MARKETS (2005), there are basically two seasons in training the farmers, namely in-season training and off-season training.

In-season training: Farmers are trained when their crops are still on the field, yet to be harvested. This type of training is emphasized because farmers can apply promptly the new skill they have learnt.

Off-season training: This type of training is carried out in the dry season when farmers had finished harvesting their crops. Farmers have the opportunity of attending trainings during this part of the year. The training on new technology includes crop raising, animal feeding and management and plant protection. For such training the following points should be considered because of its andragogy nature:

i. **Time of holding the training:** It should be at the convenience of the farmers i.e., when they are comparatively free from much of the agricultural operations. This will differ according to the season, weather and climate.

ii. **Duration of course:** For farmers who are engaged in farming, a one week course is sufficient for special topics such as use of irrigation facilities and water management, operation of implements and plant protection etc. It may be of two or three days' duration.

iii. **Venue of course:** Besides physical facilities, the appropriate environment under which the course is to be conducted i.e. where the farmers can see the actual crop, method demonstrations, and operations with some machines and implements or some treatments such as fertilizer application. Venue has to be given due consideration.

iv. **Production cum demonstration camps and discussion groups of the farmers:** These should be arranged in the villages because the farmers cannot afford to go away from their farms and homes. It is important, however, to note that training is a major pre-requisite for technology adoption and for obtaining optimum result from every technology adopted and the roles played by whatever demonstration method cannot be over emphasized.

4.0 Technology

Scientific knowledge, when put to routine use for the benefit of mankind, is called technology. For any new technology to find acceptance, it must be competitive into today's and tomorrow's environments, and bring about economic benefits at all levels of a society while maintaining eco-friendliness, self-sustainability of the system, and social and cultural compatibility. Technology development is a response of scientific knowledge to the changing needs of consumers, farmers, community, country, and world trade. In the late 1960s and early 1970s there was a need to increase total production by intensive agriculture. However, since the 1990s, the emphasis has shifted towards technology development that considers farmers' needs, uses indigenous technology to complement scientific developments, and gives due consideration to sustainability of natural resources and other environmental concerns to enhance adoption promotion through different dissemination methods such as method demonstration and results demonstration method through training as indicated in Figures 6-8.

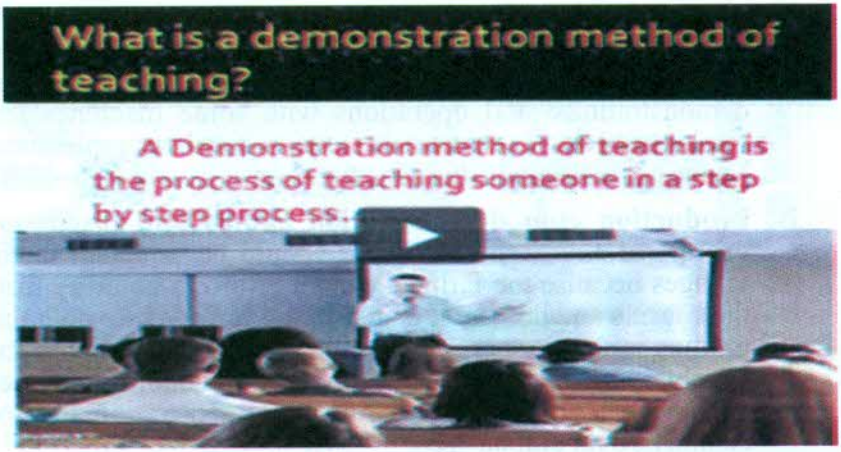


Figure 6: Method Demonstration
Source: FAO, (2017)

Figure 7:Result Demonstration
Source:FAO, (2017)

Figure 8: Pictures of farmers receiving training
Source:Cornel Cooperative Extension (1996)

4.1 Technology Adoption

Technology adoption is a multistage process the decision makers (farmers) undergo from the time they get exposed to the technology (become aware of its existence) through to the time that they decide to start using the technology. In other wards technology adoption can be described as the decision to use a technology in long-run equilibrium given full information about its potential (Feder *et al.*,1985). It can also be described as the decision to use an innovation and continue using it (Tsado, 2014).

The adoption process starts with the potential adopter becoming aware of the existence of a technology. The second stage involves a process of information acquisition, through which the potential adopter gets to know technology attributes and builds up his or her perceptions (positive or negative) about the technology. It is also a learning phase during which the potential adopter gets to understand the attributes of a technology further. Consistent with this notion, Klotz *et al.* (1995) posit that a producer's optimal information level is the solution to an underlying utility-maximization problem characterized by an income-leisure trade-off and that is conditional upon the producer being aware of a new technology, the decision of whether or not to adopt the new technology is made. The third stage involves trial or experimentation by the potential adopter before adopting the technology, based on perceived benefits of the technology. The individual goes through the fourth stage which involves the actual technology adoption. Once the technology is adopted, the adopter may decide to continue using it or discontinue depending on the experience and benefits after adoption (Tsado, 2014)

5.0 Appropriate Technology and Methods of Technology Transfer

Campbell and Berker (1996) posit that agricultural development can be facilitated by the development and transfer of appropriate

technologies. As a result of the relationship between the developing and the developed countries, most of the developing and developed countries accept or develop technologies that are not always in accordance to the need of either farmer or the farming environment, which are always not appropriate to the farmers. An appropriate technology must be defined within the scope of what is technically realistic, economically feasible, socially acceptable, environmentally safe and sustainable (Campbell & Barker, 1996). Furthermore, Van den Ban and Hawkins (2002) emphasized that for a technology to be appropriate and to be adopted by the farmers, it must have the following characteristics: compatible with socio-cultural values and beliefs, less complex, have relative advantage, trialability on small scale possible, and observability in that the difference made can be observed easily by the farmers. Okechukwu *et al* (1994) stressed that for a technology to be appropriate, it should enhance the increase use of local resources such as labour, risk involved should be minimal, result should be both quick and superior to current or existing practices, and suitable to the needs and requirement of farmers. Some major factors also seek to provide a framework for the development of appropriate technology, and they include ecological zones, access to resources, gender, age and ethnic group.

Developing and transferring technology and persuading resource-poor farmers to adopt them through functional and cost-effective advisory and distribution service is the business of Agricultural Research Technology Generation and Extension systems (Nwosu & Ike, 2005). Ganpat and Sespersad (1996) pointed out that for a successful adoption of a technology, farmers must not only know about it, but must be able to follow the recommendation given. According to Agbamu (2006), there are several models of explaining the adoption process. One of the models is that accepted by the USA North Central Rural Sociology Committee of Iowa in 1995 which recognized the following sequence for explaining the process of technology adoption as indicated in Figures 9 and 10:

Awareness → Interest → Evaluation → Trial → Adoption

After the first stages, the fifth stage is adoption in which a decision is taken on whether to accept agricultural technology or otherwise (Agbamu, 2006).

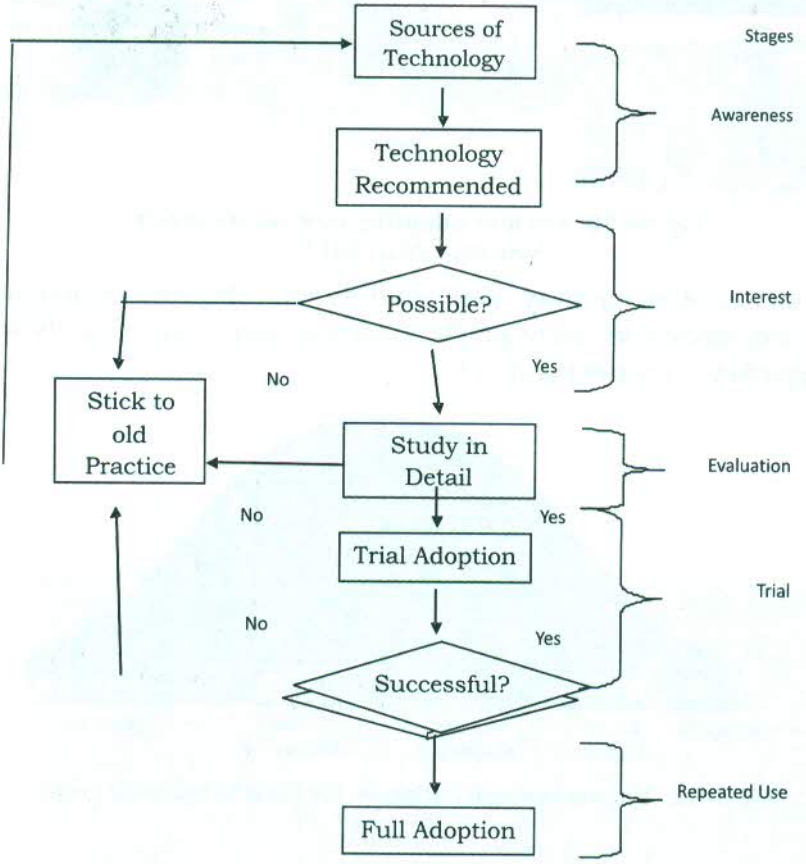


Figure 9: The adoption process
Source: Alviar (1994)

Figure 10: Farmer adopting new technologies
Source: FAO, (2017)

In the adoption pathway there are different categories of adopters namely innovators, early adopters, early majority, late majority and laggards as shown in Figure 11

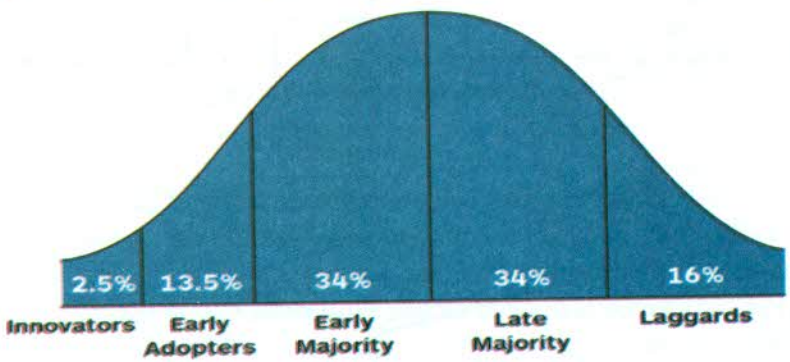


Figure11: Adopters categorization on the basis of innovativeness
Source: Rogers (2003)

6.0 Hunger

According to the UN Hunger Report (2015), hunger is the term used to define periods when populations are experiencing severe food insecurity, meaning that they go for entire days without eating due to lack of money, lack of access to food, or other resources and other

reasons as indicated in Figure 12. Also hunger can be defined in scientific terms, but essentially hunger is present when people lack the food they need for an active and healthy life.Here are some widely accepted definitions of key terms relating to hunger as contained in Development Policy Centre (1995) and World Bank Discussion Paper (1983):

- Hunger is the distress associated with lack of food. The threshold for food deprivation, or undernourishment, which is fewer than 1,800 calories per day.
- Under-nutrition goes beyond calories to signify deficiencies in energy, protein, and/or essential vitamins and minerals.
- Malnutrition refers more broadly to both under-nutrition and over-nutrition (problems with unbalanced diets).
- Food security relates to food availability, access, and utilization. When a person always has adequate availability and access to enough safe and nutritious food to maintain an active and healthy life, they are considered food secured.
- Food insecurity is when people lack secure access to sufficient amount of safe and nutritious food for normal growth and development as indicated in Figure 12

Fig 12:Illustration on why people go hungry
Source: WFP (2015)

Hunger and extreme poverty go hand in hand forming a vicious cycle. Also hunger and undernourishment undermine peoples' health, happiness, and life chances. They deprive unborn children of nutrient vital to their development. They stop girls and boys from attending school and impair learning when they do attend. Furthermore, they prevent adult from managing physically and mentally demanding work that would increase their families' food production or their income and keep generations trap in poverty. The above is the main reasons why the two monsters (poverty and hunger) must be eliminated from human race by all possible means, and the roadmap for this is through training and adoption of technology to increase the productivity of the small scale farmers who constitute the vast majority involved in agricultural production in Nigeria. It is important to note, however, that hunger is strongest in rural areas where the huge amount of the food is produced as shown in Figure13.

Figure 13:Hunger statistics of rural and urban area
Source: WFP (2015)

The situation is particularly bad in the countryside where three-quarters of all hungry people live. Almost all of them produce food themselves. As smallholders, however, they and their families only cultivate small fields, on average just 1.6 hectares, which is the equivalent of about two football pitches. Pastoralists have less and less pastureland available. Indigenous population groups, which traditionally have a diet of forest fruits and other wild plants, are increasingly being driven from their land. Landless people, who have to work for low wages as day labourers, are also seriously threatened

by hunger. Food insecurity and hunger is a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life which is usually manifested in their growth and development as shown in Figures 14 and 15.

Figure 14: Hunger leading to malnutrition
Source: FAO (2019)

Figure 15: Hunger leading to malnutrition of mother and child
Source: FAO (2019)

Specialists like FAO (2019) and WFP (2015) identify three types of hunger as acute, chronic and hidden as indicated in Figures 16-18

1. **Acute hunger** (famine) designates undernourishment over a definable period. It is the most extreme form of hunger and arises frequently in connection with crises like droughts due to wars and disasters. It often affects people who are already suffering from chronic hunger. This applies to almost eight percent of all hungry people.

Figure 16: Children suffering from acute hunger
Source:FAO (2019)

2. **Chronic hunger** designates a state of long-term undernourishment. The body absorbs less food than it needs. Although the media mostly report on acute hunger crises, globally, chronic hunger is by far the most widespread. It usually arises in connection with poverty.

Figure 17: Children suffering from chronic hunger
Source:FAO (2019)

3. **Hidden hunger** is a form of under-nutrition that occurs when intake and absorption of vitamins and minerals (such as zinc, iodine and iron) are too low to sustain good health and developmentin children and normal physical and mental

function in adults(FAO, 2013). The hidden hunger due to micronutrient deficiency does not produce hunger as we know it; you might not feel it in the belly, but it strikes at the core of your health and vitality (Grebmer *et al*, 2013).

Figure 18: Hidden hunger (A child diagnosed of hidden hunger)
Source:FAO (2019)

6.1 Solutions to hidden hunger

Supplementation: Vitamin A supplementation is one of the most cost-effective interventions for improving child's survival. According to UNICEF, at least 70% of the young children aged 6-59 months need to receive vitamin A supplements. However, Vitamin A supplements typically target only vulnerable population (Tan-Torres *et al.*, 2005).

Figure 19: Maize plant supplemented and fortified with pro. Vitamin A(Oba super 6)
Source: FUTMinna seed extension demonstration field (2021)

Fortifying food: It is recommended by FAO (2013) that food should be commercially fortified, which adds trace amounts of micro nutrients to staple foods or condiments during processing which help consumers get the recommended levels of micro nutrients. Fortification may be particularly effective for only urban consumers who buy commercially processed and fortified foods as shown in Figure 20.

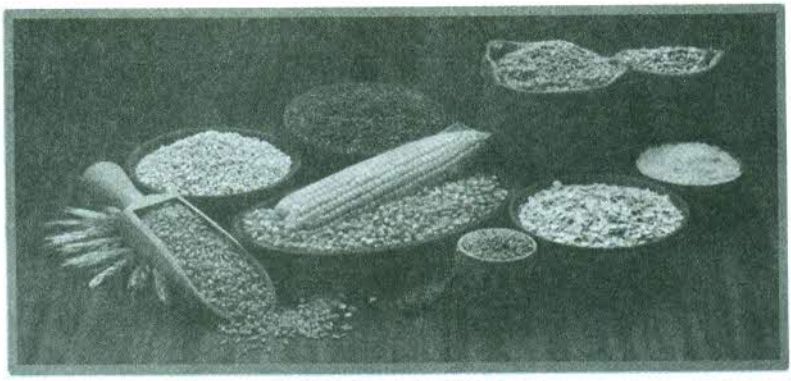


Figure 20:Solution to hidden hunger
Source: FAO (2013)

Bio-fortification: This involves using a conventional or transgenic method to increase micro nutrient contents of food. Bio-fortified crops that have been released so far according to Saltzman *et al.* (2013) include vitamin A orange flesh sweet potato, vitamin A maize, vitamin A cassava, iron bean etc.

Diversifying Diets: According to Thompson and Amoroso (2010), increasing dietary diversity is one of the most effective ways to sustainably prevent hidden hunger. Effective ways to promote dietary diversity involve food-based strategies, such as home gardening and educating people on better infant and young child feeding practices, food preparation and storage/preparation methods to prevent nutrient loss.

Hunger is strongly interconnected with poverty, and it involves interactions among an array of social, political, demographic, and societal factors. People living in poverty frequently face household food insecurity, use inappropriate care practices, and live in unsafe environments that have low access to quality water, sanitation, and hygiene, and inadequate access or availability to health services and education all of which contribute to hunger (Kanayo, 2017).
Infact, hunger is the greatest scandal on our planet, because the earth can feed everyone.

We can over come hunger and malnutrition, but we must possess the will to do so and we must make this the focus of our work. It is simply unacceptable that around 8,000 children die an unnecessary death everyday. Would it not be cynical to accept that some 800 million people in the world do not get enough to eat everyday, while some 600 million people suffer from obesity (UN, 2015).

Hunger of any type is as a result of food insecurity. According to Aworh (1999), the following factors among others are responsible for the national food insecurity particularly in West African countries: Low food production, high post harvest losses/wastage, season food shortage, high food prices, high poverty level, high rate of unemployment, poor health facilities, low level of nutrition education, cultural factors and taboos that reduce access to food, policy failure, corruption and lack of foresight on the part of government.

7.0 A Hunger-free Nation

Food is the cure of hunger. For a Nation to be free from hunger the first step is to invest in agriculture and rural development because the world's poor people live in rural areas and depend mainly on agriculture for their livelihood. However, these rural farmers face serious constraints which hinder their productivity, which among others include scares and scant knowledge of improved

technologies/practices, low use of improved seeds, low fertilizer use, inadequate irrigation, absence of strong institutions, ineffective policies, lack of incentives, prevalence of diseases, conflicts and insecurity (Kohli & Singh, 1997). These constraints should be adequately addressed and then the farmers exposed to training on improved practices and subsequent adoption of such technologies for increased productivity, increased income, poverty eradication and freedom from hunger.

8.0 My Noble Contributions

Over the years I have been involved in several training programmes for the purpose of enhancing farmers' skills in adopting improved technology to increase their productivity, ensure food security and overcome hunger.

8.1 Farmers' sources of information and training

Table 8.1: Farmers' sources of information and training in North Central Nigeria

Sources of Information/Training	Participants
Extension Agents	127(79.4)
Field Officers	160(100.0)
Other Farmers	147(91.9)
Parents/Relative/Friends	48(30.0)
Farmers Groups	156(97.5)
Progressive/ Contact Farmers	39(24.4)
Land Owners	17(10.6)
Mass/Print Media	146(91.3)
Field Days/Agric Shows	145(90.6)
Demonstration	153(95.6)

Figures in parenthesis are percentages
Source: Tsadoet *al*,(2014)

Tsado *at el* (2014) conducted a research on information and training sources used by rice farmers in North Central, Nigeria and discovered that adequate information and training are the major pre-requisites for widespread acceptance of agricultural technology. Such information usually abounds through a variety of sources. Table 8.1show that participants confirmed that farmers group (97.5%) and field officers (100%), were their main sources of information and training received. This study concludes that farmers receive information and training from different sources. This agrees with the finding of Agbamu *et al.,* (1996) that farmers received training and information from different sources.

8.2 Farmers'reasons for participating in training programmes

Farmers' especially small holder farmers are traditionally bound in respect of knowledge and skills being used on most of the programmes they participate in. Participation in such programmes is mainly geared towards increased yield and consequently resulting in poverty alleviation. In one of our works, as revealed in Table 8.2, participants main reasons for participating in the training programme was for poverty alleviation, which ranked 1st (97.5%), followed by increase in yield which ranked 2nd (91.9%) and economic empowerment (88.1%) which ranked 3rd.The conclusion was that farmers participate in training programmes to overcome hunger through increase in productivity and economic empowerment (Tsado *at el.*, 2014).

Table 8.2:Reasons for participating in the training programme

Reasons for Participation in training	Frequency	Percentage	Rank
For Poverty Alleviation	156	97.5	1st
Increase productivity	147	91.9	2nd
Economic Empowerment	141	88.1	3rd
Source of Technical Information	127	79.4	4th

Source: Tsado *et al,* (2014)

8.3 Access to training by farmers and technology adoption

Table 8.3: Result of access to training by the farmers and technology adoption

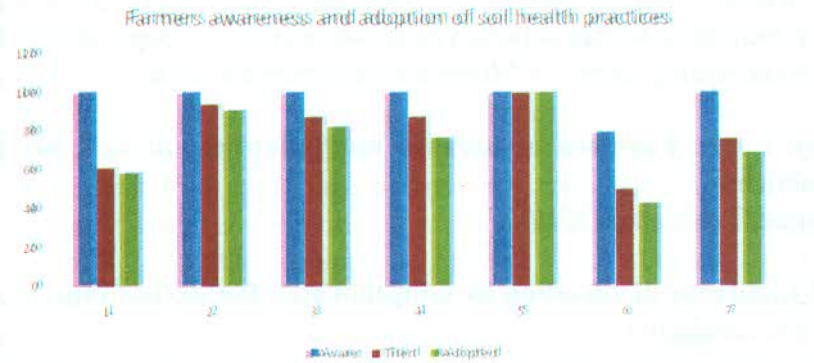
Extension Contact	Participant (N=160)	Non-Participant (N=160)	
Access	160(100)	38(23.8)	105.085***
No access	-	122(76.3)	
Total	160(100)	160(100)	

Source: Tsado *et al,* (2014)

Table 8.3 reveals the result of the study conducted by Tsado*et al,* (2014). According to the Table all the farmers who participated in the programme had access to training and only a few (23.8%) of the non-participants had access to training. The Table also shows that the difference is statistically significant at $p<0.01$. This implies that rice farmers that always had access to training were more conversant with improved technology and may be more likely to accept and readily adopt improved technology. This result is in agreement with those of Asfaw *et al.* (1997) and Kediri (1998) who reported that frequency of visit by extension agent and access to training were perhaps the main variables that emerged significant in most of the research work on technology transfer and adoption.

8.4 Adoption of soil health practices in Niger State

Tsado *et al (2019)* investigated the adoption of soil health practices in Niger State as shown in Figure 21 and reveals that most adopted practices were crop rotation (100%), increase in organic matter input (90.83%) and use of cover crops (87.50%). It should be noted, however, that these soil health practices adopted are compatible with the farmers' existing practices.



1= Reduce inverse tillage, 2= Organic matter input 3= Cover crop/mulching 4= Reduction of pesticide usage, 5= Crop rotation, 6= Nutrient management, 7= Monitoring soil performance

Figure 21: Farmers awareness and adoption of soil health practices
Source: Tsado *et al (2019)*

8.5 Incidence of adoption by adoption step for sixteen improved rice technologies

The result of the research conducted in Kwara and Niger States indicates that there are various stages involved in the adoption process. It is however argued by some authors that it is not necessary that a farmer passes through the five stages of adoption. Some experts like Agbamu (2006) revealed that rice farmers in Japan necessarily pass through three stages. As evident in Figure 22, all the participants (100%) claimed awareness of all the 16 technologies. The Figure also indicates that for participants, there was 100% awareness, trial and adoption of the following technologies: direct seeding, adding up, herbicide use, fertilizer use, timely harvesting and improved threshing floor. While for non-participants and for the pool respondents, there is only 100% awareness, trial and adoption of direct seeding, herbicide use and fertilizer use technologies.

1= Reduce inverse tillage, 2= Organic matter input 3= Cover crop/mulching 4= Reduction of pesticide usage, 5= Crop rotation, 6= Nutrient management, 7= Monitoring soil performance

Figure 21: Farmers awareness and adoption of soil health practices
Source: Tsado *et al (2019)*

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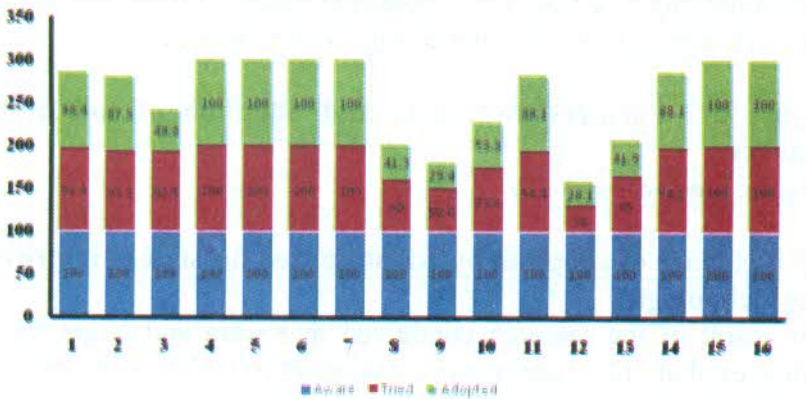


process. It is however argued by some authors that it is not necessary that a farmer passes through the five stages of adoption. Some experts like Agbamu (2006) revealed that rice farmers in Japan necessarily pass through three stages. As evident in Figure 22, all the participants (100%) claimed awareness of all the 16 technologies. The Figure also indicates that for participants, there was 100% awareness, trial and adoption of the following technologies: direct seeding, adding up, herbicide use, fertilizer use, timely harvesting and improved threshing floor. While for non-participants and for the pool respondents, there is only 100% awareness, trial and adoption of

direct seeding, herbicide use and fertilizer use technologies.
It should be noted, however, that awareness, trial and adoption of other technologies in the package were at different percentage levels. The implication of this result is that for every technology, the awareness level varies, trial level varies and adoption level varies. The movement from one stage to another depends greatly on the farmers' interest and conviction. The study concludes that awareness of a technology is not acceptance, acceptance is not trial, and trial is not adoption. A farmer may decide to stop at any of the stages. Adoption is when a farmer decides to fully put into practice the

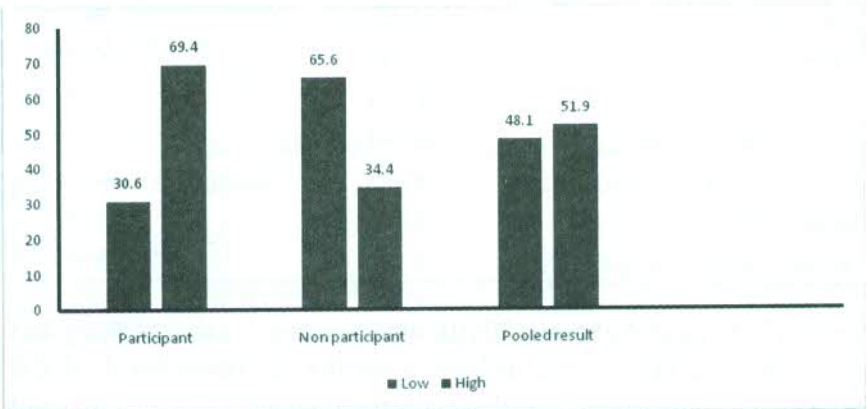


Figure 23: Distribution of respondents by levels of rice package adoption
Source: Tsado *et al* (2013)

technology he became aware of, has tried and he is convinced beyond reasonable doubt that the technology is economically feasible for adoption.
1=High yielding varieties, 2=Use of healthy seed, 3= Recommended land preparation, 4= Direct sowing, 5= Adding up, 6= Use of herbicide, 7= Use of fertilizer, 8= Insect control, 9= Rodent control, 10=Disease control, 11= Bird control, 12= iron toxicity control, 13=Nursery practices, 14=Hand weeding, 15= Timely harvesting, 16=Improved threshing floor

Figure 22: Participants incidence of adoption by adoption step for sixteen improved rice technologies.
Source: Tsado *et al* (2013)

8.6 Level of rice package adoption by farmers

Figure 23 revealed that majority (69.40%) of the participants with mean scores of equals to 11.93 and above were high adopters, while majority (65.60%) of the non-participants with mean scores of less than 7.99 were low adopters. This is in agreement with the findings of

Variables	Coefficient	Z-value
Constant	-0.092	-0.09
Age (X_1)	-0.096	-3.03 ***
Farm size (X_2)	-0.954	2.39 **
Educational level (X_3)	-0.083	3.12 ***
Farming experience (X_4)	-0.045	1.69 *
Household size (X_5)	-0.161	2.05 **
Access to extension agents (X_6)	-0.552	0.77 NS

Abebe (2010) and Agbamu (2010), who pointed out that training has a significant and positive influence on the adoption level of the farmers. The conclusion was that training of farmers had a significant and positive influence on the farmers' level of adoption of improved technologies.

8.7Adoption of improved potato technologies

Tasdo*et al* (2014) investigated factors affecting the farmers' level of adoption of sweet potato production technologies and discovered

F-cal	F-tab	Decision	Remark
26.79	2.98	if F-cal > F-tab; then there is a significant difference between participant and non-participant output	The programme had an impact on the participant crop output

Source: Tsado *et al* (2014)

that the coefficient of age is significant at 1% level but negatively correlated with adoption of improved sweet potato production technologies. This implies that as the farmers get older the propensity to accept and adopt new technologies decreases. Farm size was significant at 5% level, educational level was significant at 1%, farming experience of the farmers was significant at 10% and household size was significant at 5%. This agrees with the finding of Agbamu (1991), who pointed out that socio-economic and institutional factors significantly affect the level of adoption of improved packages of practices. The conclusion was that in an attempt to influence farmers to accept and adopt improved technologies these factors must seriously be put into consideration to enhance farmers' ability to accept and take up the technologies.

Table 8.7: Factors affecting the rate of adoption of improved potato technologies

Pseudo R^2=0.131.

Note: ***= Significant at 1%, **= at 5%, *= at 10%&NS= Not significant

Source: Tsado *et al* (2014)

8.8 Impact of training and adoption on participants' output

Table 8.8: Chow Test Estimate of impact of training and adoption on participants' output

The result of the research carried out by Tsado *et al* (2014) as presented in Table 8.8 shows that there was an impact of the

F-cal	F-tab	Decision	Remark
60.97	2.04	if F-cal > F-tab; then there is a significant difference between participant and non-participant income	The programme had an impact on the participants income

Source: Tsado *et al* (2014)

programme on participants' output. Chow test was carried out to be sure whether the difference in output was due to participation in training the trainers' programme or otherwise. According to Chow (1960), Doran (1989), Doughety (2007), and Gujarati (2004), the

Variables	Mean	t-value	Significance
Paired difference in participant and non-participant output	35.863	14.292	.000
Paired difference in participant and non-participant income	149113.8	9.949	.000

Source: Tsado *et al,* (2014)

Chow Test is statistical and econometric test to test if the coefficients of the two linear regressions on different data sets are equal as indicated by Simonyan (2009). As revealed in the Table, the Chow F-calculated was 26.79 while that of F-tabulated for 3 degree of freedom (df) and sampled population (N) of 320 was 2.98 at 5% level of probability. Following the decision rule, therefore, it can be concluded that there was a significant impact of the training programme on the participant output, since the F-calculated was greater than the F-tabulated.

8.9 Impact of training and adoption on participants' income

In a similar study conducted on the impact of training on participant income, the result obtained revealed impact of the programme on participants' income. As indicated in Table 8.9, the Chow F-calculated was 60.97 while that of F-tabulated for 3 degree of freedom (df) and sampled population (N) of 320 was 2.04 at 5% level of probability. Following the decision rule, therefore, it can be concluded that there was a significant impact of the training programme on participants' income, since Chow F-calculated was

Mean scores	Variance	Z –value	Significance
Before adoption (74.06)	17411.13	-1.25	0.003***
After adoption (95.17)	25173.63		

Source: Tsado *et al* (2014)

greater than F-tabulated.

Table 8.9: Chow Test Estimate on impact of training and adoption on participants' income

8.10 Estimate of difference in participants and non-participants output and income

Table 8.10: Pair-wise T-test estimate of participants and non-participants output and income

Table 8.10 shows the result of the paired mean difference between the output (35.863) and income (149113.8) of training participants and non-participants. The Table shows clearly significant mean deference, implying that training and adoption of improved rice package had a positive and significant effect on output and income. Adoption of improved rice package increased the participants output and income drastically. This was revealed in the mean difference of 35.863 and t-value of 14.292 between participants and non-participants, which is significant at 1%. The mean difference in income (N149,113.80) and the t-value 9.949*** also revealed that training and adoption of improved rice packages had a positive and significant effect on the farmers' output and consequently on the household income. Similar Mwabu*et al.*,(2006), Janvry and Sadoulet (2002),Medola, (2007), Tsado and Zakari (2007), observed that there was significant mean difference in output between beneficiaries and non-beneficiaries of intervention programmes

8.11Effects of adoption of improved production technologies

Table 8.11: Sweet potato yield before and after adoption of improved production technologies

The result in Table 8.11 shows a significant mean deference in yield before (74.06) and after (95.17) adoption of improved potato production technologies, significant at 1%, implying that adoption of

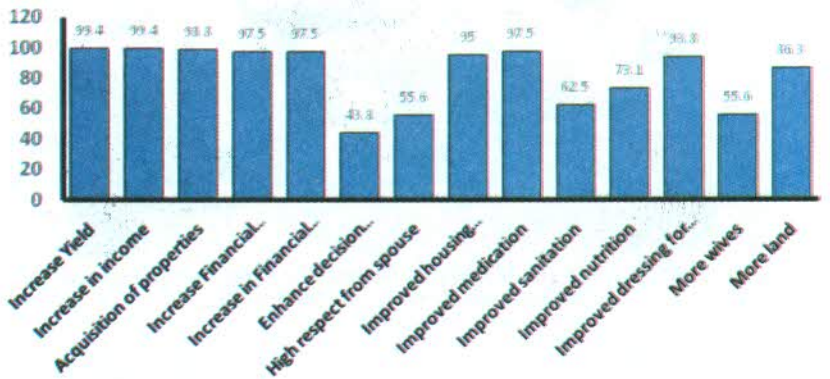
Effects of Adoption	Weighted Sum	Weighted Mean	RII	Rank
Increase income	554	4.10	0.82	1st
Increase-food availability	540	4.00	0.8	2nd
Increased-food accessibility	539	3.99	0.79	3rd
Attain food security	531	3.93	0.78	4th
Improve nutrition	530	3.92	0.78	5th
Reduce poverty	527	3.9	0.78	6th
Reduce food scarcity	524	3.88	0.77	7th
Empowerment	519	3.84	0.76	8th

Source: Tsado *et al* (2019)

improved potato production technologies had the tendency to boost potato production in the study area. This result is in line with those of Alfred (2000) and IPC (2012), who pointed out that adoption of improved techniques usually resulted into increase in output, income and consequently improvement in the standard of living. The conclusion was that training and adoption of technologies significantly and positively influence farmers' output and could result into reduction in hunger.

8.12 Effect of adoption of improved cereal crops storage on the livelihood of the farmers

Storage plays a very important role in ensuring availability of food at all times or seasons of the year. Tsado *et al* (2019) investigated the effects of adoption of improved cereal crops storage on the livelihood of cereal crop farmers and the result presented in Table 8.12 shows that adoption of improved cereal crops storage affects the farmers positively. It has led to increase in their income, food availability, and



accessibility. It also reduces food scarcity, poverty, improve nutrition, attain food security and create empowerment. The conclusion was that the adoption of improved cereal crop storage systems has a positive effect on the livelihood of the farmers by improving their well-being by ensuring food accessibility and

S/N	Year	Agricultural Extension Training Programmes	Target Beneficiaries
1	2009	Master Trainer USAID/MARKET: Training of facilitators on adoption of recommended production practices (Rice Programme of Train the Trainers).	Selected rice farmers'cooperative society leaders and lead farmers in Niger State.
2	2011	Resource Person:Training of small-scale farmers on Rice Seed production and storage	Cooperative rice farmers in selected communities in Doko District of Lavun Local Government Area of Niger State.
3	2017	Training of farmers on adoption of sweet sorghum innovation at Tegina Farm Centre in collaboration with the Raw Material Research Council of Nigeria, Abuja.	Sweet sorghum farmers in the innovation platform at TeginaCommunity in Niger State.
4	2019	Technical Support training of lead farmers on Agricultural Marketing Information System (AMIS) in collaboration with IFAD	Selected lead farmers in Agricultural Zone 1, Niger State.
5	2019	Training of lead farmers on tracking of agricultural produce in collaboration with IFAD	Selected lead farmers in Niger State.
6	2020	Gap training of small farmers on cassava production and post harvest activities in collaboration with IFAD	Selected small scale farmers in Bankogi Community in Agricultural Zone 1, Niger State.
7	2020	Training on standard weight and measures in collaboration with IFAD	Selected lead farmers in Agricultural Zone 1, Niger State.
8	2020	Training on packaging of high-quality rice and cassava products in collaboration with IFAD	Selected lead farmers in Agricultural Zone 1, Niger State.

Extension training and outreach pictures

Plate I: Train the trainer workshop for extension personals and lead rice farmers in 2009in Minna

Plate II: OLAM out grower farmers with the Lecturer in 2012 at Lade Kwara State during train the trainers programme

Plate III: Training of lead farmers in 2020 at Agricultural Zone 1 Bida

Plate IV: The Vice-Chancellor of FUT Minna, Prof. Abdullahi Bala (1st from left) and DG National Agricultural Seed Council, Dr. Philip Olusegun Ojo (2nd from left) during FUT Minna Programme for Quality Seed Extension Field Day 2021

Plate V: The lecturer and the local leaders/farmers during FUT Minna Programme for Quality Seed Extension Field Day 2021

Plate VI: Officials of the NISS-OCP AFRICA PROJECT MinnaProject Site disseminating innovation and technology to farmers on solutions to problematic soils

Plate VII: Farmers with NISS-OCP AFRICA PROJECT Officials during the dissemination of innovation and technology to farmers on solutions to problematic soils

Map of Nigeria showing training and technology adoption pathway to a Hunger-Free Nation

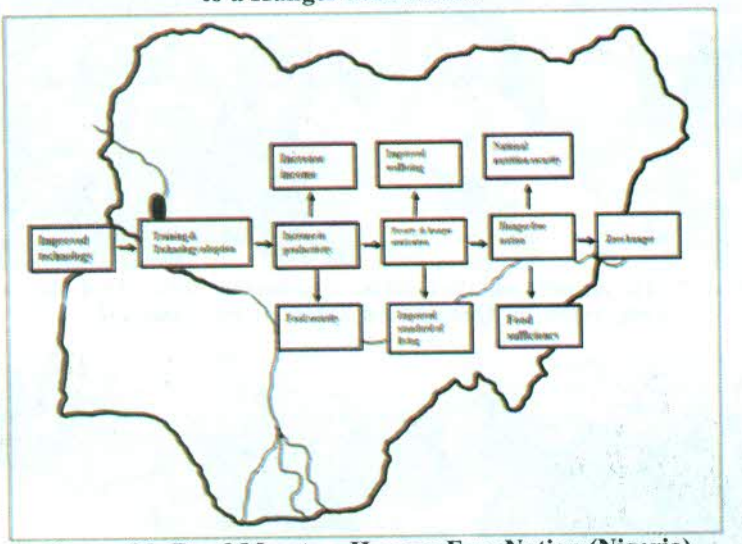


Figure 25: Road Map to a Hunger-Free Nation (Nigeria)
Source: Tsado (2021)

Training and technology adoption has a potentially large impact beyond the individual level. For example, in the agri-food sector, higher productivity can lead to a higher supply of food, improved food quality, and lower prices due to larger production volumes, less waste, and more efficient use of resources. These outcomes, in turn, affect the food security of a country and poverty reduction along with higher incomes in the agri-food sector which may lead to better nutrition and in the long run further boost the whole economy thereby eliminating hunger as indicated in Figure 25.

10.0 Conclusion

Training and technology adoption is a key to increasing farm productivity. Yield of farmers could be more than double rapidly through training in conjunction with the adoption of improved soil and crop management practices. Many small farmers could easily increase their productivity with access to training (practical

knowledge and skills), market, capital and inputs such as improved seeds, fertilizers, pesticides and agricultural machinery. Also, through training and technology adoption farmers could make the leap from subsistence farming to modern market-oriented production, guarantying greater income generation for escaping poverty and consequently freedom from hunger.

11.0 Recommendations

A nation without hunger is possible. However, for a long time the fate of rural areas and the small scale farmers has been ignored and their high potentials for development unrecognized. Food is the question of the survival of human kind and the answer to it for now and for a long time to come will be provided in the rural areas of our Nation. It is time to make the needed change of approach in policy making and unwavering commitment to it. Be it as it may, I still wish to make some recommendations, which include the following:

i. The fast step in reducing poverty and hunger in developing countries like Nigeria is to invest more in agriculture and rural development.
ii. Agricultural value chain should be made more attractive by ensuring availability and accessibility to appropriate and gender sensitive technologies.
iii. Farmers should be motivated through the provision of incentives like loans with low interest rate, readily available markets and price control mechanism should be put in place.
iv. Agricultural extension services should be strengthened to provide informal training that willhelp to unlock the potentials of the farmers for better understanding of new production techniques and technology leading to increase productivity and income with reduction in poverty and consequently freedom from hunger.
v. Input played a larger role in the rapid adoption of high yielding varieties and efforts should be geared towards making the technological innovation and their complementary inputs more easily and cheaply available to allow the technology to diffuse faster

12.0 ACKNOWLEDGEMENTS

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I sincerely appreciate my parents Mr. John Salawu Tsado and Mrs. Margret Woye Tsado who by the grace of God nurtured me from childhood to this day. You always taught me that "Godliness with contentment is a great gain." This teaching greatly influenced my perception and attitude to many things. I thank God for sparing your lives to witness this day. It is a rare privilege to still have both of you alive. Live on and continue to reap the fruits of your labour. For my mum, my healing prayer for you every day is that you will still rise to your feet one day. Amen. I deeply appreciate my siblings and their spouses: Mrs. Grace Edu and her late husband, Mr. and Mrs.(Dr) Miceal Jiya, Mr. and Mrs. Paul Yisa Yisa, Mr. and Mrs. Daniel Tasdo, Mr. and Mrs. Abraham N. Tsado, Mr. and Mrs. Nathaniel Umaru, and Mr. and Mrs. Peter Yisa. I sincerely appreciate my twin brother from another mother, Mr. David D. Tsado and his wife Mrs, Keziah K. Tsado, for their love and support. I also appreciate my uncles and aunties who include Mr. and Mrs. Jacob Garba Tsado, Mr. and Mrs. Abraham Z. Tsado, Professor and Mrs. D. N. Tsado, Rt. Rev. Daneil A. Yisa, the Bishop of Minna Anglican Communion and the Arch Bishop of Lokoja Province. Mr. Mathew Tsado and his wife, Eng. and Mrs. Isaac D. Tsado and all the Salawu's, I appreciate you all.

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BRIEF PROFILE OF PROFESSOR JACOB HARUNA TSADO

Professor Jacob Haruna Tsado was born on 4th January, 1968 to the family of Mr. and Mrs. John Salawu Tsado Doko from Lavun Local Government Area of Niger State, Nigeria. He started his Primary School at Langbafu Primary School, Doko in 1975. In 1981 he gained admission to Community Secondary School, Gaba and transferred to Mokwa Teachers' College where he completed his Secondary education. In 1986 he gained admission to College of Education, Minna and graduated in 1989 with Nigeria Certificate in Education (NCE) in Agricultural Education (double major). He worked briefly with the Niger State Secondary Education Board.

In 1992 he gained admission at University of Benin, Benin City, Nigeria, and graduated with B.Sc. (Ed) Degree in Agriculture. In 1995 he participated in the one year mandatory National Youth Service Corps at Yobe State and served at Produce Inspection Division, Potiskum. On completion of National Youth Service Corp, he returned to Niger State Secondary Education Board. In 2002 he got admission at University of Ilorin and graduated in 2004 with M.Sc. Degree in Agricultural Extension.

In 2007 he was employed by the Federal University of Technology in the then Department of Agricultural Economics and Extension Technology as Lecturer II. Two years after, he enrolled for PhD in Agricultural Extension and Rural Sociology at Federal University of Technology, Minna and completed in 2013. He rose through the ranks in his esteemed career and was promoted to the rank of a Professor of Agricultural Extension and Rural Development in 2019. He has served proficiently in the University; he is the pioneer and current HOD of Department of Agricultural Extension and Rural Development, he has also served as Level Adviser, Postgraduate Coordinator, and has chaired many Committees at the Departmental, School and the University levels.

Professor Tsado has graduated many undergraduate, Masters and PhD students. He has published over 70 peer reviewed papers in reputable journals and conference proceedings locally and internationally, and has attended several academic conferences both within and outside the shores of Nigeria. He is a member of many professional associations such as Agricultural Extension Society of Nigeria (AESON), Agricultural Society of Nigeria (ASN), Association of Teachers of Technology and he is a Registered Teacher with Teachers' Registration Council of Nigeria (TRCN). He is also a member of many Christian bodies like Fellowship of Christian Students, Nupe Intercessors and a host of others.

Professor Jacob Haruna Tsado has served as external examiner and assessors to Niger State College of Education, Federal Polytechnic, Bida; Ahmadu Bello University, Zaria; and University of Ilorin. He is a reviewer for several journals and has also served as ad-hoc staff of Independent Electoral Commission (INEC) as Collation Officer. He has served as consultant to Raw Material Research Institute, Abuja and International Fund for Agriculture and Development (IFAD) and has conducted several trainings for farmers to impart in them knowledge and skills for increased agricultural productivity for enhanced livelihood. Professor Tsado is married to Mrs. Alice .F. Tsado and the marriage is blessed with four Children: Jason, Gladys, Israel and Japheth and one foster child (Grace). His hobbies include farming, reading and playing football.

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