*Available online at* www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2812

**ISSN: 2320 – 7051**

*Int. J. Pure App. Biosci.* **5 (6):** 794-808 (2017)

*Research Article*

International Journal of Pure & Applied Bioscience

OPEN ACCESS

# Technology Adoption Levels in Yam Production in the Era of Trade Liberalisation in Ghana

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Received: 7.04.2017 | Revised: 16.05.2017 | Accepted: 20.05.2017

## ABSTRACT

*This paper assessed the level of technologies (both primitive and innovative) in yam production in the era of trade liberalisation and its related policies in Northern Ghana. Since the extent of adoption of technologies in the country is unknown; they are often are addressed with doubt. Through a multistage random sampling technique, 510 yam farm households were sampled and interviewed using structured schedules. Data on technology adoptions at the production level (seed yam, staking, labour, tillage, agrochemicals, system of cultivation, variety of yam, and number of times of harvest) were collected and analysed. The results revealed that, in terms of system of cultivation and agrochemical (fertilizer) use, innovation adoption level were very low (<5%) while medium levels (50-69%) of adoption were found for seed yam, non-staking, labour, tillage mechanization and agrochemical (weedicides) use. However, adoption of innovations in terms of the number of harvest and variety of yam cultivated was high (>70%). It was recommended that effort should be made to increase the adoption levels of minisett and staking technologies. Similarly, adoption of hired and skilled labours should be improved by increasing labour income status. Increasing tractor ploughing technology should be based on establishing plant pool in the producing districts.*

***Key words:*** *Seed Yam, Labour, Staking, Weedicides, Fertilizer, Innovation, Shifting Cultivation*

## INTRODUCTION

Trade liberalisation, a component of the Economic Recovery Programme of 1983 in Ghana, constituted a very ambitious supply-side programme with the aim of removing physical, technical and fiscal non-tariff barriers to the movement of goods, services, capital and persons inside the country. The successful elimination of these barriers in 1990 aimed at creating a large integrated trade for goods and services, allowing the realisation of economies of scale, and increasing competition in the internal market, which would end up in efficiency gains in all the sectors of the country.

**Cite this article:** Seidu, M., Sanjay, Yankyera, K.O., Seidu, A., and Frimpong, F.K., Technology Adoption Levels in Yam Production in the Era of Trade Liberalisation in Ghana, *Int. J. Pure App. Biosci.* **5(6):** 794-808 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2812

The agricultural sector is no exception so is the yam subsector. Trade liberalisation and its related policies also aimed at providing incentives for Ghanaian producers to invest in innovations. One of the major motivations of trade liberalisation in the Agricultural sector especially the yam subsector is the belief that trade liberalisation stimulates innovation adoption, encourages efficiency and drives consumer prices down[6,9].

However, in Ghana, the state of adoption of innovations in the yam subsector is largely unknown. As such the extent of innovations are addressed with mixed feelings and doubt since they are also unknown. The assertions of Tetteh & Saakwa[21], Amanor[3], Otoo[12], Otoo *et al*[12], Ennin *et al*[5], Seidu[20], point out to the fact that there have been changes at the farm level in the yam subsector in terms of seed yam and labour use, staking, yam varieties, system of farming, mechanisation, agro chemical usage, harvesting, and the market demands for yam however the extent and level of adoptions were apparently missing out from their findings. Most stakeholders and researchers who attempt to explain the state of adoption of technology or innovation in the yam subsector in Ghana base their assertions on subjective notions about the conventional practices and technologies of farmers but not on empirical evidences. Therefore, an empirical description regarding the extent and level of technologies (both primitive and innovation) adoption is necessary.

In a nutshell, the extent and level of innovation adoption in the yam subsector in Ghana is largely unknown so the current state/level of technology or innovation adoption is inconclusive and unknown. Only with a thorough knowledge of this concern can further insight be developed concerning strategies to promote the adoption of improved technologies or innovation in the yam subsector. The paper focused on technologies and levels of adoption in yam production in the areas of seed yam, cultural practice such as staking, labour use, tillage practice such as ploughing, weed control, system of farming, soil nutrient requirement, variety of yam cultivated and number of harvest (double or single). Hence the paper assessed and identified the levels of technologies (both primitive and innovative) in yam production in the environment of trade liberalisation and its related policies in Kpandai district in Northern Ghana. The study defined innovation as technology or practice or system that has been developed, modified or gain special attention or consideration due to the change trade liberalisation has brought to the yam subsector and otherwise described as primitive technology.

## MATERIALS AND METHODS

The study was conducted in the Kpandai District of Northern Region of Ghana (*see* Figure 1). Multistage sampling was employed in the study. The first and second stages were a purposive selection of the region (Northern) and the district (Kpandai) because of their respective massive yam production relative to other regions and districts. Moreover, most of the farm households in the district are engaged in yam production. The district consists of four major Agricultural Zones namely; Kpandai, Katiejieli, Jamboi and Ekumidi. In the fourth stage, the study included all the zones in the survey in order to get representative sample from each zone in the district. In the third stage, within each Agricultural zone four (4) communities were randomly sampled except Katiejieli where five communities were randomly sampled because the number of communities in the zone was many relative to the other zones. The total number of communities that were sampled was seventeen (17). A random sampling technique was again employed in stage five to select thirty (30) farm households within each selected communities. In all 510 farm households were selected and interviewed using structured schedules. Information regarding farm household's socio-economic characteristics and various technologies (primitive and innovations) farmers adopt in domains of seed yam, cultural practice such as staking, labour use, tillage practice such as ploughing, weed

control, system of farming, soil nutrient requirement, variety of yam cultivated and number of harvests (double or single) were collected using structured schedules. The level of technology adoption was measured as the frequency and percent of farmers taking on a particular technology. Moreover, technologies and practices that were innovative were identified by considering technologies that have emerged or gained patronage which used not to be in the past in the environment of trade liberalisation and its related policies and otherwise define as primitive practice or technology. Descriptive statistics consisting of frequency counts and percentages as well as a comparison of means and standard deviations for some key variables were used in the empirical analysis.

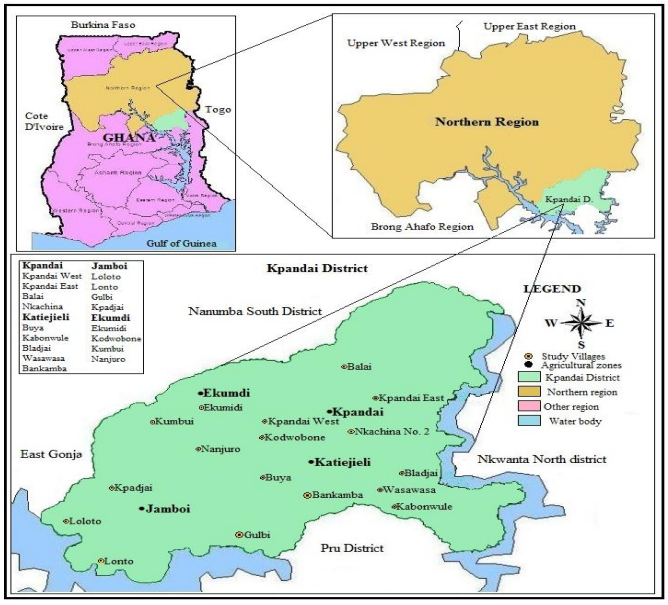



**Fig. 1: Geographical location of Kpandai District**

**Source: Author's construct**

**Instrumentation and definition of technology (innovation and primitive)**

Seed yam: The study identified minisetts, small setts cuttings, large setts cuttings, small whole tubers and milked seeds as seed yam technologies in the study area. Based on the study definition of innovation and that of Seidu & Yankyera[17], minisetts, small setts and milked seeds technology were considered as seed yam innovation while large setts cuttings and small whole tubers were defined as primitive technology.

**Cultural practice (staking):** Traditionally, farmers cultivate yam on small scale hence, they either adopt the parkland system to provide stakes[12] or fetches stakes from the wild. In locations where deforestation was the case, farmers purchase staking materials and transport to their farm's fields. However, with the growing demand and associated supply of yam partly due to trade liberalization and its related policies, yam production on large acreages has been the case hence the adoption of the traditional parkland system and fetching of stakes in the wild are almost impossible due to the scarcity of the staking materials. The cumbersome, laborious and expensive natures of the technology have made it unattractive to the farmers[19]. In certain parts of the country very limited number of farmers use ropes as staking materials; nevertheless this practice was not observed in the study area. The study defined staking as the artificial provision of stakes or supports (apart from life shrubs and trees) for yam vines 'trained' as they grow by farm households. Over the years, non-staking and other methods of staking have been increasing in yam production. The paper basically measured innovation adopters as farm households adopting non-staking otherwise as primitive technology adopters. However, in terms of the types of staking the study again classified farm households that

practice single stake per yam stand (1:1) as adopting primitive technology whereas farmers that use a stake for two or more yams vines (1:2/more). Considering the source of staking materials, the paper categorized households that purchased staking materials as being innovative while those that obtained theirs from the wild virtually for free as practicing primitive technology.

**Labour use:** The paper also categorise labour use in two ways; these were the source of labour (family and hired) and type of labour (skilled and unskilled); where hired and skilled labour for each category were defined as innovation and the other (family and unskilled labour) as primitive practice which is similar to the definition of Seidu[14,18].

**Tillage practice (ploughing):**Farm households who during tillage (e.g. ploughing) used mechanized means were classified as adopting an innovation (mechanization) while those who used the zero and manual tillage techniques were noted as adopting primitive technology. The study, therefore, defined mechanized ploughing based on the premises of Seidu[15] as a ploughing achieved either by animal-drawn ploughs or tractor- mounted ploughs.

**Weed control:** The use of weedicides or herbicides by farm households to control weeds was identified as innovation adoption whereas the use of hoes and/or cutlasses for controlling weeds as primitive practice[16].

**System of farming:** In terms of the system of farming, the study identified that continuous cropping is rapidly replacing the traditional shifting cultivation partly due to the scarcity of land, labour and the cost involved in developing a new land for cultivation. The paper, therefore, distinguished continuous cropping system as an innovation while shifting cultivation as a primitive technology.

Soil nutrient requirement: Farm households adopt the traditional fallowing practice and the use of inorganic fertilizer to supply nutrient requirements to yam. The paper therefore isolated farm households that use inorganic fertilizer during cultivation as innovation adopters while those that stick to fallowing as primitive technology adopters.

**Variety of yam cultivated:** The paper also considered farm households cultivating varieties of yam that have high market demand (white yam: Pona, Larebako, Asana, Olodo, Mpuano, Danye and Alaba) as adopting innovation while varieties that have low market demand (water yam varieties: Akaba and Seidubile) as practicing primitive technology.

**Number of harvest (double or single):** Cultivation of late maturing varieties (water yam: Seidubile or Akaba) of yam use to be the main yam on most producers farm. However, the cultivation of early maturing yam varieties is competing with the late maturing varieties for space in producers' farm because of the high market demand. For early-maturing varieties (e.g. white yam or yellow yam: Pona, Larebako) tubers for consumption or sale are harvested first (early) via a process called milking. The plant then produces new tubers, which are used as planting tubers for the next cropping season. Because of the two successive harvesting within a single season the term "double harvest" is common among yam producers. Tubers from milking are of poorer quality and sometimes diseased[8] nonetheless, double harvest yam varieties are gaining more attention due to the increasing market demand and consumption of yam. In the past yam was harvested once in a planting season because late maturing varieties were patronised by then. However recently due to the nature of demand, most farmers harvest their yam twice in a season; the first harvest in June or July (milking/tapping) and the final harvest in August to November. Therefore the study categorised farm households mostly practicing double harvest or milking (harvesting twice) on their farms as innovation adopters and otherwise as adopting primitive technology.

## RESULTS

From Table 1, the study identified that farm households in the study area cultivated yam on large acres; which reflected a large number of tubers harvested by them. Table 2, further pointed out that yam cultivation in the study area was male domineering and most farm

households engaged in yam cultivation were between the ages 31-40 years and the least were below 21 years. It was also observed from Table 2 that most farm households have no formal education, group membership and financial assistance (credit). Mostly the type of fund available for yam cultivation the households was personal cash savings and it was obvious also from Table 2 that the households were averagely solvent.

**Table 1: Distribution of the sampled households by size of land cultivated**

| Household characteristics | Mean | SD | Min | Max | Total |
|---|---|---|---|---|---|
| Size of land cultivated (acres) | 18.64 | 16.79 | 1 | 100 | 9507 |
| Output (Number of yam tubers) | 17428 | 15503 | 400 | 86995 | 8,888,368 |

Source: generated from field survey data

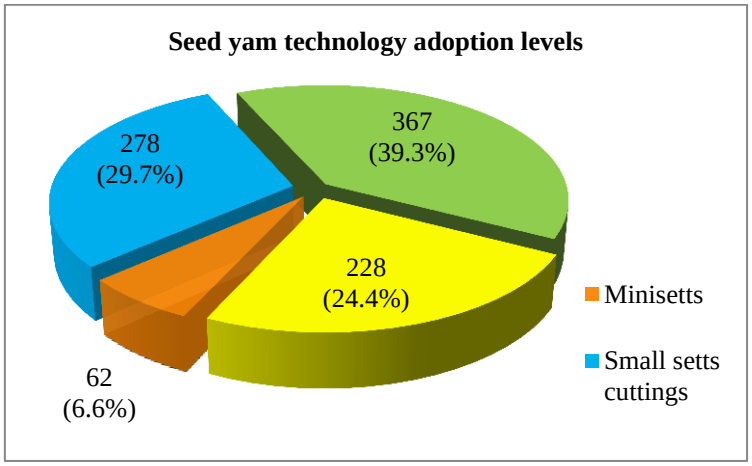
**Table 2: Summary of basic statistics of sampled household: non-continuous variables**

| Household characteristics | Response | Freq. | % (N=510) |
|---|---|---|---|
| Gender | Female | 16 | 3.1 |
| | Male | 494 | 96.9 |
| Age | <21yrs | 15 | 2.9 |
| | 21 – 30 yrs | 148 | 29.0 |
| | 31-40 yrs | 179 | 35.1 |
| | 41-50 yrs | 133 | 26.1 |
| | >50 yrs | 35 | 6.9 |
| Educational level | No formal schooling | 372 | 72.9 |
| | Primary | 42 | 8.2 |
| | JSS/JHS/O-Level | 33 | 6.5 |
| | Middle | 17 | 3.3 |
| | SSS/SHS/A-level | 33 | 6.5 |
| | Voc/tech/Commercial | 4 | 0.8 |
| | Post-secondary diploma | 4 | 0.8 |
| | Bachelor degree | 5 | 1.0 |
| Group membership | No | 330 | 64.7 |
| | Yes | 180 | 35.3 |
| Financial assistance (credit) | No | 510 | 100.0 |
| | Yes | 0 | 0.0 |
| Type of fund apart from credit | Cash savings | 356 | 69.8 |
| | Remittances | 143 | 28.0 |
| | Both | 11 | 2.2 |
| level of solvency | Very Low solvency | 47 | 9.2 |
| | Low solvency | 98 | 19.2 |
| | Average solvency | 207 | 40.6 |
| | High solvency | 105 | 20.6 |
| | Very High solvency | 53 | 10.4 |

Source: generated from field survey data

**Technologies/Practices and Innovation adoption levels**

Among the four seed yam technologies identified in the study area, milked seeds were highly adopted on most farms nevertheless minisett technology was the least patronized (see Figure 2 and Table 3). Table 3 further highlights that, farm households were innovative by mostly using minisetts, small setts cuttings, and milk seeds in cultivation instead of traditional setts.




Source: generated from field survey data

**Fig. 2: Distribution of adoption levels of seed yam technologies**

**Table 3: Distribution of seed yam technologies by adoption levels**

| Seed yam technologies | Freq (f) | % (N=∑f) | % (N=510) | Technology | Adoption (%) |
|---|---|---|---|---|---|
| Minisetts | 62 | 6.6 | 12.2 | Innovation | 75.6 |
| Small setts cuttings | 278 | 29.7 | 54.5 | | |
| Milking / tapping | 367 | 39.3 | 72.0 | | |
| Traditional setts | 228 | 24.4 | 44.7 | Primitive | 24.4 |
| **Most used Seed yam** | | | | | |
| Traditional setts | 219 | 42.9 | 42.9 | Primitive | 42.9 |
| Minisett/Small setts /Milk seed | 291 | 57.1 | 57.1 | Innovation | 57.1 |

Source: generated from field survey data

Considering Table 4, it is obvious that non-staking of yam vines dominated yam cultivation in the study area because most households cultivated yam on bare lands (lands without staking materials or supports for yam vines) and some few on lands with shrubs. Nonetheless, in terms of the sources of staking materials, many households purchased their stakes for cultivation. Similarly, 1:2/more staking type was common among the farmers who patronized staking technology.

**Table 4: Distribution of staking practices by adoption levels**

| Staking Practices | Freq (f) | % (N=∑f) | % (N=510) | Technology | Adoption (%) |
|---|---|---|---|---|---|
| Staking | 193 | 37.8 | 37.8 | Primitive | 37.8 |
| Non Staking | 317 | 62.2 | 62.2 | Innovation | 62.2 |
| **Source of Stakes** | | | | | |
| Purchased | 121 | 62.7 | 23.7 | Innovation | 23.7 |
| From wild | 72 | 37.3 | 14.1 | Primitive | 14.1 |
| **Type of Staking** | | | | | |
| 1:1 Staking | 63 | 32.6 | 12.3 | Primitive | 12.3 |
| 1:2/more Staking | 130 | 67.4 | 25.5 | Innovation | 25.5 |
| **Non staking Methods** | | | | | |
| Farming on lands with shrubs | 56 | 17.7 | 11.0 | Innovation | 62.2 |
| Cultivation on bare lands | 261 | 82.3 | 51.2 | | |

Source: generated from field survey data

Table 5 unveiled that in terms of labour source and type, sampled households were innovative; majority of the farm households adopted hired and skilled labour for their farming activities. Mechanised ploughing (the use of tractor for ploughing) has gained much patronage over non-ploughing of fields during tillage.

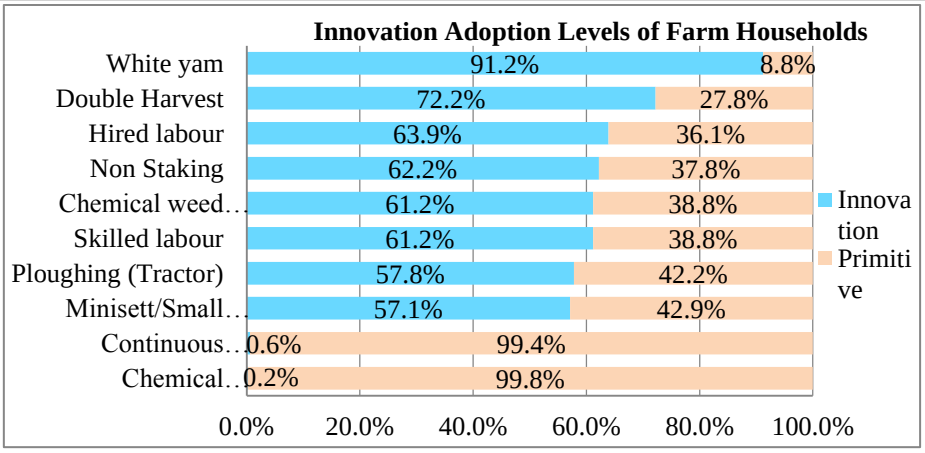
**Table 5 below gives simple summary statistics of technology adoption levels**

| Practices/ technologies | Freq (f) | % (N=∑f) | % (N=510) | Technology | Adoption (%) |
|---|---|---|---|---|---|
| **Labour Use** | | | | | |
| ***Source:*** Hired | 326 | 63.9 | 63.9 | Innovation | 63.9 |
| Family | 184 | 36.1 | 36.1 | Primitive | 36.1 |
| ***Type:*** Skilled | 312 | 61.2 | 61.2 | Innovation | 61.2 |
| Unskilled | 198 | 38.8 | 38.8 | Primitive | 38.8 |
| **Mechanisation** | | | | | |
| No Ploughing | 215 | 42.2 | 42.2 | Primitive | 42.2 |
| Tractor Ploughing | 295 | 57.8 | 57.8 | Innovation | 57.8 |
| **Weed Control** | | | | | |
| Chemical weed control | 312 | 61.2 | 61.2 | Innovation | 61.2 |
| Non Chemical weed control | 198 | 38.8 | 38.8 | Primitive | 38.8 |
| **System of Farming** | | | | | |
| Shifting Cultivation | 507 | 99.4 | 99.4 | Primitive | 99.4 |
| Continuous Cropping | 3 | 0.6 | 0.6 | Innovation | 0.6 |
| **Soil Nutrient Requirement** | | | | | |
| Chemical Fertilizers | 1 | 99.8 | 99.8 | Innovation | 99.8 |
| Non Chemical Fertilizers | 509 | 0.2 | 0.2 | Primitive | 0.2 |
| **Variety of yam** | | | | | |
| White/yellow yam (High demand) | 465 | 91.2 | 91.2 | Innovation | 91.2 |
| water yam (low demand) | 45 | 8.8 | 8.8 | Primitive | 8.8 |
| **Number of Harvesting** | | | | | |
| Single | 142 | 27.8 | 27.8 | Innovation | 27.8 |
| Double (Milking / tapping) | 368 | 72.2 | 72.2 | Primitive | 72.2 |

Source: generated from field survey date

It was isolated that majority of the farm households used chemicals to control weeds instead of hoe and cutlass. Almost all the farm households during cultivation adopted the system of shifting cultivation. Unsurprisingly, Table 5 revealed that all the farm households do not use chemical fertilizer for cultivation of yam but one. White yam varieties were more cultivated than the water yam varieties in the study area. Table 5 further revealed that majority of the farm households harvested their yam twice in a season.

A careful observation of Figure 3 pointed out that chemical fertilizer application is the least adopted innovation while white yam cultivation is the highest patronized practice. Moreover, Figure 2 showed that the sampled households were innovative in relation to variety seed yam (minisetts, small setts cuttings, and milk seeds), cultural practice (non-staking), labour type (skilled), labour source (hired), tillage practice (tractor ploughing), weed control (chemical), variety of yam cultivated (white yam) and number of harvest (double). On the contrary in terms of system of farming (shifting cultivation) and soil nutrient requirement (non useage of chemical fertilizer) the sampled households were not innovative.




Source: generated from field survey data

**Fig. 3: Innovation adoption levels among farm households**

## DISCUSSION

### General characteristics of sampled farm household

The study responses were obtained from 510 farmers from 17 communities in four agricultural zones with a combined output of 8,888,368 tubers of yam under an approximate total land size of 9507 acres (*see* Table 1). Moreover, the assertion of Seidu[14], Seidu & Yankyera[17], Seidu[15,16,18] showed the worth of a farm household based on the number of tubers harvested in a season, these assertions pointed out that, a batch of 100 tubers of yam ranges from GH₵ 50.00 to GH₵ 400.00 depending on the sizes and time of marketing of yam.

As shown in Table 2 majority (96.9%) of the farmers were male and 67% of the farmers were below 40 years of age. With most of the farmers being male, Udoh *et al*[22] believe that the subsector is unstable and unsustainable. However, Manyoung *et al*[7],found that yam is considered to be "man's crop" in Africa because it is labour intensive, this might account for why majority (96.9%) of the farmers were males and were in their active production years. Similarly, Abiola and Omoabugan[1] confirmed that farmers around age 40 years are economically active. Having the younger farmers indicated that the subsector is becoming more income oriented. It is also interesting to note those within the age range of 31-40 years formed the mass of the farmers (35.1%). This might imply that the yam farming is very lucrative in the area so these farmers have actually taken up yam farming as a serious venture and would want to remain in the business. The level of formal education among the sampled farmers was very low (27.1%) representing 138 farmers. Among these farmers, only five (1%) has attained tertiary education with a Bachelor degree. The remaining 26.1% who have acquired formal education, majority (8.2%) of them were primary school leavers (Table 2). Because of the low level of education among the farmers, it would be easy to juxtapose that innovation adoption among the farmers is going to be very slow and most of the farmers are likely to be laggards when innovation adoption becomes important. More than half of the producers thus 330 representing 64.7% belonged to a local farmer's organisation. None of the farmers interviewed use credit for production however they depend mainly on cash savings and remittances. Farmers using only cash savings and remittances were 356 (69.8%) and 143 (28%) respectively, nonetheless, 11 (2.2%) of the farmers uses both (Table 2). From the study, it was observed that formal credit accessibility was lacking. Therefore, sampled farmers in the study area did not access formal credit for production. It is not as if households do not access credit of any form. Informal forms of credit existed in very limited supply in the study area. However, to the surprise of the study, the sampled household did not access these forms of credit too. Nonetheless, a personal informal conversation with some

opinion leaders of the district revealed that in very rare situations few number of farm households opt for seed yams and other inputs from other households in difficult times. The seed yam credited is later paid in the same units or in cash.

The level of solvency, which is a measure of farmer's liquidity and worth status shown in Table 2, clearly points out that most (40.6%) of the producers were within the average solvency group followed by high solvency producers (20.6%). Only 9.2% of the farmers were very low solvent. This suggests that sampled farmers have a good worth status and have a higher likelihood to practice improved technologies that are cash demanding because they would be capable of meeting financial obligations. Not only can they finance the cost of innovations but they can also easily absorb shock and risk. Moreover, they can easily access credit if made available because they have support to overcome credit risks.

**Technologies/Practices and Innovation adoption levels**

**Seed Yam technology adoption level:** Seed yam technologies adopted in the study area were minisetts, milked seeds, small setts and traditional setts cuttings (big setts cuttings and small whole tubers). As shown in Figure 2, milked seeds technology recorded the highest level of adoption (39.3%), followed by small setts cuttings (29.7%), traditional setts cuttings (24.4%) and minisett (6.6%) being the least technology adopted. Among the seed yam technologies; minisetts, small setts cuttings and milked/tapped seeds were the new technologies practiced by farmers in the area. However, traditional setts (made up of big setts cuttings and small whole tubers) was the technology primitive to the farmers. The level of adoption of innovation considering seed yam was found to be 75.6% while the remaining percentage represents primitive practice (see Table 3). Since a farmer could adopt more than one seed yam technology in a season, the study found out the major technology the farmers adopted. From Table 3, it was again observed that, 57.1% of the farmers used mainly innovative technologies (minisetts, small setts cuttings, and milk seeds) while 42.9% adhere to primitive technology such as (big setts cuttings and small whole tubers). From the result, it can be deduced that farmers in the study area have been innovative with regards to seed yam technologies. However, considering the time span since the release of minisett technology, the 6.6% level of adoption (see Table 3) might be an indicator of unattractiveness of this technology to the farmers. The unattractiveness of minisett technology might stem from the reasons that most of the farmers were unaware of the technology, extent of education on the technology was very low, and incidence of high rate of rot accompanied with poor sprouting rate at the initial period of introduction

**Cultural Practice (Staking):** Staking had a low level of adoption. One hundred and ninety-three farmers representing 37.8% practice staking. However, three hundred and seventeen farmers (62.2%) did not adopt staking (see Table 4). Non-staking of yam has become a very common innovation in the study area. It was not as if the farmers in the study area did not know the importance of staking their yam farms, but because the demand for yam over the past few years has forced the cultivation of the crop on large acreages, there have been shortage of stakes in the district. Indeed, in some parts of the district, the shortage is so acute that the stems of elephant grass and dried palm fronds were used as stakes for yam. These have made staking practice very expensive and farmers find it very difficult to stake their farmlands. Therefore, most farmers have resorted not to stake their yam farms. Moreover, over the years, the practice of non-staking has not resulted in poor outputs which might be due to the high fertility status of the soils in the area therefore, the practice has been attractive to most farmers in the area (whether cultivating on small or big farms) within this period.

Among farmers that practiced non-staking, another form of innovation was also identified. Thus, the cultivation of yam on

farm lands with shrubs. Farmers purposively identify farmlands with shrubs and small trees to cultivate yam. In so doing they also escape the cost of obtaining artificial stakes. Artificial stakes are supports apart from life shrubs and trees along which yam vines twines around as they grow. Table 4 shows that, 62.2% of farm households practiced non-staking, out of which 11.0% adhere to yam cultivation on lands which have some shrubs and small trees growing on it and 51.2% adopted non-staking on farm land without natural or artificial staking. Although staking of yam was not an innovation in the study area, however, a critical view and understanding of the forms of staking in the area revealed that there have been some changes in the practice. In the past staking was done by mounting a stake per mound (1:1 staking) nevertheless new forms of staking have evolved in order to cater for the high cost involved in staking. The mounting of a stake to two or more mounds (1:2/more staking) for yams to twine on is now very common among the sampled households involved in staking. The adoption of 1:1 staking practice stands at 12.4% level while the 1:2/more staking is 25.5% among sampled households. The implication is that most of the sampled farmers practicing staking are becoming more business oriented and trying to reduce their cost of production by adopting the 1:2/many staking technique.

Moreover, there was another form of innovation identified in relation to the source of stakes by the farmers. Some farmers obtained their stakes in the wild at a free (zero) cost while others purchased theirs. The latter is an innovation at an adoption level of 23.7% while the former is a primitive practice adopted at 14.1% level. From the result in Table 4, it can be perceived that yam stakes are becoming increasingly scarce and farmers find it stressful in getting stakes from the wild therefore purchasing of the stakes now commands the greater percentage of the source of stakes.

**Labour Use:** The use of labour was approached in two major ways; viz. the source of labour and type of labour. Considering the source of labour, an innovation that was witnessed in the subsector was the use of hired labour. Hired labour used not to exist however, currently the use of hired labour dominates the yam subsector representing 63.9% adoption rate (see Table 5) which was consistent to the findings of Echebiri & Mbanasor[4] however inconsistent to the results of the studies of Ojo[11] in Nigeria. Furthermore, the level of adoption of family labour among the sampled farmers was 36.1%. The shift of attention from the use of family labour to hired labour might probably be due to the rural urban migration drift and the quest for education, which makes children and other family members unavailable for farm work.

Moreover, for the type of labour, it was observed that farmers employed special kind of labours for special operations (such as mounding, ploughing, and weedicides application). The study considered these labours as skilled and therefore an innovation practice. From Table 5 it was again observed that 61.2% of the sampled farmers adopted skilled labour and 38.8% of the farmers use only unskilled labours in all farming activities. Unskilled labour in the study suggests labours that would not be considered for the aforementioned special operations where even these special labours are available.

**Plough Mechanisation:** In general, the level of mechanisation in the area was very low; however, in the field of land preparation, ploughing was the most tillage practice where mechanisation was common. Among the sampled households, none of the farmers used animal power to plough their lands. Farmers' ploughed their lands with tractors. The only farm operation mechanised during land preparation in the area was ploughing. From Table 5, it was revealed that 57.8% of the farmers where innovative. These farmers hired the services of tractor to plough their farm before planting on the lands. However, 42.2% of the farmers did not plough their lands. Inference made from the result suggests that the level of innovation in relation to ploughing is encouraging.

**Weed Control:** Chemical weed control has been one of the innovations that have widely been accepted by a lot of farm households in the study communities. The successful adoption of the use of agro chemicals to control weeds may mostly be due to the reason that, most farmers believe that this technology has helped them to increase their acreage under cultivation. This success was been achieved because the innovation has helped them to solve the drudgery and laborious nature of yam cultivation to some extent. The use of cutlass and hoe to control weeds is not only laborious but also expensive and time consuming. Therefore, it was unsurprising to observe that adoption of agro chemicals to control weeds was 61.2% and the use of primitive techniques (hoe and cutlass) was 38.8% (see Table 5)

**System of farming:** In an attempt to reduce the drudgery component of yam cultivation and reduce the cost component associated with the preparation of new lands, shifting cultivation was thought economically wise to be replaced by a permanent system such continuous cropping. However, the level of adoption of continuous cropping in the study communities was very low (0.6%) while shifting cultivation being a primitive farming system commands an adoption rate of 99.4% (see Table 5). The low adoption of continuous cropping in the area might be because farmers in the study area cannot afford the associated cost of buying chemical fertilizers, and pesticides to arrest soil fertility decline and disease and pest problems that might arise in the cause of time. Some farm households did not even see the need for the use of chemical fertilizers since lands were available for them to shift to for cultivation.

**Soil Nutrient Requirement (Fertilizer application):** Farmers in the study area generally tended not to apply fertilizers on yam. The high expense involved in fertilizer input purchase may be a limiting factor. Furthermore, farmers change their yam farms every cropping season to new farmland where the soil fertility level is high, and the use of an expensive input would not be consistent with economic rationality of producers' decision-making. Hence, it is only fair to observe that adoption rate of fertilizer is very low (0.2%) and cultivation of yam without chemical fertilizers are very high (99.8%) in the study area (see Table 5). From the survey it was observed that chemical fertilizer adoption level would increase if continuous cropping in yam production increases.

**Cultivated Variety of yam:** Cultivating varieties of yam that have high market demand were considered as innovation while cultivating varieties that have low market demand as indigenous practice by the study. In the study area, cultivation of white yam such as Pona, Larebako, Asana, Olodo, Mpuano, Danye and Alaba were yams that have high market demand. However, the water yam varieties such Akaba and Seidubile have low market demand. Demand for yam in the market forced farm households in the study area to adopt the cultivation of white yam varieties at a very high level (91.2%) while that of water yam as low as 8.8% (see Table 5). The result of the study is consistent with findings of Tetteh and Saakwa[21], Ojofeitimi and Olufokunbi[11] and Aidoo[2].

**Number of Harvest (double or single):** From Table 5, 27.8% and 72.2% of farmers in the study area practiced single harvesting and double harvesting respectively, suggesting a low preference for single harvesting as compared to double harvesting. Clearly, it suggests that most farmers cultivate varieties that are early maturing. It also affirms that milking and white yam cultivation is highly adopted by farmers in the study area.

From Figure 3, it was observed that chemical fertilizer application is the least adopted innovation while white yam cultivation is the highest patronized practice. A second look at the adoption levels also gives room for the study to comment that households easily adopted innovations that seems to increase their income strength (e.g. white yam cultivation and double harvest) however the opposite was the case for innovations that drained their coffers (e.g. continuous cropping and fertilizer application).

Conclusion and Recommendation

The various technologies/practices identified and their respective level of adoption fall under seed yam, staking, labour, mechanisation, weed control, variety of yam, system of farming, soil nutrient requirement and the number of harvest in a season.

**Seed yam:** Milked seeds recorded the highest level of adoption (39.3%), followed by small setts cuttings (29.7%), traditional setts cuttings (24.4%) and minisett (6.6%) being the least technology adopted. Holistically, the level of innovation adoption was 75.6% and that of old practice was 24.4% (traditional setts). Moreover, it was generally observed that 57.1% of the sampled farmers mainly use innovative technologies while 42.9% adhere strictly to primitive technology (traditional setts). Policies should, focus on measures to improve the adoption of minisett technology in order to enhance higher integration of farm households into the foreign market and reduce high cost and scarcity of seed yam in the country. In doing so it would be expedient for policies to focus on building a good relationship between yam producers and exporters. Such a strong vertical integration between the parties would help to bridge the gap of trust between farmers and yam exporters and would also promote effective communication between the two parties.

**Cultural Practice (Staking):** The adoption of staking was low (37.8%) in relation to non-staking adoption level (62.2%). Although, non-staking is an innovation farmers employ to cut down the high cost of production and also to reduce the labour associated with production however this practice cannot survive the yam subsector in the long run since non staking is disadvantageous in areas where the soil fertility and sunshine is low and when the soil fertility is reducing. It is therefore recommended that yam research programmes should consider means of solving non-staking menace to sustain the subsector. The study recommends that research should focus on producing yam varieties that would be acceptable by farmers and would do well in all conditions even without staking through a collaborative research between farmers and researchers. Moreover, efforts should be directed in establishing woodlots in farming communities to supply stakes for farming. Promotion of staking techniques that require the use of fewer numbers of stakes should be invigorated and promulgated.

**Labour Use:** The study addressed labour use under the broad headings; the source and type of labour. Under the source of labour; 63.9% and 36.1% of farmers in the study area used hired and family labour respectively. Furthermore, majority of the farmers (61.2%) use skilled labours while only few (38.8%) of them use only unskilled labours for yam cultivation. The use of skilled and hired labours promote efficiency in production so it is recommended that a deliberate policy should be developed in order to improve the income levels of these labours to ensure the effective maintenance and continuity of the labours. Furthermore, policies should be developed to incorporate labour saving technologies such as draught power for tillage and/or transportation in order also to reduce the cost of production on the part of the farmers.

**Plough Mechanisation**: It was observed that more than half (57.8%) of the sampled households adopted tractor ploughing technology while the remaining households (42.2%) adopted zero ploughing technology. The adoption level of tractor ploughing technology could have been higher than the observed but inadequate availability of tractor in the district has been the main factor. Therefore, in order to further improve the adoption of this technology establishment of tractor plant pool in yam cultivating districts would help to reduce the difficulties farmers face in hiring the services of tractors in peak demand periods (May-July).

**Weed Control:** The control of weeds in the study area was predominantly done by the use of agrochemicals (weedicides: 61.2%) and/or hand weeding (hoe and cutlass: 38.8%). Adoption of weedicides technology alone does not ensure efficiency in production but however using it in recommended quantity, and time can help to achieve good results.

Therefore it is recommended that promotion of education on the use of weedicides should be heightened.

**System of Farming:** Almost all the households still adopt the old system of cropping thus, shifting cultivation. Only 0.6% of the farmers adopted continuous cropping and the remaining 99.4% adopted shifting cultivation. Shifting cultivation though highly patronized by farm household but requires large land size for constant yam cultivation. This suggests that in areas where land availability and accessibility is difficult yam production would not be effective. What is more, shifting cultivation system will be compromised and negatively affected by rapid increases in population, economic and social change in the future. The study therefore recommends that research and policy directions should be directed towards developing land saving technologies that are farmer friendly such as continuous cropping, fertilizer use, and crop rotation.

**Soil Nutrient Requirement:** Sampled farmers mainly cultivated yam on virgin or new farm lands which have been left to fallow. Fallowing and the use of inorganic fertilizers were the means farmers adopted to supply nutrients to soil and the crops as well. However, it was observed that farmers generally stuck to fallowing which is the old method of restoring soil fertility. Only 0.2% of the farmers adopted inorganic fertilizer technology whiles 99.8% of the farmers adopted fallowing as a soil nutrient management practice. Farmers in the study area generally did not apply fertilizers on yam. The high cost involved in the purchase of fertilizer may be a limiting factor. Moreover, since farmers were practicing shifting cultivation they did not see the importance of apply inorganic fertilizer to new fertile land since it does not make economic sense. Fertilizer adoption improvement can be achieved by effective development of land saving technology and developing measures that would make fertilizers easy to be purchased by farmers.

**Cultivated Variety of Yam:** Two major varieties of yam were cultivated in the study area, thus the white and water yam varieties. The study revealed that white yam was mostly cultivated among farm households. Farmers cultivating white yam (high market demand) varieties were innovative while water yam (low market demand) variety cultivators where non innovative. 91.2% of the farmers cultivated white yam varieties (Pona, Larebako, Asana, Olodo, Mpuano, Danye and Alaba) while only 8.8% mainly cultivated water yam varieties (Akaba and Seidubile). It was recommended that all intended policies that would be directed toward the improvement of the yam subsector in future should be friendly to the white yam so that it can easily be accepted by farmers.

**Number of Harvest (double or single):** In terms of the number of harvest in a season, most of the sampled households (72.2%) harvested yam twice a season and few farmers (27.8%) still succumb to single harvesting. Thus, double harvest was the most adopted practice by yam producers in the study area. The need to ensure availability of seed yam have accounted for this practice. This suggests that improvement of seed yam development and measures for acceptance of developed technology must be paramount to the research and extension institutions.

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