

**ADOPTION OF OYSTER MUSHROOM PRODUCTION AMONG BENEFICIARIES  
OF THE PROMUSH PROJECT IN THE ADENTAN MUNICIPALITY OF GHANA**

**BY**

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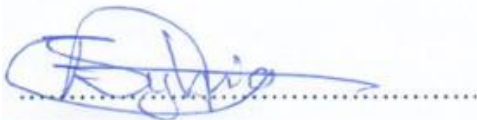
**COLLEGE OF BASIC AND APPLIED SCIENCES**

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### DECLARATION

I, Sylvia Edem Agyeman, hereby declare that this thesis, “**Adoption of oyster mushroom production among beneficiaries of the PROMUSH project in the Adentan Municipality of Ghana**”, is entirely my own work produced from research under supervision. To the best of my knowledge, no part of this work has been presented for another degree elsewhere, and that this thesis has been examined and approved by my supervisor Prof. Irene S. Egyir. I also declare that any quotation(s) or paraphrase(s) from published or unpublished works of any other author(s) has been duly acknowledged.

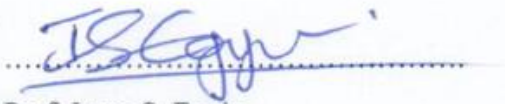


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## **DEDICATION**

This thesis is dedicated to the Almighty God, the most merciful, my parents, Mr. and Mrs.

Agyeman, my siblings, Vivian, Mansa, Stella and my daughter, Nice. God bless you all for your support and prayers.

### **ACKNOWLEDGEMENTS**

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## ABSTRACT

Mushroom farming is being promoted by governments, national and other international development organisations to reduce rural and urban poverty, creating employment and improving food security. The main objective of this study was to assess the adoption of oyster mushroom farming among beneficiaries of the PROMUSH Project implemented by the Adentan Municipal Assembly in 2015. Specifically, the study sought to, i) determine the knowledge level of PROMUSH trainees of oyster mushroom farming ii) estimate the determinants of adoption among trainees and iii) identify and rank constraints to oyster mushroom farming in the Adentan Municipality. Primary data was collected using structured questionnaires for individual respondents and interview guide for focus group discussions. Seventy (70) respondents were sampled from mushroom farmers who have been trained under the PROMUSH Project in the Municipality. The knowledge index formula, descriptive statistics, binary logistic regression model as well as Kendall's Coefficient of Concordance were used in the analysis of the data. The results indicate that, about 73% of respondents had medium knowledge level, 17% had high knowledge level, and 10% had low knowledge level of oyster mushroom farming. This means that mushroom farmers in the Municipality have moderate knowledge in oyster mushroom farming. The results of the adoption level show that 55 respondents, representing (78.6%) were currently producing oyster mushrooms. This makes adoption level high among respondents. The results from the logistic regression show that variables such as gender, household size and annual income tended to be factors that statistically influenced adoption of oyster mushroom farming. The Kendall's result shows that there is agreement among respondents ranking of constraints. The four (4) main constraints of mushroom farmers in the Municipality were high cost of production, inadequate storage facilities, difficulty to accessing credit and non-availability of some inputs. There is high adoption of oyster mushroom farming among beneficiaries of the PROMUSH training project in the municipality. Males with high income are more likely to adopt oyster mushroom farming in the municipality. The Municipal Assembly should finance the training of more extension officers in oyster mushrooms production so that they can provide extension services to mushroom farmers within and out of the Municipality. Financial institutions within the Municipality should extent credit facilities to mushroom farmers. This will assist them in their mushroom business. More skills development in mushroom is required to supply labour to support commercial production since large household size does not affect adoption oyster mushroom farming. The training centre should also improve on the lecture delivery methods and testing of trainee's knowledge during training.

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### ACRONYMS

AdMA	Adentan Municipal Assembly
CSIR	Council for Scientific and Industrial Research
FAO	Food and Agriculture Organisation
GAWU	TUC – Ghana Agricultural Workers Union of Trade Union Congress
GSS	Ghana Statistical Service
HYI	High Yielding Varieties
KIOF	Kenya Institute of Organic Farming
PCI	Problem Confrontation Index
PMP	PROMUSH Mushroom Project

PWD	People Living with Disability
RWA	Russian Wheat Aphid
SID	Swedish International Development

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background to the Study

Agriculture plays an important role in urban development, food security, poverty reduction and overall economic growth. According to FAO (2003), agriculture is the main source of income for about 2.5 billion people in developing countries. Peri-urban development in developing countries around the globe is mainly income diversification and attainment of competitive structure for agriculture, creating job opportunities, improving food security, and reducing poverty. According to Anon Biotech, (2010) mushroom production can assist in poverty alleviation, through the provision of a fast yielding nutritious source of food, strengthen livelihoods and provide a reliable source of income. Agriculture all over the world was mainly the production of crops and rearing of animals for consumption. However, in recent times, agriculture has evolved to include the domestication and production of certain products that were picked in the wild such as snails, mushrooms, and honey, among others. Mushroom also serve as a potentially valuable and cheaper source of protein, more importantly to the low-income households in most developing countries.

The forest, which serves mankind with benefits such as food, fodder, building materials, carbon sink, energy, and recreational purposes, has been home for many species of mushroom growing in the wild. A persistent problem like climate change, bush fire, deforestation, application of chemicals (herbicides, fungicides insecticides), and the over-exploitation of timber and other forest resources has now reduced and in some cases stopped the growth of wild mushrooms in forest and rural areas. Mushroom cultivation involves the provision of the medium and the right environment for the fungi (mushrooms) to expand their mycelia till it forms a fruiting body.

There are about 2,000 species of edible mushrooms around the world and very few have been cultivated artificially. The most popular among these are, white button mushroom (*Agaricus biosporus*), paddy straw mushroom (*Volvarcella volvacea*), shiitake mushroom (*Lentinula spp*) and oyster mushroom (*Pleurotus ostreatus*). According to Eger *et al.*, (1976), oyster mushroom was first cultivated in Germany in the 1900s. Oyster mushroom is the second most cultivated mushroom after the white button (*Agaricu spp*) and its popularity can be attributed to ease in production, the abundance of agricultural waste or substrate materials and less capital cost (Miles *et al.*, 2004). It is also preferred due to its aroma and delicious flavour (Hall *et al.*, 2003).

Edible mushrooms have now become an important part of human diet worldwide than ever because of its medicinal properties. Oei, (1996), opine that edible mushrooms are high in vitamins (B1, B2 and C) and has minerals such as sodium, phosphorus, and potassium with a lesser amount of calcium. Further researches by Mattila *et al.*, (2001); Guillamón *et al.*, (2010); Anno *et al.* (2016) and Finimundy *et al.* (2014), reveal that cultivated mushrooms, compared with other food such as vegetables have high vitamins, inorganic minerals, dietary fibre and proteins. Chan, (1981) said the mineral content of mushroom is higher than that of meat or fish and other vegetables, which makes it considered as a healthy food. Edible mushrooms also contain all the nine essential amino acids, devoid of starch and low in carbohydrates and calories (Chan, 1981). A nutritional analysis also reveal that mushrooms have a high amount of protein than fish or meat on a dry weight basis (Hafiz *et al.*, 2003). Mushroom is thought to be an immune booster which enhances the immune system to fight against various viral infections, cardiovascular diseases, constipation, diabetes, and cancers (Roupas *et al.*, 2012; Schneider *et al.*, 2011).

World mushroom production is dominated by China, USA, and The Netherlands. These countries account for more than 60% of world production. However, China alone accounts for 85% of world production.

According to Wakchaure, (2011), China consumed most of their mushroom locally with only less than 5% being exported to other Asian countries. The leading countries in the export of mushrooms are Poland, Netherland, Ireland, China, Belgium, Lithuania, Canada and USA while countries like United Kingdom (U.K.), Germany, France, The Netherlands, Belgium, Russian Federation and Japan import mushrooms from these major exporters. Wakchaure, (2011).

**Table 1.1. World leading countries in mushrooms production (metric tonnes)**

<b>Countries</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
China	566782	653678	707625	765461	836510	750495	786878
United States	390902	402904	408157	432100	420853	427925	421208
Netherland	304000	307000	323000	310000	310000	300000	300000
Poland	220000	230006	249148	265357	277876	290396	302916
Spain	146100	147440	149700	149854	218795	148037	159018
Canada	134673	137597	132448	134545	126416	130857	132556
France	115696	116602	104461	108671	101135	101949	990960
U. K	707400	785800	854840	948570	103197	998130	996520
India	406000	300000	170000	280000	510000	760000	982460
Germany	620000	529070	598840	599230	625940	721410	734540
Ireland	577000	696000	677000	696000	722000	700000	665000
Italy	761858	101689	604530	600110	594840	683620	695580
Japan	662360	661010	659660	658320	656970	655630	654280
Iran	875250	935600	103694	118775	958630	629570	768930
Australia	496960	464930	499540	600230	427770	503870	463260
Indonesia	458540	408870	445650	374100	334850	409060	370200
Belgium	388220	420000	365530	345250	304400	294500	280000

Source: World mushroom & truffles: Production, 2011-2017; United Nations, FAO, FAOSTAT

With the growth in market share of the mushroom business across the globe which is estimated to be around 63 billion US dollars in 2013 (Zied *et al.*, 2017), several programmes and projects financed by governments and development partners are being implemented across the globe to take advantage of this market share.

These projects and programmes target women, youth, people with disabilities(PWD) and households with marginalised land holdings particularly in urban and rural areas in developing countries. Mushroom cultivation is simple, and the cost of production is low since it uses agricultural waste such as rice straws, sawdust, compost, and others. It is a suitable business

venture for urban, peri-urban, and rural dwellers because it only requires a small piece of land to start production.

In Ghana, edible mushrooms are consumed as food. It is mostly picked from the wild mostly in the forest and semi deciduous forest of the country. These wild mushrooms are seasonal and mostly grow once or twice in a year. Wild edible mushrooms serve as an important recipe in the diet of most rural and urban dwellers in Ghana. Rural households harvest wild mushrooms for both house consumption and sell some in the markets for income. During the season of wild edible mushrooms, most household are engaged in the harvesting of it to the market as an alternative source of income. In removing the seasonality of edible wild mushrooms to make mushrooms available throughout the year for consumers, cultivating of edible mushroom in villages and urban centers must be encouraged throughout the country. Ghana has an abundance of waste from farms and industries which serve as a medium for growth of mushrooms. According to Senyah and Robinson, (1998), if the right conditions are applied to most abundant industrial and agricultural waste in Ghana, mushroom cultivation will become a good agricultural venture in reducing unemployment. Unemployment among youth and women in both rural and urban centers could be reduced through the cultivation of mushrooms in Ghana. Mushroom cultivation does not need vast land and as such its adoption and production would not pose a major challenge in urban centers.

Chang *et al.* (2017) also opine that since mushroom production is an intensive agro-industrial activity, it will be a great source of income and employment for both women and the youth mostly in the rural areas of less developed countries impacting on their economic and social life and reducing vulnerability to poverty (Rachna *et al.*, 2013). Mushroom production also helps in reducing environmental pollutants through the bioconversion of lignocellulosic biomass to food and other useful products a significant impact on pollution levels (Chang *et al.*, 2003; Chang, 1984)

The Adentan Municipality is a peri-urban area with limited land for agriculture purposes. The Municipal Agriculture Office promotes backyard farming to create employment and reduce poverty among its dwellers. The European Union (E.U.), seeing the benefit of the mushroom industry such as taking advantage in the foreign and local market and directly reducing poverty and malnourished conditions among poor people, creation of jobs and improving food security, introduced the PROMUSH project to the Adentan Municipality in the Greater Accra Region. The PROMUSH Project is about the promotion of mushroom cultivation in the Municipality. The Project chooses the production of Oyster mushrooms due to the ease in cultivation and the increase in the demand of it in the Municipality and the larger markets in the Region. The ease in getting agricultural waste for production is also considered because the Municipality is home to many agro-based industries such as sawmills, rice mills and others. The PROMUSH Project is a three-year local economic development project funded by the EU and its partners seeking to create employment opportunities for women, youth and people living with disabilities (PWDs). The main objective is to improve and sustain incomes of mushroom farmers, develop an environmentally sustainable production chain in the mushroom industry and to reduce poverty within the Adentan Municipality. The project seeks to create about 5,500 jobs, improve and sustain incomes of mushroom farmers and ensure 100% usage of waste from mushroom farming as a manure in crop production ([www.adentanpromushproject.org](http://www.adentanpromushproject.org)).

***Picture A PROMUSH TRAINING CENTER***



*Picture A showing a section of the PROMUSH mushroom training centre with solar dryers for processing fresh mushrooms*

**Picture B**



*Trainees going through lessons at the PROMUSH training centre.*

## **1.2 Problem Statement**

The extension of the period of availability of mushroom thus removing seasonality and the reduction in the risk associated with hunting of mushroom in the wild has made an evolution in the technical knowledge in commercial production of mushroom in the world. A lot of mushroom species are grown in urban and rural communities to meet the growing demand and taste of consumers. Farmers are trained to acquire the necessary skills and knowledge to produce edible mushrooms for consumption.

These training activities are sometimes organised by non-governmental organisations (NGOs) or the government. In Ghana, the Council for Scientific and Industrial Research (CSIR) has been offering mushroom production training to farmer-based and community-based organisations, through the government's own initiatives or financed by non-governmental organisations. With the aim of creating employment, reducing poverty, and improving the food security and nutritional status of farmers, training has been offered to a lot of farmers across the country in mushroom production.

It was observed in 2011, by the Ghana Agricultural Workers Union (GAWU of TUC) that 30% of what is produced by farmers in Ghana never reached their final consumers. These products are lost through post-harvest handlings which cause spoilage and deteriorating in quality (freshness and nutrition). This reduces farmer's income and decrease farmer's incentives or motivation to produce. The uptake of mushroom farming as a business by trainees will largely depend on the profitability of the mushroom enterprise.

One of the main targets of the PROMUSH oyster Mushroom Project is to train 1,500 farmers consisting of 1,000 females and 500 males in oyster mushroom farming in the Municipality. Although the project is about to enter its final year of implementation (2020), little is known

about the level of adoption of oyster mushroom production technology by trainees in the Municipality. The market shares of fresh and dried mushroom in the country and abroad keeps on increasing, farmers are not able to meet the quality requirement and the demand of these markets. As it is all known in every production firm, there are several limitations or problems producers encounter in their production cycle which makes them not meeting certain quality standards and output levels.

The project has trained 600 people (comprising mushroom farmers and other people who want to enter oyster mushroom farming) on the production of oyster mushrooms, but few of the trainees are producing oyster mushrooms now. What is causing the non-adoption of oyster mushroom farming has not yet been evaluated. Therefore, there is lack of information on specific factors affecting adoption. It is imperious to recognize why such opportunities have not been fully utilized by farmers, hence this study is geared towards filling this knowledge gap. Although oyster mushroom is produced in the Adentan Municipality, little is known about the constraints, determinants of adoption of oyster mushroom production and the knowledge level of oyster mushroom producers. The study is aimed at unraveling the major constraints faced by producers of oyster mushrooms in the municipality together with its adoption rate among trainees. Therefore, this study seeks to fill the gap in the literature by using household data to analyze the adoption of oyster mushroom production in the Adentan Municipality. Thus, the research questions are:

1. What is the knowledge level of oyster mushroom production among beneficiaries of the PROMUSH project after the training?
2. What are the factors that influence the adoption of oyster mushroom farming by the beneficiaries?

3. What are the constraints to oyster mushrooms production in the Adentan Municipality of Ghana?

### **1.3 Objectives of the Study**

The major objective of the study is to assess the adoption of oyster mushroom production among beneficiaries of PROMUSH project in the Adentan Municipality of Ghana. The specific objectives are to:

1. Determine the level of knowledge of oyster mushroom farming among beneficiaries of the PROMUSH project after training in Adentan Municipality of Ghana.
2. Identify factors that influence the adoption of oyster mushroom farming by the beneficiaries.
3. To identify and rank constraints to oyster mushrooms farming in the Adentan Municipality of Ghana.

### **1.4. Justification of the Study**

Employment in developing and developed countries among the urban youth, aged, and people with disability who have small land size, or no land could be enhanced by the introduction of mushroom cultivation. This research provides literature and empirical evidence on the success of promoting oyster mushroom cultivation in the Adentan Municipality and Ghana as a whole. The study provides an insight into the oyster mushroom business and its challenges faced by producers. With the active training and promotion of mushroom cultivation among urban and rural farmers, there is the need to know whether the investment in terms of time and resources

from farmers on the one hand and trainers and financiers (including governmental and non-governmental organizations) on the other hand, is worthwhile for the consumption and reinvestment in oyster mushroom production.

The findings will be used as a basis for future investment in the mushrooms sector. The challenges outlined could serve as a guide to potential entrants into the business of producing oyster mushroom in the Municipality. The areas of risk would be well understood and necessary preparations before venturing can be made. The study will serve as a reference document to the Adentan Municipal Assembly and other governmental and non-governmental organizations for future replication of such projects across the country and any other developing country.

### **1.5 Organization of the Report**

This study has been organized into five (5) chapters. Chapter one provides a background, problem statement, research questions and objectives as well as the justification for the study. Chapter Two presents a contextual review of literature relevant to the study including the concept of adoption, empirical review on the adoption of mushroom farming around the world, and about adoption level and its determinants of adoption. Chapter Three discusses the research methods that were adopted for this study including the design, sources of data, sampling and sample size determination, and a brief description of the study area. Chapter Four provides detailed information on the results and an analysis of the data that were collected from the field. The summary of the findings based on the study and the conclusions and recommendations have been presented in Chapter Five.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter presents a literature review of the study. It includes the concept of adoption, followed by an empirical review of mushroom adoption around the world. It also entails a review of empirical studies done on the knowledge level and its measurement. This is followed by a review of adoption level and determinants of adoption of mushroom production by trainees. The review ends with the literature on constraints of mushroom farming and its ranking.

#### **2.2 Concept of Adoption**

According to Rogers, (1962), adoption is a mental process an individual goes through from hearing an innovation or new technology first to its final usage. He further argued that there exists a difference between an individual (farm level) adoption and aggregate adoption. Farm-level adoption is the degree of use of new technology when farmers have full knowledge about the new technology and its potential benefits, while aggregate adoption is the spread of new

technology within an area or region. It takes into consideration the aggregate level of adoption of the new technology or innovation within the given geographical area or target group.

Feder, Just & Zilberman (1985), also defined adoption as the extent of the use of new technology. They posit that some technology can be adopted as a whole or part. This is in the case of agricultural technologies introduced in packages. This may give rise to the adoption of complete packages of innovation introduced in the region or subset of it. They stipulated that in case the technology was not divisible, the choice of resources (land and labour) and the allocated quantity to the new technology were all involved in the processes. However, if it is divisible technology, then the decision process involved are allocation and level use.

Adoption of farm technology or innovations is sometimes determined by a lot of factors. These factors may be either social, economic, institutional, technological and or farm characteristics. However, perception of the farmers to new technology or an innovation is one of the determinants of adoption (Mwangi *et al.*, 2015). These determinants categorized adoption into levels or types due to time and how it is adopted. According to Rogers (1983), adoption is into five (5) types. These are innovators, early adopters, early majority, late majority, and laggards. The innovators are always young, risk takers, good financial standing and first to use such new technology. These people can absorb any risk due to their good financial background. The early adopters are considered as the risk takers, always young and are educated. The laggards are those that, although may adopt, will discontinue the usage of such innovation due to disappointments. The late majority are always risk-averse and will wait till they are convinced by the results of the usage of the technology by others before they also adopt. They are mostly characterized by old age, less educated and conservative in nature. The early majority are those whose opinions are mostly respected by a larger number of people and have a degree of opinion leadership.

Adoption was defined by Bonabana-Wabbi (2002) as the mental process an individual pass from first hearing an innovation to its final usage. She further argues that adoption is in two (2) categories: rate of adoption and intensity of adoption. The rate of adoption refers to the relative speed with which an innovation is adopted by farmers or individuals. This has a significant element called “time” which defines it. The intensity of adoption refers to the level of use of innovation in any time. Factors that influence adoption can be grouped into three (3) broad categories, (1) factors related to the producer or the farmer; (2) factors related to the characteristics and relative performance of the technology and (3) programme and institutional factors (Teklewold *et al.*, 2013).

In agricultural technology adoption assessment, the first thing to consider is whether adoption is a discrete state with a binary response variable or not (Doss, 2003). This means the farmer is an adopter of a technology or an innovation or non-adopter. Adoption takes the value of one or the response is a continuous variable while’s non-adoption takes the value of zero (Challa, 2013).

## **2.3 Overview of Global Mushroom Production and Promotion**

### **2.3.1 Situation in Africa**

Africa mushroom biodiversity constituted 25% in the world but its contribution to mushroom product and sales was just 0.4% globally (Anchang, 2014). This means Africa must invest in research and infrastructure to stimulate the production of edible mushrooms to take advantage of the emerging mushroom markets globally. The adoption of mushroom production as a means of livelihood diversification is on the rise due to its economic, nutritional, and social benefits that the individual farmers, together with their families and the nation, derived.

In Kenya and some Eastern African countries’ land allocation for agricultural activities has reduced due to rapid population growth and subdivisions of land and this had made income from

agricultural activities very small (Marenya *et al.*, 2003). Adoption of mushroom production has become possible when it was almost not possible to set up any meaningful agricultural production ventures as a means of livelihood diversification in areas where small and fragment land allocation to individual households was eminent (Ongoche *et al.*, 2017).

According to Ongoche *et al.* (2017), factors such as age, gender awareness level, consumption of mushrooms and total land availability positively influenced farmers' willingness to engage in mushroom production in Western Kenya. Kimole, (2012), also researched into the adoption of mushroom farming among smallholder farmers, a case of women mushroom farmers in Makuyu, Kenya. He opined that although a total of 210 smallholder women farmers had been trained by the Kenya Institute of Organic Farming (KIOF) in 2008, the adoption rate as at 2010 from a survey conducted by (KIOF) was 30% and only 20% out of the 30% were still producing mushroom. This led to finding the reason why the adoption rate was low among trained farmers.

Some of the findings were:

1. Inadequate knowledge of the mushroom farming procedures. (knowledge gaps among trained farmers especially on skills)
2. Limited understanding of the benefits of mushroom farming to the farmers.
3. Delay in obtaining mushroom seeds from private and public research institutions.
4. Inadequacy of capital to run the mushroom business.
5. Inadequate market and high labour requirements.

The KIOF concluded that although there seemed to be knowledge gaps among trained farmers, other stakeholders along the mushroom value chain were also not involved in building the business module. Stakeholders such as input suppliers, financial institutions and market outlets for the mushroom were required to be involved in the training in the future to make the mushroom business sustainable.

In Tanzania, adoption of oyster mushroom production was increasing gradually because the country generated a large quantity of agro-residues from sisal, sugar cane and cereals which were a potential substrate for growing mushrooms. This led to the introduction of mushroom cultivation by the Ministry of Agriculture and Cooperatives in 1993. According to Chuwa *et al.*, (1996); Mshandete, (1998); Kivaisi *et al.*, (2003), research aimed at mushroom only was embarked on by the Applied Microbiology Unit of the University of Dar es Salaam to support the adoption of mushroom cultivation and its technology in Tanzania. The research funded by the Dutch government, through the Netherlands Organization for International Cooperation (NUFFIC) under the Applied Microbiology project and the Swedish International Development Agency/Swedish Agency for Research Cooperation with Developing Countries (SID/SAREC). The research led to the discovery of locally available substrate that was suitable and could grow two (2) Tanzanian wild mushrooms *Oudemansiella tanzanica* (Magingo *et al.*, 2004) and *Pleurotus flabellatus* (Mamiro, 2003) all year round.

In most West African countries, especially Ghana, Nigeria, and Côte d'Ivoire the by-product from major crops such as cocoa, oil palm, maize, and cassava amounted to 9 million metric tonnes annually (Rasper, 2006). If one-fourth of this by-product were used in growing mushroom, it could be estimated that over 1.2 million metric tons of fresh mushroom could be harvested every two (2) months. Both edible and poisonous mushrooms were common in these countries and mostly grew in the wild. In Nigeria, mushroom cultivation was common and both medicinal and edible mushrooms were cultivated by farmers (Ndem *et al.*, 2016). The most common mushroom grown by farmers in Nigeria was the button mushroom (*Agaricus Bisporus*) and oyster mushroom (*Pleurotus Sp*) (Ndem *et al.*, 2016). In their research, Ndem *et al.*, (2016), concluded that mushroom farmers in Nigeria faced a lot of problems in the production of mushrooms and these problems were inadequate quality spawn, the problem of pest and disease, complex process of obtaining credit and inadequacy of proper skills in production. Some farmers

were not aware of the new method of farming mushrooms and did not even have any way of receiving information on mushroom farming. This had a consequence on the production of mushrooms in Abia State, Nigeria. Some of the constraints that farmers faced were difficulty in preparing the substrate, pest attack, inappropriate timing of harvesting period, inadequate knowledge of environmental requirements and shortage of water. In Zambia, the contribution of Non-Timber Forest Products (NTFP) such as mushrooms to the welfare of rural and peri-urban households that depended on it was enormous. It contributed to the food and income of most household especially women-headed households. (Tembo et al., 2011)

It was opined that, most Ghanaians used mushrooms as a substitute for meat and vegetables (Sawyer, 1991) and about 5,000 to 7,000 farmers are engaged in mushroom farming. This aided in the usage of most non-viable arable lands which contributed to the improvement of food security, create jobs both in the rural and urban areas and finally as a source of food (Bempah, 2011). The Government of Ghana, realizing the importance of mushroom farming to the country through the Ghana Export Promotion Council, in collaboration with the Food Research Institute in 1990 established the National Mushroom Development Project (N.M.D.P.) (G.E.P.C., 1992). The main goal was to make Ghana a major competitor in the mushroom export market. The interest in mushroom farming have grown since then with some international development organisation championing it in a bid to assist poverty reduction in both rural and peri-urban center in the country.

Mushroom cultivation was documented by Apetorgbor et al., (2005) when they researched about the utilization and cultivation of mushrooms for rural livelihood in southern Ghana. They opined that, mushroom cultivation was mainly done in the urban areas with few done in the rural communities mostly the Sekyere East district in the Ashanti region. This is largely because most rural folks pick edible mushrooms freely from the wild in the forest and forest reserves. These mushrooms are consumed by the rural households and the excess are sold in markets at urban

centers. These shows that, there is adoption of mushroom farming in some rural and urban areas in Ghana.

### **2.3.2 Situation in Asia**

China is the leading country in the production of mushroom in the world accounting for over 85% of world production (Chang *et al.*, 2017). Although it consumes almost all with a little less than 5% exported to other Asian countries, it is home to more varieties of mushrooms than any other county (Chang *et al.*, 2017). China is the first country to successfully cultivate many species of mushrooms such as, *Auricularia auricula-judae* (estimated date, 600 AD), *Flammulina velutipes* (800–900 AD), *Lentinula edodes* (1000– 1100 AD), *Volvariella volvacea* (1700 AD), and *Tremella fuciformis* (1800 AD) (Chang *et al.*, 2017). It was reported by Rühl *et al.*, (2006) that China also produced mushrooms as far back 600 AD by artificially inoculating twits with *Auricularia auricula-judae* (wood-ear mushroom) a common mushroom to the Asians.

The strides that China has made as the leading producer, consumer and exporter of mushrooms can be attributed to some factors according to (Chang, 2005). Out of the four (4) reasons Chang referred to, the most significant one which has contributed to Chinas success is its strong scientific support from the academic institutions. This has led to the discoveries of innovations in the production, storage and the development of suitable varieties preferred by the market. The Chinese mushroom industry is dominated by small scale-farmers as according to research by (Li *et al.*, 2014), almost 90% of production is from the small-scale farmers with the large-scale commercial production mainly form a little over 10%.

In India, the annual production of mushrooms has doubled since 2001 from 5,000 tons to 10,000 tons in 2014 and it is expected to rise by about 25% in the coming years (Chang *et al.*, 2017). The relative push factor in the rising level of production can be attributed to the medicinal value and the higher prices of some selected varieties in the markets. It was opined by Shirur *et al.*,

(2017), that the button mushroom is the most preferred variety in India. According to them, the good price farmers obtained from growing button mushrooms from the local urban markets, has made farmers produce this variety under a controlled environment. Vijay (2011) reported that farmers in the northern part of India plains record a low success rate from cultivating button mushroom in the thatched houses in winter season mostly in the villages. A study was conducted by Shahi *et al.*, (2018) to find the impact of a vocational Mushroom Training programme on the lives of trainees in the district of Krishi Vigyan Kandra and its environs. It was found that the knowledge of trainees had gone up to about 81% mostly among the youth and woman and this has led to the adoption of mushroom production as a self-employment venture and others as a side business aside from their main source of livelihood. Other beneficiaries of the training had also ventured into spawn production to supply quality spawns to mushroom farmers in the District and beyond.

The Government of India, knowing the significance of the mushroom industry to the livelihood of its citizens and the nation, has been supporting the development of the mushroom industry through the introduction of schemes in Himachel Pradesh (Vaidya, 2001). This scheme targets the poor and marginalised in society, the small-holder farmers and the scheduled caste and scheduled tribe families in Himachel Pradesh. Some of the Mushroom Projects in the districts are Chambaghat (Solan) for the districts of Solan, Shimla and Sirmour under the Indo-Dutch Project, Palampur for the districts of Kangra, Mandi, Chamba and Hamirpur.

The government provided incentives such as trainings on mushroom production which were organised from time to time with the trainees being given allowance to boost participation, a registration by the horticulture department, which was to enable the individual farmers to receive government subsidy on compost and spawns, bank loans to the registered mushroom farmers with nationalised banks in their districts, a subsidy of 50% on compost for farmers and a 100% subsidy of transportation of compost for farmers taking 400 trays or more and lastly an extension

education from regular visits by technical people (Vaidya, 2001). Other projects reported by Vaidya (2001) as being undertaken by the government in other parts of the country included the government schemes to develop the mushroom industry in Utter Pradesh. This project also provided incentives such as training on mushroom farming, spawn production and supply, compost production and supply and extension delivery. The Indo-Dutch Mushroom Project and a pasteurised compost unit established in Rajendra Agricultural University, Pusa (Samastipur) Bihar for the development of mushroom farming among the people with the financial support from Government of Bihar all have the same modules. All these initiatives were geared towards the adoption of mushroom production with the aim to provide employment, improved income and food security.

A study was conducted by Delmia *et al.*, (2018) in three villages in Arwal district of Bihar India into the economic status of rural women entrepreneurs' adoption and engagement in oyster mushroom farming in addition to other economic activities they were already engaged in. The knowledge levels on quality spawn production, harvesting techniques, grading and packaging of mushrooms produced by these women were improved. This had assisted these rural women to earn more money from the mushroom business and the amount could be higher if the barriers in accessing credit and current market linkages could be improved.

Febrianda *et al.* (2018) also researched into the adoption of mushroom farming partnership in Indonesia. The partnership was between smallholder farmers and an off-taker (an enterprise or company) who was to buy all the mushroom farmers' produce. It was always in the form of contract farming with a well-defined role by both parties and hinged on quality standards. The result showed that the partnership was beneficial to the farmers and was being recommended to other rural societies in the developing world. The partnership created a ready market for the farmers' products, relieving the farmers of the burden of marketing constraints.

### **2.3.3 Situation in Europe**

Modern mushroom cultivation started in France in the 18th century (Fresh, 2000). Production of mushrooms using trees stumps and wood logs started in Germany on experimental basis (NHB, 2005). The European mushroom industry was dominated by high-tech machines. In Europe, the Netherlands, Poland, and Spain were the leading countries in the production and export of fresh and processed mushrooms. In 2011, the Food and Agriculture Organisation estimated increasing growth in production for the 2011-2017 period for countries such as France, United Kingdom and Germany. Although there was scanty information on mushroom industry in Europe, it was mainly automated and characterised by large scale commercial farmers unlike in Africa and Asia which was dominated by small scale farmers.

### **2.3.4 Situation in North and South America**

The United States of America (U.S.A.) is the second leading country in the production of mushrooms in the world. It produces about 16% of the total world output. Mushroom production is the leading specialty crop in terms of value in production in the U.S. It is topped by only potatoes, lettuce, and tomatoes. Its consumption per capita had increased from 0.6 pounds in 1965 to 4.0 pounds in 2011 (Jiang *et al.*, 2015). Per capita consumption of fresh mushrooms had increased, while processed mushrooms (mostly canned) decreased in the United States. In the U.S.A, the fresh mushroom market was dominated by countries such as Canada, Mexico, China and Korea. The United States imported fresh mushrooms from. In the 1990s, mushroom production gained much interest in the Caribbean. According to Paulraj *et al.*, (1995), several countries in the Caribbean produced a lot of agricultural waste that could produce mushrooms in large quantities. It was evident that in Jamaica, coffee waste was used in producing oyster mushrooms while in Trinidad rice straws and in Dominica and St Lucia it was bagasse and banana waste respectively (Paulraj *et al.*, (1995).

## 2.4 Empirical literature review

### 2.4.1 Determining knowledge level among smallholder farmers

For a technology or an innovation to be adopted by any farmer or group of farmers, the basic knowledge on how to use such technology or innovation should be well understood. Such groups of people were always given an intensive training running into weeks, months or even years depending on the complexity of such technology. Trainees' knowledge needed to be assessed after they had been trained and were using or applying such knowledge on their business or farms. In assessing whether trainees had acquired the requisite knowledge well or not, Meena *et al.* (2012) assessed the knowledge level and adoption pattern of rice production technology among farmers in Hanumangarh District India. They assessed the farmers' knowledge by designing a questionnaire about 12 main practices of rice production for farmers to answer. A right or wrong answer gives a farmer 1 or 0 mark, respectively. Farmers were categorised into having low, medium and high knowledge based on the mean (67.40) and standard deviation (4.60) score. The results showed that most farmers 70% (63-72 scores) had a medium level of knowledge followed by low 16 % (below 63 scores) and high level 14% (above 72 scores).

In determining the knowledge level of farmers in organic farming in Tamil Nadu, India, Jaganathan *et al.*, (2016), adopted the method used by Bonny (1991) and Sushama (1993) in calculating the knowledge level of farmers. They developed the knowledge index as follows:

$$\text{Knowledge Index} = \frac{\text{Respondent's total score}}{\text{Total possible score}} \times 100$$

Farmers were grouped into very low, low, medium, high and very high knowledge level based on the mean and the standard deviation score. It was found that majority of farmers (67.5%) had medium knowledge level of organic farming followed by low (18.3%) and high (11.7%). Few farmers (2.5%) were found to be having very low knowledge of organic farming and no farmer was found to be having a very high knowledge of organic farming. They concluded that

characteristics such as farmer's innovativeness, exposure to mass media (which is a link to their educational level), exposure to extension education and market orientations had an influence on the farmers' knowledge level of organic farming in the District.

The knowledge index postulated by Bonny (1991) and Sushama (1993) was also used by Srivastava *et al.* (2012) in assessing the knowledge level and training needs of potato growing tribal farmers of Meghalaya. The results of their finding showed that majority of farmers (71.3%) had high knowledge level of potato farming followed by (16.6%) and (12%) of medium and low knowledge level, respectively. They concluded that even though farmers have high knowledge level on potato growing, their score on individual agronomic practices in potato farming was at medium level.

Shah *et al.* (2016) also conducted research into finding the knowledge levels and adoption pattern of rice production technology among the Navsari District farmers. The study revealed that the knowledge level of farmers concerning scientific cultivation practices of paddy had changed from 73% for low, 20% for medium and 7 % for high knowledge level to 19%, 67% and 14%, respectively after farmers had undergone training in scientific cultivation of paddy with the District Agricultural Centre. This knowledge translated into yields with the farmers recording more output of paddy per unit area.

#### **2.4.2 Identifying adoption level and factors that influence the adoption of an agricultural technology**

In finding farm-level adoption and the impacts of Russian Wheat Aphid (RWA) resistant cultivars adoption on the smallholder wheat farmers in South Africa, Marasas *et al.* (2005) employed a farm level survey in the Central and Eastern Free State of South Africa. There was a rapid adoption of the cultivars since the demonstration and the total land put under cultivation of this cultivar increased from 3% to 46% within 4 years of its introduction to wheat farmers.

Further analysis using multiple regression in determining the factors that influence the adoption of this cultivars revealed that the educational level of farmers, farm size, output, quality grades and increases in income were the main factors that influenced the adoption of the new cultivars. They concluded that although the research focused on the farm level adoption and its associated benefits to farmers, it also had a potential benefit to the environment, institutions and the economy of the country in the adoption of RWA resistant cultivars.

The adoption level of trained and untrained rural women in improved cultivation practices of mushroom was also researched by Kushwah *et al.* (2016). The results showed that the majority of rural women that had been trained, 45.33% of the respondents, had a high adoption rate of improved cultivation practice as compared to untrained rural women (33.33%). The farmers from the trained categories showed a high extent of adoption of twelve (12) oyster mushroom cultivation practices technology than the untrained.

Research by Dhraief *et al.* (2018) in finding factors affecting the adoption of innovative technologies by livestock farmers in arid areas of Tunisia despite the Government and international organisations promotion of innovative technologies. Using binary logistic regression for the analysis of the economic, socio-demographic and institutional variable selected, farm education, size of cattle flocks and off-farm income were statistically significant and had influence on technology adoption positively while age and farm experience was significant but negatively influenced the adoption of technology. It was also found that membership of an FBO, extension services and source of technical knowledge was significant and positively affected the adoption of technology. They concluded that Government and other international development organisations should focus on educating young farmers with large flock sizes and encourage them to have other business (off-farm) apart from cattle rearing to enhance technology adoption. The government should also intensify training programmes to extension officers and farmers in collaboration with other international organisations.

In reviewing factors affecting the adoption of new agricultural technologies in Ethiopia, Mwangi *et al.* (2015) did a research and came out with the findings that factors that influence the adoption of new agricultural technologies were technological, economic, institutional factors and human-specific factors. They opined that future studies on adoption studies related to new agricultural studies should include the perception of farmers towards the new technology. They also emphasized the need to consider farmers' problems and needs in formulating or designing new agricultural technologies.

Melesse (2018) also researched on new agricultural technologies such as usage of improved seed, pesticides, improvement on farm storage techniques, methods of small-scale irrigation and fertilizer usage among smallholder farmers in Ethiopia. He opines that various factors (socio-economic and risk aversion) may be the cause of a low rate of adoption of these technologies nationwide. The variables that significantly affected the adoption of new agricultural technologies by farmers were age, education level, family size, farm size, extension service provision and access to credit. To ensure optimal adoption of these new agricultural technologies throughout the country, the Government must design projects based on the farmers' need and problem.

In determining the factors that influenced technology adoption and how these affected farmers' welfare measured by their consumption expenditure in Tanzania and Uganda, Kinuthia *et al.* (2017) used Probit and linear probability model for identifying the determinants of improved seeds varieties usage in these countries. They concluded that factors such as access to credit, farm size, contact with government agencies and the number of improved seed varieties were the determinants of technology adoption in these two (2) countries. They also found that the consumption expenditure of farmers' households that used improved seed varieties was higher than farmers who did not. This made the welfare of the farmers that used improve seeds better than those that did not. One most important advantage of using improved agricultural technology

was its effect on farmers' income. Hailu *et al.* (2014), researched into the determinants of agricultural technology adoption decision and its impact on farm income by using a cross-sectional data. Using Probit and Ordinary Least Square regression, agricultural technology adoption was significant and had a positive effect on farm income. However, the determinants of chemical fertilizer usage were different from planting high yielding varieties (HYV).

The Probit regression result showed that land ownership right security, access to credit, gender, contact with extension workers, irrigation usage, and off-farm businesses were found to be significant and positively determining chemical fertilizer adoption decision with plot distance from the homestead, distance to the nearest market and Tropical Livestock Unit being statistically significant but negatively influenced chemical fertilizer adoption decision. Nevertheless, factors such as land ownership right security, access to credit, irrigation usage and tropical livestock unit were significant and positively influenced the adoption of high yielding varieties; whereas age and distance to the nearest market was also significant but negatively influenced the adoption of high yielding varieties.

Motalleb (2018), opined that although adoption of farm level technology by farmers mostly in developing countries was necessary, some factors needed to be taken into consideration when introducing these technologies. These factors may aid or prevent the adoption of such technologies by the farmers. He mentioned how the cost, or the price of the new technology may be the problem for its adoption and the perception of its cost may override the benefit of using this new technology. He opines that if the price of the technology were higher than the prevailing technology it would prevent farmers from purchasing the new technology. Therefore, the price of the new technology must be competitive with the prices of the existing available substitute technologies to ensure a rapid uptake and scaling up of this new agricultural technology. He advised policy makers, to always introduce technologies that adapted well to local demand and specifications.

### 2.4.3 Identifying and ranking of constraints

In identifying constraints that oyster mushroom farmers encountered in their day to day production of mushrooms, Kushwah *et al.* (2016) identified 17 problems that rural women of Banka District in India encounter. The 17 constraints were categorised into three main headings and they are *Technological Constraints* (inadequate of awareness of technology, insufficient training programme, unavailability of trained experts), *Institutional constraints* (inadequate information sharing from state and central government, weak extension services at village level, inappropriate fund to strengthen the technology, inadequate transport facilities, no market linkage, lack of proper communication structures) and *Socio-economic constraints* (High cost of input and low purchasing power of women, unavailability of fresh spawn, illiteracy among rural women, unavailability of skilled labour, non-availability of bank linkage, inadequate subsidy for inputs, inadequate support price, inadequate SHGs and Cluster approach). Using a correlation coefficient, the major constraints faced by the farmers were lack of awareness of technology, unavailability of fresh spawn and weak extension work at the village level.

Earlier research by Bashar, (2006) about constraints that mushroom farmers faced in Dhaka in Bangladesh as well as a research done by (Pattnaik *et al.*, 2008 and Singh *et al.*, 2008) in India and a further by Kushwah *et al.* (2016) were not different from the constraints identified in Thilakaratna *et al.* (2018) in Sri Lanka about the problems and constraints of mushroom farmers. The problem revolved around unavailability and lack of quality spawn, access to credit, lack of storage and transportation facilities etc.

In ranking constraints identified by smallholder cotton farmers in Northern Region of Ghana, Abdul-Rahman (2016) used Kendall's Coefficient of Concordance to analyse and find an agreement among the constraints ranked by the farmers. The results of the analysis revealed that there was 87.4% agreement among the constraints ranked by farmers. The four (4) major

constraints of the farmers were poor pricing of seed cotton, untimely input supply, difficulty in acquiring labour and pest and diseases. Osei (2017) also ranked the constraints smallholder farmers in adapting to the effects of climate change. He used Kendall's coefficient of Concordance and Friedman's test to test the level of agreement and significance of mean ranks of identified constraints. There was 50% agreement among the constraints of smallholder farmers to climate change. The three (3) major constraints were an unreliable water source, lack of information on climate change and limited income.

Ranking of constraints can also be done by using the Problem Confrontation Index (PCI). It uses a formula below to rank constraints based on a four (4) Likert scale ranging from not encountered to high

$$PCI = (P_n \times 0) + (P_l \times 1) + (P_m \times 2) + (P_h \times 3)$$

Where PCI = Problem Confrontation Index,  $P_n$  = Frequency of the farmers who rated the problem as not encountered,  $P_l$  = Frequency of the farmers who rated the problem as low,  $P_m$  = Frequency of the farmers who rated the problem as moderate,  $P_h$  = Frequency of the farmers who rated the problem as high (Uddin *et al.*, 2014). The results of Uddin *et al.*, 2014 research revealed that lack of available water (both irrigation and drinking), shortage of land, unpredicted weather and lack of credit/money were the four (4) main problems faced by farmers in adapting to the effects of climate change in Bangladesh. Other research (Hossain *et al.*, 2011; Alam *et al.*, 2010) also used the Problem Confrontation Index (PCI) in the ranking of problems faced by farmers toward seed potatoes production and problems faced by youth in undertaking selected agricultural activities respectively. The four (4) main problems faced by farmers toward seed potatoes production were lack of quality seed potato, disease, insect problem and the high price of quality seed potato based on the results of the PCI.

## **CHAPTER THREE**

### **METHODOLOGY**

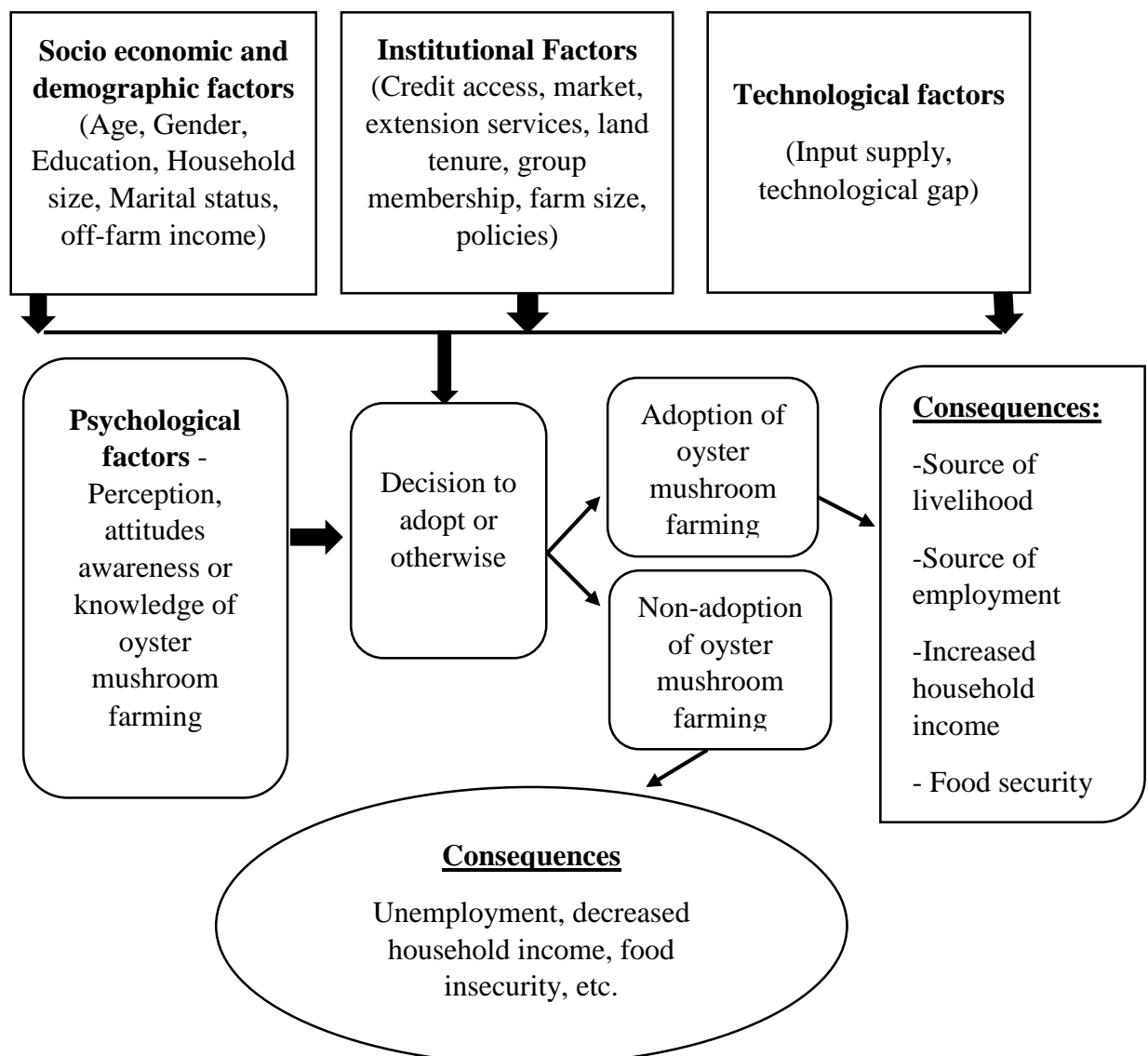
#### **3.1 Introduction**

This Chapter describes the methodology applied in the study. It includes the conceptual and theoretical framework underpinning the study, key concepts, and the methods of analyses of the different objectives, data collected and sampling method. The chapter also describes the geographical features of the study area.

#### **3.2 Conceptual Framework**

The study assumes that the decision to adopt or not to adopt oyster mushroom farming is a function of farmers' knowledge or awareness of oyster mushroom farming as compared to other enterprises. According to FAO (2000), there are several reasons why farmers adopt new farming technology or innovations. While some may be rational in their behaviour, their awareness may be influenced by the availability of information pertaining to such innovation, their socioeconomic factors and farm characteristics. There are several factors that may influence the adoption or non-adoption of innovation by smallholder farmers. These factors may be

institutional such as credit, markets, and extension services; socio-economic such as age, gender, education, household size, marital status; and technological such as input supply and technological gap. Small scale farmers or individual farmers who wished to enter oyster mushroom farming may benefit from the training. A farmer's access to the PROMUSH Training does not mean that farmer will be producing oyster mushroom after successfully going through the training. These factors combine to determine whether a farmer will adopt or not adopt this training to produce an oyster mushroom. It means that these factors may be incentives or disincentives to the adoption of the technology. Understanding these variables and how they influence adoption are important in developing strategies for promoting oyster mushroom farming.



**Figure 3.1: Conceptual Framework of adoption of oyster mushroom farming**

**Source: Adapted and modified from Borges *et al.*, (2015)**

**3.3 Theoretical Framework of the Study**

**3.3.1 Random Utility Theory**

Following Hoque *et al.* (2015), a farmer or household’s decision to adopt oyster mushroom production can be analysed within a random utility framework. Let  $U_{tA}$  denotes the utility obtained by a farmer or household  $t$  from adopting oyster mushroom production and  $U_{tN}$  the utility of non-adoption. Let  $Y_t$  be a vector of farm and household characteristics affecting oyster mushroom farming adoption decisions and  $\epsilon_t$  be the error term. According to the state of adoption, household  $t$  utility is approximated as:

$$\begin{cases} U_{tA} = fY_t + \epsilon_{tA} \\ U_{tN} = fY_t + \epsilon_{tN} \end{cases} \quad (3.1)$$

A household would choose to adopt oyster mushroom farming only if the utility derived from adopting is greater than the utility from not adopting:  $U_{tA} > U_{tN}$ . The utilities derived by adopting oyster mushroom farming can be income, source of employment, food, and a good source of livelihood. Since these utilities are not observable, they can be expressed in the following latent structure model for adoption of oyster mushroom production:

$$V_t^* = \beta Y_t + \epsilon_t \quad (3.2)$$

$V_t \begin{cases} 1, V_t^* > 0 \\ 0, V_t^* < 0 \end{cases}$  Where  $V_t$  is a binary indicator taking the value of 1 in the case where the household adopts oyster mushroom farming and 0 otherwise.

According to Akudugu (2012), the threshold decision-making theory proposed by Hill and Kau (1973) and Pindyck and Robinfield (1998), were used to determine farmers demand for credit. It can also be used to determine factors that influenced the adoption of oyster mushroom farming. Farmers are faced with a decision to adopt or not to adopt an innovation of technology. This gives every farmer a reaction threshold which depends on a certain set of factors. Farmers do not adopt innovation when their threshold value is below the critical value whiles at the critical value a reaction is stimulated (Akudugu, 2012).

Such phenomena are generally modelled using the relationship:

$$Y_i = \beta X_i + U \tag{3.3}$$

Where  $Y_i = 1$ , when a choice is made and 0, otherwise. This means

$$Y_i = 1 \text{ if } X_i \text{ is } \geq X^* \tag{3.4}$$

$$Y_i = 0 \text{ if } X_i \leq X^* \tag{3.5}$$

$X^*$  represents the combined effects of explanatory variables ( $\beta_i X_i$ ) at the threshold level.

The model is a binary choice model involving estimation of the probability of adoption of a given innovation (Y) as a function of the explanatory variable (X). That is:

$$\text{Prob} (Y = 1) = F (\beta' X) \tag{3.6}$$

$$\text{Prob} (Y = 0) = 1 - F (\beta' X) \tag{3.7}$$

Logit, probit and linear probability models are normally used to evaluate factors that influence the probability that a choice will be made (Gujarati, 2004; Gujarati and Porter, 2009). However,

there are certain problems associated with the use of a linear probability model. These problems are:

i) Non-normality of the disturbances ( $U_i$ );

ii) Heteroscedastic variances of the disturbance;

iii) Non-fulfilment of  $0 \leq E(Y|X) \leq 1$  (Possibility of  $\hat{Y}$  lying outside the 0-1 range);

iv) A questionable or low value of  $R^2$  as a measure of goodness of fit.

v) The linear probability model assumes that  $P_i = E(Y = 1 | X)$  increases linearly with “X” (i.e., the marginal effect of X remains constant throughout), hence it is not a logical model (Gujarati, 2004; Gujarati and Porter, 2009). Therefore, there is a need for a probability model that has two features:

i. As “X” increases,  $P_i = E(Y = 1 | X)$  increases but never steps outside the 0-1 interval, and

ii. The relationship between  $P_i$  and  $X_i$  is non-linear (Gujarati, 2004; Gujarati and Porter, 2009).

Logit model and probit model satisfy these conditions and give similar results (Gujarati, 2004; Greene, 2008).

Logit is often chosen over Probit because of its simplicity, mathematical convenience, and asymptotically consistent estimates (Gujarati and Porter, 2009; Akudugu, 2012). Logit analysis is used to identify factors that affect or influence the decision-making status; factors that affect the adoption of an innovation or technology. The logit model was considered for this study and is described in the next section.

### **3.3.2 The logit model**

According to Gujarati (2004), a dummy regression model is assumed to have a dependent variable  $Y$  being qualitative while independent variables are either quantitative or qualitative.

The dependent variable is dichotomous in nature, which takes the value of 1, of those who adopt oyster mushroom farming and 0, to those who do not adopt.

The logit of a number  $p$  is between 0 and 1. The Logit model, which is used to estimate dichotomous choices, is based on the “probability” of an “event” occurring and it is appropriate for determining factors that influence the adoption of oyster mushroom farming by beneficiaries of PROMUSH Mushroom Project. The logistic regression model does not follow the assumptions of Ordinally Least Square regression (OLS) which makes it robust.

Following Gujarati (2004), the Logit model is specified as:

$$P_i = P(Y = 1|X_i) = B_1 + B_2X_i, i = 1, 2 \dots, n \quad (3.8)$$

Where:  $P_i = P(Y = 1|X_i)$  is the probability of the  $i^{\text{th}}$  farmer adopting oyster mushroom farming. Then  $Y = 1$  means adoption;  $Y = 0$  means otherwise,  $X_i =$  explanatory variables,  $\beta_0 =$  the intercept,  $\beta_i =$  the corresponding coefficients and  $n$  is the sample size.

Participation can also be represented as:

$$P_i = P(Y = 1|X_i) = \frac{1}{1 + \exp\{-(B_1 + B_2X_i)\}} = \frac{1}{1 + \exp(-z_i)} \quad (3.9)$$

Where  $Z_i = \beta_1 + \beta_2X_i$ . This equation is known as the cumulative logistic distribution function. Here  $Z_i$  ranges from  $-\infty$  to  $+\infty$ ;  $P_i$  ranges between 0 and 1 and  $P_i$  is non-linearly related to  $Z_i$  (i.e.  $X_i$ ), and thus, satisfying the two conditions required for a probability.  $P_i$  is non-linear in both  $X$  and  $\beta$  parameters.

The log of odds of adoption is given by:

$$P_i = \frac{1}{1 + \exp(-Z_i)} \quad (3.10)$$

Then  $(1 - P_i)$ , the probability of non-adoption is:

$$(1 - P_i) = \frac{1}{1 + \exp(Z_i)} \quad (3.11)$$

Therefore, the two equations above can be written together as:

$$\frac{P_i}{(1 - P_i)} = \frac{1 + \exp(Z_i)}{1 + \exp(-Z_i)} \quad (3.12)$$

$\frac{P_i}{(1-P_i)}$  is the odds ratio of adopting oyster mushroom farming i.e., the ratio of the probability that a beneficiary of PROMUSH Mushroom Training will adopt the farming of oyster mushrooms to the probability that a beneficiary of the PROMUSH Mushroom Training will not adopt oyster mushroom farming.

Taking natural log of (3.8), we obtain:

$$L_i = \ln \left[ \frac{P_i}{1-P_i} \right] = Z_i = \beta_0 + \beta_1 + \beta_2 X_i + U \quad (3.13)$$

Where: Y= adoption of oyster mushroom farming (adoption = 1; otherwise = 0),  $\ln \left[ \frac{P_i}{1-P_i} \right] = \log$  odds in favour of adoption of oyster mushroom farming;  $P_i$  = probability of the  $i^{\text{th}}$  farmer;  $\beta_0$ = the intercept parameter;  $\beta_i (\beta_1, \beta_2, \dots, \beta_n)$  = parameters to be estimated;  $X_i$  = explanatory variables; U = error term (Pindyck and Robinfield, 1998; Gujarati and Porter, 2009).

### 3.3.3 Marginal effect of explanatory variables in the Logit model

In Logistic Regression Model, the slope coefficient of a variable gives the change in the log of the odds associated with a unit change in the variable, holding all other variables constant. The rate of change in the probability of an event happening is given by:

$$\beta_j P_i (1 - P_i) \tag{3.14}$$

Where  $P_i$  is the probability of an event occurring and  $\beta_j$  is the partial regression coefficient of the  $j^{\text{th}}$  explanatory variable (Gujarati and Porter, 2009).

The relative effect of each explanatory variable on the likelihood that a beneficiary of PROMUSH Mushroom Project (PMP) will adopt the farming of oyster mushroom is given by the marginal effect as:

$$\frac{\partial P_i}{\partial X_i} = f(X_i \beta) * \beta_j \tag{3.15}$$

Where  $f(X_i \beta)$  is the normal marginal density function. For dummy variables, the marginal effect with respect to variable  $X_i$  is found by taking the difference in predicted probabilities calculated at  $X_i = 1$  and  $X_i = 0$ , holding other variables constant at their means (Gujarat & Porter, 2009).

### 3.4 Methods of Analyses

#### 3.4.1. Knowledge level of oyster mushroom farming among PROMUSH Mushroom Project (PMP) beneficiaries

The knowledge level of mushroom farmers on oyster mushroom production was assessed by asking mushroom farmers their understanding or technical know-how on carefully selected cultural practices performed in the production of oyster mushroom. Farmers' knowledge was scored quantitatively depending on the understanding of particular cultural practices. A score of 1 was given to a farmer who has a good understanding of any of the cultural practices, 0.5 to a farmer with moderate knowledge and 0.25 to a farmer with low knowledge on any of the selected cultural practices. Following the work of Jaganathan *et al.*, (2016) and Srivastava *et al.*, (2012) the knowledge level of respondents was determined using the knowledge index formula which is:

$$\text{Knowledge Index} = (\text{KI}) \frac{\text{Sum (Respondents total score)}}{\text{Total possible score}} \times 100 \quad (3.16)$$

For the purpose of a clearer analysis to inform policies and recommendations on the knowledge level of farmers on oyster mushroom farming, the knowledge level was then categorized into high, medium and low knowledge level by using the formula:

$$\text{KI} = \text{Mean} \pm \text{S.D} \quad (3.17)$$

Where, KI is the knowledge index and SD, is the standard deviation.

**Table 3.1: Knowledge level of respondents**

Knowledge level	Score	Index
Low	0.25	$\leq (\text{Mean} - \text{SD})$
Medium	0.5	$\text{Mean} \pm \text{SD}$
High	1.0	$\geq (\text{Mean} + \text{SD})$

Source: Jaganathan *et al.*, (2016)

### 3.4.2. Level and factors of adoption of oyster mushroom production

#### Estimating level of adoption

In estimating the level of adoption of oyster mushroom production by trainee farmers, descriptive statistics were used to analyze the data. The ratio of number of sampled farmers using techniques in oyster mushroom management to total number of trainees in the sample was first calculated and expressed in percentage. The results were presented by pie chart and percentage tables.

#### Factors that influence the adoption of oyster mushroom production

The logistics Regression Model was used to identify the factors that influence the adoption of oyster mushroom farming. The adoption of oyster mushroom farming is a dichotomous, involving two (2) mutually exclusive alternatives. It is either you are adopting or otherwise. This

can be empirically expressed as a farmer adoption of oyster mushroom farming ( $Y_i$ ) model to observable explanatory variables.

$$Y = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum \beta_i X_i + U \quad (3.18)$$

Where  $Y$  = adoption of oyster mushroom farming;  $X_i$  is the vector of explanatory variables relevant to influence the adoption of oyster mushroom farming;  $\beta$  is the vector of unknown parameters;  $U$  is the residual error term assumed normally distributed with zero mean and constant variance.

Institutional, socioeconomic, and technological factors interaction can influence the adoption of oyster mushroom farming by trainees of PROMUSH Mushroom Farming. Thus, the empirical model is expressed as:

$$Y_i = \beta_0 + \beta_1 AGE + \beta_2 GEN + \beta_3 HH + \beta_4 EDU + \beta_5 AINCOME + \beta_6 MS + \beta_7 HP + \beta_8 HCP + \beta_9 NM + \mu_i$$

The variables, their descriptions, units of measurement and expected outcomes are shown in Table 3.2.

**Table 3.2: Variables, their descriptions, unit of measurement and their expected outcomes**

<b>Variables</b>	<b>Description</b>	<b>Unit of Measurement</b>	<b><i>Apriori</i> Expectations</b>
<b>Dependent Variable</b>			
$Y_i$	Adoption of oyster mushroom farming	Dummy(Adopter=1 else = 0)	
<b>Independent Variables</b>			
$AGE$	Age	Years	+/-
$GEN$	Gender	Dummy (If male =1; female = 0)	+/-
$HH$	Household Size	Actual number of persons	+/-
$EDU$	Educational Level	Years of education	+
$AINCOME$	Annual Income	In (GHS)	+
$MS$	Marital Status	Dummy (If married =1;else = 0)	+/-

<i>HP</i>	High perishability	Dummy (If yes =1;else = 0)	-
<i>HCP</i>	High cost of production	Dummy (If yes =1;else = 0)	-
<i>NM</i>	No ready market	Dummy (if yes = 1,else = 0)	-

### Description of Variables

**(AGE):** It is hypothesized that age will either have a positive or negative correlation with adoption of oyster mushroom farming. Since there is no available market for of oyster mushroom, because oyster mushroom is new, it will take time before people develop taste for it. This makes producing oyster mushroom a risky business. Older trainees may be risk averse and as such will not even venture into producing the production of oyster mushroom of the fear of not getting market for it. However young trainees are known to be risk takers and will love to taste the market. Age is measured in years.

**Gender (GEN):** The study expects male trainees to be more willing to adopt oyster mushroom farming as compared to female trainees. This is because males easily adopt new technology and are more endowed with resource as compared to females. Gender is measured as a dummy with 1 for males and 0 if otherwise.

**Household Size (HH):** The number of people living under the same roof and eating from the same pot can positively or negatively affect adoption of oyster mushroom farming. A trainee with a large household size may be willing to adopt the production of oyster mushroom because of the availability of family labour since production oyster mushroom is labour intensive.

**Educational Level (EDU):** The higher the level of education of the beneficiary of PROMUSH mushroom project, it is more likely the trainee will adopt oyster mushroom farming. Educational level is expected to have a significant positive effect on adoption. This study expects that as a farmer advances in education and acquires more knowledge, the probability to understand and

acquire new knowledge is high. Educational Level is measured by the number of years the farmer had formal education.

**Annual Income (AINCOME):** Annual income refers to the money farmers got from the sales of oyster mushroom throughout the year in review. Annual income is expected to have a significant effect on adoption of oyster mushroom farming. The higher the returns from the sales of oyster mushroom the more people venture into this enterprise. Annual income is measured in Ghana cedis (GHS).

**Marital Status (MS):** This is expected to either have a positive or negative correlation with adoption of oyster mushroom farming. Married farmer will find other source of income and will cling to the production of oyster mushroom. Marital status is measured as a dummy with 1 for yes and 0 if otherwise.

**High Perishability (HP):** This attribute of oyster mushroom is expected to have a significant correlation on adoption of its production. The higher the perishability the less farmers will produce oyster mushroom. High perishability is measured as a dummy with 1 for yes and 0 if otherwise.

**High Cost of Production (HCP):** The higher the cost of production the more likely less people will venture into its production. It is hypothesized to have a negative influence on adoption of oyster mushroom farming. Farmers who do not have enough capital cannot venture into oyster mushroom farming. High cost of production is measured as a dummy with 1 for yes and 0 if otherwise.

**No Ready Market (NRM):** No Ready Market for oyster mushrooms is expected to have a negative impact on its production. this is expected to give low incentive to farmers and

subsequent affect its adoption. No ready market is measured as a dummy with 1 for yes and 0 if otherwise.

### **3.4.3 Ranking of farmer's constraints**

The constraints faced by farmers were identified through structured questionnaires and complemented by findings from literature. These constraints were analyzed using descriptive statistics and results presented in percentages tables.

Kendall's Coefficient of Concordance was used to test the agreement among respondents' ranking of constraints. The coefficient is an index that measures the ratio of the observed variance of the sum of ranks to the maximum possible variance of the sum of ranks. The main aim of the index is to find the sum of the ranks for each constraint being ranked and examine the variability of this sum. The variability among these sums will be a maximum if the rankings are in perfect agreement (Mattson, 1986). The coefficient is stated below.

$$\text{Kendall's Concordance Coefficient, } W = \frac{12S}{p^2(n^3-n)-pT} \quad (3.19)$$

Where; T denotes the corrections factor for tied ranks, S=sum of squares, n= number of constraints being ranked, p= number of variables.

## **3.5 Method of Data Collection**

### **3.5.1 Sources of Data**

The study used both primary and secondary data. The primary data at the farmer level in the Municipality was solicited using a questionnaire and semi-structured interview. These instruments were used to ensure thorough examination and understanding of the phenomenon and operations involved in the oyster mushroom production. A questionnaire covering variables such as farmer's household, demographic characteristics, knowledge of oyster mushroom

production, institutional settings, as well as the constraints farmers encountered in the production of oyster mushroom was administered to farmers. Statistical packages such as STATA 14, SPSS 21 and Microsoft Excel was used in the analysis of the data obtained from the farmer level.

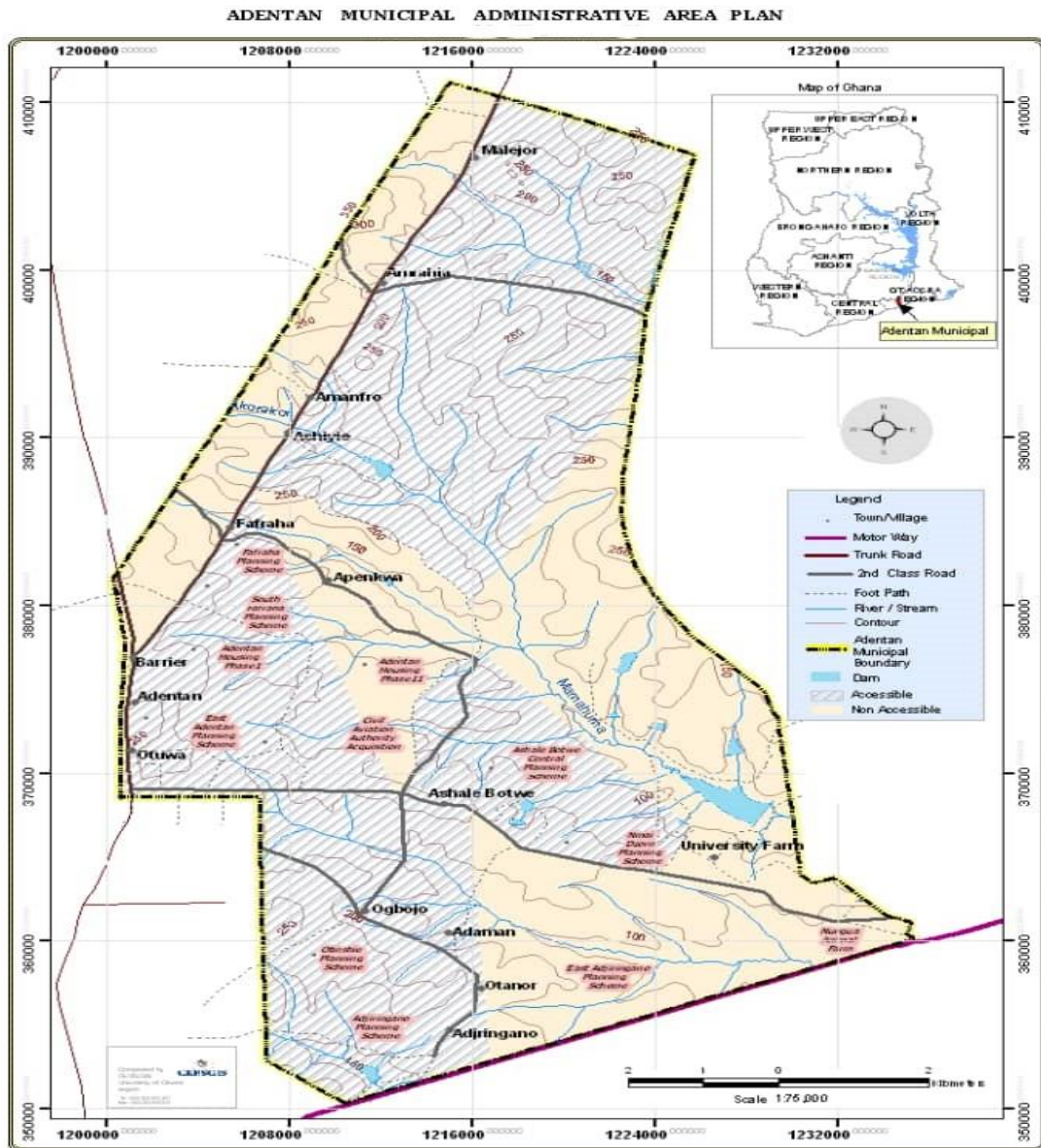
### **3.5.2 Sampling techniques and sampling size**

A multi-stage sampling technique was employed in choosing the oyster mushroom farmers for this study. First purposive sampling was used to select Adentan Municipality because the PROMUSH Project is being implemented in the Municipality. Simple random sampling was used to select 70 mushroom producers who have been trained under the PROMUSH project to respond to questionnaires. A list of farmers was obtained from the Coordinator of the Project and farmers who responded to telephone calls and were ready to participate in the face-to-face interviewing with a specific period were targeted. A total of 126 were consulted; 70 respondents provided information on all the questions posed. The responses were used for analysis. The logit model estimation could do with larger sample size.

### **3.5.3 The study area**

The Adentan Municipal Assembly (AdMA) is among 16 districts in the Greater Accra Region of Ghana. The AdMA, with Adentan as its administrative capital, lies 10 kilometres to the North East of Accra. It is specifically located on latitude 5°43' North and longitude 0°09' West. The Municipality is bordered to the North by the La Nkwantanang Municipality, to the East by the Kpong Katamanso Municipality and the Tema Metropolis, to the South by the Ledworkuku Krowor Municipality and to the West by Accra Metropolis. It has a total land size of 92,84 square kilometres. According to the 2010 Population and Housing Census, the population of the Municipality was 78,215 with males being 39,366 and females being 38,849. The Municipality experiences two (2) rainy seasons in a year. The first is from May and ends in mid-July while the second begins from mid-August and ends in October. The Municipality has an average rainfall of 730mm per annum. The mean monthly temperature ranges from 24.7°C in August to 33°C in

March. The relative humidity is relatively high varying from 65% in the midafternoon to 95% at night.



**Figure 3.2: Map of Adentan Municipal Area**

Source: Adentan Municipal Assembly (2015)

## CHAPTER FOUR

### RESULTS AND DISCUSSION

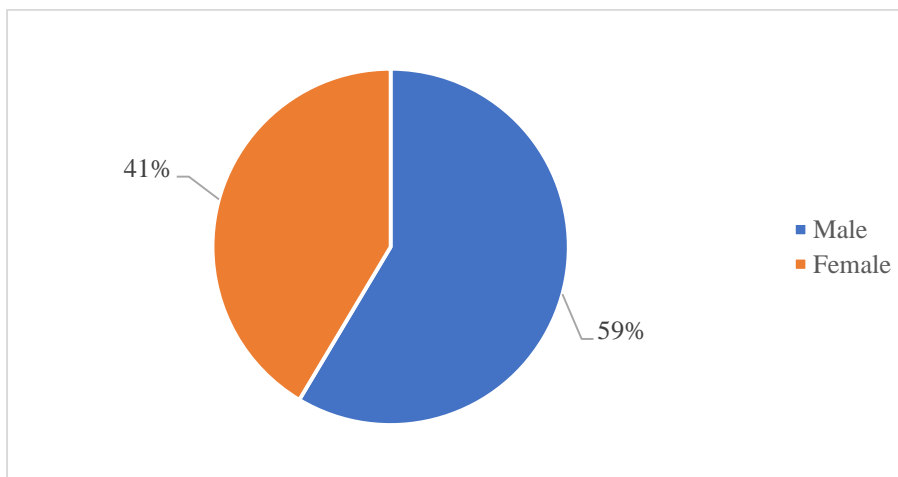
#### 4.1 Introduction

This chapter presents the results and the discussions of the findings of the study. It begins with a description of socio-economic characteristics of the respondents. Follow by farmer's knowledge level on selected practices. The third section describes the level and factors that influences the adoption of Oyster mushroom production.

#### 4.2 Socio-economic Characteristics of Respondents

##### 4.2.1 Gender distribution of respondents

Out of the 70 mushroom farmers interviewed, 29 of them representing 41.4% were females while the remaining 41 (58.6%) were males as shown in (Figure 4.1). The male dominance could possibly be due to strenuous and capital-intensive nature of mushroom farming as females are relatively disadvantaged in that regard.

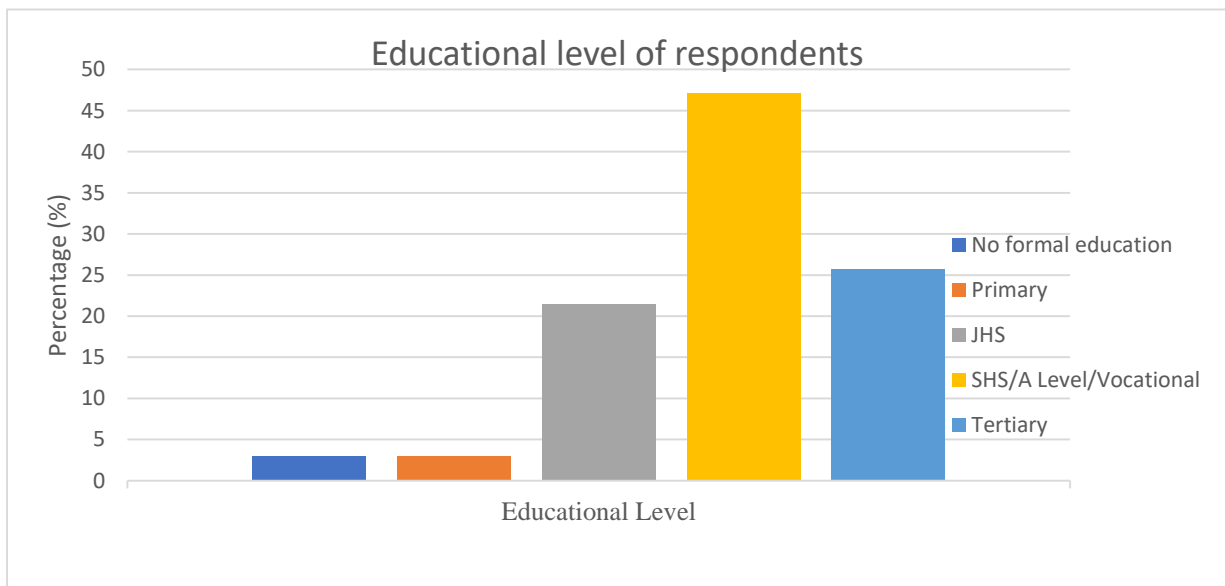


**Figure 4.1: Gender distribution of respondents**

Source: Field Survey, February 2019

#### 4.2.2 Educational level of respondents

Education is important for the wellbeing of an individual and the benefit of society. It assists an individual to make informed decisions that may impact their health and wellbeing. Education provides an individual with the knowledge and skills that lead to a better quality of life. The modal educational level was SHS/A Level/Vocational with 47.1 per cent of the respondents sampled. Only 2.94% of the respondents interviewed had no formal education (Figure 4.2). The fact that majority of the respondents had some form of formal education puts them in a position to participate in income diversification because attaining a high level of education enhances one's skills and increases chances to being innovative. This corresponds with Ackah (2013) who was of the view that attainment of at least primary education increases the chances of getting an on-farm job.



**Figure 4.2: Level of education of respondents**

Source: Field Survey, February 2019

### 4.2.3 Age of respondents

The age of respondents was between 19 years and 62 years as shown in Table 4.1, and the average age was 35.8 of the sample. The age distribution implies that majority of the farmers were within their economically active times and as such can engage in a multiple income-generating activity. The modal age group was between 35 to 60 years of age.

**Table 4.1 Socio-economic characteristics of respondents**

Variable	Frequency	Percentage	Mean	Minimum	Maximum	Standard Deviation
<b>Age (years)</b>			35	19	62	8.53
≤ 35	33	47.14				
35-60	36	51.43				
≥ 60	1	1.43				
<b>TOTAL</b>	<b>70</b>	<b>100.00</b>				
<b>Household size</b>			5	1	16	2.43
≤ 4	35	50				
5-9	32	45.7				
≥ 10	3	4.3				
<b>TOTAL</b>	<b>70</b>	<b>100.00</b>				
<b>Primary occupation</b>						
Mushroom farming	6	8.6				
Trading	15	21.5				
Self-employed	22	31.4				
Crop farmer	5	7.1				
Agricultural Wage employment	1	1.4				
Non-Agricultural salaried worker	16	22.9				
Student	5	7.1				
<b>Mushroom Output (kg/Bag)</b>			216.1	20	1,500	
20-150	35	50				
151-300	18	25.7				
301-450	9	12.8				
451-600	6	8.6				
≥ 601	2	2.9				
<b>Total</b>	<b>70</b>	<b>100</b>				

Source: Field Survey, February 2019

#### **4.2.4 Household size of respondents**

The household is defined as an individual or a group of individuals, who share the same dwelling unit or compound and share the same household system and forming a single consumption unit (GSS, 2012). Majority of the respondents have a household size of between 1 to 4. The mean household size of the sample is 5 as shown in Table 4.1. This is higher than the region estimated household size of 3.9. (GSS, 2010)

#### **4.2.5 Primary occupation of respondents**

The occupations in the study area were mushroom farming, non-agricultural salaried work, agricultural wage employment, self-employment, crop farming and trading. The modal primary occupation among the respondents was self-employment, with 31.4% of the respondents reported it as their primary occupation Table 4.1. This is because of the study area being a peri-urban area and majority engaged in the establishment of small and medium enterprises to provide goods and services. Employment in a non-agricultural salaried sector is the second highest of the respondents 22.9%. These are people working with governmental and non-governmental agencies, mostly teachers and the private sector that are not engaged in agriculture. This could be because of the Municipality's closeness to the Central Business District of the capital city of Ghana Accra. Trading as a means of employment also followed with 21.5% of the respondents. This could also be because of the Adentan Municipality's closeness to the biggest market in the north-eastern part of the Greater Accra Region (Madina Market). Mushroom farming followed with 8.6% of the respondents. This small number could be attributed to the fact that a very small number of mushroom farmers in the Municipality engaged this enterprise as a fulltime business. The Majority 91.4% are engaged in it as a part-time business or have attached it to their primary occupation. Respondents who are students and crop farmers also followed with 7.1%. The crop farmers grow crops such as cassava, maize, chilli, cabbage, lettuce, carrot, cucumber, and other vegetables. Respondents engaged in

agricultural wage employment are the lowest 1.4% among the respondents. These are respondents working as agricultural extension officers operating in and around the study area.

#### **4.2.6 Distribution of mushroom Output**

The output of mushrooms from a farmhouse is directly proportional to the number of substrate bags put under production. Output here is the measure of the total quantities of mushrooms that a farmer can produce in a year per production cycle. The production cycle here is the period from compost preparation to harvesting of mushrooms. This is typically three (3) months. Total quantities (Output) was measured in kilogram. For a bag of substrate, a farmer is expected to record a yield of 1kg of fresh oyster mushrooms per harvest. The average output of mushroom in the study area was 216.1kg (Table 4.1). Majority of mushroom farmers recorded output between 20 kg to 150 kg representing 50 per cent of the total production by the respondents. Two mushroom farmers representing 2.9% recorded quantities above 600kg per production cycle. The average yield could be attributed to oyster mushroom been a new variety in the study area. And with time produces will master the production skills.

#### **4.2.7 Distribution of farm income by respondents**

In determining the income mushroom farmers earned from their mushroom business, the price of a kilogram of fresh mushroom was recorded 5 GHS. The amount per kilogram of fresh mushroom is then multiply by the total quantity of fresh mushrooms harvested by a farmer per production cycle. The total farm income earned by a farmer from the sales of fresh mushroom is then calculated by summing the amount earned by each farmer per the number of time he/she produced in the year (2018) under review. Farm income earned from the cultivation and sales of mushrooms in 2018 ranged from GHS 100.00 to GHS 7,500.00 with a mean of GHS 1,080.36 of the sampled farmers. Majority of the farmers earned between GHS 100.00 – GHS 1,000.00 per production cycle. Some farmers produced two times a year while others produced 3 to 4 times in a year. Farmers who were not able to produce 4 times a year, which is the maximum number a

mushroom farmer can produce oyster mushrooms, was attributed to the unavailability of growing medium all year round, inadequate initial capital to start production and unavailability of spawns. The average farm income was GHS 3,267.86 as shown in (Table 4.2). More than half of the respondents made an annual farm income between GHS 200.00 – GHS 4,000.00 representing 74.3 per cent. Next to this was GHS 4,001.00- GHS 8,000.00 income earners who were 18.6 per cent of the respondents

**Table 4.2 Income distribution of respondents**

Variable	Frequency	Percentage	Mean	Minimum	Maximum
<b>Mushroom income per production cycle (GHS)</b>			1080.36	100	7500
100-1000	48	68.6			
1001-2000	14	20			
2001-3000	6	8.5			
≥ 3001	2	2.9			
<b>Mushroom income per year (GHS)</b>			3267.86	200	30000
200-4000	52	74.3			
4001-8000	13	18.6			
8001-12000	4	5.7			
≥ 12001	1	1.4			
<b>Total</b>	<b>70</b>	<b>100</b>			

Source: Field Survey, February 2019

### **4.3. Knowledge level of farmers on oyster mushroom farming**

The knowledge level of mushroom farmers with respect to oyster mushroom production was determined by asking mushroom farmers their understanding or technical know-how about the various activities performed in the production of oyster mushroom. These activities span from: (1) construction of mushroom cropping house, (2) choice of building materials suitable for mushroom crop house, (3) how to prepare mushroom compost and substrate, (4) bagging of compost, (5) choice of growing medium and source, (6) sterilization of mushroom compost or substrate, (7) spawning, (8) mushroom house cultural practices, (9) controlling of diseases,(10)

how to prepare spawn, (11) harvesting and storage, (12) transportation of harvested mushroom and (13) cleaning of cropping house after production. A mushroom farmer's understanding of each of the named activities is assigned a mark. A mark of 1 is given to a farmer having a clearer understanding of any of the activities named above, 0.5 to a farmer with moderate knowledge and 0.25 to a farmer having low knowledge of the named activity (Jaganathan *et al.*, 2016).

From Table 4.3, it is shown that, out of 70 mushroom farmers interviewed, 51 representing 72.9 per cent have a medium knowledge of oyster mushroom production. This means the majority of respondents have moderate knowledge about oyster mushroom production. This was followed by 12 farmers representing 17.1 per cent having high knowledge level of oyster mushroom production. Only 7 farmers representing 10 per cent of the respondent were having low knowledge level of oyster mushroom farming. This result means that oyster mushroom farmers within the study area do not have all the necessary knowledge in oyster mushroom production. The findings are in conformity with the findings of Meena *et al.* (2012) who researched about the knowledge level and adoption pattern of rice production technology among farmers in Hanumangarh district of Rajasthan India. They opine that 70% representing majority of the famers trained have a medium (moderate) level of knowledge.

**Table 4.3 Knowledge level of mushroom farmers**

Category	Index range	Frequency	Percentage
Low (Mean - SD)	$\leq 47.9$	7	10
Medium (Mean $\pm$ SD)	47.9 – 73.3	51	72.9
High (Mean + SD)	$\geq 73.3 - 100$	12	17.1
Mean	60.6		
Standard Deviation	12.7		
<b>Total</b>		<b>70</b>	<b>100</b>

**Source: Field Survey, February 2019**

#### **4.3.1 Knowledge level of the respondents on selected practices of oyster mushroom production**

In identifying farmers' knowledge about the various selected recommended practices of oyster mushroom farming among respondent, oyster mushroom farmers' knowledge was tested on some carefully selected recommended practices of oyster mushroom farming. From Table 4.4, most respondents have medium knowledge about most recommended practices except cleaning of crop house after production or harvesting that farmers were having high knowledge.

*Construction of cropping house for oyster mushroom production:* Majority of respondents (68.6%) interviewed were having moderate knowledge about this practice. This is one of the determining factors of yield when it comes to oyster mushroom farming. All the farmers said the crop house was the determining factor in controlling humidity and temperature which were always regulated by the farmers through the various stages of production. A well-constructed crop house should be able to prevent pests such as rodents' mice and lizards from entering.

*Choice of building material suitable for oyster mushroom crop house:* About 45.7% of farmers interviewed had moderate knowledge about this practice. The choice of building material has the potential of absorbing moisture or heat in the crop house. This will either affect humidity or temperature in the crop house and might not be host to most pest and diseases.

**How to prepare spawn:** Spawns are prepared in well equipped and regulated laboratories. None of the farmers interviewed produced spawns on their own. They received their spawns from the Centre for Scientific and Industrial Research (CSIR). Although farmers did not produce spawns, they were well abreast with the process of spawn production with most of the farmers interviewed (67.1 %) having a moderate knowledge in the preparation of spawn. Since its production require a laboratory specialist (microbiologist), who have been schooled to handle such a complex and sophisticated scientific procedure, a mere farmer will not understand some of the complex procedures. But farmers were trained on how to differentiate between good and bad spawns.

**Picture C**



*Spawns stored in a cold room for presevation*

**Picture D**



*Picture C and D are pictures of spawns stored in refrigerator and a cold room for presevation*

**How to prepare mushroom compost/ substrate:** Oyster mushroom is produced from industrial agro waste. In preparing compost, farmers need a tropical saw dust from hard wood which will support the growth, development, and fruiting of the mushroom mycelium since saw dust from soft woods shrink in size rapidly. The saw dust is then composted in the open space where sun can shine on it for a period of 28 days with regular turning of the stockpile every 4 days. The turning will remove ammonia in the compost material. It was revealed that; most farmers do not really know how to do the formulation of compost. The problem was due to the measurement of compost materials. The ideal composition for 100kg substrate is 88kg parts of saw dust, 11.5kg of wheat or rice bran and 0.5kg of lime. About 65.7% of the farmers interviewed had moderate knowledge of the preparation of compost or substrate.

**Picture E**



*Trainees taking through compost preparation and turning of compost under the direct sunshine to remove ammonia*

**Choice of growing medium and source:** The knowledge of the growing medium (substrate) as well as the source is the most important practice of the oyster mushroom farming. The quality of the compost determines the quality of the substrate. The yield or output depends on the quality of the growing medium. About 71.4% of the respondent have a moderate knowledge of the practices.

**Table 4.4 Distribution of the respondents according to the level of knowledge about selected practices of oyster mushroom production**

No	Practices	Knowledge level						Total	
		Low		Medium		High		F (70)	% (100)
		F	(%)	F	(%)	F	(%)		
1.	Construction of cropping house for oyster mushroom production	1	1.4	48	68.6	21	30		
2.	Choice of building material suitable for oyster mushroom crop house	20	28.6	32	45.7	18	25.7		
3.	How to prepare spawn	10	14.3	47	67.1	13	18.6		
4.	How to prepare mushroom compost/ substrate	7	10	46	65.7	17	24.3		
5.	Choice of growing medium and source	6	8.6	50	71.4	14	20		
6.	Bagging of compost	7	10	39	55.7	24	34.3		
7.	Sterilization of compost	9	12.9	46	65.7	15	21.4		
8.	Spawning	16	29.9	37	52.9	17	24.3		
9.	Observation of other mushroom house cultural practices	12	17.1	40	57.1	18	25.7		
10.	Controlling of disease and pest	7	10	41	58.6	22	31.4		
11.	Harvesting and processing	10	14.3	36	51.4	24	34.3		
12.	Storage of mushroom	16	22.9	29	41.4	25	35.7		
13.	Cleaning of crop house after production and or harvesting	12	17.1	27	38.6	31	44.3		
<b>Total</b>									
<b>F = Frequency</b>		<b>133</b>		<b>518</b>		<b>259</b>		<b>910</b>	
<b>% = Percentage</b>			<b>14.6</b>		<b>56.9</b>		<b>28.5</b>		<b>100</b>

Source: Field Survey, February 2019

**Bagging of compost:** Compost is bagged into polythene sacks and placed vertically in the crop house. This bagged compost is referred to as the substrate. The substrate is the growing medium on which mushrooms grow. Before a compost are bagged, water is added to it to make it moist. The moisture level is supposed to be at 70% level, but most farmers do not have a moisture

meter to accurately measure it, so they usually manually test it by taking a sample of the moist compost and squeeze it. This method is called the squeezing test. If little droplets of water drip from the palm, then it can be said that the moisture level is about 70% but if the flow of water is freely then it can be said that the water has been over added. This method is not always accurate since the squeezing depends on the strength of the one squeezing. Majority of farmers interviewed (55.7%) had a moderate knowledge of this practice.

**Picture F**



*Bagged substrate arranged vertically in a crop house*

**Pasteurization /Sterilization of compost:** The bags compost (substrate) are sterilize to kill all unwanted microbes that are still in the saw dust after composting using autoclave. In the absence of autoclave which most farmers cannot afford, the bagged composts are put into a metal drum with a tight-fitting lid with little opening for steam out, and some water in the bottom. The drum

is sealed and heated over a fire to create steam, which rises through to sterilize the bags. The main aim of sterilization is to kill all micro-organisms that could compete with the mushrooms on the growing medium. Majority of respondents (66.7%) have a moderate knowledge of this cultural practice.

*Picture G*



*Picture G shows a picture of an Autoclave at the training center.*

*Picture H*



*Picture H shows trainees going through how to use a metal drum to sterilize substrate*

**Spawning/Inoculation:** About 52.9% per cent of respondents have moderate knowledge of this cultural practice. This is the application of spawns onto the substrate or growing medium. An average of 5grams/bag of spawns are inoculated into the substrate. An average of 15-25 bags can be inoculated with a bottle of spawn.

*Picture 1*



*Trainees taking through inoculation procedures at the PROMUSH training centre*

**Controlling of disease and pest:** Controlling of pest and diseases from the crop house is of major importance to farmers. This pest and diseases reduce the output of farmers thereby decreasing their revenue at the end of production. Pest such as flies, mites, termites, beetles, rodents and molluscs and diseases such as mycoviruses, die-back caused by virus, green mould, dry-bubble, brown spot and cobweb caused by fungal, bacterial yellowish, bacterial brown blotch, soft rot, stipe necrosis also caused by bacteria are the common diseases of oyster mushroom. Majority of respondents (58.6%) have moderate knowledge of the prevention and control of pest and diseases.

**Harvesting and processing:** Majority of the farmers (51.4%) interviewed have moderate knowledge in harvesting and processing of oyster mushroom. Most of the farmers sell their mushroom to bakeries who baked mushroom bread which is gaining much popularity in the

study area because of the nutritional value. Some mushroom farmers' also sundry fresh mushrooms to preserve it.

*Picture J*



*Picture of fully developed mushrooms ready to be harvested*

***Storage of mushroom:*** Although farmers were complaining of a storage problem, (41.1%) have moderate knowledge of the storage of mushroom. Oyster mushroom is very perishable and requires a good refrigerator to store for a longer period.

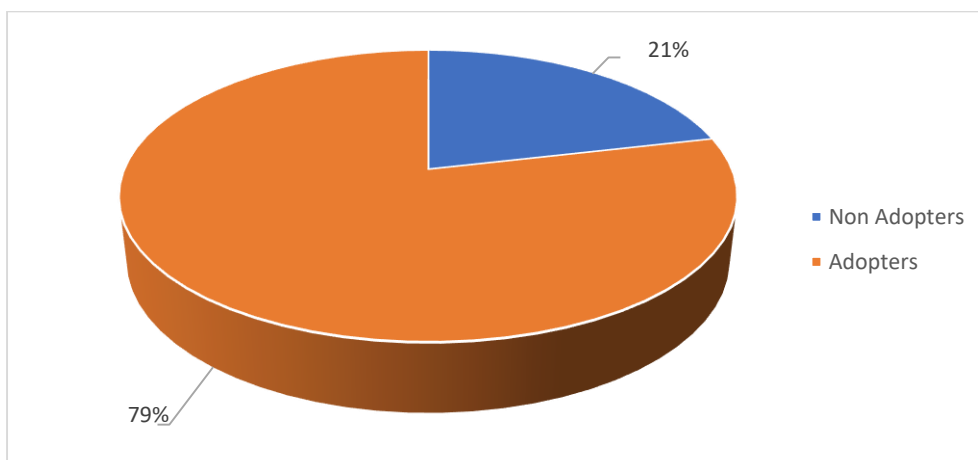
***Cleaning of crop house after production or harvesting:*** Out of the 70 respondents interviewed 43.3% have high knowledge of cleaning the crop house after production. Practising good hygiene in and around the crop house reduces the incident of pest and diseases.

***Observation of other mushroom house cultural practices:*** The other cultural practises which were not captured under any of the cultural practices such as spraying substrate with water to conserve and provide good moisture for the mycelium to grow and others were also asked. Most of the farmers interviewed have moderate (57.1%) knowledge of these cultural practises.

The total responses recorded from farmers concerning their level of knowledge of the 13 carefully selected practices of oyster mushroom production shows that, majority (56.9%) of the respondents have medium knowledge level followed by (28.5 %) of the respondents having high knowledge level with only (14.6 %) of the respondents having low knowledge level.

#### 4.4. Level and factors of oyster mushroom adoption

In determining the level of adoption of oyster mushroom farming or production among mushroom farmers who have benefited from the PROMUSH Project in the Adentan Municipality, mushroom farmers were asked whether they were producing oyster mushroom or not. Out of 70 mushroom farmers interviewed, 55 respondents representing 78.6% were producing oyster mushroom while 15 mushroom farmers representing 21.4% were not producing oyster mushroom but other types of mushrooms despite successfully going through all the training modules. This means majority of farmers over 75 per cent have adopted the production of oyster mushroom in the study area. This result is in consistency with the findings of Kushwah *et al.* (2016). Farmers who are not producing oyster mushrooms cited constraints such as high perishability of the variety, the difficulty in producing, high cost of production and non-availability of a ready market for this variety.



**Figure 4.3: Adoption of oyster mushroom farming by respondents**

Source: Field survey, 2019

#### 4.4.1 Factors that influence adoption of oyster mushroom farming

From Table 4.5, the pseudo R<sup>2</sup> of 0.3973 measure the proportion of the total response variable explained by the regression model. This means that about 39.7% change that occurs in the dependent variable (adoption of oyster mushroom) are equally explained by the independent variable. The P-value of 0.0007 implies that the model is 99.93% correct and not mis-specified.

**Table 4.5 Results of binary logistic regressions of factors influencing the adoption of oyster mushroom farming**

Variable	Coefficient	Marginal effects	P >  z
Age	-0.041	-0.004	0.383
Gender	2.820***	0.337	0.008
Household size	-2.622***	-0.240	0.002
Educational Level	0.014	0.003	0.938
Annual Income	0.0005*	0.00004	0.085
High Perishability	-0.111	-0.010	0.893
High cost of Production	-0.586	-0.047	0.566
No ready market	-1.147	-0.097	0.213
Marital Status	0.1773	0.016	0.731
Cons			0.017
Number of Observation	70		
Log likelihood	-21.920		
LR Chi2 (9)	28.90		
Prob > chi2	0.0007		
Pseudo R2	0.3973		

Source: Authors computation

\* and \*\*\* denote statistically significant variables at 10% and 1% significant levels respectively

Gender of the respondents was statistically significant at 1% with a marginal effect of 0.337. This implies that the probability of a male mushroom farmer to adopt oyster mushroom farming is higher than their female counterparts by 0.34%, all things being equal. This result is consistent with the findings of a study conducted by World Bank and IFPRI (2010) in Ghana, India and

Ethiopia which revealed that male farmers and household heads adopt agricultural production technologies or innovations faster than females. According to Ragasa, *et al.*, 2015, women are more risk-averse in terms of trying out new technology or innovations

Household size was statistically significant at 1% with a marginal effect of -0.240. This means that a 1% increase in household size will result in 0.24% reduction in the probability of adoption of oyster mushroom farming, all other things held constant. This could be that an individual need to be trained before he or she can be productive in the mushroom labour market. Members of household need to be trained before they can offer a substantial helping hand to the mushroom business

Annual income of the respondent was statistically significant at 10% with a marginal effect of 0.0004. This means that an increase in income is likely to lead to adoption of oyster mushroom farming. The result is consistent to previous studies (Abdulai & Binder, 2006; Moser & Barrett, 2003 and Egyir *et al.*, 2011). They opine that producers used income from previous sales or production as their major source of capital and the larger the sales the more funds they invest in producing more mushrooms.

#### **4.5 Constraints faced by farmers in the production of oyster mushroom**

The constraints of mushroom farmers in the production of oyster mushroom were identified during the survey and are presented in Table 4.6. The Kendall's Coefficient was found to be 0.166 and significant at 1% level. The null hypothesis was rejected in favour of the alternate hypothesis which stated that there is an agreement among oyster mushroom farmers in the ranking of the constraints

**Table 4.6 Ranking of constraints faced by oyster mushroom farmers**

Identified constraints	Mean Score	Ranks
High cost of production	4.14	1 <sup>st</sup>
Lack of storage facilities	4.51	2 <sup>nd</sup>
Difficulty to access credit	5.36	3 <sup>rd</sup>
Non-availability of some inputs	6.52	4 <sup>th</sup>
Inadequate market outlet	6.63	5 <sup>th</sup>
Delay in spawn supply	6.82	6 <sup>th</sup>
Unavailability of spawns	6.89	7 <sup>th</sup>
Lack/inadequate extension service	7.42	8 <sup>th</sup>
Contamination of spawns	8.34	9 <sup>th</sup>
Poor development of spawns into mushrooms	8.38	10 <sup>th</sup>
Post-harvest loses	8.47	11 <sup>th</sup>
High pest and disease infestation	8.70	12 <sup>th</sup>
Inadequate clean water for production	9.01	13 <sup>th</sup>
<b>Diagnostics</b>		
Number of observations	70	
Kendall's W	0.166	
D.F	12	
Asymptotic significant	0.000	

Source: Constraints Assessment from Author's Survey Data (2019)

The Kendall's 'W' of 0.166 implies that there was 16.6% agreement among the respondent in the ranking of constraints faced by oyster mushroom production in the Adentan Municipality of Ghana.

Among the identified constraints of mushroom farmers, high cost of production, lack of storage facilities and difficulty to access credit were the three main constraining factors of mushroom farming the study area.

The high cost of producing oyster mushroom in the study area is the biggest constraining factor facing farmers. This problem has made most of the farmers to produce below their potential. Most of these costs according to farmers were mostly incurred through the transportation of materials, and compost from the industries to the crop house.

Lack of storage facilities is the second most pressing constraints of mushroom farmers in the study area. Oyster mushroom was perishable and required storage in a refrigerator to protect and

prolong its freshness. This constraint makes farmers run at a loss by throwing away spoiled mushrooms. This same constraint compels farmers to sell the oyster mushrooms at a cheaper price just to reduce wastage.

Difficulty in accessing credit facilities from financial institutions in the study area is a compelling constraint to mushroom farmers. Not having enough capital which could be supplemented with credit facility prevents farmers from scaling up their production, purchasing of some tools and material as well as simple machines and purchase of refrigerators to improve storage.

Non-availability of some simple tools and materials locally has increased the price of imported ones which compel farmers to perform most of the cultural practices without the appropriate tools and machines. This makes farming oyster mushroom more drudgery and unattractive to the teeming youth.

The marketing of oyster mushrooms in the study area is limited to the selling of fresh mushrooms. This has made the market limited because most people have not developed the taste for dried and processed oyster mushrooms. Sensitization and awareness of the nutritional qualities of dried or processed oyster mushroom will open the markets for farmers and those who have storage problem can target the dried mushroom market.

Delay in spawn supply and unavailability of spawn is a common problem to all oyster mushroom farmers in the Municipality. The delay and unavailability of spawns cost farmers money in the long run. Availability of another spawn production and supply center operating alongside CSIR will give farmers some form of relief and create competition which will benefit the farmers in terms of cost and service.

Most extension officers in the Municipality have limited knowledge of oyster mushroom production. Thus farmers do not have adequate extension services whenever they faced problems during production.

Contamination of spawns and poor development of spawns is another constraints oyster mushroom farmers faced. The problem according to farmers were always reported to spawns' producers and suppliers. Yet the problem persists. This reduces their profit margin as they cannot recoup the money invest if spawns could not develop into mushrooms fully.

Poor development of spawns into mushrooms is also a constraints oyster mushroom farmers were facing in the study area. This could be attributed to so many factors from the spawn suppliers. This problem affects yield and in the long reduces their income.

Postharvest loses occurs during the handling of freshly harvested mushrooms. And because farmers do not have enough storage facilities to store freshly harvested mushroom.

High pest and disease infestation which can be attributed to the usage of unclean water in the farmhouse was another challenge. The Adentan Municipality is among the many areas in the Greater Accra Region which experiences acute shortage of pipe born water. Thus oyster mushroom farmers uses any source of water to maintain moisture in the crop houses for the successful growth of mushrooms. These waters, which are sometimes not clean, causes outbreak of diseases in the crop house.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Introduction**

The summary, key findings and conclusions of the study are presented in this Chapter. It also contains policy recommendations based on the findings of the study.

#### **5.2 Summary of the Study and major findings**

The study analyzed the adoption of oyster mushroom farming among the beneficiaries of PROMUSH Project (PP) in the Adentan Municipality of Ghana. Improving livelihood, creation of jobs, reducing poverty and malnutrition among poor people and largely improving food security are the main objectives of the PROMUSH Project. Specifically, the study analyzed the knowledge level of oyster mushroom farming among beneficiaries of the PROMUSH Project, identified the level of adoption of oyster mushroom farming and factors that influence the adoption of oyster mushroom farming among beneficiaries and lastly identified and ranked the constraints to oyster mushroom farming. The study was conducted in the Adentan Municipality in the Greater Accra Region of Ghana. Data was collected using a structured questionnaire in survey of 70 randomly sampled trainee mushroom farmers during a face to face interview.

- The analysis of knowledge level of oyster mushroom farming among the trainee beneficiaries revealed, that majority of the farmers 72.9% had a moderate knowledge of oyster mushroom production. This was followed by 17.1% of respondents having a high knowledge level of oyster mushroom production. Ten percent of the respondents were having low knowledge of the production of oyster mushroom. Farmers knowledge level

on 13 carefully selected recommended cultural practices of oyster mushroom farming were also analyzed. Farmers were having moderate knowledge of the following recommended practices; construction of cropping house for oyster mushroom production, choice of building material suitable for oyster mushroom crop house, spawn preparation, preparation of mushroom compost or substrate, choice of growing medium and source, bagging of compost, sterilization of compost, spawning, observation of other mushroom house cultural practices, controlling of disease and pest, harvesting and processing and storage of mushroom. Farmers were having a high knowledge level on the cleaning of crop house after production and or harvesting. There were no recommended cultural practices that farmers have low knowledge level of.

- The level of adoption of oyster mushroom farming by respondents was analyzed and results reveal that majority (78.6%) of respondent had adopted oyster mushroom farming. About 21.4% of the respondents had not adopted oyster mushroom farming although they had gone through the mushroom training successfully.
- Econometric analysis of factors influencing the adoption of oyster mushroom farming shows that gender, household size and annual income were the main determinants of the adoption of oyster mushroom farming among beneficiaries of mushroom training. Male farmers were found to be adopting oyster mushroom farming more than their female farmers. This could be linked to the fact that males were thought to be more of risk takers than females and as such will risk adopting oyster mushroom farming in addition to their main occupation than females. Farmers having smaller household size adopted oyster mushroom farming more than households with larger size contrary to expectation. Annual income obtained from the cultivation of oyster mushroom also determined the adoption of oyster mushroom farming.

- The four (4) most pressing constraints faced by oyster mushroom farmers in oyster mushroom production were high cost of production (with a mean score of 4.14), lack of storage facilities (with a mean score of 4.51), difficulty to access credit and non-availability of some inputs (with mean scores of 5.36 and 6.52 respectively).

### **5.3 Conclusions of the study**

- Majority of beneficiaries of the PROMUSH Mushroom Training had moderate knowledge on oyster mushroom farming. This moderate knowledge level extended to 13 carefully selected cultural practices of oyster mushroom farming except cleaning of crop house after harvesting or production that respondents were having high knowledge level of.
- There was high adoption level of oyster mushroom farming among beneficiaries of PROMUSH Training project in the Adentan Municipality. Males and those with high income were more likely to adopt oyster mushroom farming in the municipality
- The four (4) most important constraints oyster mushroom farmers faced in the production of oyster mushrooms were high cost of production, inadequate storage facilities, difficulty in accessing credit and non-availability of some inputs.

### **5.4 Recommendations of the study**

- The high adoption rate shows that, efforts by trainers and extension officers is yielding results and that, the Adentan Municipal Assembly (AdMA) should finance the training of more Extension Officers in mushrooms production so that they can provide extension services to mushroom farmers within and out of the Municipality. These extension officers should also be well resourced to make their work easier. This will make extension services widely available, accessible, and affordable to farmers in the study area to increase the adoption of better practices.

- The high interest shown by trainees should be sustained with financial support, input support and market availability. This could be achieved when financial institutions within the project enclave extend credit facilities to mushroom farmers. This will enable mushroom farmers afford some common tools and materials, which will make the production of mushrooms easier and faster. The credit facilities will also help more farmers to afford a bigger refrigerator to aid storage and conservation of the freshness of harvested mushroom. As this will help reduce post-harvest loses.
- Large household size did not pose much issue as more skill development in mushroom production is required to supply labour to support commercial production. This will create a sustainable job for the teaming youth within the district and even beyond.
- Males are self-selecting in mushroom production, so more females should be encouraged to adopt oyster mushroom farming through women empowerment programmes to achieve gains by targeting and sensitizing to ensure inclusiveness.
- For high knowledge to be achieved by trainees, lecture delivery methods and testing of knowledge during training should be improved. This could be achieved by making participants practically cultivate oyster mushrooms as part of their training assessment.

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**APPENDIX I**

Logistic Regression

Number of obs = 70

LR chi2 (9) = 28.90

Prob > Chi2 = 0.0007

Log Likelihood = -21.919919

Pseudo R2 = 0.3973

Add	Coef.	Std. Err.	z	P> z	[95% Conf.	Interval]
Gender	2.8200810	1.059155	2.66	0.008	.7441759	4.895989
Age	-.0411786	.0471846	-0.87	0.383	-.1336587	.0513014
Household Number	-2.6215080	.8418623	-3.11	0.002	-4.271528	-0.9714887
Educational Level	.0144463	.1849344	0.08	0.938	-.3480185	.3769112
Annual Income High	.0004774	.0002771	1.72	0.085	-.0000657	.0010205
Perishability High cost of production	-.1113214	.8261313	-0.13	0.893	-1.730509	1.507866
No Market	-.5860374	1.022226	0.57	0.566	-2.589563	1.417488
Marital Status	-1.146739	.9210108	-1.25	0.213	-2.951887	0.6584093
_cons	.1773955	.5169337	0.34	0.731	-.8357759	1.190567
	6.4856500	2.714081	2.39	0.017	1.166149	11.80515

Marginal effects after logit

y = Pr (Add) (predict)

= .89822585

Variable	dy/dx	Std. Err.	z	P> z	[95% Conf	Interval]	X
Gender	.337446	.13825	2.44	0.015	.06649	.608402	.585714
Age	-.0037644	.00426	-0.88	0.377	-.012113	.004584	35.7571
Household Number	-.2396483	.0885	-2.71	0.007	-.413113	-.066184	1.95714
Educational Level	.0013206	.0169	0.08	0.938	-.031805	.034447	2.77143
Annual Income High	.0000436	.00003	1.64	0.101	-8.5e-06	.000096	3267.86
Perishability High cost of production	-.0101403	.07517	-1.13	0.893	-.1574466	.137185	.542875
No market	-.047117	0.07176	-0.66	0.511	-.187772	0.93538	0.785714
Marital Status	-.968583	0.7381	-1.31	0.189	-.241533	.047816	.614286
	.0162168	.04753	0.34	0.733	-.076931	.109365	1.51429

(\*) dy/dx is for a discrete change of dummy variable from 0 to 1

**APPENDIX II**

**SURVEY QUESTIONNAIRE**

UNIVERSITY OF GHANA

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS

**ADOPTION OF OYSTER MUSHROOM PRODUCTION AMONG BENEFICIARIES OF THE PROMUSH PROJECT IN THE ADENTA MUNICIPALITY**

Questionnaire ID:	
Name of enumerator:	Number:
Sex:	Phone code:
Community:	Community code:

**A. PERSONAL & HOUSEHOLD CHARACTERISTICS**

1. Sex 1=Male [ ] 0=Female [ ]
2. Age of Respondent [.....]
3. Marital status 1=Married [ ] 2=Single [ ] 3=[Divorced/Separated] 4=[Widowed]
4. What is the size of your household? [ ]
5. Number of persons with age below 15 years: .....
6. Number of persons between ages 15 and 65 years. ....
7. Number of persons with age above 65 years
- (Household size in this study is the number of people who eat from the same cooking pot)**
8. Are you educated? Yes [ ] No [ ]
9. If yes, what is your level of education? A. Primary [ ] B. Junior High [ ] C. Senior High/Technical [ ] D. Tertiary (Diploma, Degree, Masters) [ ]
10. Is mushroom farming your main occupation? [.....] 1= yes 2= No
11. If NO what other work do you do apart from mushroom farming  
a ..... b.....
12. What is your current farm size of mushroom production (Bags)? [.....]
13. Do you have access to organic waste for mushroom composting? [.....] 1= Yes 0 =No
14. Do you have access to farm inputs? [.....] 1=Yes 0=No
15. Do you have access to credit? [.....] 1=Yes 0=No
16. Do you have access to extension services? [.....] 1=Yes 0=No

17. Are you a member of an FBO? [.....] 1=Yes 0=No

If yes, did you receive any of the following assistance from Promush? Tick the appropriate box.

- Technical assistance/training 1=Yes [ ] 0=No [ ]
- Access to inputs (spawns) 1=Yes [ ] 0=No [ ]
- Machinery services 1=Yes [ ] 0=No [ ]
- Equipment 1=Yes [ ] 0=No [ ]
- Credit in kind 1=Yes [ ] 0=No [ ]
- Credit in cash 1=Yes [ ] 0=No [ ]
- Storage 1=Yes [ ] 0=No [ ]
- Marketing services 1=Yes [ ] 0=No [ ]
- Transportation of inputs and/ products 1=Yes [ ] 0=No [ ]

If no to 17, did you receive any of the following assistance from Promush? Tick the appropriate box.

- Technical assistance/training 1=Yes [ ] 0=No [ ]
- Access to inputs (spawns) 1=Yes [ ] 0=No [ ]
- Machinery services 1=Yes [ ] 0=No [ ]
- Equipment 1=Yes [ ] 0=No [ ]
- Credit in kind 1=Yes [ ] 0=No [ ]
- Credit in cash 1=Yes [ ] 0=No [ ]
- Storage 1=Yes [ ] 0=No [ ]
- Marketing services 1=Yes [ ] 0=No [ ]
- Transportation of farm inputs/produce 1=Yes [ ] 0=No [ ]

**B. Knowledge level of Promush Mushroom production among beneficiaries**

18.. Have you been trained or have knowledge on PROMUSH?.....

Giving a score from 1 - 0.25 on the knowledge level of oyster mushroom cultivation

ACTIVITY	HIG (1)	MODERAT E (0.5)	LOW (0.25)
1. How to produce oyster mushroom			

2. How to construct and prepare a cropping house for oyster mushroom production			
3. Choice of building material suitable for mushroom crop house			
4. How to prepare spawn			
5.. How to prepare mushroom compost/ Substrate			
6. Choice of growing medium and sources			
7. Bagging of compost/Substrate			
8. Sterilization of mushroom compost/substrate and material			
9. Spawning			
10. Mushroom house cultural practices			
11. How to control diseases			
12. Harvesting and processing			
13. Storage of oyster mushroom			
14. Cleaning of cropping house after production and harvesting			
<b>others</b>			

**C. level of adoption of oyster mushroom production among beneficiaries**

19. What variety of mushroom do u produce 1= oyster mushroom 2= others
20. Why do you cultivate that variety? 1= high yield 2= early maturity 3= market preference 4= others
21. What is the source of your spawn for cultivation 1=CSIR 2= PROMUSH 3= own laboratory 4= private source
22. Are you aware of PROMUSH oyster mushroom training. 1=Yes [ ] No= [ ]
23. If yes, through what source did you get to know of it. 1= Extension Agents 2= Radio 3= Relatives and friends 4= Television 5= others
- 24 Have u received training from the PROMUSH mushroom training center? 1= Yes [ ] 2= No [ ]

25. If yes, have you used the knowledge to produce or producing oyster mushroom 1= Yes [ ] 2= No [ ]

26. If no, why? 1= it is difficult 2= it is labour intensive 3= its expensive to produce 4= others

27. If yes to 24, for how long have you been producing oyster mushrooms ..... years

**D. Constraints to Mushroom production in the Adentan Municipality**

Please rank and identify constraints that you encounter in order of decreasing severity

CONSTRAINTS	RANKS
1.Lack of storage facilities	
2.High cost of production	
3.Post-harvest losses	
4.Lack/ inadequate extension services	
5.Contamination of bags/spawns	
6.Delay in substrate supply	
7.Unavailability of spawns	
8.Access to water for production	
9.High pest and disease infestation	
10.Inadequate market outlet	
11.Poor development of spawns into mushrooms	
12.Difficulty to access credit	
13.Non-availability of some inputs	

### APPENDIX III- PLAGIARISM REPORT

This is the summary of the plagiarism report of my thesis submitted to [www.turnitin.com](http://www.turnitin.com)

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REPORT

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10%

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ADOPTION OF OYSTER MUSHROOM PRODUCTION AMONG BENEFICIARIES OF  
THE PROMUSH PROJECT IN THE ADENTAN MUNICIPALITY OF GHANA

By SYLVIA EDEM AGYEMAN

TIME SUBMITTED: 26-JUL-2019 11: 49 AM

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