SMALLHOLDER RICE FARMERS' WILLINGNESS-TO-PAY FOR PRIVATE EXTENSION SERVICES IN LIBERIA: A CASE STUDY OF GIBI DISTRICT

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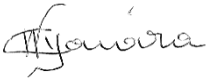
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DECLARATION

This thesis is my original work and has not been presented for an award in any other University.

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DEDICATION

To my inspiration, my mother, for her continuous love and support, and

to my life-coach, my dad, whom the veil that divides us could not allow him see me write this

thesis, you always challenged me to be courageous. Lastly, to my family, with love.

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ABBREVIATIONS AND ACRONYMS

AEAS	Agricultural Extension and Advisory Services
AGRA	Alliance for Green Revolution in Africa
ASRP	Agricultural Sector Rehabilitation Project
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CVM	Coefficient of Variation Method
DC	Dichotomous Choice
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization
FAPS	Food and Agriculture Policy and Strategy
GDP	Gross Domestic Product
HDI	Human Development Index
HIC	Humanitarian Information Center
IMF	International Monetary Fund
KM	Kilometer
LASIP	Liberia Agriculture Sector Investment Program
LD	Liberian Dollars
LISGIS	Liberia Institute of Statistics and Geo-Information Services
MT	Metric Tons
NAES	National Agriculture Extension Service
NGOs	Non-Governmental Organizations
ODK	Open Data Kit
PAPD	Pro-poor Agenda for Prosperity and Development
PRS	Poverty Reduction Strategy
R&D	Research and Development
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
Std. Dev.	Standard Deviation
Std. Err.	Standard Error
TPB	Theory of Planned Behavior
UNDP	United Nations Development Program
USAID	United States Aid for International Development

USAID-BEST	United States Aid for International Development Bellmon Estimation Studies for Title II
VCE	Variance Co-variance Estimator
VIF	Variance Inflation Factors
WFP	World Food Organization
WTP	Willingness-to-pay

ABSTRACT

Agriculture plays a crucial role in the post-conflict developmental agenda of Liberia. Despite the many pro-growth policies and programs implemented in the sector, most farmers still do not have access to agricultural extension services. Due to limited funding, the Government of Liberia is currently promoting a demand-driven extension policy. However, in most rural areas where the majority of resource-poor smallholder farmers live, extension services are primarily offered by non-governmental organizations (NGOs). It is not clear if rural farmers would be able and willing to pay for private extension services that the government is promoting. Against this background, this study was designed to evaluate smallholder rice farmers' willingness-to-pay (WTP) for agricultural private extension services in Gibi District of Liberia. The specific objectives of the study were to determine the factors influencing rice farmers' perception of the effectiveness of NGO-provided extension services and to assess the determinants of demand for and intensity of use of those services. Also, the study estimated smallholder rice farmers' WTP for private extension services and determine the factors influencing that WTP.

Multistage sampling technique was used to select 296 smallholder rice farmers in Gibi District of Liberia. Primary data were collected using a semi-structured questionnaire administered by trained enumerators in face-to-face interviews. The contingent valuation method (CVM) was used to elicit respondents' maximum WTP for private extension services. Descriptive statistics were used to characterize the farmers and the extension delivery system. Probit model was used to assess the factors influencing farmers' perception of the effectiveness of NGO-provided extension services and heckpoisson model was employed to evaluate the drivers of demand for extension services and the intensity of use. Finally, a double-bounded logit model was used to estimate the farmers' mean WTP for the extension services and its determinants.

The results indicated that 48.6 percent of the farmers received extension services. About 97.9 percent of those services were provided by NGOs. The farmers' opinions differed concerning the adequacy, usefulness, and quality of follow-up activities offered by NGOs and the majority perceived NGO-offered extension services as moderately effective. The probit model results revealed that gender of the household head, number of training sessions, membership of saving club, extension agent credibility and access to inputs had significant effect on farmers' perceived effectiveness of NGO-provided extension services in the district. The heckpoisson model results showed that farm income, commercialization of crops and mobile-phone ownership significantly influenced farmers demand for extension services, while gender, cash-

crop ownership, use of improved seeds, and awareness of extension services significantly influence the intensity of their use. Furthermore, results of double-bounded logit revealed that 78.7 percent of the rice farmers are willing to pay for privatized extension services and on average, a farmer was willing to pay US$11.21 per farm visit. Farmer's age, years of formal schooling, household size, annual income and distance to extension source had a significant effect on smallholder rice farmers' WTP for private extension services.

The study recommends that policymakers and other stakeholders in Liberia should consider replicating the strategy used by NGOs to encourage smallholder rice farmers to adopt private extension services. In addition, they should formulate policies that foster collaboration between extension service providers and local financial institutions to enhance farmers' credit access. It is also imperative for policymakers to implement agricultural programs that increase farmers' income and access to improved rice varieties. Further, private sector should be encouraged to invest in extension services to take advantage of the high farmers' WTP. This could be achieved through demand-pull approach such as contract farming between farmers and agribusiness entrepreneurs. Finally, the Government of Liberia should design and implement programs that will increase farmers' income to enhance their capacity to pay for private extension services and services should be tailored according to the farmers' socio-economic characteristics.

Keywords: Agricultural extension services, contingent valuation method, double-bounded model, post-conflict, smallholder farmers, rice, willingness-to-pay, Liberia

CHAPTER ONE
INTRODUCTION

1.1 Background

Food security, poverty, and social-stability are critical global priorities targeted by the United Nations Sustainable Development Goals (SDGs) 1, 2, and 16 (Ponniah et al., 2008; FAO, 2017). The achievement of these priorities is more complicated in developing countries, especially those in conflict situations such as Liberia. In 2015, about 489 million hungry people lived in post-conflict situations globally (Food and Agriculture Organization [FAO] & World Food Program [WFP], 2019), and 413 million poor people lived in sub-Saharan Africa (SSA) with a poverty rate of 41 percent (World Bank, 2018a). Moreover, in the last two decades, about 48 percent of global armed conflicts occurred in Africa (FAO, 2016), where about 70 percent of the population live in the rural areas eking a living from agriculture (Mutimba, 2014). In much of SSA, agriculture provides jobs, food security, reduce poverty, and contribute to maintaining overall social stability (Shimeles et al., 2018). The sector accounts for about a quarter of gross domestic product (GDP), and up to 90 percent of the rural population depends on it for their livelihood (Mukasa et al., 2017). Additionally, around 60 to 70 percent of the labor force is employed in the sector and the majority work in small farms that produce about 85 percent of the food (Asfaw et al., 2012; Alliance for Green Revolution in Africa, 2018).

In Liberia, the agricultural sector plays a crucial role in the country post-war growth and development, providing more than one-third of the GDP, employment for over 70 percent of the population, and approximately 60 percent to export earnings (African Development Bank 2020; Central Bank of Liberia, 2019; Government of Liberia, 2014). The main actors in the sector are smallholder subsistence farmers who use traditional technologies. Rice, cassava and vegetables are the main food crops cultivated, while rubber, oil palm and cocoa are export-oriented tree crops produced (World Bank, 2018b).

The prolonged armed conflict that ended in 2003 and the Ebola virus pandemic of 2014 severely devastated Liberia economic growth and development such that per capita GDP (US$367.00) fell by 60 percent of the average for low-income countries in 2016 (Tyson, 2017). For example, research institutions, roads and bridges were destroyed thereby compromising food production in the post-conflict period (Government of Liberia, 2007). Moreover, the pandemic severely affected food production in the most productive regions due to restrictions on movement (United Nations Development Program [UNDP], 2015). The pandemic also led

to a sharp decline in Liberia's post-conflict development prospects leading to a decrease in real GDP from 8.8 percent in 2013 to 0.7 percent in 2014 (Cook, 2018; Sigman & Davis, 2017).

Like most post-conflict and fragile countries, Liberia is characterized by high levels of poverty and food insecurity. The UNDP Human Development Index (HDI) 2019 report ranked Liberia 176 out of 189 countries with an HDI score of 34.9. Furthermore, about 40.9 percent of the population live below the poverty line of US$ 1.90 per day (UNDP, 2019) and 39.1 percent is food insecure (Government of Liberia, 2017). Since a large proportion of Liberia's population depends on agriculture, accelerating growth in the sector has the potential to reduce poverty, enhance food security and maintain peace (Larsen et al., 2010). The Government of Liberia, like other African Union (AU) members that signed the 2003 Maputo Declaration, expects the sector to contribute to the country's quest for achieving middle-income status by 2030 through job creation, food security, foreign exchange, and poverty reduction (World Bank, 2018a).

Rice is the main staple food in Liberia, accounting for about half of the adult calorie intake and 22 percent of agricultural GDP (Saysay et al., 2016; Roberts et al., 2017). The average Liberian consumes about 108kg per year, one of the highest in SSA compared to 35kg in Nigeria, 41kg in Tanzania, and 43kg in Ghana (FAO, 2020). Most of the rice produced by smallholder farmers who cultivate an average of 1.6 hectares (ha) of land is used for household consumption (Government of Liberia, 2017). About 70 to 75 percent of the total land under food crop production in Liberia is occupied by rice (USAID-BEST, 2014). Although rice production increased sharply after the war from 110,000 metric tons (MT) in 2003 to 335,179 MT in 2016, the yield has been low, averaging just 1.1 MT/ha relative to the potential of 4 MT/ha whereas annual rice consumption was at 400,000 MT (FAO, 2019a; Government of Liberia, 2012c). With the increasing demand, the country continues to rely on imports to fill the supply gap, thus draining scarce foreign exchange and making it vulnerable to food insecurity and malnutrition during global price fluctuations (Government of Liberia, 2018).

Agricultural transformation has been one of the key focus of the Government of Liberia's post-conflict growth and development strategy. Several programs and projects of considerable expenditures have been launched to revive the agricultural sector. In 2008, the government launched a three year (2008 – 2011) multi-sector medium-term development program called the Poverty Reduction Strategy (PRS). The PRS provided the framework for equitable and inclusive growth and poverty reduction, emphasizing agriculture as a priority sector (International Monetary Fund [IMF], 2008). The Food and Agriculture Policy and Strategy

(FAPS) was developed in 2008 within the context of the PRS to identify specific policies and strategies to make the sector more productive. Specific focus was placed on harnessing the potential of many smallholders (Government of Liberia, 2008b).

Consequently, the Agricultural Sector Rehabilitation Project (ASRP) was formulated in 2010 to rehabilitate existing farm-to-market roads, irrigation, storage and processing facilities to enhance productivity and increase farm income (FAO and ECOWAS Commission, 2018). Moreover, the Liberia Agriculture Sector Investment Program (LASIP) was developed in 2010 in line with the PRS and in adherence to the Comprehensive Africa Agriculture Development Program (CAADP) framework to coordinate investments in the agriculture sector (Government of Liberia, 2010). Furthermore, in keeping with recommendations from FAPS and LASIP to transform the extension system, the Agricultural Extension and Advisory Services (AEAS) Policy was developed in 2012 to facilitate the delivery of a decentralized participatory and demand-driven extension (Government of Liberia, 2012b).

The role of extension services in facilitating farmers' access to new knowledge is critical in transforming the agricultural sector of agro-based economies. In Liberia, the government prioritizes agriculture because approximately 80 percent of the population is involved in the sector, by focusing on strengthening agricultural extension services (Government of Liberia, 2017). Extension services are provided by the government, non-governmental organizations (NGOs) and the private sector (Moore, 2017; Sigman & Davis, 2017). However, the current extension system has not adequately addressed farmers' access to new knowledge and technologies because of limited funding due to competing developmental priorities as the country tries to recover from the war. The government is therefore unable to fully fund the delivery of extension services. Relative to the private sector, NGOs have taken over to augment government effort by providing extension services (Sigman & Davis, 2017).

However, Liberia as a nation cannot rely on NGOs to provide extension services forever, because these services are not sustainable and are often donor-funded projects. Hence, the more sustainable strategy is to encourage a demand-driven private extension delivery approach where farmers pay a fee rather than depending on free services. Gibi District has more than four NGOs providing extension services to smallholder farmers engaged in rice production (Murphy et al., 2016). This makes the district a suitable area for a study aimed at understanding smallholder farmers' perception of, demand and intensity of use of extension services and how much they are willing to pay for private extension services.

1.2 Statement of Research Problem

Despite the many pro-growth interventions carried out by the Government of Liberia and its partners, most smallholder farmers do not have access to private extension services (Sigman & Davis, 2017). Moreover, only a few farmers have been linked to new technologies and knowledge. For example, in 2016, less than 10 percent of the farmers received extension services, while less than five percent used fertilizers and improved seeds (Government of Liberia, 2016, 2018). According to Moore (2017), limited public funding undermines public agricultural extension delivery in Liberia. Further, the private sector focuses more on commercial farmers, while NGOs provide most of the services to smallholder farmers.

Although NGOs play a vital role in expanding the reach of extension services, their programs are usually donor-funded and tied to specific deliverables, usually outside government's sector priorities, and implemented based on a predefined period (Government of Liberia, 2008b). The sustainability of such programs becomes a major constraint when the donors withdraw funding or does not produce the expected impact that leads to additional funding (McNamara et al., 2011). This leaves the farmers both unserved and excluded. For instance, global crisis such as the COVID-19 pandemic and recession directly or indirectly affect donor countries leading to diminished funding to NGOs (Joseph & Bill, 2014; Zhou & Babu, 2015). Unlike the NGOs, private sector extension service can be demand-driven and target specific farm problems. Hence, NGO-provided extension services often follow donor's priorities rather than farmers'. This means that NGOs often give farmers what they have relative to what farmers need.

It is argued that if privatization of extension services is an effective change agent for providing extension services to farmers or their networks, returns would be high (Rivera & Alex, 2004). This may involve sending personnel who are subject-matter specialists in the field to address farm-related problems. With the limited public-sector spending on agriculture in Liberia coupled with the disadvantages of donor-funded NGO extension programs, transferring the cost of extension services to farmers could be a better alternative to sustain the agricultural extension system. The agricultural extension system needs to promote a cost-recovery approach to respond to emerging changes and responsibilities, because in commercially-oriented agriculture, extension needs more investment to provide services based on farmers' demand (Birner & Anderson, 2007; Tolera, 2014). Furthermore, farmers' willingness-to-pay (WTP) for agricultural extension services will make service providers more accountable to them (Birner & Anderson, 2007; Qamar, 2011). WTP evaluates the potential demand and by

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doing so estimates the cost for extension services that may be provided on a cost recovery basis (Badr, 2019). According to Yegbemey (2014), WTP attempts to explain whether individuals are ready to pay a cost for potential goods or services. It also gives insights into whether the mechanism to provide the services to farmers would be useful.

Although past studies have addressed agricultural extension service delivery methods, barriers of personnel capacity and opportunities for improving service delivery in Liberia (Lah et al., 2018; Moore, 2014; Moore & Harder, 2015), none focused on farmers' WTP for extension services. The lack of studies on farmers' WTP for private agricultural extension services in Liberia makes it difficult to understand the likely behavior of farmers towards demand-driven extension services. Elsewhere outside Liberia, studies focusing on farmers' WTP for extension services reveal that farmers are generally willing to pay for extension services and that a demand-driven extension system contributes to quality service delivery. Yegbemey et al. (2014) found that farmers in Northern Benin expressed WTP for extension services that could raise their awareness on climate issues and make them adapt to climate change. In Bangladesh, Uddin et al. (2014) found that farmers were willing to pay for extension services on condition of higher economic benefits. Finally, Shausi et al. (2019) found that household socio-economic characteristics and institutional factors were significant determinants of WTP in Tanzania.

These studies illustrate the need to understand farmers' WTP for private extension services. In Liberia, this has not been addressed by previous studies. Thus, it is not clear whether or not smallholder rice farmers would be willing to pay for private extension services and the amount they would be willing to spend. Moreover, the factors that are likely to influence rice farmers' WTP for private extension services have not been studied. The current study was undertaken to fill this knowledge gap using smallholder rice farmers in Gibi District as a case study.

1.3 Objectives of the Study
The overall objective of this study was to examine smallholder rice farmers' willingness-to-pay for private agricultural extension services in Gibi District of Liberia. The specific objectives were to:
1. Determine smallholder rice farmers' perceptions of the effectiveness of existing agricultural extension services delivery systems in Gibi District of Liberia.
2. Assess factors influencing smallholder rice farmers' demand for and intensity of use of existing agricultural extension services in Gibi District of Liberia.
3. Estimate smallholder rice farmers' willingness-to-pay for private extension services.

4. Evaluate the factors influencing smallholder rice farmers' willingness-to-pay for private extension services in Gibi District of Liberia.

1.4 Hypotheses Tested in the Study

For the above objectives, the study tested the following hypotheses:

1. Smallholder rice farmers do not have a positive perception of the effectiveness of existing agricultural extension services delivery systems in Gibi District of Liberia.
2. Socio-economic and institutional factors do not influence smallholder rice farmers' demand for the existing extension services and the intensity of their use District of Liberia.
3. Smallholder rice farmers are not willing to pay for private extension services.
4. Socio-economic and institutional factors do not influence smallholder rice farmers' WTP for private extension services in Gibi District of Liberia.

1.5 Justification of the Study

The provision of adequate extension services on a fee-for-service basis that addresses farm-level constraints can increase farm productivity and income, and reduce poverty and farmers' reliance on free NGO extension services. Therefore, an understanding of the factors that influence farmers' demand for existing extension services and the intensity of their use is essential to providing insights for evidence-based policymaking to improve service delivery to rice farmers in Liberia. It will also enhance services delivery to those who seek for extension services and encourage their full utilization. At the same time, the findings of this study can be used by extension service providers to ensure that service delivery is better guided to increase farmer's demand for the services and their use.

The Government of Liberia is faced with many developmental priorities resulting from the civil conflict and the Ebola virus pandemic, thus limiting funding to agriculture. Hence, the best alternative to sustain agricultural extension delivery is to engage the private sector on a cost-recovery or demand-driven extension system that reduces the government's burden. Since the private sector services are driven by demand, there is need to demonstrate whether the demand for their services is viable or not. To this end, if rice farmers are willing to pay for private extension services, it would justify the delivery of private extension services and further promote the development and commercialization of specialized extension services for rice farming. The mean WTP amount found in this study provides baseline information on farmers' propensity to meet extension costs and can help providers in pricing their services.

Furthermore, using the information on factors that are likely to influence rice farmers' WTP, service providers could design appropriate extension packages targeted to different clientele.

Also, the results of this study will guide the governments and other stakeholders engaged in agricultural extension service delivery in devising policies and investment decisions that reflect cost-recovery or user contribution in the agricultural sector. Liberia, a country that is just recovering from the twin shocks of civil war and Ebola virus pandemic, the results of this study will help in achieving the Pro-poor Agenda for Prosperity and Development (PAPD) goals and those of SDGs on hunger, poverty and peace. Finally, it will contribute to the existing gap in literature on smallholder rice farmers' WTP for private extension in Gibi District, Liberia.

CHAPTER TWO
LITERATURE REVIEW

2.1 Agricultural Extension Services in Liberia

2.1.1 Definition of Agricultural Extension Services

There is no generally accepted definition of the term "agricultural extension". However, Swanson & Rajalahti (2010) defined "agricultural extension" as the transfer and application of agricultural technologies or knowledge from researchers through farmer education to improve their farming practices. This definition highlights agricultural extension as a system that provides farmers with skills and technical advice to improve farm production. It does not consider factors such as improving the value chain and networks of the farmers (Swanson, 2008). Besides the transfer of technologies, extension services provide more comprehensive learning and capacity development activities for farmers that reflect those factors (Bonye et al., 2012; Swanson, 2008). According to Christoplos (2010), "agricultural extension" is the activities that facilitate farmers and their networks access to knowledge, information, and technologies; and link them to researchers to develop their skills and practices to improve their welfare. This definition is more inclusive such that it brings together the different factors needed to make a unique extension system. It offers what is required to make an extension system more effective. This study adopts Christoplos' (2010) definition because it touches all the different activities along the agricultural value chain that require knowledge and skills transfer by extension to make farming a rewarding business.

2.1.2 A Brief History of Agricultural Extension Services

The history of agricultural extension can be traced to the mid-19th century when the universities of Oxford and Cambridge first used the term "extension" for an educational program in England (Jones & Garforth, 1997). The term was also used in Ireland to mean "an advisory service to transfer information on crop diversification and intercropping practices to potato farmers during the potato famine between 1845 and 1851" (Swanson & Rajalahti, 2010 p. 1). The name "agriculture extension" was first used in 1914 by the United States Federal Smith-Lever Act that formalized state extension programs in colleges and universities (Al-Kaisi et al., 2015). Later, the term "Advisory service" was used as an alternative for "extension services" with the two being used interchangeably (Swanson, 2008).

2.1.3 Overview of Agricultural Extension Services in Liberia

The initial administration of agricultural extension services in Liberia was in 1960 when the government established the National Agriculture Extension Service (NAES) to transfer agricultural technologies to farmers using a top-down supply-driven system that promoted the adoption of improved inputs such as seeds and fertilizers (Sigman & Davis, 2017). The system was underfunded, and the mode of application was not effective in driving the uptake of technologies (Government of Liberia, 2012b). Funding from the World Bank in the 1970s helped to increase the number of public extension agents and accelerated information and knowledge transfer (Government of Liberia, 2000). However, the system collapsed during the 14 years of civil war (1989 – 2003), leading to extension services being primarily provided by NGOs (McNamara et al., 2011).

The Liberian agricultural extension system has undergone a major structural change where services are provided under a participatory and demand-driven system that promotes farmer-led and market-driven services delivery (Government of Liberia, 2012b; Oladele, 2011). Extension services are provided under the new policy by the Ministry of Agriculture, varieties of private firms, and NGOs (Lah et al., 2017). The public sector extension faces numerous limitations such as underfunding and low personnel capacity, making it unable to effectively reach out to farmers while the private sector is also underdeveloped (Murphy et al., 2016).

2.1.4 Benefits of Agricultural Extension to Farmers

Agricultural extension has become an efficient framework in agricultural development with enormous benefits in advancing agriculture as an engine of growth (Elias et al., 2016). It also accelerating productivity, increasing food security, reducing rural poverty, and by addressing the information needs of all farmers (Maoba, 2016; Zhou & Babu, 2015). This is done by facilitating the transfer of information and technologies for farmers to improve their farming practices (Al-Zahrani et al., 2016). Furthermore, it is one of the major strategies for promoting rural development by assisting farmers in identifying their problems and finding appropriate solutions (Maoba, 2016). According to Birner et al. (2009), the benefits of agricultural extension services can be viewed in three stages. First, the immediate outcome is a behavioral change of the farmers such as increased capacity and improved decision-making in adopting new technologies and production and marketing strategies. Second, intermediate outcomes reflect changes at the farm household level, such as welfare gain and, lastly, the ultimate outcome or impact that contributes to society's broader goals such as increased productivity,

income, employment, food self-sufficiency, and innovation of new technologies. On the impacts of access to extension services and cooperative membership on technology adoption in rural Nigeria, Wossen et al. (2017) demonstrated that agricultural extension services positively impact poverty reduction and technology adoption among smallholder farmers. Therefore, affordable and accessible extension services for smallholder rice farmers in Gibi District of Liberia, are likely to lead to welfare gain.

2.2 Theoretical review of willingness-to-pay

2.2.1 Theoretical background of economic valuation of market and non-market goods

Willingness-to-pay (WTP) is defined as the maximum amount of money an individual is willing to offer for a new product that is not available on the market (Zhao & Kling, 2004). WTP estimates are also regarded as the maximum utility that an individual seeks to derive from using a good or service (Bateman & Willis, 2005). Valid estimates of WTP play a crucial role in developing and pricing new products (Bir et al., 2018). With the increased development of new technologies in response to agricultural transformation, WTP has become essential in determining the value individual farmers are willing to pay for new technologies and services (Channa et al., 2019). It has gained considerable attention in agribusiness studies as a standard model for pricing new farming products and services (Aydogdu, 2017; Badr, 2019; Kokoye et al., 2018). According to Kokoye et al. (2018), the amount an individual is willing to offer for a good or service is based on their preferences and the perceived benefit derived from using it. This approach aims to provide policymakers and researchers with information that facilitates the commercialization of new agricultural products such as private extension services (Bateman & Willis, 2005; Maalouf & Chalak, 2019).

2.2.2 Theories underpinning the concept of willingness-to-pay

There are competing theories or models that underpin the concept of an individual's WTP. These theories include the theory of public goods and collective action, random utility theory, and theory of planned behavior [TPB] (Liebe et al., 2011; Yussif et al., 2017). The theory of public goods/collective action considers the dilemma involved when an individual's cooperation is based on trust which, in turn, influences the individual's WTP (Ostrom, 2000). According to Franzen (1995), the dilemma is used to determine the extent to which individuals perceive public intervention and comply with conditional cooperation strategies. The dilemma arises when individuals perceive and consider their WTP for the provision of public goods whose provision is non-rival and non-excludable (Olson, 1965; Sandler, 1992). An essential

concept of this theory is that no one can be excluded from using public goods once it is made available, thus giving rise to a social dilemma that individuals will rely on the contribution of others and use the goods as free riders (Liebe et al., 2011; Ostrom, 2000). On the contrary, the concept of "trust in other people's cooperation" demonstrates a person's belief that others would be willing to pay or perform their share of the task. With conditional cooperation, it is assumed that individuals who believe that others will pay are more likely to be willing to pay than those who do not (Ostrom, 2000). However, a major weakness of the theory is that individuals consider the contribution of others to public goods as a substitute for theirs or reason to contribute less than what is necessary for the supply of the goods or services (Marwell & Ames, 1980).

The random utility theory assumes that individuals are rational decision-makers and choose the alternative from a set of choices that maximize their utility (Cascetta, 2009). In this framework, the choice of alternatives that maximize utility is influenced by observable factors such as sex, age and education, and unobservable ones such as motivation (Greene & Hensher, 2010). These unobservable aspects are inherently unmeasurable and are captured by the error terms (Greene, 2012). The random utility model is advantageous in WTP estimates compared to the theory of public goods because it captures individual decision-makers' preferences, maximum WTP amount, and determinant of the maximum WTP based on latent or unobservable variables associated with the choices (Greene & Hensher, 2010). However, a major shortcoming of the random utility theory is that the theory focuses more on the preferences of the decision-maker relative to the available alternatives (Azari et al., 2012).

The theory of planned behavior (TPB) is concerned with the consumer's behavioral intention which is a critical determinant of an individual's preference for a non-market good (Gbénou-Sissinto et al., 2018; Obeng et al., 2019). It offers the framework for WTP preferences for non-market goods (Liebe et al., 2011). The TPB is a psycho-social model that describes an individual's behavior considering rational choices, motivation, and attitude (Liebe et al., 2011; Pouta & Rekola, 2001). It posits that an individual's intention to perform a behavior is the strongest predictor of that behavior (Ajzen, 1991). It is an extension of the theory of reasoned action (Morris et al., 2012). According to Ajzen (1991), an individual's intention to engage in a behavior is a direct predictor of the behavior. On the other hand, behavioral intention is a function of attitude toward behavior, subjective norm, and perceived behavior control that influences behavioral intention (Liebe et al., 2011).

Attitude towards behavior defines how an individual appraises a given behavior as favorable or unfavorable; the subjective norm is the social pressure to perform the behavior or not, and the perceived control implies perceived ease or difficulty of executing the behavior (Obeng et al., 2019; Liebe et al., 2011). In the valuation of non-market goods, WTP is anticipated to increase when individuals demonstrate a more satisfactory attitude toward paying for the goods with increased social pressure towards payment and an increased perceived behavioral control regarding paying for such goods (Liebe et al., 2011). The theory of planned behavior has been applied in several valuation studies to explain individual WTP for non-market or environmental goods (Lopez-Mosquera, 2016; Lopez-Mosquera & Sánchez, 2012; Obeng et al., 2019; Pouta & Rekola, 2001).

The TPB offers a tested framework for WTP for non-market goods as it explains consumer's behavioral intention to purchase a given good or service. The current study seeks to explain smallholder rice farmers' WTP for private extension services in the Gibi District of Liberia, which currently does not exist in the market. As such, it is impossible to observe smallholder rice farmers' demand for private extension services. In this case, the researcher can only predict their WTP for private extension services by creating a hypothetical market scenario to elicit their stated preferences, which is the focus of this study.

2.2.3 Methods used to estimate willingness-to-pay

The contingent valuation method (CVM) is the stated preference method commonly used in non-market valuation studies. It is a survey-based method used to elicit valid estimates of WTP for non-market goods such as private extension services in Gibi District of Liberia (Haab & McConnell, 2002; Hanemann et al., 1991). This method circumvents the absence of a market by creating a hypothetical one for the good or intervention for the respondents and asks them to state how much they would be willing to pay (Nafziger, 2005; Birner et al., 2009). The estimated values are contingent on the information presented to the respondent during the survey. It is constrained by both income and alternatives available to the respondents (Baker & Ruting, 2014). According to Haab & McConnell (2002), the hypothetical scenario is more flexible in dealing with valuation problems.

The CVM became popular in valuation literature when it was applied by the National Oceanic and Atmospheric Administration (NOAA) panel to assess monetary value for damages caused by the Exxon Valdez oil spill in the United States (Birner et al., 2009). According to Birner et

al. (2009), it has gained tremendous attention in valuation research, especially in the absence of previous market information about the good or service being valued. The method was chosen for this study because it is flexible in generating valid estimates of farmer's WTP. It has been widely applied in many studies to derive efficient price estimates of non-market goods (Bogale & Urgessa, 2012; Danso-Abbeam et al., 2014; Mezgebo et al., 2013; Paudel et al., 2019).

The CVM is based on four different valuation questions: open-ended, bidding game, payment card, and closed-ended or referendum (Haab & McConnell, 2002). According to Haab & McConnell (2002), the open-ended format is one of the earliest question formats of the CV methods in which respondents are asked to state their maximum WTP amount for a public good or service (Haab & McConnell, 2002). For example, a respondent could be asked the following: "What is the maximum amount you are willing to pay for good Y?" (Portney, 1994). One major advantages of the open-ended elicitation technique is that data collection is straightforward, simple to interpret and very informative as maximum WTP for each respondent can be identified using relatively simple analytical techniques (Haab & McConnell, 2002). However, this approach has got some shortcomings. The open-ended question format can lead to protest answer (no vote), more zero responses or large maximum WTP values (Carson, et al., 2001 & Haab & McConnell, 2002). Furthermore, Roe et al. (2002) and Hanemann (1994) pointed out that the use of open-ended questions lead to respondents lowering their maximum WTP amount in anticipation that a high amount could lead to a future increase in prices or attracting strategic bias in responses.

Originally devised by Davis (1963), the bidding game is a CVM question format that consists of a series of dichotomous questions in which respondents are repeatedly asked whether they would be willing to pay a given amount for a proposed good beginning with a lower or higher amount. The respondents would then say "yes" ("no") to the bid amount and the interview continues until the highest positive response is given (Hoyos & Mariel, 2010). The bidding process stops at the point where a response lies between a "yes-no" (respondents rejects the highest bid value) or "no-yes" (respondents accepts the lowest bid value) (Portney, 1994). By presenting a series of bid prices, the iterative bids elicit a more accurate estimate (Willis, 2002). Additionally, the process provides the respondent with sufficient time to consider the value presented in a hypothetical scenario and encourages careful consideration of their preferences (Portney, 1994; Willis, 2002). However, the bidding game is not freed of shortcomings. According to Carson et al. (2001), the initial value of the bidding game is assumed to influence

starting point bias. The method also leads to huge numbers of positive responses and implementation is costly (Cummings et al., 1986).

The payment cards elicitation technique was developed as an alternative to the bidding game by Mitchell & Carson (1984). The method contains a range of value (starting at zero to a larger amount) for the proposed intervention from which the respondents are asked to choose their maximum WTP amount. The questions is then stated as follows: "Which of the amounts listed on the card best describes your maximum WTP?" (Haab & McConnell, 2002). The payment card method is advantageous in eliciting maximum WTP value. It provides a clue to the alternative bid value, while avoiding starting point bias and minimizing the number of outliers compared to open-ended and iterative bidding methods (Mitchell & Carson, 1984). The method has some problems in that respondent's WTP value would be influenced by the range of the numbers used in the card and cannot be used in telephone interviews (Competition Commission, 2010).

The closed-ended question format is where respondents are presented with predetermined bids in a dichotomous choice (DC) question asking whether they would be willing to pay said amount (Haab & McConnell, 2002; Hoyos & Mariel, 2010). The typical DC question format is: "Would you be willing to pay $X amount for good Y?" A DC question where a respondent is presented with one question is known as single-bounded DC format and where a follow-up question is presented is referred to as double-bounded DC question format (Hoyos & Mariel, 2010). The single-bounded format generates only a single bound on each respondent's WTP – an upper bounder if the individual answer "no" or a lower bound if the answers "yes". The approach is easier for data collection. It provides less burden for the respondents who only answer by saying "Yes" or "No" to the stated bid value. At this point, the respondents can accept the bid value if it is greater or equal to what they are able to pay or reject otherwise. According to Pearce & Ozdemiroglu (2002) and Prasenjit & Sarmila (2009), the single-bounded question provides less information, leads to positive responses and not efficient in that the respondent provides less information compared to open-ended questions.

On the other hand, the double-bounded DC question format has gained enormous attention in WTP studies because it is more information-intensive and increases the efficiency of WTP estimates by asking a follow-up question (Alberini et al.,1997; Hanemann et al., 1991). The format has proven to be more efficient than the single-bounded format in eliciting more

information about each respondent's WTP (Haab & McConnell, 2002; Pearce & Ozdemiroglu, 2002). Moreover, it collects more efficient information from respondents and minimizes the number of protest answers and strategic biases in the survey responses (Cawley, 2008). For these reasons, this study used the double-bounded DC question to elicit farmers' WTP estimates for private extension services.

The double-bounded DC format presents respondents with two bids – an initial and a follow-up. First, a respondent is asked whether he is willing to pay a certain amount for a change, then a follow-up question is asked depending on the answer provided to the first question (Haab & McConnell, 2002). If the respondent answers "no" to the initial bid, a lower bid value is then presented; if the answers "yes", a higher bid value is then presented (Freeman et al., 2016). The observed ordered outcomes are no-no (NN), no-yes (NY), yes-no (YN), and yes-yes (YY). The advantage of this approach is that one can easily identify where a respondent's maximum WTP lies. Also, information from the follow-up question makes the double-bounded question format more efficient than the single-bounded question format (Hanemann et al., 1991).

2.3 Review of empirical studies

2.3.1 Perception of farmers toward agricultural extension services

The development of new agricultural technologies substantially impacts agricultural productivity by enhancing farmers' competitiveness (Zhou & Babu, 2015). However, developing them is only appropriate when they are adopted and used by farmers (Anderson, 2016). According to Al-Zahrani et al. (2016), agricultural extension plays a crucial role in facilitating farmers' access to new technologies through knowledge transfer. Although extension services have been designed to disseminate the new knowledge and technologies, farmers' behaviors towards the technologies have been influenced by the perceived effectiveness of the extension services they received (Alwarritzi et al., 2017). Farmers' perception can be used as an alternative approach for evaluating agricultural extension programs (Agbarevo, 2013). The role of extension in improving farm productivity forms the basis for their perception of the services (Zhou & Babu, 2015).

The effectiveness of the extension delivery system in enhancing capacity of farmers, technology transfer and adoption and the ultimate improvement of agricultural output depends on key attributes associated with the adequacy of the service provided, usefulness of

information provided, and follow-up on activities carried out (Buadi et al. 2013; Zhou & Babu, 2015). According to Hassan et al. (2020), a well-planned extension programs with careful choice of activities serves the needs of the farmers. The way service providers implement activities, disseminate information and following-up on the use of those activities and information have a direct bearing on how farmers perceive their adequacy, usefulness and quality. Therefore, it may require services to be tailored based on the different socio-economic characteristics of the users (Moaba, 2016). Hence, knowledge of farmers' perceptions provides needed information for planners and service providers to improve service quality. Pasts studies have focused on farmers' perceptions of different agricultural support services using various methods for analysis.

Buadi et al. (2013) assessed farmers' perception of the quality of agricultural extension services provided by non-governmental organizations (NGOs) in Ghana. The study used a five point Likert-scale to collect primary data from beneficiary farmers of NGO extension programs and descriptive statistics was used for analysis. The findings showed that farmers mostly perceived the services as relevant to their needs but held mixed perceptions about adequacy, availability and timeliness of the services. Besides, follow-up activities were perceived to be generally acceptable. The present study benefits from Buadi et al. (2013) regarding the different attributes used to evaluate NGO extension services. However, this study goes further to assess what determines perceptions.

Moaba's (2016) studied farmers' perception of agricultural extension service delivery in Germiston Region, Gauteng Province of South Africa. The study used purposive and simple random sampling method to collect data from 78 farmers. Likert-type scale method was used to elicit farmers' perception of effectiveness of extension methods. Results revealed that farmers' perceptions of training and demonstrations were highly effective; individual farm visits, farmers' days, study groups and on-farm trials and research were perceived to be effective. The findings also showed that the farmers perceived delivery methods such as workshops, print materials and office calls to be slightly effective while telephone calls was perceived to be ineffective by famers.

Using descriptive statistics to analyze primary data collected on a five-point Likert-scale from farmers who participated in extension programs, Agbarevo (2013) evaluated farmers' perception of the effectiveness of extension delivery mechanisms in Cross-River State in

Nigeria. The results revealed that farm visits, meetings between farmers and extension personnel and field demonstrations were strongly effective. In contrast, training programs for farmers, distribution of training materials and organization of research-extension-farmer-linkage were ineffective. Unlike Agbarevo (2013), who looked at extension services provided by different actors, the current study assessed farmers' perception of NGOs provided services.

In Ghana, Hassan et al. (2020) assessed maize farmers' perception of the effectiveness of extension delivery tools. The study used primary data and analysis was done in means at four and three point Likert scale using descriptive statistics. The results revealed that creating awareness by extension agents was perceived to be very effective, visitation of farmers and organization of field meetings were effective. However, research-extension-farmer linkage, farmer training program, extension delivery was poor in field days, and organization of demonstrations. The study under review explored perception of farmers about different delivery methods. However, the analysis was based on the means of the three-point Likert scales thus making it difficult to know the distribution of responses on scale. Therefore, the current study analysis will based on the frequency of the responses on the Likert-scale for each attribute.

2.3.2 Factors likely to influence farmers' perception

In Ethiopia, Assaye (2017) analyzed smallholder farmers' perceptions of climate change and its determinants. Primary data were randomly collected from156 households and probit model was used to estimate the factors that infouenced perception. The results revealed that educational level, number of extension contact, off-farm income and age of the household-head were significant determinants of farmers' perception. While Assaye (2017) focused on farmers' perception of climate change, the current study assessed rice farmers' perception of NGO provided extension services in Liberia.

Applying a logit model, Sarker & Itohara (2009) investigated the determinants of farmers' perception of the effectiveness of agricultural extension program for smallholder organic farmers in Bangladesh. Data for the study were collected from 90 smallholder organic farmers of the Madhupur sub-district and Logit model was used for analysis. The study found that the credibility of the extension workers, types of services received, frequency of extension contact and education significantly influenced perception. However, the present study differed from

this study in terms of the analytical approach used. The current study used the probit regression for analysis.

David & Abbyssinia (2017) examined the determinants of smallholder farmers' perceptions of the use of soil conservation technologies in South Africa. Ordinary least squares regression was used, and results indicated that perception was significantly influenced by age, incomes, education, marital status, awareness, and participation in extension services. The present study differs with David & Abbyssinia (2017) on the analytical approach since the dependent variable was binary.

Also, in Omotesho et al. (2015) study into farmers' perception of the accountability of agricultural extension services provided in Oyo State, Nigeria used a two-stage random sampling technique to collect data from 195 farmers in rural communities across four agro-ecological zones. Data were analyzed using descriptive statistics and ordinary least square regression. The results of the study show that level of education, access to training and membership of farmer-groups negatively influenced accountability. The study used the means of the liker-scale score as dependent variable. Unlike the study under review, the current study used a binary dependent variables obtained from the perception index.

2.3.3 Determinants of demand for agricultural extension and intensity of use

The importance of farmers' demand for extension services and their intensity of use have received attention in agricultural extension literature. Researchers who explored the determinants of farmers' demand for extension services and the use intensity have modeled it as separate decisions using models such as probit or logit model for binary choice outcome and Poisson or negative binomial regression models for count outcomes. However, studies have shown that different socio-economic factors influenced farmers' demand and use decisions.

Gido et al. (2015) studied the level of demand for extension services and its determinants among small-scale maize farmers in Kenya. The study used primary data and a zero-inflated negative binomial regression to predict the factors that influence demand for extension services. The findings revealed that demand for extension services was significantly determined by education level, age of the household head, group-membership, credit values, land tenure, off-farm income, farming experience, and distance extension service provider. The current study differs from the study under review in that the authors looked at only the drivers of demand for extension services leaving out the drivers of the intensity of their use. Hence,

this study sought to jointly assess the determinants of demand and intensity of use of extension services.

Abdallah & Abdul-Rahaman (2016) assessed the drivers of access to extension services in Northern Ghana. The study used a logistic regression model to analyze data from 320 smallholder women farmers. The results showed that farm size, age, time spent on the farm, access to fertilizer, group membership, farming experience, and proximity to the input store were variables likely to determine farmers' access to extension services. While Abdallah & Abdul-Rahaman (2016) focused on only female farmers and their access to agricultural services, the present study looked at both genders and their access and intensity of use of extension services.

Using ordinary least square regression, Chandio et al. (2020) examined the influence of socioeconomic characteristics on credit demand by smallholder farmers in Sindh, Pakistan. The results showed that the demand for credit was significantly influenced by farming experience, formal education, road-access, landholding size and extension contacts. The current study differs from Chandio et al. (2020) such that it focused on demand for extension services and employs a two-step analysis of demand and use intensity.

Muema et al. (2018) evaluated the determinants of farmers' access and utilization of climate information services in Kenya. The study used data from 250 households and employed a two-step Heckprobit model for analysis. The results revealed that that household size, age of the household head, income, group membership, farm size, livelihood activity and television ownership were positively related to accessing climate information services. The results also showed that sex and age of the household head, household income, exposure to drought, access to improved seed, livelihood activity and radio ownership determined the utilization of climate information services. Building on the two-step analytical approach, the current study used the heckpoisson model to analyze the determinants of demand for and use of extension services in Liberia. However, unlike the study under review, which focused on climate information services, the current study focuses on extension services.

In their study, Jaleta et al. (2013) examined the adoption and use intensity of improved maize varieties in Ethiopia. The study used the Heckman selection model to estimate factors affecting adoption and use intensity. The study found that family labor, education level, soil fertility and soil depth of maize plots, farmers' confidence in extension agents' skills, and access to credit

as significant factors related to the intensity of use. However, while these authors focused on adoption and use intensity of maize, the current study looks at demand for extension services and the use intensity of extension services specifically in Liberia.

2.3.4 Determinants of willingness-to-pay for private extension services

The current study benefits from existing literature on factors that explain WTP, even though differs across locations and case studies. Farinde & Atteh (2009) investigated arable crop farmers' WTP for extension services in the Niger Delta State of Nigeria. The study adopted an open-ended CVM format to elicit WTP for extension services. The ordinary least squares (OLS) regression was used to explain the determinants of WTP. The study found that 60 percent of the respondents were willing to pay for extension services. On average, farmers were willing to pay about US$103.00 per year for extension services. The results further revealed that total cost of inputs used, family size and number of hired laborers were significant determinants of farmers' WTP. The current study differs from the one under review by using the double-bounded dichotomous choice CVM to elicit rice farmers' WTP for private extension services in Liberia. The double-bounded CVM was preferred because it elicits a valid maximum WTP amount that produces good estimate of mean WTP than the open-ended approach.

In Uganda, Mwaura et al. (2010) estimated WTP for extension services among farmers engaged in crop production and animal husbandry. The study used secondary data from the Ugandan Bureau of Statistics and a probit model was employed to evaluate factors that influenced WTP. The results revealed that 35 percent of the farmers in crop production and 40 percent of those in husbandry were willing to pay US$ 1.80 and US$ 2.00, respectively, per visit by an extension agent. Further, the results show that age, sex, education level, preferred means of access to extension services and regions of residence influenced farmers' WTP. Unlike the study under review which focused on farmers involved in crop production and animal husbandry, the current study used primary data to estimate smallholder rice farmers' WTP for private extension services in Liberia using a double-bounded dichotomous CVM.

Budak et al. (2010) analyzed livestock producer's needs and WTP for extension services in Adana Province of Turkey. The study used open-ended CVM to elicit livestock producers' WTP. A probit model was employed to analyze the factors hypothesized to influence farmers' WTP. The results showed that herd size and distance to extension source had a positive and

significant influence on livestock producers' WTP. Additionally, 52.5 percent of the producers were willing to pay US$ 2.53 per extension visit. The current study differs from Budak et al. (2010) by estimating the WTP of smallholder rice farmers from Gibi District in Liberia using the double-bounded CVM.

Uddin et al. (2014) assessed farmers' WTP for agricultural extension services in Bangladesh. An opened-ended CVM was used to elicit respondents' WTP and binary logit and Tobit models were used to assess the determinants of WTP. The findings show that education, farming experience and income from agriculture had a positive effect on farmers' WTP for extension services. The results further show that over 80 percent of the farmers were willing to pay US$ 0.65 on average for a single visit by an extension worker. The current study differs from Uddin et al. (2014) in that it employed the double-bounded CVM rather than the open-ended CVM as the former mimics the real-world situation better than the latter.

From the foregoing review of previous studies, cost-recovery is an important approach in agricultural extension delivery especially for smallholder farmers because it makes service providers to be contended with the farmers' needs. Several studies have focused on the determinants of WTP for agricultural extension services in different countries using different elicitation formats of the CVM to estimate WTP and different econometric models to assess the determinants of WTP. However, while these studies exist, there is no study focusing on smallholder rice farmers' WTP for private extension services in Liberia. Hence, this study seeks to fill the knowledge gap.

2.4. Conceptual framework

From a social-psychological perspective as in the theory of planned behavior, the double-bounded CVM follows the behavioral intention of a smallholder rice farmer in purchasing private extension services once they are offered in the market. The underlying motivation for a farmer's WTP for the non-marketed private extension services [the behavioral intention] is to maximize the utility derived from the proceeds of the investment. But because utility is unobservable, the researcher can only infer the farmer's utility from the behavioral intention when WTP for the non-marketed private extension services is verbally expressed. Accordingly, and following Hanemann (1984), the farmer's initial welfare level can be expressed as a utility function. The farmers WTP for appropriate cost-effective private agricultural extension services are likely to improve farming practices, increase technological uptake, increase rice yield and income and enhance farmers' welfare. WTP is therefore influenced by socio-

economic characteristics of the farmers (age, Gender, years of schooling, household size, income, farming experience, distance to extension source, crop diversification, farm size and mobile phone ownership) and institutional factors (access to credit, land ownership and group membership) as illustrated in Figure 1.
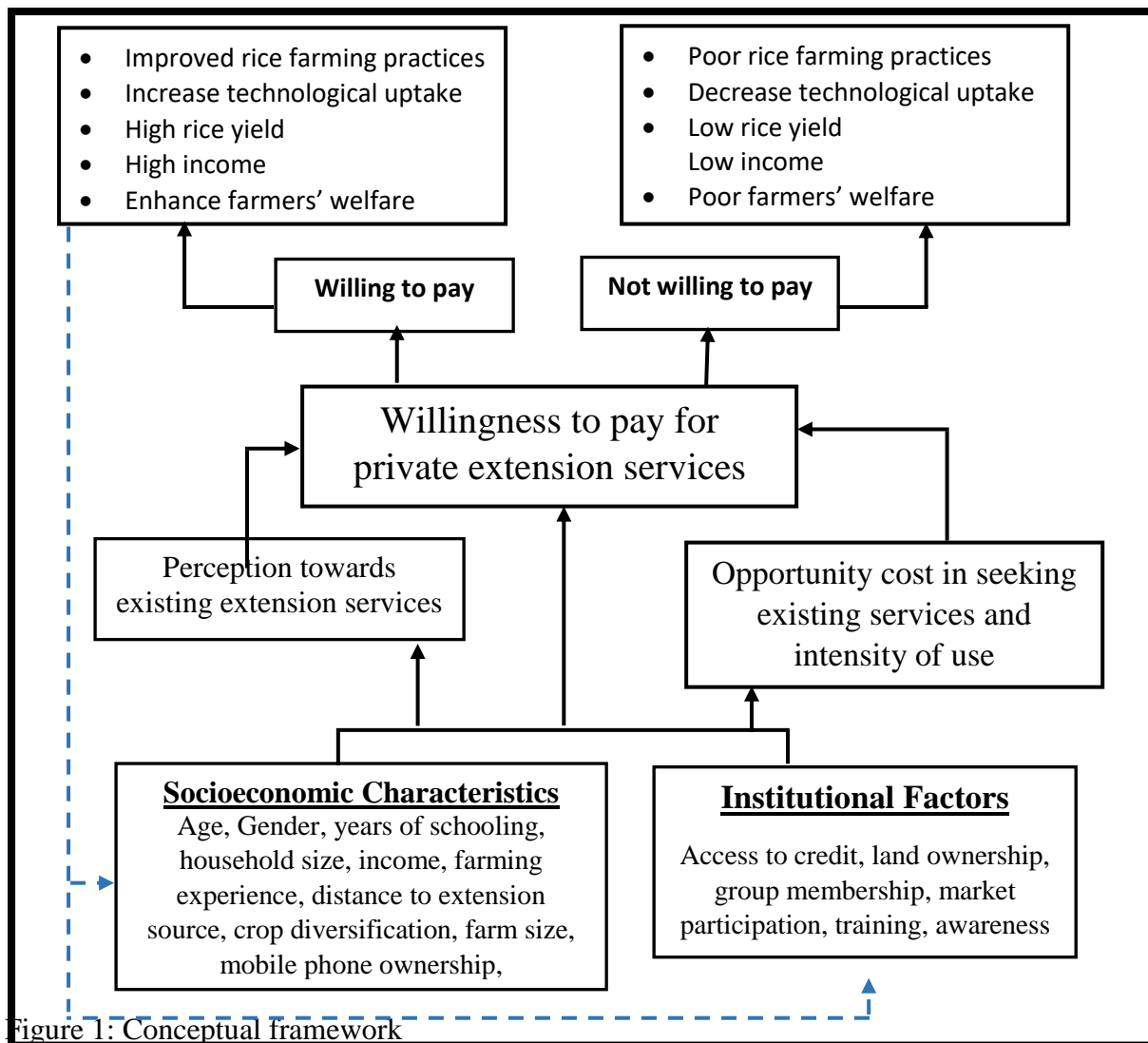
Figure 1: Conceptual framework
Source: Author's conceptualization

2.5 Justifications of variables hypothesized to influence farmers perception; demand for extension services and intensity of use and willingness-to-pay for private extension services

Age of the household head: Farmer's age is an indicator of a wealth of experience over time and is expected to have either positive or negative effect on farmers' decision to seek and use agricultural extension services. The variable is also hypothesized to have negative influence on positive perception, intensity of use and willingness-to-pay for extension services. Gido et al. (2015) found a positive effect of age on demand for extension services while Abdallah &

Abdul-Rahaman (2016) found a negative influence of the variable on demand for extension services in Kenya and Ghana, respectively. Similarly Terfa et al. (2015) noted that age has a negative significant influence on farmers' WTP for extension services and in Ethiopia, Meseret & Taye (2017) findings show that age had a negative effect on farmers' perception to use soil and water conservation technologies.

Gender of the household head: There exists an enormous resource disparity in farming households wherein females lack ownership and control of productive resources than their male counterparts (Bani & Damnyag, 2017). It is expected that male-headed households will have a positive perception and higher demand for extension services than female-headed households. Komba et al. (2018) findings showed that female-headed households were less likely to perceive extension service to be effective in Tanzania. Also, Ogato et al. (2009) found that males were more likely to seek and use new knowledge than females. Furthermore, the variable plays a key role in farmers' demand and WTP for private extension services and is hypothesized that male-headed households will have a higher WTP than their female counterparts. Yegbemey et al. (2014) found a positive influence of gender on WTP for extension services in Benin.

Farming Experience indicates more knowledge about the different activities that are carried out in farming and what is needed to address farm constraints. In Turkey, Aydogdu (2017) found a positive effect of farming experience on WTP for extension services. David & Abbyssinia (2017) and Meseret (2014) reported that years of farming experience was positively related to farmers' perception of the effectiveness of agricultural extension services in South Africa and Ethiopia, respectively. Additionally, Gido et al. (2015) found that years of farming experience increased farmers' demand and use of agricultural extension services in Kenya and Nigeria, respectively. Therefore, the variable is expected to have a similar effect on farmers' perception, demand and willingness-to-pay for extension services.

Gido et al. (2015) and Kiprotich et al. (2019) findings show that **years of formal education** to have a significant positive influence on demand and use of agricultural supports services. Working with farmers with more years of formal education can be rewarding for extension services providers especially when introducing new concepts because the most educated farmers have the ability to understand, interpret and apply new information well than the less educated ones (Ragasa et al., 2013). Eyinade & Akharume (2018) confirmed a positive effect of years of schooling on farmers' perception in in South Africa and Terfa et al. (2015) found a

positive relationship between years of formal schooling and WTP for extension services in Ethiopia. Therefore, it is hypothesized that the variable will positively influence demand for and intensity of use of extension services, willingness to pay for private extension services and farmers' perception of extension services.

Awareness of extension services: Farmers who claimed to be aware of extension services also seek for more from any available sources and used it fully. The variable is expected to have a positive significant influence on farmers' perception and demand for extension services. David & Abbyssinia (2017) found the variable to have significant effect on farmers' perception of soil conservation in South Africa and Anang et al. (2015) found that awareness of credit availability increased farmers' access to that service in Ghana.

Farm income measured as the total monthly income generated from farming is a proxy for wealth, and farmers with higher incomes are more likely to seek and demand agricultural extension and their perceived effectiveness. A study by Pinthukas (2015) in Thailand found that monthly farm income positive significant influence on farmers' perception organic vegetables and Nambiro et al. (2006) found the variable to have postive effect on farmers perception in Estern Kenya. This study therefore hypothesizes that the variable will have a positive effect on demand extension services and farmers' perceived effectiveness of agriculture extension services in Gibi District.

Annual Income: Tolera et al. (2014) and Aydogdu (2017) found that better income farmers were willing to pay more for extension services in Ethiopia and Turkey, respectively. Thus, income is more likely to increase farmers' WTP for private extension services. Based on the findings from these studies, this study expects a positive relationship between income and rice farmers' WTP for private extension services.

Family Size: Households with large family size in most cases translated in to agricultural labor due to the dependence on unskilled farm labor and indicates that there is need for more food, thus creating the need for the household to grow more crops that requires knowledge transferred from extension service providers. Elias et al. (2016) found that family size to have positive effect on farmers' satisfaction with agricultural extension services in Ethiopia, while Ndambiri et al. (2013) found a negative significant effect on farmers' perception of adaptation of climate change in Kenya. Also, Gebreegziabher & Mezgebo (2020) found a negative relationship between household size and WTP for extension services in Ethiopia. Tadesse (2017) found a

positive effect of household size on women's access to poetry extension services in Ethiopia. Hence, the variable is hypothesized to have both positive and negative influences on farmers' perception of the effectiveness of extension services and negative effect on demand and intensity of use of extension services and WTP for private extension services

Distance to nearest extension source to the nearest extension source is hypothesized to have a negative influence on the demand for extension services and WTP for private extension services because roads in rural parts of Liberia are in deplorable conditions. Mutambara et al. (2013) found that distance to veterinary services negatively induced farmers' demand for those services in Zimbabwe and Budak et al. (2010) found distance to have negative influence on farmers WTP in Turkey.

Crop diversification is a viable strategy to strengthen farmers' resilience against potential risks in agricultural production. Hence, farmers will seek extension services to properly manage their crops and increase for optimal return. Crop diversification was found to have a positive effect on the demand for extension services and new technologies such as improved seeds among farmers in Kenya (Ouma et al., 2014). Similarly, Kokoye et al. (2018) found that farmers who grew rice and banana were willing to pay more for soil testing services. Therefore, hypothesizes that the variable will have a positive and signficant effect on demand for extension services and farmers' WTP for private extension services.

Nambiro et al., (2006), Wossen et al. (2017) and Makau et al. (2016) found that **mobile phone** ownership had a positive and significant demand for extension services and the quantity of fertilizers purchased, respectively while Manja et al. (2015) study found the variable to have a positive and significant influence on WTP for subsidized farm inputs in Malawi. Mobile phone as a medium of access to information, farmers use it to search for information that can help them improve their farming practices and arrange appointments with extension agents. Mobile phone ownership was hypothesized to have a positive effect on demand and intensity of use and willingness-to-pay for private extension services.

Cash crops ownership are a major source of income and households growing them are more likely to demand agricultural extension services targeting higher income. Maonga et al. (2017) found cash crop ownership induced increased demand for extension services. The variable is therefore hypothesized to positively influence demand for and use of extension services.

Farm Size influences farmers' demand and use of extension services. If farmers have bigger farm size, they will have higher demand for the services. It hypothesized that large farm size induces the demand for extension services positively. Studies by Abdallah & Abdul-Rahaman (2016) and Wossen et al. (2017) found that farm size increased the demand for extension services and the intensity of their use.

Use of improved rice seed, a proxy for technology adoption, requires technical knowledge from extension agents in order to get optimum output. Studies have found a significant positive effect of use of improved seeds on farmers' demand for and use of agricultural extension services (Makau et al, 2016; Maonga et al. 2017; Ragasa et al. 2013). In this study, use of improved rice seeds was hypothesized to have a positive influence on farmers' demand for and use of extension services.

Sale of rice: The variable is an indication that farmers market a proportion of their crops for income generation. Farmers who generate income from crop sales are likely to seek extension services to improve their production. Studies have shown that sale of crops influenced farmers' demand for extension services in Zimbabwe and Kenya (Foti et al. 2007; Makau et al. 2016). Therefore, the variable is expected to increase farmer's demand for extension services.

Access to Input is expected to have a significant positive effect farmers' perception of extension services given that the adoption and use of agricultural inputs enables requires the use of extension services. David & Abbyssinia (2017) found input use by farmers to have significant effect on their perception of soil conservation in South Africa.

Decision Criteria: The variable is hypothesized to have a negative influence on farmers' perception of extension services. If the decision to use household resources require the consent of members of the household, it may render production decision untimely and use of resource inefficient.

Extension Agent Credibility: Extension agent credibility is an important indicator for the delivery of effective extension services. The variable was hypothesized to have a positive significant effect on farmers' perception. Sarker & Itohara (2009) showed that the credibility of an extension worker was positively related to farmers' perception in Bangladesh.

Training sessions: Attending skill training programs related to farm management practices are important for farmers to enhance their farming knowledge and practices. It is hypothesized that the variable will have a positive influence on perception as confirmed by the findings of Ani et al. (2018) that number of training session a farmer attended has significant influence on perception in Indonesia.

Land Ownership: Ownership of land is likely to increase farmers' WTP for extension services because land is a productive input required for replanting of crops for which the extension service is needed. Danso-Abbeam et al. (2014) found that Land ownership had a significant positive influence on farmers' WTP for extension services. This study hypothesized that the variable will have a similar effect on WTP for private extension services.

Membership of village saving club is a proxy for group membership and is expected to have a positive and significant influence on farmers' perceived effectiveness of agricultural extension services. The variable is linked to increasing farmers to access to credit. Omotesho et al. (2015) findings showed a positive effect on farmers' perception in Oyo State, Nigeria.

2.6 Diagnostics test of the model

Before performing data analysis, multicollinearity, heteroscedasticity and Pearson correlation matrix were performed to ensure that the basic assumption of the econometric models were not violated.

2.6.1 Multicollinearity test

According to Wooldridge (2012), multicollinearity denotes the presence of linear relationships among the independent variables used in models. The existence of multicollinearity in the variables included in the econometric models were assessed using the variance inflation factor (VIF). According to Greene (2012), any variable with a VIF greater than 10 indicates presence of multicollinearity. The result for the test showed the mean VIF value (Appendices 5, 6 and 7) for each of the models were below two, ruling out the existence of severe multicollinearity among the explanatory variables used in the probit, heckpoison and double-bounded logit models used for analysis (Greene, 2012). Pearson correlation matrix was performed to determine evidence of a strong linear relationship among the explanatory variables in the probit model. The results (appendix 4) showed that extension contacts and training sessions were closed to ±1, indicating a strong linear relationship between the two variables. Therefore, following Hinkle et al. (2003), extension contact was excluded from the model.

2.6.2 Heteroscedasticity test

Heteroscedasticity or the absence of homoscedasticity exist when the variance of the error term are not constant across observations. It is one of the basic assumption of the Ordinary Least Square (OLS) regression that all residuals are drawn from a population that has a constant variance (Wooldridge, 2012). According to Greene (2012) if it is present, the estimates no longer meet the requirement of best linear unbiased estimator (BLUE). Following Wooldridge (2012), the data were tested for heteroscedasticity using the Breusch-Pagan / Cook-Weisberg test that tests the null hypothesis that the variances of the error terms are constant. The test was implemented using the "*hettest*" command in STATA version 15. The output below shows the results from the test for the variables used in probit model to estimate the factors influencing farmers' perceptions and was insignificant. The null hypothesis was rejected, meaning there was constant variance across the error terms in the probit model.

Chi^2 (1) = 1.15

$Prob > Chi^2$ = 2.844

Similarly, the output below shows result for the heteroscedasticity test for determinants of farmers demand for extension services and the intensity of their use. The chi-square value of 50.72 was large and statistically significant at 1 percent. This led to the rejection of the null hypothesis of constant variance of the error terms across observations. To correct for this problem, a robust probit regression model was estimated so as to obtain robust standard errors.

Chi^2 (1) = 50.72

$Prob > Chi^2$ = 0.000

Lastly, the Breusch-pagan and Cook-Weisberg test results for the willingness-to-pay estimated are given below:

Chi^2 (1) = 1.61

$Prob > Chi^2$ = 0.2050

CHAPTER THREE

Determinants of rice farmers' perception of non-governmental organizations agricultural extension programs in Gibi District, Liberia

3.1 Abstract

Since the end of the Liberian civil crisis, Non-Governmental Organizations (NGOs) continue to play essential role in the economic recovery and growth process. They contribute to agricultural development by augmenting government extension delivery efforts. This study assessed smallholder rice farmers' perception of the effectiveness of NGO-provided extension services and the factors influencing that perception in Gibi District of Liberia. Multistage sampling technique was used and data were collect from 141 smallholder rice farmers who received extension services from NGOs. Descriptive statistics and probit model were used for analysis. The findings show that farmers' opinions differed concerning the adequacy, usefulness, and quality of follow-up activities offered by NGOs. Majority of the farmers perceived extension services provided by NGOs to be moderately effective. The probit model results revealed that gender of the household head, number of training sessions, membership of saving club, extension agent credibility and access to inputs had significant effect on farmers' perceived effectiveness of NGO-provided extension services in the district. The study recommends that other service providers should consider replicating the strategy used by NGOs to achieve the level of monitoring and evaluation of extension activities. Additionally, the government should formulate policies that will foster collaborations between extension service providers and local financial institutions to enhance credit access for farmers.

Keywords: Extension Services, Perception, Smallholders Farmers, Margibi, Liberia

3.2 Introduction

Agriculture is the primary source of income and livelihood to more than 80 percent of rural Liberians making it the most important sector in the economy (Government of Liberia, 2017). The sector contributes about one-third of gross domestic product (GDP) and employs over 70 percent of the labor force (Central Bank of Liberia, 2019; African Development Bank, 2020). Even though Liberia is endowed with a conducive climate, fertile soil, adequate rainfall averaging 5,000 mm per annum, agricultural production continues to be low. For example, the main staple (rice) yield is low hovering between one and 1.6 metric tons (MT) per hectare (FAO, 2019a). The main causes of low agricultural productivity are low utilization of yield-enhancing inputs such as improved seed, high pest and disease incidence, and absence of appropriate policies to support smallholder farming (Saysay et al., 2016; USAID-BEST, 2014).

The limited use of improved seed and other yield-enhancing inputs in Liberia has been blamed largely on lack of extension services as well as the devastating impacts of the 1989-2003 civil war and the 2014/15 Ebola crisis (Roberts et al., 2017; Saysay et al., 2016). Moreover, like many countries in sub-Saharan Africa, a weak policy environment to attract private sector investment in agriculture amidst low public sector spending has limited smallholder farmers' ability to access modern technologies through agricultural extension services (Kyle & Resnick, 2019; Buadi et al., 2013). Yet, studies show that agricultural extension enables farmers to adopt modern technologies thereby improving productivity, and enhances their capacity to make rational decisions on what to produce, what means to use to produce and where to sell their products (Al-Shayaa, 2012, Al-Zahrani et al., 2016; Asfaw et al., 2012; Christoplos, 2010.

In Liberia, extension services are provided by several organizations. These include the Ministry of Agriculture, agribusiness companies, farmers' unions and a variety of donor-funded non-government organizations (NGOs). However, due to the government's limited capacity, NGOs provide most of the extension services to poor farmers in rural parts of Liberia to augment the efforts of the Ministry of Agriculture. NGOs provide knowledge and information on post-harvest loss, climate and, markets and help farmers form groups and provide training (Government of Liberia, 2012a; McNamara et al., 2011). Even though NGOs are making vital contributions to Liberia's agricultural sector, information on the effectiveness of their services remains unknown. According to Kivlin & Fliegel (1966), farmer perception of the effectiveness

of extension service determines their willingness to use it. Buadi et al. (2013) argue that farmers' perception influences their decision to participate in agricultural extension programs, adopt new technologies, and apply them.

According to Abudulai et al. (2011), knowledge of farmers' perception of the effectiveness of agricultural extension services contributes to improving the design, planning, and quality of the services offered. In Liberia, however, empirical studies on farmers' perception of the effectiveness of extension services are virtually non-existent. Elsewhere, studies that have assessed farmers' perception in said matter demonstrated significant effects on farmers' perception on their decision to participate in extension programs. Furthermore, socio-economic factors tend to increase the probability of positive perception. For example, Buadi et al. (2013) showed that farmers' perception of the effectiveness of NGO provided extension services in the Central Region of Ghana led to improvements in farm operation. In the Ibague Province of Columbia, Alwarritzi et al. (2017) noted that farmers perceived training, variety development, research dissemination and input availability as the most satisfying services among those provided by Federal Services. Additionally, Komba et al. (2018) found that socio-economic characteristics such as sex, farm size, household size and annual income significantly influenced farmers' perceived effectiveness of extension services in Tanzania.

This study was designed to fill the knowledge gap that exists in Liberia of the lack of evidence on farmer perception of the effectiveness of available extension services and assess the determinants of said perception. The study was motivated by the pivotal role of NGOs in providing extensions services in Liberia. NGOs provide extension services in almost all parts of the country and their programs are well funded by donors and implemented based on predefined periods. Thus, leaving the farmers unserved when the donors withdraw funding or the project does not produce an impact that leads to additional funding. However, smallholder farmers in Gibi District of Margibi County which is the major producer of rice in the country are beneficiaries of the services provided by NGOs. The information generated by the study will inform the government, its partners, and extension practitioners about what factors need to be improved to make available extension service delivery more effective. The rest of the paper is arranged as follows: the paper is structured as follows. Section 4.3 describes the methodology, section 4.4 presents the results and discussion of the findings and section 4.5 presents conclusions and recommendations.

3.3 Materials and methods

3.3.1 Theoretical framework

A farmer's willingness to participate in an extension program is inherently based on their perception of the effectiveness of the program in delivering extension services at the right quality, quantity and timeliness. Such perception is, in turn, intrinsically based on the underlying motivation to participate in the program. That motivation is essentially farmer's desire to maximize utility from program participation and can be analyzed using the random utility theory (McFadden, 1974). If the farmer is faced with two alternatives of whether or not to participate in an agricultural extension program, he assigns a particular level of utility to each alternative based on its attributes and then chooses the one that yields the highest utility (Adesina & Zinnah, 1993). Hence, if a farmer chooses to participate in an extension program, then the utility obtained is higher than that of not participating. If the utility obtained by the ith farmer from participating in the jth extension program is denoted by U_{ij}, then, U_{ij} can be expressed as a linear sum of two components; a deterministic part V_{ij} that captures the observable components of the utility function and a random error term ε_{ij} that captures the unobservable components of the function (Greene, 2012):

$$U_{ij} = \alpha_i V_{ij} + \varepsilon_{ij} \tag{3.1}$$

where ε_{ij} is represents the error term assumed to be independently and identically distributed (IID) with mean = 0 and variance = δ^2 (Greene, 2012). Equation (1) does not restrict the function F to be linear. As the utilities U_{ij} are random, the ith farmer will select the alternative $j = 1$ if $U_{1i} > U_{2i}$ or if the non-observable (latent) random variable $j^* = U_{1i} - U_{2i} > 0$. The probability that Y_i equals one (i.e., that the farmer positively perceived NGOs extension services) is a function of the independent variables:

$$P_i = \Pr(Y_i = 1) = \Pr(U_{1i} > U_{2i})$$
$$= \Pr(\alpha_1 V_{1i} + \varepsilon_{1i} > \alpha_2 V_{2i} + \varepsilon_{2i})$$
$$= \Pr[e_{1i} - e_{2i} > V_i(\alpha_2 - \alpha_1)]$$
$$= \Pr(\sigma_i > - V_i \beta) = F(X_i \beta) \tag{3.2}$$

where X is the n x k matrix of the independent variables, and β is a k x 1 vector of parameters to be estimated, $Pr(\cdot)$ is a probability function, σ_i is a random error term, and $F_i(X_i\beta)$ is the cumulative distribution function for error term evaluated at $X_i\beta$. The probability that a farmer will participate in an extension program is a function of the vector of explanatory variables and of the unknown parameters and error term. For all practical reasons, equation (3.2) cannot be estimated directly without knowing the form of F. It is the distribution of σ_i that determines the

distribution of F. If σ_i is normal, F will have a cumulative normal distribution (Adesina & Zinnah, 1993; Rahm & Huffman, 1984).

3.3.2. Computation of perception index

Farmers' perception of the effectiveness of NGO-provided extension services in Gibi District of Liberia was computed from Principal Component Analysis (PCA), a data-reduction technique that is used to simplify multidimensional data to identify and weight indicators in order to calculate index such as perception (Nyangena, 2008). The elicitation of farmer perception used 24 indicators of the effectiveness of NGO-provided extension services compiled from FGDs and previous studies (e.g., Buadi et al., 2013; Elias et al. 2016; Tatlıdil et al., 2009 & Mirani & Memon, 2011). Three effectiveness attributes were used: adequacy of the service provided by the NGOs, usefulness of information provided, and follow-up on activities from the NGO. These attributes were measure on a five-point Likert scale as follows: (a) Adequacy of service: 1= Not adequate, 2 = Barely adequate, 3= Adequate, 4= Very adequate and 5= Extremely adequate; (b) Usefulness of information provided: 1= Not useful, 2 = Barely useful, 3= Moderately useful, 4= Useful and 5= Very useful, and (c) Follow-up activities from the service provider:1= Poor, 2 = Fair, 3= Good, 4= Very good and 5= Excellent.

Following Agbarevo (2013), Hassan et al. (2020) and Ibrahim et al. (2014)The indicators used to access the adequacy attributes included (i) group meeting with farmers, (ii) farmer training programs, (iii) follow-up on training activities, (iv) organization of regular field meeting with farmers, (v) demonstration methods, (vi) provision of prior notice of planned programs, (vii) information and technology availed, (viii) field days organization, and (ix) research-extension linkage workshops.

For the usefulness of information provided, the following statements were used based on previous studies (Buadi, et al. 2013): (i) I understood the extension advice I received and have applied it, (ii) The extension services I received enabled me to make better use of my limited resources (land, land purchased inputs), (iii) The information that I received on post-harvest losses has enabled me to reduce losses incurred, (iv) The extension services I received are relevant to my farming activities, (v) The information provided on rice and other crops during planting seasons was useful, (vii) The extension services I received were tailored to my needs, (viii) The information I received enabled me to reduce the risks caused by droughts, floods, diseases and pests, and (ix) The information I received on input dealers enabled me to identify sellers of quality fertilizers and agrochemicals.

For the follow-up activities from the service provider, the following statements were used: (i) Land preparation was done properly, (ii) Planting was correctly and timely done, (iii) Weed control was timely, (iv) Farmers received timely and updated information, (v) Pest and disease control methods were properly applied, (vi) free or emergency inputs arrived on time, and (viii) Fertilizer and agrochemicals were appropriately applied (Komba et al., 2018; Mirani & Memon, 2011).

These attributes were tabulated using PCA in STATA software to generate the factor score coefficients (Appendix 1) which were later used to compute the perception index using the following formula (Ahuja et al., 2003; Filmer & Pritchett, 2001).

$$P_{ij} = \sum_k f_k \frac{p_{ijk} - m_{jk}}{S_{jk}} \qquad (3.3)$$

where,

P_{ij} = the value of the perception for the ith household in the jth indicator

f_k = the factor coefficient for the kth perception, as determined by the PFA procedure

p_{ijk} = the value of the kth perception for the ith household in the jth indicator

m_{jk} = the mean of the kth perception overall households in the jth indicator

S_{jk} = the standard deviation of the kth perception overall households in the jth indicator

The summary of the factor score coefficients used as the weight is presented in Appendix 1.

3.3.3 Model specification

The perception index derived in Section 3.3.2.1 above ranged from -27.9 to 8.9 (see appendix 2) with a mean of -9.5. It was used to create a binary perception variable where values above the mean were used to indicate a positive perception and hence denoted by 1 while those below represented a negative perception denoted by zero (Sarker & Itohara, 2009). Accordingly, a probit regression model was used to assess the influence of socio-economic factors on the probability of smallholder rice farmers having either a positive or negative perception of the effectiveness of NGO-provided extension services in Gibi District. Following Greene (2012), the probit model was fitted into the data:

$$Y_i = X_i\beta_i + \varepsilon_i \qquad (3.4)$$

where Y_i is the perception index of the ith household with a value of 1 positive perception and zero otherwise. X_i is a vector of explanatory variables that influence perception, β is a vector of coefficients, and ε is the random error component. Empirical model is expressed as:

$$PER_i = \beta_0 + \beta_1 AGE + \beta_2 GENDER + \beta_3 EXP + \beta_4 TRAIN + \beta_5 DCRIT + \beta_6 FRMINC +$$

$$\beta_7 SCHL + \beta_8 CRDBTY + \beta_9 MEVSC + \beta_{10} ACINPUT + \beta_{11} FMSIZE + \beta_{12} AWARE + \varepsilon_i \quad (3.5)$$

The dependent variable used in the probit model is the farmer perception index score where positive (above the mean of the index score) and negative (below the mean of the index score) are denoted by (1; 0), respectively. Table 3.1 presents the meaning and hypothesized signs of the vector of regressors (X_i).

Table 3.1: Explanatory variables hypothesized to influence farmers' perception of the effectiveness of NGOs provided extension services in Gibi District

Variable code	Variable name	Description	Expected signs
Dependent variable			
PER	Perception	If household positively perceived extension services (1=positive; 0:Negative)	
Independent Variables			
AGE	Age	Age of household head in years	-
GENDER	Gender	if the household head is male = 1; female = 0	±
EXP	Farming Experience	Number of years household head spent in farming	+
TRAIN	Training Sessions	Number of agricultural training session attended	+
SCHL	Years of Schooling	Formal education of the household head in years	+
DCRIT	Decision Criteria	If decision is made by household=1; 0=otherwise	-
CRDBTY	Agent Credibility	If extension agent is credible 1 = Yes; 0 = No	±
FRMINC	Monthly farm income	monthly income generated from crop in dollars	+
MEVSC	Membership of Village Saving Club	if household head is member of a village saving club. 1 = Yes; 0 = otherwise	+
ACINPUT	Access to input	if farmers accessed farm inputs 1 = Yes; 0 = No	+
FMSIZE	Family size	Number of family members of a farm household	±
AWARE	Awareness of extension services	If farmer is aware of extension 1 = Yes; 0 = No	+

Justification for inclusion of the explanatory variables in the probit model and the diagnostics test for the models are presented in sections 2.5 and 2.6 respectively.

3.3.4 Study Area

The study was carried out in Gibi District in Central Liberia. The district is situated in Margibi County which connects the two major port cities, Monrovia and Buchanan cities along the coast and Bong County in the North Central Region. Gibi District is a rural setting and the main rice production zone in Margibi County (Figure 3.2).
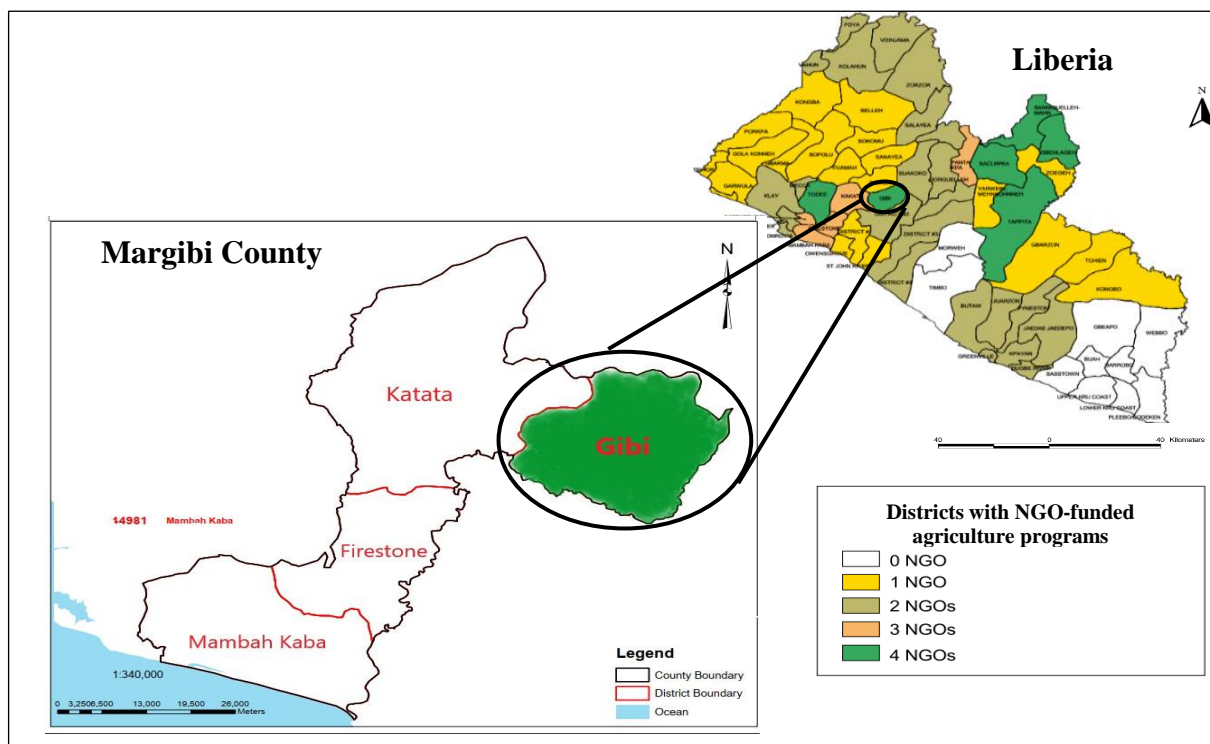
Figure 3.1: Margibi County showing Gibi District
Source: LISGIS (2017) and **https://reliefweb.int**

The district covers more than 17,000 km2 and has fertile and swampy lands along the rivers and creeks and receives a very high annual rainfall between 4,400 mm to 4,500 mm and longer sunshine with a humidity of 85 to 95 percent, which makes it ideal for agriculture activities (Government of Liberia, 2008a). The highland has a tropical forest with an elevation above 30m above the mean sea level. The vegetation is dominated by evergreen and deciduous trees. Agriculture is the main economic activity in the district. Most of the population in the district is engaged in small-scale mixed food and cash crop production for livelihood (Government of Liberia, 2008a, 2018). Rice is the major food crop followed by cassava grown on farms with an average size of 1.2 hectares, while rubber, cocoa, coffee, and oil palm are the cash crops commonly produced in the district (Government of Liberia, 2008a). Despite the agricultural potential of the district, it remains a place that is difficult to reach by public and private extension service providers due to impassible roads and bridges. As a result, about 96 percent of the farming households had no access to extension services in 2017 (Government of Liberia, 2017). However, most of the farmers who received extension services benefited from NGO initiated extension services. Gibi District is one of six districts dominated by NGOs extension programs in Liberia (Moore 2014; Murphy et al., 2016). Gibi District was preferred to be suitable for the study on the evaluation of smallholder rice farmers' willingness-to-pay for private extension services.

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3.3.5 Sampling and sample size determination

Multistage sampling technique was used to select smallholder rice farmers in Gibi District of Liberia. In the first stage, Margibi County was purposively selected as one of the counties where smallholder farmers who depend on NGO provided extension services are predominantly engaged in rice production. In the second stage, Gibi District was purposively selected because it is the major rice production zone in Margibi County and has more NGOs providing extension services for smallholder farmers. In the third stage, three townships, Peter's Town, Wohn, and Yanquilee, with a high population of smallholder rice farmers in Gibi District were purposively selected. Finally, smallholder rice farmers were randomly selected from a list of smallholder rice farmers in Gibi District constructed with the assistance of extension officers. The target sample size was 267 smallholder rice farmers and was obtained using the Cochran (1977) formula:

$$n = \frac{Z^2 pq}{e^2} \tag{3.5}$$

where n is the sample size, Z is the desired confidence level taken at 95 percent, p is the maximum variance assumed to be 0.5 since the proportion of rice farmers was unknown, q is $(1-p)$ and e is the desired level of precision or the acceptable margin of error taken at 5 percent level of precision and a 95 percent level of confidence interval, the sample size was calculated as:

$$n = \frac{(1.96)^2(0.5)(1-0.5)}{0.06^2} = 267 \text{ farmers} \tag{2.1}$$

However, a total of 296 farmers were interviewed comprising those who accessed and those who did not access agricultural extension services with a total of 86 from Yanquilee (41 accessors and 45 non-accessors), 92 from Peter Town (48 accessors and 44 non-accessors) and 118 from Wohn (55 accessors and 63 non-accessors). Distributing by access to extension services, 144 (NGOs services = 141 and government services = 3) were accessors while 152 were non-accessors. The sample size used in past willingness-to-pay studies informed the current study. For example, Gebreegziabher & Mezgebo (2020) assessed farmers' willingness-to-pay for privatized agricultural extension services and it's determinants in Ethiopia based on a sample of 240 respondents. Similarly, Shausi et al. (2019) based their analysis on a sample size of 292 to determine crop farmers' WTP for agricultural extension services and identified determinants of their willingness in Tanzania.

3.3.6 Data Collection and Analysis

Primary data used in the study were collected in May 2019. A pretested structured questionnaire was used to collect data on smallholder rice farmers' socio-economic and farm characteristics, perception of agricultural extension services and maximum willingness-to-pay amount for private extension services in Gibi District of Liberia. The researcher hired services of four enumerators who were trained on how to administer contingent valuation questions. The questionnaire was administered through face-to-face interviews with the heads of farming households who grew rice in the last farming seasons or their designated respondents in the case where the targeted household head was not available or unable to take the interview. The questionnaire was written and administered in English, and in some cases, it was explained in the local language (Bassa or Kpelleh) for clarity to respondents who did not understand the English language. The interview took an average of 40 minutes to be completed. The data were collected using Open Data Kit (ODK) application. To ensure the quality of data collected, the researcher checked the filled up questionnaires submitted by each enumerator every evening to ensure accuracy. Data analysis was undertaken in STATA version 15.

3.4 Results and Discussion
3.4.1 Selected socio-economic characteristics of smallholder rice farmers

Table 3.2 presents the selected socio-economic characteristics of the farmers in Gibi District.

Table 3. 2: Selected socio-economic characteristics of household in Gibi District

Variable	Means
Age of the household head	44.1
Monthly Farm income	42.9
Family Size	6.6
Years of schooling	4.3
Number of training sessions	1.9
Farming experience in years	15.0
	Percentages
Input access (yes)	35.8
Membership of Village Saving Club (yes)	10.8
Decision criteria (Individual)	61.8
Gender (Male)	82.4
Agent Credibility	38.2
Awareness of extension services	68.6

n=296
Source: Survey Data 2019

Majority of the farm households were male-headed with an average age of 44 years similar to the one reported by the Liberia Institute of Statistics and Geo-Information Services [LISGIS] (Government of Liberia, 2017). This implies a high level of experience in farming as indicated by a further analysis which shows that the average farming experience was 15 years. Furthermore, males are more involved in farming than females who are mostly engaged with household chores or do not have productive assets, thus limiting their participation in farming income-generating activity (Mohamed & Temu, 2009). These results reaffirm Lah et al. (2018), Robert et al. (2017) and Government of Liberia (2017) reports on years of experience and males dominance in farming in Liberia. On average, farmers earned about US$43.00 as monthly farm income from crop sales and cultivated about 1.4 hectares. The low income is probably because farming in Gibi District is mainly for subsistence purposes. According to LISGIS only 12 percent of rice growers in Liberia sell a proportion of their yields (Government of Liberia, 2017). The average years of formal schooling completed by rice farmers in Gibi District completed is four years, and attended at least two agricultural training sessions. Furthermore, each farm household had approximately seven members. The years of formal training agree with the Government of Liberia (2017) and is likely due to the prolonged civil-conflict which occurred at the active secondary school-going ages of most of the farmers.

Additionally, more than two-thirds of the farming households owned land. More than one-third of the farmers said they have access to input and more than half were aware of the presence of extension services in their locale. The low Access to input among the farmers can be explained by a low involvement of private input providers in the study area. Further, only 10.8 percent of the farmers were member of village saving clubs and 38.2 percent regarded agent agents as credible. More so, about 61.8 percent of the farmers said that household farm-level decisions were made by individual. The findings concur with Sarker & Itohara (2009) who found that majority of the farmers received credit in Bangladesh.

3.4.2 Distribution of respondents by access and sources of extension services

Table 3.3 presents data on the distribution of rice farmers by access and sources of extension services.

Table 3.3: Distribution of rice farmers by access and sources of extension services in Gibi District

Characteristic	Mean
Access to Extension Services	
Yes	48.6
No	51.4
Extension Contact	2.5
Extension Sources:	**Percentage**
Non-Governmental Organizations	97.9
Government Sources	2.1
Private extension services	0.0
Total	**100.0**

n=144

Source: Survey Data 2019

Of the 296 respondents interviewed, 144 respondents, or 48.6 percent, received extension services. The mean contact with extension agents was approximately three times during the farming season before the survey. Among the 144 samples that received extension services, 97.9 percent received services from NGOs, while only three (2.1 percent) received government-provided extension services indicating that the scope of public extension services is limited in the study area, and private extension services do not exist. This might be due to high operational costs incurred in delivering services in rural areas as a result of constraints such as impaired roads and lack of electricity. A study by Sarker & Itohara (2009) reported similar findings that farmers in Bangladesh received organic agricultural extension services from NGOs. The more frequent farmers have contacts with extension agents, they are likely to get more reliable information from them and reciprocate farm-related problems for expert advice, thus enhancing the quality and effectiveness of the extension services delivery (Buadi, et al. 2013; Sarker & Itohara, 2009).

3.4.3 Types of information received by rice farmers from extension services

Table 3.4 presents a summary of information received by 144 smallholder rice farmers who received extension services.

Table 3.4: Distribution of types of information need by extension accessors in Gibi District

Types of information	Percentage
Soil Preparation techniques	66.7
General agriculture knowledge	45.1
Post-harvest loss management information	52.8
Pest and disease control information	13.5
Nursery preparation and transplanting technique	10.4
Marketing information	7.8
Information on input access and use	4.2

n=144
Source: Survey Data 2019

Of the farmers who received extension services, about two-thirds received information on soil preparation techniques, little over half received post-harvest management information and close to half received general agricultural knowledge. Additionally, only 14 percent of the respondents received information on pest and disease control, 10.1 percent received information on nursery preparation and transplanting technique, and those who received information on marketing and input access and used, were below 10 percent, respectively.

Even though NGOs are contributing to expanding the reach of extension services in Gibi District, access to information continues to be low. The low level of information dissemination in the district may be a major contributing factor to rice farmers sticking to their traditional farming methods which results in poor crop productivity. Agricultural extension is the main source of information for farmers. Thus, the availability of up-to-date information and its ingredients enhances farmers' knowledge and skills to use new technologies to produce more and generate more income (Ayoade, 2010; Onubuogu & Onyeneke 2012).

3.4.4 Farmer perception of the adequacy of NGO-provided extension services in Gibi District

Table 3.5 presents the variation in smallholder rice farmers' perception about the adequacy of extension activities undertaken by NGOs in Gibi District of Liberia.

Table 3.5: Perception of smallholder rice farmers towards the adequacy of extension activities undertaken by NGOs in Gibi District

Statement	Perceived level of effectiveness of extension activities (%); n= 141					
	EA	VA	A	BA	NA	Means
Organizing group meeting with farmers	21	58	4	16	1	3.83
Farmer training programs	16	57	8	16	3	3.67
Follow-up on farmers training activities	19	48	6	25	2	3.56
Organization of regular field meeting with farmers	17	43	8	30	2	3.42
Appropriateness of methods of demonstration	8	53	13	23	3	3.41
Provision of prior notice of planned extension programs	25	19	16	36	4	3.28
Appropriateness of information and technology availed	19	21	18	36	6	3.11
Appropriateness of field days organization	14	22	10	22	32	2.63
Appropriateness of research-extension linkage workshops	2	9	12	22	55	1.81
Overall mean						**3.19**

Notes: EA= Extremely Adequate; VA = Very Adequate; A= Adequate; BA= Barely Adequate; NA = Not adequate
Source: Survey Data 2019

In the survey, farmers were asked to indicate their perceived level of adequacy about various extension activities carried out by NGOs. The scale ranged from extremely adequate to not adequate. Generally, the farmers were varied in their opinions concerning the different activities carried out by NGOs. On average, they perceived the activities to be adequate with an overall mean of 3.19. More than half of the farmers perceived organization of group meetings, training programs, and appropriateness of demonstration methods as very adequate. Further, about 48 percent and 43 percent of the farmers perceived follow-up activities and field meetings to be very adequate. This is because extension agents meet mostly with farmers in groups, especially when providing training.

The findings are similar to Ibrahim et al. (2014), Agbarevo (2013), and Hassan et al. (2020) that farmers perceived that methods of demonstration, awareness, and technology transfer were effective in Ghana and Nigeria. Particularly, Alwarritzi et al. (2017) showed that farmers perceived technology transfer to be effective in the Ibangue Province of Colombia. About 36 percent of the farmers perceived that the provision of prior notice and appropriateness of information and technology availed were barely adequate while approximately 32 and 55 percent perceived that appropriateness of field day organization and research-extension linkage workshop were not adequate, respectively. The low perception of research-extension linkage workshops implies that NGOs are not linking farmers to new agricultural research. In this

regard, close and mutual interaction among research, extension and farmers is needed to improve the poor linkage problem. The result is consistent with Hassan et al. (2020) in Ghana.

3.4.5 Farmer perception on usefulness of the information provided by NGOs in Gibi District

During the survey, respondents were asked to indicate their perceived level of usefulness on a scale ranged from very useful to not useful. The results of farmers' perceived usefulness of extension information disseminated by NGOs in Gibi District is presented in Table 3.6. On average, the farmers moderately agree that extension services provided NGOs were useful with an overall mean of 3.36. The high level of usefulness of the services is due to the huge farmers' desired for new knowledge and the quality of the services provided by the NGOs. More than 70 percent of the farmers stated that information they received on appropriate use of inputs, better use of limited resources and improved farming practices were useful. The finding on improved farming practices is similar to Maoba's (2016) that farmers in Gauteng Provence in South Africa perceived extension services to have improved their farming practices.

Table 3.6: Perception of smallholder rice farmers towards the usefulness of information provided by NGOs in Gibi District

Statements	Perceived levels of usefulness of information provided by NGOs (%); n =141					Means
	VU	U	MU	BU	NU	
Information I received on the timely and appropriate use of inputs was useful, and I was able to apply it.	15	73	7	4	1	3.96
Information I have received was useful in making better use of my limited resources of land, labor and purchased inputs.	16	72	6	3	3	3.94
Information on useful in reducing the level of post-harvest losses I usually incurred	18	65	9	6	2	3.91
Information I received farming practices was useful in improving my farming work	11	73	8	4	4	3.85
Information provided on rice and other crops planting procedures was useful	12	47	16	16	9	3.38
I was able to use the information that was tailored to my needs	6	43	8	31	12	3.01
Information I received on risks was useful in reducing the effect of droughts, floods, diseases and pests.	6	21	16	33	24	2.50
Information I received on input dealers was useful in identifying sellers of quality seeds, fertilizers and agrochemicals easily	5	21	7	35	32	2.31
Overall Mean						**3.36**

Note: VU = Very useful, U = Useful; MU= Moderately Useful, BU = Barely Useful, U = Useful Not
Source: Survey Data 2019

Furthermore, 65 percent of the farmers perceived information on post-harvest losses to be useful while 47 percent and 43 percent of the respondents perceived information on planting procedures and those tailored to their needs as useful. On the other hand, farmers perceived information on risk reduction and input dealers as barely useful. The findings are consistent with Buadi et al. (2013) who reported that farmers perceived a range of services provided by NGOs to be useful in the Central Region of Ghana.

3.4.6 Farmer perception of the quality of follow-up activities by NGOs in Gibi District

In the survey, farmers stated their perception about the quality of NGO follow-up activities on a scale ranging from excellent to poor. Table 3.7 presents rice farmers' perception about the level of follow-up activities carried out by NGOs in the Gibi District. The results show that on the overall, farmers perceived extension follow-up activities to be good with a mean of 3.23.

Table 3.7: Perception of smallholder rice farmers towards the effectiveness of NGO follow-up activities of selected agronomic practices in Gibi District

Follow-up activities	Perceived effectiveness of NGO follow-up activities (%); n = 141					
	E	VG	G	F	P	Means
Planting was correctly done and was timely	38	38	12	8	4	4.09
Land preparation was properly done	36	48	9	3	4	4.00
Timely weed control	16	49	17	11	8	3.54
Farmers received timely information	16	24	32	26	2	3.25
Pest and disease control methods are correctly applied	14	22	16	37	11	2.89
Free or emergency inputs arrived on time	3	28	9	36	25	2.48
Fertilizer and agrochemicals are appropriately applied	6	16	13	38	27	2.35
Overall mean						3.23

Notes: E = Excellent; VG = Very Good; G =Good; F = Fair and P = Poor
Source: Survey Data 2019

The results show that the farmers expressed mixed opinion about the monitoring of correct and timely planting of their crops. About 38 percent indicated it was excellent and very good. On the average, 48 and 49 percent of the respondents perceived follow-up on land preparation and timely weed control to be very good. About 32 percent of the farmers perceived that receiving timely information to be good. However, 37, 36 and 38 percent of the farmers perceived follow-up on pest and disease control, timely delivery of inputs and appropriate use of fertilizers and agrochemicals to be fairly effective, respectively. The findings are in line with the work of Buadi et al. (2013) that farmers in Northern Ghana perceived monitoring of land preparation, timely planting, timely information delivery, and pest and disease control activities by farmers

to be effective. Follow-up of activities by extension service providers enables farmers to communicate feedbacks, build a relationship, and receive technical assistance on newly adopted technologies from service providers (Rizan et al. 2014).

3.4.7 Factors influencing farmers' perception of effectiveness of NGO extension services

Table 3.8 presents the results of the probit model used to explain the effect of socio-economic factors on farmers' positive perception.

Table 3.8: Factors influencing farmers' perception of the effectiveness of NGOs extension services in Gibi District

Dependent variable: Perception index is positive where the ith score of the jth respondent is above the means and negative otherwise were denoted by (1 ; 0)

Variables	Coefficients	Standard errors	Marginal effect
Age	-0.010	0.017	-0.004
Gender (1=male; 0=female)	1.101***	0.396	0.400
Farming experience (years)	0.023	0.017	0.009
Training sessions (count)	0.387***	0.144	0.154
Membership of saving club (1=yes; 0=no)	1.192***	0.392	0.402
Aware of extension services (1=yes; 0=no)	0.395	0.335	0.156
Years of schooling (years)	-0.033	0.031	-0.013
Decision criteria (1=individual; 0=household)	0.315	0.334	0.125
Extension agents credibility (1=credible; 0=otherwise)	-0.620**	0.314	-0.244
Farming income (dollars)	0.003	0.003	0.001
Household Size (count)	0.055	0.053	0.022
Access to input (1=yes; 0=no)	1.043***	0.269	0.392
Constant	-2.771	0.915	

Number of observations = 141
LR chi^2(12)   = 49.78
Prob > chi^2 = 0.000
Pseudo R^2 = 0.2518
Log likelihood   = -72.75

Note: *** & ** implies statistically significant at 1% and 5% respectively
Source: Survey Data 2019

The goodness-of-fit of the model shows that the Log-likelihood ratio chi-square was statistically significant at 1 percent level, suggesting that all the model parameters taken together, explain the variations in the probability of farmers' positive perception of the effectiveness of NGOs provided extension services. Furthermore, the Pseudo R-square

indicates that the independent variables explained 25 percent of the variation in farmers' perception. Only five out of 12 variables specified in the model were statistically significant in explaining the variations in farmers' perception. The gender of the household head, number of training sessions, membership of a village saving club, household decision criteria and access to inputs were factors that have significantly influenced farmers' perception.

The results show that the coefficient for gender of the household head was positive and significant at 1 percent level of probability. The marginal effect shows that a male-headed household is likely to increase the probability of positively perceiving extension services provided by NGOs as effective by 40 percent compared to female-headed households. A possible reason would be that male-headed households have a higher prospect of acquiring information on extension services than female-headed households. The findings is consistent with Komba et al. (2018) who found that gender of household heads had a positive effect on farmers' perception of the adaptation to climate change in Tanzania.

Attending more training sessions had a positive coefficient and significant at 1 percent level of probability. This implies that every additional training session a farmer attend increases the probability of positively perceiving NGO extension to be effective by 15.4 percent. The result was expected and a plausible explanation is that the more training sessions a farmer attended, the more the farmer could acquire and apply knowledge learned and therefore be more receptive to extension services. The result is contrary to the findings of Omotesho et al. (2015), who observed that training had a negative significant influence on farmers' perception of the accountability of agricultural extension services in Oyo State, Nigeria.

The coefficient for membership of saving club had a positive and significant influence on farmers' positive perception of NGO provided extension services at 1 percent level. This means that farmers who hold membership of a saving club probability of perceiving the services to be effective increased by 40.2 percent. The probable explanation is that the activities of farmers in the saving club did provide effective support for farmer to improve their farming practices to seek extension services, thus perceiving it effective. The result is contrary to Yusuf et al. (2011) findings that farmers' group membership had a negative effect on farmers' positive perceptions about the privatization of agricultural extension services in Kaduna State, Nigeria.

The credibility of extension agents had a positive coefficient and significantly influenced farmers' positive perception of extension services at 5 percent level. This means that if a farmer perceives the extension agents as credible, the probability of positively perceiving the services offered to be effective increases by 12.5 percent. A probable reason is that farmers are more receptive to extension agents that are responsible, communicate well, honest, committed to promises and well organized and have service attitude and courage to diagnose problems and provide solution. Thus, the farmers will have a positive perception of the effectiveness of the services they provide. The result is consistent with Sarker & Itohara (2009) who findings show that the credibility of extension workers had a positive effect on farmers' positive perceptions of the effectiveness of NGO-based agricultural extension services in Bangladesh.

As expected, the coefficient of access to input was positive and had a significant influence on farmers' perception of extension services provided by NGOs at 1 percent level, indicating that increase access to input in the study area will increase the probability of the farmer positively perceiving NGO provided extension services to be effective by 39.2 percent. The result can be explained as farmers who have experienced the benefit of using improved inputs because of the pieces of advice they received from extension agents will therefore perceive the services to be effective. The finding is consistent with Alwarritzi et al. (2017), who found that farmers who used input such as fertilizers had a positive perception of the National Federation of Rice agricultural technical services in Columbia.

3.5 Conclusion and policy implications

The paper assessed smallholder rice farmers' perceptions of extension services provided by NGOs in Gibi District, Margibi County, Liberia with emphasis on adequacy, usefulness, and quality of follow-up activities. The study also examined the determinants of those perceptions. Using a multistage sampling technique, 296 smallholder rice farmers were sampled. Descriptive statistics and binary probit regression model were used to analyze the data.

The descriptive statistics show that 144 farmers or 46.5 percent received extension services. Of the 144 rice farmers, the majority (97.9 percent) received extension services from NGOs implying a limited role of pubic extension service delivery. More than three-quarters of the households were male-headed. Regarding information needs, two-thirds (66.7 percent) of the farmers need information on soil preparation, 45.1 percent need general agricultural knowledge and more than half (52.8 percent) need post-harvest loss management information. The

findings also indicated that beneficiary farmers differed in perception of the effectiveness of NGO extension services in terms of its adequacy, usefulness, and quality of follow-up activities but on the average, perceived it to be adequate, moderately effective and good, respectively. The findings also show that NGO performed best in terms of the usefulness of their services to the farmers with an overall mean of 3.36. Further, research-extension linkage workshop was perceived to be inadequate. Finally, the probit model results revealed that rice farmers' perception was significantly influenced by gender of household head, number of training sessions, access to input, extension agent credibility and membership of village saving club.

The study recommends that farmers' perceptions should be considered a fundamental element in evaluating performance of extension service providers. The government should ensure that NGOs and others providing extension services begin to linking farmers to new research and up-to-date farming practices. Furthermore, the finding that follow-up by NGOs was perceived as effective in the study area suggests that a similar strategy used to accomplish such a level of effectiveness should be examined by the government of Liberia and replicated in other parts of the country. Also, given the positive influence of access to input on farmers' perception, it is suggested that NGOs should collaborated with local input dealers to enhance input access. Finally, efforts should be directed at providing more agricultural training for farmers to improve their knowledge and skills for better farming practices.

CHAPTER FOUR

Factors influencing smallholder rice farmers' demand for extension services and intensity of their use in post-conflict Liberia: the case of Gibi District

4.1 Abstract

Agricultural extension services is key not only to agricultural productivity but also economic transformation of agricultural-based economies such as post-conflict Liberia where productivity is below optimum levels. The demand and use of extension services by smallholder farmers in is very low despite the importance of the sector. This paper examined the factors influencing smallholder rice farmers' demand for agricultural extension services and the intensity of their use in Gibi District of Liberia. Multistage sampling method was used to sample 296 smallholder rice farmers. Descriptive statistics were used to compare farmers' socio-economic characteristics and heckpoisson model was used to access the determinants demand and intensity of use. The model results showed that farm income, commercialization of crops and mobile-phone ownership significantly influenced farmers demand for extension services, while gender, cash-crop ownership, use of improved seeds, and awareness of extension services significantly influence the intensity of their use. We suggests the implementation of programs that will increase farmers' income and access to improved rice varsities to increase demand for and utilization of extension services. Furthermore, extension agents should tailor services according to the farmers' socio-economic characteristics.

Keywords: Agricultural extension services, demand, heckpoisson, Liberia, Gibi District, Post-conflict

4.2 Introduction

Limited use of improved agricultural technologies, and inadequate extension services that facilitate their use are major threats to productivity improvement, food security and poverty reduction in Sub-Saharan Africa [SSA] (FAO, 2009; Ragasa et al., 2016). The low adoption of new technologies and low farm yield weakens efforts to increase productivity and is compounded by lack of credits, limited access to markets and unsustainable use of limited resources by smallholders. Even though the demand for food in SSA is increasingly driven by population growth and urbanization (Mohanty, 2013), increasing productivity through agricultural transformation is therefore needed to achieve food security, poverty reduction, and social stability (Pye-Smith, 2012; Tomich et al., 2019).

Experience from the Green Revolution in Asia shows that agricultural transformation could be achieved based on how new technologies are developed and used especially using a demand-driven approach (DeJanvry & Sadoulet, 2002; Evenson & Gollin, 2003). Demand-driven extension underscores the need to make available services that meet the needs and priorities of farmers, even if the "invisible hand of the market" does not ensure that extension services are supplied in the quantity and quality expected by farmers (Birner & Anderson, 2007). According to Birner & Anderson (2007), the approach might better address the goal of making extension services meet the needs and priorities of farmers.

Investment in research and development (R&D) for generation of new agricultural technologies and their dissemination to farmers play a crucial role in raising agricultural productivity (Mellor, 2017; Tiruneh et al., 2015). Agricultural extension services strengthen farmers' capacity to make decisions leading to optimal use of their resources (Otchia, 2014; Swanson & Rajalahti, 2010). Often this involves influencing their attitude towards making appropriate farm-level decisions particularly adoption of new technologies to improve productivity (Al-Zahrani et al., 2016). Adoption and use of technologies that address problems at the farm level are knowledge-driven (Zhou & Babu, 2015). Transfer of knowledge and skills, and ensuring the adoption of new technologies plays a critical role in raising production and improving livelihood which in turn contributes to maintaining peace (Piesse & Thirtle 2010).

In Liberia, agriculture is the primary source of livelihood for about 80 percent of the population (Government of Liberia, 2017). The sector contributed about 36 percent to Gross Domestic Product (GDP) in 2017 and the food sub-sector contributed about 50 percent of agricultural GDP (Central Bank of Liberia, 2016; Tyson 2017). Rice, the leading staple food, is a vital

component of this contribution and accounts for about 50 percent of adult calorie intake (Adeola, 2018). Per capita annual rice consumption is estimated at 108 kg, one of the highest in SSA when compared to 35 kilograms (kg) in Nigeria, 41 kg in Tanzania, 43 kg in Ghana and 65 kg globally (FAO, 2020).

Following the end of the 14-year civil conflict in 2003, several strategies were implemented by the Government of Liberia and partners to transform the agricultural sector to spur economic growth. Among these strategies, the Agricultural Sector Rehabilitation Program (ASRP) was created in 2010 to rehabilitate existing research institutions, agro-processing facilities, and roads destroyed during the civil conflict (Peterson, 2016). The National Rice Development Strategy (NRDS) was initiated in 2012 to enhance farmers' capacity to increase rice yields through tailor-made solutions generated by R&D (Government of Liberia, 2012c). In particular, priority was given to agricultural extension to facilitate the transfer of technologies and knowledge to improve productivity and promote peace and stability in rural areas. A national Agricultural Extension and Advisory Services (AEAS) policy was formulated to drive the transformation effort (Mcnamara, et al., 2011; Moore & Harder, 2015). Despite these well-intentioned interventions and the high rice production potential of Liberia, rice yields are low at an estimated 1.2 to 1.6 metric tons per hectares (MT/ha) compare to those of neighboring countries Ghana (2.8 MT/ha), Cote d'Ivoire (2.6 MT/ha), and Senegal (4.1 MT/ha) (FAO, 2019a). As a result, the country imports more than one-third of its annual rice demand (FAO, 2019b) draining the scarce foreign exchange reserves.

Although previous studies have focused on extension delivery methods and human resource capacity of extension staff in Liberia (Lah et al., 2018; Moore, 2017; Moore & Harder, 2015), there is no empirical evidence of the drivers of farmers' demand for extension services and intensity of use in Gibi District. Past studies show that an understanding of the drivers of demand for extension services and the intensity of their use can contribute to improving the quality of extension service delivery and technology transfer to rural poor farmers (Abdallah & Abdul-Rahaman, 2016; Ragasa et al., 2013). It also expose them to the effects on yields and household welfare, as an incentive leading to its adoption (Tadesse, 2017; Wossen et al., 2017). Therefore, the objective of this study was to assess the drivers of smallholder rice farmers' demand for agricultural extension services and intensity of their use in Gibi District, Liberia. The rest of the article is organized as follows. Section two explains the methodology used in addressing the key research objective, section three presents the key research findings and discussions and the final section presents the conclusion and policy recommendations.

4.3 Materials and methods

4.3.1 Theoretical framework

Farm households' decision to seek extension services is a behavioral response to the need to increase agricultural productivity based on its production objectives. If the household production and consumption decision are assumed to be inseparable, then the agricultural household model (AHM) of Singh et al. (1986) can be used to explain the underlying motivation to seeking extension services. In this model farm output is consumed by producing households and the surplus is marketed (Taylor & Adelman, 2003), underscoring the inseparability and joint nature of production and consumption. The first-order conditions for profit-maximizing household gives the demand for extension services as a function of input and output prices (Makau et al., 2016). Since household production and consumption decisions are inseparable, households' socio-economic characteristics are assumed to affect the desired level of extension use (Liverpool-Tasie, 2014; Ricker-Gilbert et al, 2011). Previous studies have used AHM to estimate demand for agricultural inputs and support services including extension (Liverpool-Tasie 2014; Makau et al., 2016; Ricker-Gilbert et al., 2011). Following Singh et al. (1986) model for demand can be expressed as:

$$F_E = f(C, P_E, P_O, A, Z) \tag{4.1}$$

Where F_E represents the number of extension visits a farmer gets considering the opportunity cost for the service providers. F_E is affected by the number of time the farmer sought extension services, denoted by C, price of extension services P_E and price of farm output sold P_O. Variables A and Z are household's socio-economic characteristics and fixed assets respectively.

In this study, the household demand for extension services and intensity of use are considered as a two-stage decision-making process. In the first stage, the farmer chooses whether or not to seek extension services and in the second stage, he decides how much of the services to use (intensity of use) contingent on the choice decision in the first stage. For those farmers who choose not to seek extension services, an observation of zero demand is taken as their optimal decision, rather than treating it as unobserved. This makes it impossible to use Heckman (1979) two-step sample selection model which treats the number of contacts as continuous rather than a count variable. In this study, the dependent variable for the second stage is the number of extension contacts which is a count variable. The combination of Probit and Poisson regression

models gives the Heckpoisson model. In this model, the bias caused by sample selection is removed by estimating parameters of binary and count data simultaneously (Cameron & Kolstoe, 2020). The model was used to assess determinants of farmers' demand for extension services and the intensity of their use. Heckpoisson is estimated in two stages, a selection and a count. Following Waruingi et al (2021), the model for the selection part is specified as follow:

$$S_i = \begin{cases} 1, \text{if } X_i\beta + \varepsilon_{1i} > 0 \\ 0, \text{if otherwise} \end{cases} \tag{4.2}$$

where S_i is the binary indicator (0;1) showing whether the ith household demanded extension services or not; X_i is a vector of predictor variables for the ith household, $\square$ the parameters to be estimated, and ε_{i1} is the error term for the selection outcome assumed to have a bivariate normal distribution with zero mean and covariance matrix. The number of time a household uses extension services ($Intensity = Y_i$) is only observed when the household demands extension services. The model for the count outcome (intensity of use) is specified as follow:

$$Y_i = X_i\beta + \varepsilon_{2i} \tag{4.3}$$

where Y_i is the frequency of extension contacts illustrating intensity of use, ε_{2i} is the error term for the count outcome assumed to have a bivariate normal distribution with zero mean and a covariance matrix and the other variables remain the same as in equation (4.2).

4.3.2 Empirical models

Equation (2) is the first stage of the model used to estimate determinants of demand for extension services (selection outcome, S). It is specified as follow.

$$S = \beta_0 + \beta_1 Gen + \beta_2 Exp + \beta_3 Dist + \beta_4 CCrp + \beta_5 MPh + \beta_6 FSize + \beta_7 Com + \beta_8 Inc + \beta_9 CropD + \varepsilon_i \tag{4.5}$$

The second stage of the model, equation (3), is applied to assess the drivers of intensity of use of extension services. The intensity indicator (Y) is only observed if demand for the services manifests (S=1). It is expressed as follow:

$$Y = \beta_0 + \beta_1 Age + \beta_2 Gen + \beta_3 Exp + \beta_4 Dist + \beta_5 Ccrop + \beta_6 Mbph + \beta_7 Fsize + \beta_8 Imseed + \beta_9 Aware + \varepsilon_i \tag{4.6}$$

The dependent variables analyzed in this study are demand for extension services (0;1) and number of extension contacts (counts). Definition of the variables used in the Heckpoisson model along with their hypothesized signs are presented in Table 4.1

Table 4.1: Explanatory variables used in the model and their hypothesized signs

Variables	Variable definition	Expected sign
Age	Age of the household head in years	±
Income	Household monthly farm income in US dollars	+
Experience	Years of farming experience of household head	+
Farm Size	Size of cultivated land in acres	+
Years of formal Schooling	Number of years household head spent in formal school	+
Distance	Distance to the extension source in kilometers	-
Awareness	Aware of NGO-provided extension; 0 =Aware, 0= Otherwise	+
Improved Rice Seed	Household use improved rice seed; 1 = improved seed; 0 = traditional	±
Cash Crops	Household grows cash crops; 1 = cash crop, 0 = otherwise	+
Gender	Gender of household head; 1= Male, 0 = Female	±
Sale of rice	1 = if farmers the sold proportion rice yield; 0 = otherwise	+
Mobile Phone	1 = Household head own mobile phone, 0 = otherwise	
Household size	Total number of person in household	+

Justification for the explanatory variables and diagnostics test for the models are presented in sections 2.5 and 2.6 respectively. The study area is presented in section 3.3.2.3, sampling and sample size determination in section 3.3.2.4 and data collection and analysis in section 3.3.2.5.

4.4 Results and Discussion

4.4.1 Household socio-demographic characteristics

Comparison of the socio-demographic characteristics of households by access to extension services are presented in Table 4.2.

Table 4.2: Comparison of selected socio-economic characteristics of smallholder rice farmers with and without extension services in Gibi District

Variable	Farmers with access (n=144)	Farmers without access (n=152)	All farmers (n= 296)	*t-ratio*
Means				
Age of household head (Years)	43.4	44.8	44.1	1.10
Farming experience (year)	14.5	15.4	15.0	0.76
Monthly farm (US$)	53.0	33.3	43.0	-4.14***
Farm Size (ha)	1.4	1.3	1.4	-0.63
Distance to extension source (km)	3.9	4.1	4.0	0.44
Years of formal schooling	4.1	4.6	4.3	0.91
Household Size	6.4	6.8	6.6	1.34
Percentages				*z-ratio*
Crop Diversification (Yes)	94.4	94.1	94.3	-0.14
Awareness of NGOs (Yes)	80.0	57.9	68.6	-4.07***
Mobile phone (Yes)	46.5	59.2	53.0	2.19**
Access to Improved seeds (Yes)	36.8	34.9	35.8	0.73
Producing Cash Crops (Yes)	51.4	53.9	52.7	0.44
Gender (Male)	81.9	82.9	82.4	0.21
Sale of rice (Yes)	21.5	9.8	15.0	-2.76***

Note: *** & ** Significant at 1% & 5% probability levels respectively.
Source: Survey Data 2019

The results show that the average household head in the study area was 44 years old and had 15 years of experience in rice farming operating a farm size of 1.4 hectares located four kilometers from an extension source. These characteristics were not significantly different between the two groups based on access to extension services. Age, farm size and distance to an extension source are similar to those report by Liberia Institute for Statistics and Geo-Information Services [LISGIS] (Government of Liberia, 2017) and years of experience reported by Roberts et al. (2017). However, those with access to extension had significantly higher monthly farm income suggesting that extension services imparted some advantages. The high farm income for extension accessors is likely due to improvement in crop production as a result of the services they received. The findings agree with Danso-Abbeam et al. (2014) who found that access to extension services increased maize farmers' income in Ghana.

About 94 percent of the rice farmers in Gibi District practiced crop diversification using locally consumed crops and approximately 69 percent were aware of the existence of NGO extension programs. Awareness of NGO extension services by rice farmers was significantly different

based on access to extension services. This could probably be the reason for a higher proportion of the aware farmers accessing extension services. Further analysis of the results shows that more than half of the rice farmers owned a mobile phone. The difference in mobile phone ownership was statistically significant at 5 percent level across those who did not access extension services.

On average, more than one-third of the rice farmers in Gibi District used improved rice seeds and more than half produced cash crops. There was no significant difference between the two categories. The finding is higher than the four percent (improved rice seed) and 33 percent (cash crops) reported by LISGIS (Government of Liberia, 2017). However, the mean is lower than the 46.5 percent reported by Saysay et al. (2016). This is because the majority of the farmers still rely on traditional varieties or are not exposed to improved varieties and depend on cash crops production as a source of income.

About 82.4 percent of the rice farmers were male. The results indicate a gender gap in rice production in Gibi Distract. This is so because most female-headed households do not have productive capital such as land to farm. The result is closed to Saysay et al. (2016) who reported 87 percent male involvement in farming in central Liberia. Degree of rice sale among rice farmers in Gibi District was low. In fact, only 15 percent of the farmers reported having sold a portion of their yield, which is just above 12 percent reported by LISGIS (Government of Liberia, 2017). Categorically, about 22 percent of the accessors sold rice compared to 10 percent of the non-accessors farmers. The difference was statistically significant at 1 percent level. The low degree of commercialization among rice farmers is likely because most of the farmers are subsistence-oriented.

4.4.2 Factors influencing demand for extension services (decision to seek extension services) by rice farmers

Table 4.3 presents the results of the Heckpoisson regression model. The Wald Chi-square statistic was significant at the 1 percent level, implying a strong explanatory power of the model. The Wald test of independent equations was significant at 1 percent level, justifying a rejection of the null hypothesis of zero correlation between the decisions to demand extension services and the intensity of use. The model results show that mobile phone ownership, sale of rice and monthly farm income significantly influenced farmers' demand for extension services. Furthermore, the intensity of use was significantly influenced by gender of the household head, use of improved seeds, awareness of extension services, and cash crop ownership.

Mobile phone ownership had a negative and significant influence on demand for extension services. The marginal effect indicates that the probability of contacting extension agents was 14.1 percent lower for farmers owning mobile phones than those without phones. The result was not expected but is likely because in rural settings, as in Gibi District, mobile phone penetration remains low among farmers, thus reducing the chances of farmers seeking information from or arranging meeting with extension agents. The finding is inconsistent with Wossen et al. (2017) who found that mobile phone ownership had a positive influence on farmers' access to extension services in rural Nigeria.

Table 4. 3: Factors influencing demand for and intensity of use of extension services in Gibi District

Variables	Selection: Demand for extension services			Outcome: Intensity of use		
	Coef.	Robust Std. Err.	Marginal Effect	Coef.	Robust Std. Err.	Marginal Effect
Age				-0.003	0.004	-0.007
Gender (Male)	-0.045	0.202	-0.018	-0.240***	0.075	-0.588
Farming experience (years)	-0.006	0.008	-0.003	-0.004	0.006	-0.009
Distance to nearest extension source (km)	-0.036	0.029	-0.015	0.005	0.014	0.012
Cash Crop ownership (Yes)	-0.068	0.155	-0.027	0.134*	0.073	0.328
Farm size (hectare)	0.039	0.042	0.018	-0.002	0.018	-0.564
Farm Income (dollars)	0.008***	0.002	0.003			
Crop diversification (Yes)	-0.246	0.325	-0.098			
Used improved seed (Yes)				0.266***	0.083	0.054
Awareness of extension (Yes)				-0.230***	0.088	-0.006
Commercialization of crops (Yes)	0.524**	0.219	0.204			
Mobile Phone (Yes)	-0.356**	0.151	-0.141	0.022	0.070	0.651
Constants	1.246	0.206		0.148	0.408	
Wald chi2(9) = 42.65						
Prob > chi2 = 0.000						
Wald test of independent equations (rho = 0): chi2(1) = 21.54						
Prob > chi2 = 0.000						
Total Observations = 296 (Extension = 144; Non-extension = 152)						

Note: ***, **, * Significant at 1%, 5% & 10% probability levels respectively.
Source: Survey Data 2019

Consistent with *a priori* expectation, the coefficient of household monthly farm income was positive and had significant influence on rice farmers' demand for extension services at 1 percent level. This indicates that a dollar increase in farm income increases the probability of farmers' demand for extension services by 0.3 percent. Higher income from the sale of farm

produce is likely to enable farmers to seek and invest in increased production. Such investments can be guided by knowledge and technologies gained from extension services. The finding tallies with Nambiro et al (2006), who found that income from crop sales had a positive effect on access to extension services in Eastern Kenya.

Sale of rice had a positive and significant influence on access to extension services at the 10 percent level. Sales of rice increased the probability of demand for extension services by 20.4 percent. A likely explanation is that access to extension services by farmers tends to increase production, which leads to a marketable surplus that enables them to generate income to purchase more inputs. Hence, it will increase their demand for extension services. The result corroborates with the findings of Foti et al. (2007) that the commercialization of farm enterprises increased farmers' ability to seek fee-for-service extension in Zimbabwe.

4.4.3 Factors influencing the intensity of use of extension services

The gender of the household head had a significant negative influence on the use intensity of extension services at 1 percent level. Being male decreased the probability of use of the service by 58.8 percent. The likely explanation is that very often, the composition of extension service delivery have been geared towards serving the needs of male household heads and sidelines female household heads who most often seek services through their colleagues who have access, thus increasing the intensity of use of the services by the accessors through the frequent contact with service providers (Atayi & Ladipo 2003). This result is contrary to Korir's (2016) findings that being a male-headed household increases the chances of adopting integrated pest management components in Embu East Sub-County, Kenya.

The coefficient of improved seeds was positive and had a significant influence on the intensity of use of extension services at 1 percent level. The marginal effect indicates that access to improved seeds increases the probability of demand for extension services by 5.4 percent. This finding is plausible because farmers who used improved seeds are likely to demand extension services to provide technical knowledge on the usage and management of the seeds for optimal output. The result is in line with Ragasa et al. (2013) that the use of improved seeds had a positive effect on the intensity of use of extension services in Ethiopia respectively.

Cash crops ownership had a positive and significant influence on the intensity of use of extension services by farmers at 10 percent level. If a farmer owns cash crops, the probability

of using extension services increases by 32.8 percent. Although cash crop is a source of income that strengthens farmer's capacity to acquire extension services, it is input-intensive and would require technical assistance from extension service providers thereby making farmers to intensify use of services. Maonga et al. (2017) made a similar observation that farmers who owned cash crops seek more agricultural support services in Malawi.

Awareness of extension services negatively and significantly influenced the intensity of the use of extension services at 1 percent level contrary to expectations. An increase in awareness level by a unit decreases the probability of the intensity of use of extension services by 0.6 percent. A plausible explanation is that a farmer might be aware of the existence of the services but does not seek to access them because they are not knowledgeable about the benefit of using them. The result is inconsistent with the findings from Kiprotich et al. (2019) that awareness increased the utilization of baobab tree products in Kenya.

4.5 Conclusion and policy implications

Knowledge of the factors that influence demand for extension services and their use intensity is crucial for effective service delivery, and its utilization among farmers to improve production, livelihood, and reduce poverty. The study sought to provide an insight into factors influencing smallholder rice farmers' demand for extension services and the intensity of use in post-conflict Liberia, particularly in the Gibi District. The Heckpoisson endogenous sample selection model was used for analysis.

The results revealed significant differences in farmers' socio-economic and institutional characteristics by access to extension services. For Instance, there exists low female participation in rice farming, low rice sale, and low use of improved seeds among rice farmers in Gibi District. The Heckpoisson model results revealed that mobile phone ownership, rice sale, and monthly farm income significantly and positively influenced the demand for extension services. Further, the result revealed that gender, cash crop ownership, use of improved seeds, and awareness of extension services significantly influenced the intensity of the use of extension services.

Given that the use of improved seeds is an important determinant of the intensity of use of extension services, there is a need for policymakers and extension stakeholders to implement programs that will encourage agribusiness entrepreneurs to provide needed agriculture inputs

affordable and sustainable way to the farmers by encouraging farmers to make greater use of extension services. Finally, the observation that farm income is a significant driver of demand for extension services is of particular interest considering the ongoing promotion of fee-for-service extension program in Liberia. This requires the government to develop and implement policies that will facilitate increased commercialization of crops for farmers to generate more income.

CHAPTER FIVE

Factors influencing smallholder rice farmers' willingness-to-pay for private extension services in Gibi District, Liberia

5.1 Abstract

Globally, many policy-makers and extension professionals have advocated for the privatization of extension services to reduce the burden of funding by the state and to adequately respond to the needs of farmers to tackle productivity problems. Hence, this study accessed farmers' willingness-to-pay (WTP) for private extension services and identified factors that influence their WTP. Multistage sampling technique was used in selecting 296 smallholder rice farmers in the Gibi District of Liberia, and the contingent valuation method was used to elicit farmers' maximum WTP value. Descriptive statistics and double-bounded logit model were used to analyze the data. The findings revealed that 78.7 percent of the rice farmers were willing to pay for privatized extension services and on average, a farmer was willing to pay US$11.21 per farm visit. The model results showed that WTP was significantly influenced by age, household size, years of schooling, annual income, and distance to extension source. The study recommends that the Government of Liberia should encourage the private sector to invest in extension services to take advantage of the high farmers' WTP. In addition, the government should design and implement programs that increase farmers' income to enhance their capacity to pay for private extension services.

Keywords: Contingent Valuation Method, Double-Bounded Model, Private Extension Services, Liberia, Willingness-to-pay.

5.2 Introduction

Agriculture development depends on agricultural extension services to disseminate relevant information and skills on new technologies to farmers so that they make necessary decision to adopt them (Msuya et al., 2017). Agricultural extension is one of the major inputs with the potential to improve agricultural productivity, increase farmer income, and improve farmers' welfare (Mukembo & Edwards, 2016; Swanson & Rajalahti, 2010). Al-Zahrani et al. (2016) notes that agricultural extension is the most effective and critical means to disseminate agricultural information to influence farmers' behavior in making better decisions in adopting new technologies. Towards the end of the twentieth century, some Sub-Saharan African (SSA) countries renewed their commitment to reform their agricultural extension systems in order to provide farmer-centered, participatory and demand-driven services (Pye-Smith, 2012). The renewed commitment was prompted by the lack of financial support and poor performance of extension systems (Pye-Smith, 2012). In the same period, development partners, economic advisers, and agricultural professionals proposed privatization of extension services given their decreasing public sector support in most SSA countries (Birner & Anderson, 2007; Swanson & Rajalahti, 2010; Uddin et al., 2014).

The rationale of privatizing extension services is to ensure that the end-user pays the cost of delivery to reduce the burden of funding by the state (Asadi et al., 2008). If farmers are satisfied by the quality and quantity of the extension services they received and are willing to pay for them, then a financially sustainable extension system would evolve (Ulimwengu & Sanyal, 2011; Komba et al., 2018). The privatization of agricultural extension services has several advantages such as reduced burden on the state, increased efficiency of delivery, and provision of specialized programs that are flexible and responsive to site-specific needs and problems of clients (Charatsari et al., 2011; Loki et al., 2019).

In Liberia, the agricultural extension system has experienced a structural change since its inception in the 1960s when the Ministry of Agriculture provided services through a top-down, supply-driven approach (Sigman & Davis, 2017). The system collapsed during the 14-year civil war (1989-2003) and attempts to revive it failed due to lack of funding (Mcnamara et al., 2011). Recognizing the critical role of extension services in technology transfer and agricultural transformation, the government formulated the Agricultural Extension and Advisory Service (AEAS) policy in 2012. The objective was to make farmers contribute to the cost of services provided and expand the scope of the services across the country (Government of Liberia,

2012a). Within the new system, extension services are delivered by the Ministry of Agriculture, private actors, and non-government organizations [NGOs] (Lah et al., 2018). However, government extension programs face severe funding constraints and low human capital. In addition, the private sector focuses mainly on commercial farmers and their services have limited coverage particularly in rural areas. NGOs are the only sources of extension services in the area not covered by the state or the private sector. (Murphy et al., 2016).

Rice is the main staple in Liberia, and accounts for about 22 percent of the agricultural gross domestic product [GDP] (Roberts et al., 2017). Smallholder farmers who account for about 71 percent of total rice production (Government of Liberia, 2012b, 2016) are constrained by limited access to improved seeds, credit, dysfunctional markets, and limited knowledge of adding value and reducing post-harvest losses (Murphy et al., 2016). Thus, rice yields in Liberia are low at an average of 1.2 metric tons per hectares (MT/ha) (FAO, 2019a). To overcome the identified constraints, and given the limited state funding, the private extension services need to reach the rural smallholder rice farmers. It is not clear if smallholder rice farmers are willing to pay for private extension services and the maximum amount they would be willing to offer.

Willingness-to-pay (WTP) studies have been used to determine the perceived economic value for non-market goods or services (Breidert et al., 2006) and the information is subsequently applied to attach prices to goods and services and to evaluate their desirability by potential users (Hole & Kolstad, 2012). For example, Yegbemey et al (2014) found that farmers in Northern Benin expressed WTP for extension services that would enhance their capacity to adapt to new approaches. In Bangladesh, Uddin et al. (2014) found that farmers were willing to pay for extension services that would increase their economic benefits. In Tanzania, Shausi et al. (2019) showed that farmer's experience, income, age, and education were significant determinants of WTP. In Liberia, however, smallholder rice farmers' WTP for private extension services is not known and the factors likely to influence it have not been identified.

Therefore, the objective of this study is to fill this gap in knowledge. Knowledge of the mean WTP and its determinants would enable policymakers and practitioners to evaluate viability of demand-driven extension services. It will inform possible pricing of extension services and underscore the attributes the farmers are looking for in such a service. The rest of the paper is organized as follows: Section two describes the methodological framework; section three presents the results and discussions, and section four concludes with a few policy implications of the main results.

5.3 Materials and methods

5.3.1 Theoretical framework

The theory of planned behavior (TPB) is a socio-psychologic model that offers a framework for analyzing WTP for non-market goods (Ajzen, 1991; Liebe et al., 2011; Pouta & Rekola, 2001). The theory assumes that behavioral intention is a function of attitude toward a behavior, subjective norm, and perceived behavioral control (Ajzen, 1991). The behavioral intention specifies the motivational factors that influence behavior and indicates an individual's readiness to perform a given behavior (Ajzen, 1991). Therefore behavior intention precedes attitude towards the behavior, which the individual evaluates as favorable or unfavorable.

From a social-psychological perspective, the double-bounded contingent valuation method (CVM) used in this study mimics the behavioral intention of a smallholder rice farmer purchasing private extension services, once the offer is made in the market. The underlying motivation for a farmer's WTP for the non-marketed private extension services, the behavioral intention, is to maximize the utility derived from the proceeds of his investment. Since utility is unobservable, the researcher can only infer the farmer's utility from the behavioral intention, i.e., the farmer's verbalization of his WTP for the non-marketed private extension services. Accordingly, and following Hanemann (1984), the farmer's initial welfare level can be expressed as an indirect utility function:

$$v(q^0, p, y) \tag{5.1}$$

where v is the utility gained from using private extension services, q_0 is the level of welfare accruing to the farmer from traditional practice, i.e., status quo, p is the price or value of forgone alternative extension services, and y is farmer's income. If the farmer has a favorable behavioral intention towards paying for private extension services, then the indirect utility function becomes:

$$v(q^1, p, y) \tag{5.2}$$

where q^1 denotes the proposed welfare change if the farmer is willing to pay for private extension services while the other variables are as previously defined. If the farmer perceives that his intended action will be beneficial to him, then the underlying utility derived from the intended action will be greater than that accruing from the status quo. Accordingly, $q_1 > q_0$, the maximum WTP can be expressed using the compensating variation as (Hanemann, 1984):

$$v(q^1, p, y - WTP, x) \geq v(q^0, p, y, x) \tag{5.3}$$

where WTP is amount deducted from farmer's income to meet payment for private extension services and x is a vector of socio-economic characteristics.

Solving for WTP in equation (5.3) yields the WTP function (Sriwaranun et al., 2015):

$$WTP = F(p, q^0, q^1, y, x, \varepsilon) \tag{5.4}$$

where q_0 is the level of welfare accruing to the farmer from traditional practice, i.e., status quo, p is the price or value of forgone alternative extension services, q^1 denotes the proposed welfare change if the farmer is willing to pay for private extension services, y is the farmer's income, z is the farmer's characteristics and ε is an unobservable stochastic component which is assumed to be normally distributed with mean $= 0$ and variance $= \delta^2$. The WTP is the amount the rice farmer would be willing to forgo to obtain q^1 rather than q^0. A rice farmer will therefore use the private extension services if the perceived gain in utility is higher than the one at status quo. WTP in this case was evaluated by averaging the 'Yes' individual bid responses which resulted in the mean WTP in United States Dollars.

5.3.2 Willingness-to-pay elicitation method

Contingent valuation method (CVM) was used to elicit smallholder rice farmers' WTP for private extension services. CVM is a survey-based technique used to obtain directly the amount an individual would be willing to pay for a proposed change that leads to improved welfare (Yussif et al., 2017). The method enables researchers to design a hypothetical market that describes the goods to the respondent, such as private extension services as is in this study (Hanemann, 1984). The double-bounded dichotomous choice question format of the CVM was used to elicit farmers' WTP values for private extension services. With the double-bounded question, a respondent is presented with two bids (an initial and a follow-up). The follow-up question attempts to reduce bias in responses and increase precision in the resulting WTP estimates (Alberini et al., 1997). The follow-up question is contingent on the response to the first bid (Prasenjit & Sarmila, 2009). If the individual answers "yes" to the first bid B_I, the second bid B_H is offered at a higher price, i.e., $B_I < B_H$, and if the individual answers "no" to the first bid, the second bid B_L is offered at a lower price, i.e., $B_L < B_I$ (Hanemann et al., 1991). Thus, four possible outcomes (yes-yes, yes-no, no-yes and no-no) are produced for the different bid responses (Alberini et al., 1997). The likelihood of the four possible outcomes are denoted as $\pi_i^{yy}, \pi_i^{yn}, \pi_i^{ny}$ and π_i^{nn} respectively. Assuming that the individual rice farmer is a utility maximizer, the probability of WTP for private extension services is given as follows (Hanemann et al., 1991):

(a) when both answers are "yes" "yes", $B_H > B_I$, then:

$$\pi_i^{yy}(B_I, B_H) = \Pr(B_I < WTP \geq B_U) = \Pr(B_H \leq maxWTP) = 1 - G(B_H, \theta) \quad (5.5)$$

(b) when the first answer is "yes" followed by a "no", $B_I > B_H$, then:

$$\pi_i^{yn}(B_I, B_H) = \Pr(B_I \leq WTP \geq B_U) = G(B_H, \theta) - G(B_H, \theta) \quad (5.6)$$

(c) when the first answer is "no" followed by a "yes", $B_I > B_L$, then:

$$\pi_i^{ny}(B_I, B_L) = \Pr(B_I > WTP \leq B_L) = G(B_I, \theta) - G(B_L, \theta) \quad (5.7)$$

(d) when the first answer is "no" followed by a "no", $B_I > B_L$, then:

$$\pi_i^{nn}(B_I, B_L) = \Pr(B_I \geq WTP < B_L) = \Pr(B_L > maxWTP) = G(B_H, \theta) \quad (5.8)$$

where $\pi^{\cdot}$ is the binary indicator variable for each response (yes-yes; yes-no; no-yes and no-no), B_I, B_H and B_L denote the value of the predetermine bid values (initial, higher and lower) used in the contingent valuation question, WTP is individual farmer's maximum WTP, $G(B, \theta)$ is the cumulative density function of the individual's actual maximum WTP, and θ is a vector of unknown parameters to be estimated. Given the expressions in equations (3) to (6), the corresponding log-likelihood function for the double-bounded dichotomous choice model can be expressed as (Hanemann, Loomis, & Kanninen, 1991):

$$\ln L^d(\theta) = \sum_{n=1}^{N}\{d^{yy}\ln\square^{yy}(B_I, B_H) + d^{yn}\ln\pi^{yn}(B_I, B_H) + d^{ny}\ln\pi^{ny}(B_I, B_L) +$$
$$d^{nn}\ln\pi^{nn}(B_I, B_L)\} \quad (5.9)$$

where $d^{\cdot}$ denotes the binary indicator variables which have the value of one or zero based on the individual responses, N is the total sample, B and $\pi^{\cdot}$ as in equations (5.3) – (5.6).

5.3.3 Model specification

Following Haab & McConnell (2002), the double-bounded logit model was used to determine the factors that influenced smallholder rice farmers' WTP to pay for private extension services in Liberia. The model is expressed as follows:

$$WTP_i = X_i\beta + \varepsilon_i \quad (5.10)$$

where WTP_i is the ith farmer's willingness to pay for private extension services, X_i is the vector of explanatory variables, β is the vector of parameters and ε_i is the error term assumed to be normally distributed. Following Lopez-Feldman (2012), the mean WTP can be calculated once the parameters of the double-bounded model are estimated as:

$$E(WTP) = \bar{x}'\hat{\beta} \quad (5.11)$$

where $\bar{x}'$ is the vector of the sample averages of the explanatory variables and $\hat{\beta}$ is the vector of the estimates of parameters. The empirical model was specified as follows:

$$WTP_i = \beta_0 + \beta_1 AGE + \beta_2 GENDER + \beta_3 SCHL + \beta_4 EXP + \beta_5 HHSIZE + \beta_6 INC +$$
$$\beta_7 LAND + \beta_8 DISTEX + +\beta_9 CROPDIV + \beta_{10} MBPHONE + \varepsilon_i \qquad (5.12)$$

The dependent variable was measured by the two bid values and their responses. The explanatory variables (Table 5.1) expected to influence the WTP for private extension services were obtained from previous studies on WTP for extension services (Shausi et al., 2019; Terfa et al., 2015; Tolera et al., 2014; Ulimwengu & Sanyal, 2011; Yussif et al., 2017). The variables are presented in Table 5.1.

Table 5. 1: Explanatory variables hypothesized to influence willingness to pay for private extension services in Gibi District

Variable code	Variable name	Description	Expected signs
AGE	Age	Age of household head in years	-
GENDER	Gender	Gender of household head (1 = Male; 0=Female)	±
SCHL	Years of schooling	Formal education of the household head in years	+
EXP	Years of farming experience	Experience in rice farming in years	+
HHSIZE	Household size	Number of persons depending on household head	+
INC	Total Annual income	Annual income of the household head in US dollars	+
LAND	Secured land ownership	1 = if household owns land; 0 = otherwise	+
DISTEX	Distance	Distance to the extension source kilometers	-
CROPDIV	Crop diversification	1 = if household diversified crop; 0 otherwise	+
MBPHONE	Mobile Phone Ownership	1 = if household owns mobile phone; 0 = otherwise	+

Justification for independent variables used in the Heckpoisson model and diagnostics test for the models are presented in sections 2.5 and 2.6 respectively. The study area is presented in section 3.3.2.3, sampling and sample size determination in section 3.3.2.4 and data collection and analysis in section 3.3.2.5.

5.3.4 Bid schemes use in the double-bounded contingent valuation survey

In order to elicit maximum WTP for private extension services in Gibi District, focus group discussions (FDGs) were held in each of the three towns to generate baseline bid value as the payment vehicle to develop the contingent valuation questions. The researcher explained the purpose of the study to the participants and then asked them to write down their maximum amount they would be willing to pay for privatized extension services. Based on the outcome of the FDGs, three bid prices (US$4.00, US$6.00, and US$12.00) were determined as payment

per farm visit for Yanquilee, Peter's Town, and Wohn, respectively. Following Haab & McConnell (2002), the follow-up bids were determined by presenting twice the first bid if the respondent says "yes" or half, if the respondent says "no". If the respondent accepts the initial bid, the follow-up bids were as follows: US$8.00, US$12.00, and US$24.00, and if respondent rejects it, the follow-up bids were as follow: US$2.00, US$3.00, and US$6.00. The bid values were randomly presented to the respondents to avoid starting point biases during the survey.

5.4 Results and Discussion

5.4.1 Comparison of household characteristics depending on their willingness-to-pay for private extension services

Table 5.2 compares smallholder rice farmers' socio-economic characteristics by WTP for private extension services.

Table 5. 2: Comparison of selected socio-economic characteristics households based on WTP for private extension services in Gibi District

Variable	Willing (n=233)	Not-willing (n=63)	Pooled (n= 296)	t-ratio
Age of household head (Years)	43.4	46.6	44.1	2.02**
Years of schooling (Years)	4.5	3.7	4.3	-1.22
Farming experience (Years)	14.7	16.2	15.0	1.03
Household size	6.9	5.8	6.6	-3.19***
Annual Income (US$)	1,017.6	729.7	956.3	-3.22**
Distance to extension source (km)	3.8	4.6	4.0	2.11**
			Percentage	**z-ratio**
Gender of household head (Male)	82.0	84.1	82.4	0.40
Land Ownership (Yes)	76.4	77.8	76.7	0.23
Crop diversification	96.7	88.9	94.3	-2.06**
Mobile Phone Ownership (Yes)	54.1	49.2	53.0	-0.69

Note: *** & ** represent 1% & 5% probability levels respectively.
Source: Survey Data 2019

The results show that majority of the farmers were male and did not differ between the two groups. The mean age of the household heads was 44 years. There was a significantly higher age in the not willing households than the willing households at 5 percent level. The mean age attests to the fact that farmers in Gibi were still active and that age is inversely related to WTP. According to Ogundele & Okoruwa (2006), only farmers below the age of 50 possess the strength to carry out farming works. The high mean age also indicates a high degree of

experience among farmers as the results further show that rice farmers in Gibi District have on average, 15 and four years of farming experience and formal education, respectively, indicating a high level of experience and low level of literacy, respectively. The age and years of schooling agree with the national averages (Government of Liberia, 2017).

On average, households earned an annual income of US$ 956.3. The difference in mean was significantly higher among the willing households compared to the not-willing households at 5 percent level. The high income among rice farmers who are willing to pay for private extension services was due to engagement in other livelihood activities including cash crop production which also requires extension services. The result agrees with Shausi et al. (2019) findings that higher-income increases farmers' WTP for agricultural support services.

The average distance from home to the nearest extension source was four kilometers. The not-willing farmers were furthest (4.6km) from the extension source compared with the farmers who were willing to pay. The difference was statistically significant at 5 percent level. Increasing distance from extension sources, decrease WTP (Mwaura et al., 2010). The majority of the farmers practiced crop diversification. The difference in crop diversification across the two groups was higher in the willing households and statistically significant at 5 percent level. More than half of the households owned a mobile phone and over three-quarters owned land. The difference in proportion was not significant.

5.4.2 Mean willingness-to-pay for the private extension services in Gibi District

The mean WTP was estimated with the covariates or explanatory variables. The results show that rice farmers were willing to pay US$11.21 per farm visit for privatized extension services. The findings imply that there is a potential demand for extension services among smallholder rice farmers. Furthermore, it demonstrates rice farmers' eagerness to embrace the fee-for-service extension program. The mean WTP is lower when compare to Farinde & Atteh (2009) who founded that yam growers in Nigeria were willing to pay a higher amount of money (US$ 26.99) for agricultural extension services. However, it is higher than the findings of Badr (2019) that crop farmers in Egypt were willing to pay US$ 6.35 for an extension visit. According to Charatsari et al (2011) WTP varies among geographical locations and based on information needs of the farmers and type of crops. Hence, the mean WTP established by this study compares well with the wage rate of US$6.00 per day for a skilled workers in Liberia.

5.4.3 Factors influencing smallholder rice farmers' willingness-to-pay for private extension services in Gibi District

The double-bounded logit model was fitted to examine factors influencing WTP. The Wald Chi-Square (χ^2) statistics of the model yielded a p-value of 0.000 implying that the explanatory variables fit the model, thus rejecting the null hypothesis that all slope coefficients, except the intercept were equal to zero. Ten key characteristics of the farmers were hypothesized to influence WTP for private extension services in the Gibi District. Out of ten explanatory variables, five were statistically significant. The factors that positively influenced farmers' WTP for private extension services were years of formal schooling, household size and annual income while age of the household head and distance to extension source had a significant negative influence on rice farmers' WTP for extension private extension services. Table 5.3 presents the results of the double-bounded logit model with explanatory variables.

Table 5. 3: Factors influencing farmers' willingness-to-pay for private extension services in Gibi District

Dependent variable: Bid 1 and Bid 2 values and their respective responses (Yes; No)			
Variables	**Coefficient**	**Std. Err.**	**z-value**
Age of household head (Years)	-0.153**	0.077	0.046
Gender of household head (Male)	-1.667	1.824	0.361
Years of formal schooling (Years)	0.434***	0.155	0.005
Experience	0.027	0.084	0.752
Household size	1.080***	0.294	0.000
Annual Income ($US)	0.003***	0.001	0.008
Land Ownership (Yes)	-0.514	1.596	0.747
Distance to extension source (km)	-0.482*	0.264	0.068
Crop Diversification	2.079	2.747	0.449
Mobile phone ownership	1.847	1.353	0.172
Constant	11.206	4.755	0.018
Number of Observations	296		
Wald Chi^2 (10) =	39.77		
Prob. > Chi^2 =	0.000***		
Log-likelihood =	-332.39447		

Note: ***, **, * Significant at 1%, 5% & 10% probability levels respectively.
Source: Survey Data 2019

The coefficient of age of the household heads was negatively related to WTP and significant at 5 percent level. The negative relationship implies that a unit increase in farmers' age leads to

0.15 unit decrease in farmers WTP for private extension services. This is logical because younger farmers are more conscious of acquiring new knowledge to improve their crops since they are less experienced in farming and would not like to risk their investment because of a lack of knowledge, thus, increasing their WTP for the private extension services. This finding is consistent with Shausi et al. (2019), who found that age was negatively associated with farmers' WTP for extension services in the Mpwapwa and Mvomero Districts of Tanzania.

Years of formal schooling had a positive coefficient and significantly influence WTP at a 1 percent level, indicating that an additional year in formal schooling increases a farmer's WTP by 0.43 unit. A plausible explanation is that educated farmers are more likely to understand, interpret and apply new information they receive. Additionally, farmers who acquire more education may need new information from subject-specialists to address farm-level constraints on a fee-for-service basis. The result was expected and concords with Abraham et al. (2012) findings that education was positively related to fish farmers' WTP for agricultural extension services in Kwara State, Nigeria.

The coefficient of household size was positive and significantly related to rice farmers' WTP for private extension services at 1 percent probability level, implying that a unit increase in household size will increase WTP for extension services by 1.1 units. The result was not consistent with expectation and implied that large households were better willing to pay for private extension services than smaller-sized households. Large household size means more food requirements and more farm labor which might lead to large farm size that requires extension services to increase production to meet consumption requirements and income generation. This result contradicts Tolera et al. (2014) findings that family size was negatively related to farmers' WTP for extension services in Haramaya District, Ethiopia.

As expected, the coefficient of annual income was positive and significantly influence smallholder rice farmers' WTP at 1 percent level. Accordingly, a unit increase in income leads to 0.003 unit increase in WTP. This means households with higher incomes have a higher WTP for private extension services. This is because income is directly related to WTP. Further, higher-income means low poverty at the household level, thus, increasing their WTP for extension services. This finding is consistent with Aydogdu (2017), who found that income positively influenced farmers' WTP for extension services in GAP-Harran Plain in Turkey.

Distance to the nearest extension source had a negative and significant influence on farmers' WTP for private extension services at 10 percent level. This indicates that one unit increase in distance to the nearest extension source decreases WTP for extension services by 0.48 unit. This indicates that farmers who live furthest from the extension sources were less willing to pay for private extension services than those closer to the source. A probable explanation is that roads in rural areas of Liberia are under deplorable conditions; therefore, farmers find it more expensive and time-consuming to travel to the extension sources. On the other hand, it is also costly for farmers in distant areas to cover the transport cost for service providers to travel to their farms compared to those closer to the sources. The result agrees with Shausi et al. (2019), who indicated that distance to the extension source negatively influenced farmers' WTP for agricultural extension services in the Mpwapwa and Mvomero Districts of Tanzania.

5.5 Conclusion and policy implications

The study was carried out to estimate smallholder rice farmers' WTP for private extension services and determine the factors that influence WTP in Gibi District of Liberia. Multistage sampling technique was used to select smallholder rice farmers, and contingent valuation method was used to elicit rice farmers' maximum WTP for private extension services. Descriptive statistics and double-bounded logit regression model were used to analyze the data.

The findings revealed significant differences in the socio-economic characteristics of the farmers compared by willingness-to-pay. Those willing to pay for private extension services were younger, spent more years in formal schooling, and earned higher annual income than their not-willing counterparts. The households which were not willing to pay had fewer family members and lived furthest from the extension sources. On average, about 78.7 percent of the farmers were willing to pay for private extension services. Accordingly, a farmer was willing to pay US$11.21 per farm visit, which compares well with the local wage rate of US$6.00 per day for a skilled worker. Furthermore, the model results revealed that annual income, years of formal schooling, and household size had a significant positive influence on WTP, while age of the household head and distance to the nearest extension source had a significant negative influence on rice farmers' WTP for private extension services.

The study, therefore, recommends that given the many development proprieties and limited funding for agriculture, the Government of Liberia should encourage the private sector to invest in extension services to take advantage of the high farmers' WTP. Service providers should

target younger farmers since they are more willing to pay for extension services compared to the older farmers. This can be done by including innovative learning approaches such as information communication technology and e-extension services. Similarly, given that formal education may be too late for the older farmers, care should be taken to avoid marginalizing or excluding them by designing and implementing adult education programs that suit their needs. Further, considering the negative influence of distance to extension sources, the government should rehabilitate feeder roads that connect farmers to service providers in rural areas. Finally, the government and other stakeholders should design and implement programs that will increase farmers' income to enhance their capacity to pay for extension services.

CHAPTER SIX

GENERAL CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Summary

Agriculture is the main economic activity in Liberia and has been a major priority in the post-conflict recovery agenda of the government. Despite many development policies and programs implemented in the last decade, most farmers mainly in rural areas do not have access to basic support services such as agricultural extension. Due to limited funding, government extension services barely exist. The Government of Liberia now promotes and encourages a participatory and demand-driven service delivery based on fee-for-service. Currently, the private sector extension concentrates on large-scale farmers while NGOs are the main source of extension services for most of the smallholder farmers. As a result, only a few numbers of smallholder farmers are linked to platforms where they can access new technologies and knowledge. Because private extension services only serve large farmers, it is not clear if smallholder rice farmers in the hard-to-reach rural areas of Liberia are willing to pay for private extension services. Therefore, this study evaluated smallholder rice farmers' willingness-to-pay (WTP) for private extension services in Gibi District of Liberia. The specific objectives were to: (i) determine smallholder rice farmers' perceptions of the effectiveness of agricultural extension services, (ii) assess factors influencing smallholder rice farmers' demand for and intensity of use of extension services, and (iii) estimate smallholder rice farmers' WTP for private extension services and its determinants.

A multistage sampling technique was used to select 296 smallholder rice farmers in the Gibi District. The contingent valuation method was used to elicit farmers' WTP values and descriptive statistics were used to characterize the farmers. Probit regression model was used to assess the factors influencing rice farmers' perception of NGO provided extension services and the heckpoisson model was used to identify the determinants of demand for and intensity of use of extension services. Finally, double-bounded logit model was used to estimate rice farmers' mean WTP value as well as to determine the factors influencing WTP for private extension services in the study area.

6.2 Conclusion and policy implications

By determining rice farmers' perception of agricultural extension services: The case of extension programs initiated by non-governmental organizations in Gibi District, Liberia (paper one), the study found that only 144 farmers (46.5 percent) received extension services. Of the 144 rice farmers, the majority (97.9 percent) received extension services from NGOs implying a limited role of pubic extension service delivery. More than three-quarters of the households were male-headed. Regarding information needs, about two-thirds of the farmers need information on soil preparation, close to half need general agricultural knowledge and more than half need post-harvest loss management information. The findings also indicated that beneficiary farmers differed in perception of the effectiveness of NGO extension services in terms of its adequacy, usefulness, and quality of follow-up activities but on the average, perceived it to be adequate, moderately effective and good, respectively. The findings also show that NGO performed best in terms of the usefulness of their services to the farmers with an overall mean of 3.36. Further, research-extension linkage workshop was perceived to be inadequate. Finally, the probit results revealed that rice farmers' perception was significantly influenced by the number of training sessions, access to credit, the credibility of the extension agent, years of formal schooling and awareness.

Therefore, the study recommends that policymakers and other stakeholders should consider replicating in public-provided extension services in Liberia the strategy used by NGOs to achieve the level of monitoring and evaluation of extension activities. NGOs and other service providers should augment efforts to follow-up on how farmers applied the knowledge acquired and the technologies adopted. This can be done through regular visitation during various stages of the cropping seasons. Furthermore, given the positive influence of access to input on farmers' perception, it is suggested that NGOs should expand collaboration with local input dealers to enhance credit access for farmers. Finally, farmers' perceptions should be considered fundamental elements in evaluating performance of extension service providers, especially those provided by NGOs.

The analysis of factors influencing smallholder rice farmers' demand for and intensity of use of extension services in the same area (paper two) the study found significant differences in farmers' socio-economic and institutional characteristics by access to extension services. For Instance, there exist low female participation, low rice commercialization and low use of

improved seeds among rice farmers in Gibi District. The heckpoisson model results revealed that monthly farm income, rice commercialization, mobile phone ownership significantly and positively influenced demand for extension services. Further, the result revealed that gender, awareness of extension services, cash crop ownership, and the use of improved seeds significantly influenced the intensity of use.

Therefore, it is suggested that the availability of improved seeds could encourage farmers to make greater use of extension services. A strategy such as demand-pull approach through contract farming would encourage agribusiness entrepreneurs to provide seeds and other inputs in a more sustainable way than delivering 'free' inputs to farmers as practiced in Liberia's donor-funded NGOs extension projects. Furthermore, there is a need for interventions that will increase farmers' income and greater levels of crop commercialization among rice farmers. The results show that farm income and crop commercialization increase demand for extension services. The government should implement policies that promote high farm yields for greater levels of commercialization for income generation among rice farmers. This will increase farmers' income to enhance their capacity to seek and pay for extension services.

Finally the analysis of factors influencing smallholder rice farmers' willingness-to-pay for private extension services in Gibi District, Liberia (paper three) found that majority (78.7 percent) of the farmers were willing to pay for private extension services. On average, a farmer was willing to pay US$11.21 per farm visit for private extension services, which compares well with the local wage rate of US$6.00 per skilled worker. Furthermore, the double-bounded logit model results revealed that annual income, years of formal schooling, and household size had a significant positive influence on WTP, while the age of the household head and distance to the nearest extension source had a significant negative influence on rice farmers' WTP for private extension services.

The study recommends that given the many development proprieties and limited funding for agriculture, the Government of Liberia should encourage the private sector to invest in extension services to take advantage of the high farmers' WTP. Service providers should target younger farmers since they were willing to pay for private extension services compared to their older counterparts. This can be done by including innovative learning approaches such as information communication technology and e-extension services which could be more attractive to them. Furthermore, formal education may be too late for older farmers, care should

be taken to avoid marginalizing or excluding older farmers by designing and implementing adult education programs that suit their needs. Finally, the government should rehabilitate feeder roads that connect farmers to service providers in rural areas.

6.3 Suggestion for further studies

This study was undertaken to examine smallholder rice farmers' willingness-to-pay for private agricultural extension services as they existed in Liberia in post-conflict periods (civil war and Ebola outbreak). It is therefore an evaluation of the performance of these services which were put in place informed by the lessons and experiences gained from the negative consequences of the conflict on livelihoods of the bulk of the population and on farmers in particular. The data was collected well before the onset of Covid-19 pandemic which can be considered as new form of conflict which has tested many systems and services serving humanity including those focusing on farming and food production. Further studies can therefore find out how well the private agricultural extension services in Liberia performed during Covid-19 pandemic, how existing constraints were exasperated and the lessons learnt. In order to provide empirical evidence for developing more resilient extension service systems for rice farmers.

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Appendix 1: Factor coefficients and summary statistics for the perception indicators index score (Total observations: 141)

Variable	Factor Coef.	Mean	SD
Group meeting with farmers	0.073	-0.657	1.296
Farmer training programs	0.025	-0.774	1.323
Follow-up on farmers training activities	0.118	-1.146	1.425
Organization of regular field meeting with farmers	0.101	-1.455	1.453
Appropriateness of methods of demonstration	0.071	-1.087	1.365
Provision of prior notice of planned extension programs	0.091	-0.113	1.134
Appropriateness of information and technology availed	0.154	-0.196	1.217
Appropriateness of field days organization	0.089	1.444	1.148
Appropriateness of research-extension linkage workshops	0.049	2.423	1.202
I understood the extension advice I received and was able to apply it.	0.042	-0.203	1.098
The extension services I have received enabled me to make better use of my limited resources of land, labor and purchased inputs.	0.036	-0.258	1.119
The information on post-harvest losses that I received enabled me to reduce losses incurred	0.029	-0.293	1.158
Extension services I received are relevant to my farming activities	0.038	-0.359	1.038
The information provided on rice and other crops during planting seasons was useful	0.048	-0.985	1.458
The extension services I received were tailored to my needs	0.064	-1.758	1.314
The information I received enabled me to reduce the risks caused by droughts, floods, diseases and pests.	0.093	-1.142	1.692
The information I received on input dealers enabled me to easily identify sellers of quality fertilizers and agrochemicals	0.034	-1.541	1.550
Land preparation was properly done	0.040	-0.180	1.153
Planting was correctly done and was timely	0.086	-0.258	1.235
Timely weed control	0.053	-0.685	1.389
Farmers received timely and up-to-dated information	0.096	-1.321	1.734
Pest and disease control methods are properly applied	0.111	-0.413	1.378
Free or emergency inputs arrived on time	0.034	-0.970	1.616
Fertilizer and agrochemicals are appropriately applied	0.072	-1.277	1.575

Appendix 2: Summary statistics of the perception index score

Summary measure	Value
Total observation	141
Mean	-9.48488
Standard Deviation	8.480662
Minimum	-27.88069
Maximum	8.910627

Appendix 3: Variance inflation factor (VIF) for explanatory variables used in the probit model

Variable	VIF Value	Tolerance (1/VIF) value
Age	1.83	0.55
Farming Experience	1.52	0.55
Decision criteria	1.69	0.59
Gender of the household	1.51	0.66
Years of schooling	1.31	0.76
Training sections	1.25	0.76
Extension agent credibility	1.24	0.80
Household size	1.23	0.81
Awareness of extension services	1.22	0.81
Access to input	1.18	0.85
Membership of saving club	1.15	0.87
Farming income	1.15	0.87
Mean	**1.38**	

Appendix 4: Pearson correlation matrix for explanatory variables hypothesized to influenced household perception of extension services

	Age	Gender	Farming experience	Training sessions	Membership of saving club	Awareness of extension services	Years of schooling
Age	1.0000						
Gender of the household head	-0.0894	1.0000					
Farming experience	0.6086	0.0464	1.0000				
Training sessions	-0.0161	-0.0753	-0.0522	1.0000			
Membership of saving club	-0.0283	-0.0966	0.0138	-0.0166	1.0000		
Awareness of extension services	-0.0998	-0.0447	-0.1149	0.1633	0.0716	1.0000	
Years of schooling	-0.0962	0.2823	-0.0897	0.0342	-0.0655	-0.0572	1.0000
Decision criteria	-0.0284	0.2656	-0.1903	-0.0404	-0.0077	0.1401	0.1467
Extension agents credibility	0.0225	-0.0185	-0.1008	0.0735	0.0287	-0.2150	0.0940
Farming income	-0.0164	0.0152	-0.0512	0.2652	0.0388	0.0725	0.0503
Access to input	-0.0123	-0.1181	0.1008	0.0693	-0.1466	0.0502	-0.0854
Household Size	0.2346	-0.0961	0.1921	-0.0458	-0.0865	-0.0157	-0.0400
Extension contacts	-0.0619	-0.0997	-0.0569	0.7586	0.0558	0.1383	-0.0695

	Decision criteria	Extension agents credibility	Farming income	Access to input	Household Size	Extension contacts
Decision criteria	1.0000					
Extension agents credibility	0.3003	1.0000				
Farming income	0.1358	0.1004	1.0000			
Access to input	-0.1672	-0.0694	-0.1238	1.0000		
Household Size	0.1013	0.2206	-0.0150	0.1088	1.0000	
Extension contacts	-0.0774	-0.0126	0.1730	0.1130	-0.0745	1.0000

Appendix 5: Variance inflation factor (VIF) for the variables in the heckpoisson model

Variable	VIF Value	Tolerance (1/VIF) value
Farming Experience	1.77	0.56
Age	1.71	0.58
Use improved seeds	1.18	0.85
Distance	1.17	0.85
Farm Size	1.10	0.91
Farm Income	1.10	0.91
Cash Crop	1.10	0.91
Gender of the household head	1.09	0.91
Awareness of extension services	1.10	0.91
Commercialization	1.07	0.93
Crop Diversification	1.07	0.94
Mobile Phone	1.06	0.94
Mean	**1.21**	

Appendix 6: Variance inflation factor (VIF) for the variables used in the Double-bounded

Variable	VIF Value	Tolerance (1/VIF) value
Age	1.73	0.58
Farming Experience	1.71	0.58
Gender	1.16	0.87
Years of Formal Schooling	1.13	0.88
Household Size	1.10	0.91
Land Ownership	1.07	0.93
Distance to Extension Source	1.07	0.93
Mobile Phone	1.06	0.94
Annual Income	1.06	0.95
Crop Diversification	1.03	0.97
Main VIF	**1.21**	

Appendix 10: Research Questionnaire

UNIVERSITY OF NAIROBI

An economic evaluation of smallholder rice farmers' willingness-to-pay for extension services in the Margibi County of Liberia.

Household Survey Questionnaire, April 2019

Introduction

This survey is being conducted by researchers from the Department of Agricultural Economics, University of Nairobi in Kenya. The objective of the survey is to gather information smallholder rice farmers' socio-economic and institutional characteristics of smallholder rice farmers. The survey also seeks of collect data on access to extension services and willingness-to-pay for privatized agricultural extension services in Margibi County. Only smallholder farmers that are engage in rice farming will be interviewed. The survey targets to interview 385 respondents. Kindly be assured that your responses and opinions will be treated with utmost confidentiality and will only be used for policy making. This interview is expected to last for 30 minutes and your cooperation and time will be highly appreciated. I therefore request your permission to begin the interview now.

Note: The respondent must be an individual who normally makes farming decisions in the household. This must be the household head, spouse or their designate.

Questionnaire Number: _____   Date of Survey (dd/mm/yy) ____/____/2019   Start Time: _____ End Time: _____

Enumerator's Name: _____ Code: _____ Township: _____ Village: _____ Respondent's Name: _____

1.1 Did you grow rice last season? [   ] [1 =Yes;   0 = No];   *[ENUMERATOR, if No, quit the interview]*

SECTION I: FARM CHARACTERISTICS

A. Farm Enterprises

1.2 Which type of land did you grow rice on last season? [   ]1 = Low Land   1 = High Land   3=Both

1.3 Did you grow other food crops in addition to rice last season? [   ] [1 =Yes;   0 = No]

1.4 *If yes*, what other types of food crops did you grow? [   ] [1 = Cassava 2=vegetable; 3 = Corn/Maize; 4 = Sweet potato; 5=plantain; 6 = None 7= (Specify)__] No option for specify

1.5 Did you sell rice during the last farming season (Commercialization of rice)? [1] =Yes;   [0] = No

1.6 If yes in 1.5, what proportion did you sell? _____

1.7 If yes in 1.5, what was the monthly income from rice sales for last season? _____

1.8 If No in Q. 1.5, what was the **main** reason for not selling rice last season? ____ [1=not enough to sell, 2=high marketing costs, 3= bad road, 4= No   buyers, 5=Poor prices, 6=Other, specify_____]

1.9 What is the distance from your farm to the nearest market? _____ kms

1.10   Besides food crops, did you have cash crops last season? [   ] [1 =Yes;   0 = No]

1.11   *If yes*, which one of the following cash crops? [   ] [1=cocoa; 2= sugar cane; 3= rubber; 4= coffee; 5=oil palm] 6 = Others (Specify)

1.12 Did you use hired labor in the last rice farming season? _____   [1 = Yes   0 = No]

1.13 If yes, at which time of the farming season did you hire labour? ___ __   1=land preparation including bush clearing;   2=planting;
3=weeding; 4=harvesting; 5=others: ____

D. Land Tenure

1.14   Do you own a land? _____ 1=YES, 2=NO

1.15   If yes, size of land own by your household in acres? _____

1.16   How many plots of rice did you have in last season? _____

1.17   Please provide the following information on your plot(s).

Number of plots	Size of the land covered with rice	Ownership (user right/ownership)	Distance to plot from homestead (Km)	Do you use fertilizer on this plot?	How do you prepare the land?	What type of water system do you use?
1)						
2)						
3)						
	1 = Yes 0 = No	1= Own with deed 2= family land/inheritance, 3= Rented /leased, 4= communal land		1 = Yes 0 = No	1 = Manually 2 = Oxen 3 = Tractor	1 = rain fed 2 = irrigated 3 = Both

E: Household Group Membership / Social Status

1.17 Do you hold membership with any farmer group?   Yes   0= No

1.18 If yes, please provide the details in the table below

Type of Group you hold membership with	Check as many	If yes, how long have you been a member (Years)?	What is the most important function of the group: (ONE)	Membership role with the group	If you do NOT hold membership to a group in 1.23, what could be the Main reason
Youth group			1= produce marketing 2= input access 3= savings & credit 4= Trainings 5= transport services 6= Farming work/Labour 7=other, specify	1 = Official 2 = Ordinary	1= Not available 2= time wasting 3= Doesn't want to be a member 4= corruption in the group 5= other, specify_
Women group					
Farm labor group (Kool)					
NGO established farmer group					
Yearly Credit & Saving Club					
Farm self-help/input supply group					

others (specify):___				

SECTION II: WILLINGNESS TO PAY FOR PRIVATIZED EXTENSION SERVICES
[Enumerator read the scenario to respondents and let them determine the initial bids]

Scenario for respondents' familiarization of the Survey

As you might notice, rice farming supports many farmers in rural parts of Liberia. However, lack of access to agricultural extension services have contributed to low rice productivity. Annual rice yield in the country averages just 1.1 metric ton per hector in Liberia. With this level of production coupled with increase in population, farm households are at risk of food insecurity and poverty. Anyway to increase farm yields will require adequate farming knowledge provided by extension workers to guide farming practices. Because of budgetary constraints, government is no longer able to provide free extension services to farmers. However, there are private individuals and companies that are available to provide adequate extension services on a fee basis. This means that the services will no longer be freed. As a farmer, you will have to pay for the services that you require. For this reason, we [researchers] would like to know the amount of money you would be willing to pay for a privatized agricultural extension services in your area. We therefore would like to ask you a few questions regarding the services. Kindly consider your personal income constraints and other farm and household expenses when answering our questions.

Preliminary Questions

i. Before I proceed, did you understand what I have just said about the private extension services? [ ]   1=Yes   2=No

ii.Do you have any questions regarding that policy? [   ] 1 = Yes   0 = No

[ENUMERATOR: If the respondent answers "YES" to both questions, then proceed with the interview. Otherwise, clarify the issue of new government policy on privatized agricultural extension services in Liberia to ensure that the respondent understand it fully before you proceed with the interview]

Willingness-to pay-for privatized extension services.

Let's now talk about the private extension services. I would like to ask you about your willingness-to-pay for privatized extension services wherein you will now paid for services from different services providers other than the one you receive from government or NGOs. Do you have any questions before I proceed?

1 = Yes   0 = No

[ENUMERATOR: If the response is YES, continue with the interview. Otherwise, clarify all the issues/concerns raised by the respondent before you proceed]

2.1   If the privatized extension services described earlier costs your household **X** amount of money, would your household be willing to pay that amount?
___ [X to be substituted randomly by one of the three different bids (US$4.00 */US$6.00 / US$12.00*)]

[ ] 1=Yes …….. If yes, go to 2.2   [   ] 0=No ……… If no, go to 2.3

2.2 If **YES** in 2.1, is your household willing to pay __2(X)__ amount?   *(US$ 8.00 / US$ 12.000 / US$ 24.00*

[ ] 1= Yes   [   ] 0= No

If **NO** in 2.1, is your household willing to pay __1/2X__ amount?   *(US$ 2.00 / US$ 3.00 / US$ 6.00*)

[ ] 1= Yes   [   ] 0= No

2.3 What is the maximum amount your household is willing to pay for privatized extension services? US$__

2.4 What kind of payment method do you prefer for extension services? ____1 = Cash; 2= Kind (Sharecropping); 3= Credit

2.5 If you were to pay for agricultural extension services, what would you forgo? _____
   [ ] 1= Food   [ ] 2 = Children school fees   [ ] 3 = Clothing   [ ] 4= Saving   [ ] 5= Loan repayment [ ] 6= others (please state) _____

SECTION III: ACCESS TO EXTENSION SERVICES

3.1 Are you aware that the government has decentralized extension services in Liberia?   [ ] 1= YES   [ ] 0= No
3.2 Did you have access to extension services? _____ [1=Yes; 0=No]
3.3 What is the level of access to extension services? _____ [1= easy; 0 = difficult]
3.4 If yes, how many times did you have contact with extension agent(s)? _____
3.5 If NO in 3.2, what was the reason for not using extension? _____   [   ] 1=not interested;   [   ] 2 = not accessible,   [   ] 3= not affordable,
   [   ] 4=not useful,   [   ] 5=too expensive / costly;   [   ] 6=Other (specify) _____]
3.6 If **Yes in 3.2**, please answer the following questions in the table

Sources of extension services	Did you receive the extension service from this source? (Yes; No)	What kind of information did you receive? (multiple options)	On a scale of 1 (not effective) to 5 (very effective) please rate the information obtained?	How many time did you receive extension service?	Which MAIN REASONS made you choose/use this particular service provider
1=Gov't extension officer 2=Out grower/Private company 3=NGOs 4=farmer group /corporative 5=Researcher 6=Fellow farmers 7=others (specify)		1 = Gen. agricultural 2 =Marketing info 3 =Inputs info 4 =Post Harvest losses 5 = IPM, 6 = Disease Control, 7 = Tillage /Soil Preparation 8 = Others (specify)	1= Not effective 2= slightly effective 3= natural 4= Effective 5=Very Effective		1= The only provider 2= get it when you need it 3= Relief Aid to farmers 4=gives information I need 5=I buy inputs from them 6= Group membership 7= other(specify)__

3.7 What is the distance from your home to the extension service provider? _____ (km)
3.8 When did you start using extension service?_____ (year only)
3.9 Have you attended an agricultural training program? _____ [1=Yes; 0=No]
3.10   If yes, how many sessions (number of training)? _____
3.11 On a scale of 1 (Very poor) to 5 (Very good), please rate the level of access to extension services in this area.
   [1] Very Poor; [2] Poor;   [3] Neutral; [4] Good;   [5] Very Good

3.12 What is the **most important** extension training need do you require as a farmer for rice production? [1] =Marketing   [2] =Inputs
    [3] =Post Harvest Mgt   [4] =IPM training   [5] = Disease Control   [6] = Soil Preparation [7] = Others (specify)
3.13 Which channel do they use to deliver the services?

Channels	Check as many	Do you pay for this service
Mass Media		
Group meeting		
Individual meeting		
SMS/Phone		
Contact farmer		
Lecture / presentation		
Other Specify		

3.14   Did you buy improved rice seeds (Access to improved rice seeds)? Yes   No
3.15   Did you buy agrochemical inputs for the last farming season? Yes   No
3.16   If Yes, please fill the table below:

Types of Inputs	Did you use any of the following inputs (Click one)	Did you pay for the inputs	How much did you pay	Source of the input
Fertilizer				
Herbicide				
Pesticides				
Insecticide				
Compost				
Manure				

SECTION IV: AWARENESS OF NGO EXTENSION PROGRAMS

4.1 Are you aware of NGO agricultural extension services and training programs in your area? _____ [1= Yes; 0 = No]
4.2 **If YES in 4.1**, do you benefit from any of the services offered by the NGOs? _____ [1= Yes; 0 = No]

4.3 Have you attended any form of NGO extension trainings?   [ ] 1 = YES   [ ] 0 = No

4.4 **If yes**, please state which one of the following trainings have you attended:

Type of training	Check as many	Provider of the training	No. of times attended 3 years	Main topics covered during the training	Did you pay for the training? 1= YES; 2=NO	If yes, how much?
IPM training						
Marketing						
Inputs						
Post-Harvest Mgt						
Disease Control						
Others (specify)						

SECTION V: FARMERS' PERCEPTION OF THE EFFECTIVENESS OF NGOS EXTENSION SERVICES

5.1 Do you receive extension services or training from NGOs? [1 =Yes;   0 = No]; *[ENUMERATOR, if No, move to section VII]*

On a scale of 1 to 5, kindly indicate to what extend you agree with following statements about NGO extension programmes in your area.

No	Adequacy of the NGO Extension Services	[1]	[2]	[3]	[4]	[5]
		Likert scale				
5.1	Appropriateness of information and technology availed					
5.2	Appropriateness of field days organization					
5.3	Appropriateness of research-extension linkage workshops					
5.4	Group meeting with farmers					
5.5	Farmer training programs					
5.6	Provision of prior notice of planned extension programs					
5.7	Follow-up on farmers training activities					
5.8	Organization of regular field meeting with farmers					
5.9	Appropriateness of methods of demonstration					
	1= Not adequate, 2= Barely adequate, 3= adequate, 4= adequate; 5 = Very adequate					
	Usefulness of information received					
5.10	I was able to use the information that was tailored to my needs					
5.11	The information I received on risks was useful in reducing the effect of droughts, floods, diseases and pests.					
5.12	Information I received on input dealers was useful in identifying sellers of quality seeds, fertilizers and agrochemicals easily					

5.13	Information I received farming practices was useful in improving					
5.14	Information provided on rice and other crops planting procedures was useful					
5.15	Information I received on the timely and appropriate use of inputs was useful, and I was able to apply it.					
5.16	Information I have received was useful in making better use of my limited resources of land, labor and purchased inputs.					
5.17	Information I received useful in reducing the level of post-harvest losses I usually incurred					
	1 = Not useful; 2= Barely useful; 3=moderately useful; 4 = Useful 5= Very useful					
	Perception of follow-up activities					
5.18	Fertilizer and agrochemicals are appropriately applied					
5.19	Farmers received timely information					
5.20	Timely weed control					
5.21	Emergency inputs arrived on time					
522	Land preparation was properly done					
5.23	Pest and disease control methods are correctly applied					
5.24	Planting was correctly done and was timely					
	1 = Poor, 2 = Fair, 3 =Good, 4 = Very Good, 5 = Excellent.					

Section VII: Access To Credit

7.1 Did you apply for credit/loan during the last farming season? ___ [1= Yes 0= No]; [**Enumerator, if no in 7.1, ask only 7.2 and move to next session**]

7.2 If **No,** what was the main reason you did not apply for credit? _____ [1=High Interest rate, 2= Too much paper work, 3= Do not have the full requirements, 4=No means of getting loan, 5=I didn't have need for credit, 6= I didn't where to credit   7=Others (specify) _____**IF YES**, *Please provide the details in the table below*

7.3	7.4	7.5	7.6	7.7	7.8	7.9
Main Source of the credit	Did you receive the credit this source? (1= Yes 0= No)	*If yes*, how did you get it?	*If yes*, In what form was the credit received?	*If yes*, who applied for the credit?	What was the **main** use of the credit?	**Majo**r challenge faced in getting credit?
Bank Microfinance Corporative/Farm Group Yearly Susu Club Relative/Friends		1= individual lending 2=group lending	1= Inputs /kind 2= Cash 3=both	1= Me 2= My spouse 3=Both of us 4=Other (Specify)	1=Farming purposes;	1 = Shortage of capital 2 = High interest rate 3 = Bureaucracy / paper work

Individual Money Lender					2= Non Farming purposes	4 = Distance from the farmer's residence
Input dealers						
Others(specify)_						5 = others specify

SECTION VIII: HOUSEHOLD CHARACTERISTICS (Kindly provide the following information about the household/head)

8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	8.10	8.11
Sex of respondent	Relation to the House-hold head	Sex of HH head	Age of the HH	Main occupation of the HH head	Marital status of HH head	Years of Schooling	Family size (No. of people that live & depend on the HH for food)?	Years of farming exper. of HH head	Total monthly income from farming	Total Monthly income from off-farm activities
1 = Male 2= Female	1=HH head 2=Spouse 3=Parent 4=Child 5=Sibling 6=Employee 7=Others	1 = Male 2= Female		1= Farmer 2= salary employed 3= casual labor (daily hire) 4=business 5=Student 6=others -specify	1 = Married 2 = single 3= Divorced 4= Widowed 5= Separated		a. Male: _____ b. Female: ____ c. Family Labor: __ d. Kids below 5 years __			

8.12 What is the household's annual income? LD$ _____ US$_____

8.13 What is the household's main source of income? __ 1 = Crop sale; 0= Otherwise

8.14 Who makes key farm decisions in your household? ___ 1=Male, 2=Female, 3=Both

8.15. How many of the family member work on the farm? _____

Indicate the number of assets owned by the household.

Housing type	Number	Farm transport	Number	Processing tools	Number	Other Assets	Number
Thatch roof/ concrete wall		Bicycle		Rice mail		Working mobile phones	
Thatch roof/mud wall				Sugarcane mail		Working radio	
		Wheelbarrow		Cassava mail		Working TV	
Iron sheet roof/concrete wall		Motorcycle (Pen-pen)		Water tank		Sofa set (Living room set)___	
Iron Sheet/mud wall		Car		Other (Specify)		Generator	
		Pickup					

"We have now come at the end of the interview. Thank you for your contribution to this survey. We hope to use this information to determine how best to provide affordable and desirable service to the farmers in your community."