LINKING SMALL-SCALE FARMERS TO MARKET USING ICT

PEMA GYELTSHEN

MASTER OF SCIENCE IN DIGITAL TECHNOLOGY INNOVATION

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT

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ชื่อเรื่อง การเชื่อมโยงเกษตรกรรายย่อยเข้ากับตลาดโดยใช้เทคโนโลยีสารสนเทศ
ชื่อผู้เขียน Mr.Pema Gyeltshen
ชื่อปริญญา วิทยาศาสตรมหาบัณฑิต สาขาวิชานวัตกรรมเทคโนโลยีดิจิทัล
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บทคัดย่อ

ในประเทศพัฒนาน้อยที่สุด (LDCs) เกษตรกรส่วนใหญ่เป็นเกษตรกรรายย่อยและเผชิญกับความท้าทายมากมายในการทำการตลาดผลิตภัณฑ์ของตน แม้ว่าเกษตรกรรายย่อยมีศักยภาพในการลดความยากจนในชนบทและบรรลุความมั่นคงด้านอาหารระดับโลกได้ก็ตาม แต่ก็ขึ้นอยู่กับศักยภาพการผลิตและการเข้าถึงตลาด

นอกจากนี้ การเข้าถึงตลาดสำหรับเกษตรกรรายย่อยขึ้นอยู่กับข้อมูลการตลาดที่เชื่อถือได้ทันเวลาและมีข้อสนเทศที่เกี่ยวข้อง ดังนั้น การศึกษาจึงมุ่งเน้นที่การระบุความท้าทายที่เกษตรกรรายย่อยต้องเผชิญในการทำการตลาดผลิตภัณฑ์ของพวกเขา การรวมระบบดิจิทัลของเกษตรกร ผู้ใช้ระบบสารสนเทศการตลาด (MIS) และความต้องการของเกษตรกร ผู้ให้บริการโครงสร้างองค์กรของ MIS และความยั่งยืนเพื่อพัฒนากรอบการทำงานเพื่อช่วยการออกแบบระบบเชื่อมโยงการตลาด (MLS) และตรวจสอบประโยชน์ของ MLS ที่ออกแบบโดยใช้กรอบการทำงานของ MLS ผ่านการสำรวจผู้ใช้ MLS จุดประสงค์ของ MLS คือการเชื่อมโยงเกษตรกรรายย่อยเข้ากับตลาดเพื่อให้ความท้าทายทางการตลาดที่ระบุแล้วสามารถแก้ไขได้ด้วยคุณสมบัติของ MLS

ผลการวิจัยชี้ให้เห็นว่าเกษตรกรและตัวแทนส่งเสริมมีความเห็นว่า MLS จะเป็นประโยชน์ในการแก้ปัญหาความท้าทายทางการตลาดของเกษตรกรรายย่อย ในทางกลับกันแม้ว่าผู้ค้ากว่าห้าสิบเปอร์เซ็นต์จะเห็นประโยชน์ในเชิงบวกของ MLS แต่เกือบสี่สิบเปอร์เซ็นต์มีความเห็นเป็นกลาง และที่เหลือมีความเห็นในเชิงลบ

คำสำคัญ : เกษตรกรรายย่อย, ระบบสารสนเทศการตลาด, ระบบการเชื่อมโยงตลาด

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ABSTRACT

In the least Developed Countries (LDCs) majority of the farmer are smallholders and they are confronted with numerous challenges in marketing their products. Although small-scale farmers have potential in reducing rural poverty and achieving global food sufficiency, it is dependent on their production potential and access to the market.

Access to market for small-scale farmers further depends on reliable, timely and relevant market information. Therefore this study focused on identifying challenges faced by small-scale farmers in marketing their products, develop a framework to help design electronic market linkage system (MLS) and validate the usefulness of the framework through MLS user survey. The aim of MLS is to link small-scale farmers with the market so that those identified marketing challenges could be solved through features in MLS.

The result indicates, farmers and extension agents had the view that MLS will be useful in solving small-scale farmer common marketing challenges. On the other hand, although over fifty percent of the vendors were positive that MLS would be useful, almost forty percent were neutral in their opinion and ten percent had a negative view.

Keywords : Small-scale farmer, Market linkage system, Market information system

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Pema Gyeltshen

TABLE OF CONTENTS

List of Tables

Page

List of Figures

Page

1. Introduction.

1.1 Background.

In the Least Developed Countries (LDCs) and developing countries, the majority of the population depends on agriculture. There are some 500 million smallholder farms worldwide, and more than 2 billion people depend their livelihood on these farms. Small farms produce about 80 percent of the food consumed in Asia and sub-Saharan Africa (FAO, 2012, 2014; Nwanze, 2011). Whereas their contribution to the economy is minimal compared to other sectors. Statistic from FAO (UN, 2011) shows that 70% of the population in LDCs depends on agriculture, but their contributions to gross domestic product is less than 30%. In this study, the small-scale farmer is defined as those households who own less than two hectares (ha) of farmland. On average, small farmers in Asia and sub-Saharan Africa own less than 2 ha of land (FAO, 2012, 2014).

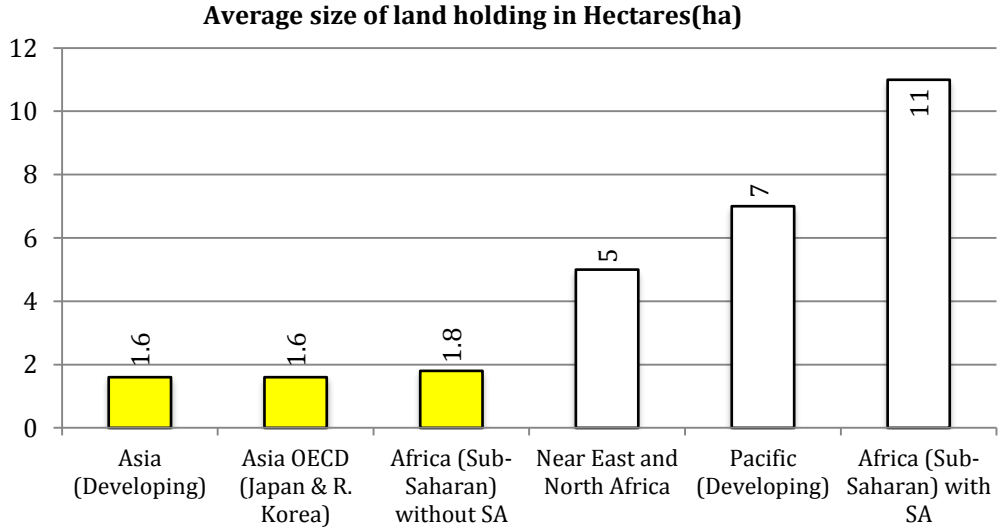


Figure 1. Region-wise average land holding (FAO, 2012)

The global population will hit 9 billion by 2050 which will requires a 70 percent increase in food production (FAO, 2009) to be able to feed us all. Although, small-scale farms have potential to contribute towards achieving global food security (Jones, 2012; Magesa, Michael, & Ko, 2014, 2015), and reducing rural poverty (Thorp, Stewart, & Heyer, 2005), it is totally depending on production potential, capacity to innovate and access to market (FAO, 2014; IFAD, 2013; Matsane & Oyekale, 2014). This study will emphasis on access to market aspect amongst the three through Market Information System (MIS). With the population growth, global demands for horticulture and livestock products are also growing. It is highlighted that the domestic market has high potential to fulfill those demands. Also, quality requirements for domestic markets are modest, which gives small-scale farmers an opportunity to compete in these markets (Poulton, Dorward, & Kydd, 2010).

1.2 Problem statement

Magesa et al. (2015) mentioned that with the growth in ICT, the agriculture marketing environment has changed in very diverse ways both locally and globally. While Industrial producer were able to leverage ICT in agriculture, small-scale farmers still depend on word of mouth and previous experience (Mcnamara, Belden, Kelly, Pehu, & Donovan, 2011). The later still follows traditional farming methods mainly focused on supply-driven production which has to be replaced by demand-driven production (Shepherd, 2007) to ease their marketing challenges.

Demand-driven production mainly depends on market information. Agriculture productivity can be realized when farmers have access to market information (Masuki et al., 2010; Siyao, 2012). With the information, farmers will be able to reduce their transaction cost, improve transportation, enhance bargaining power and access more market for their products (Benfica & Mather, 2013; Jama & Pizarro, 2008; Jari & Fraser, 2009; Matsane & Oyekale, 2014; Rehman, Selvaraj, & Ibrahim 2012; Vadivelu & Kiran, 2013).

1.3 Objective of the study

Through literatures related to agriculture marketing, from Shepherd (1997) "Theory and Practice" to the latest review conducted by FAO (2017), it is evident that in last two decade MIS mainly focused on one-way flow of information, and Kizito (2011) used the term "vertical integration of MIS activities" for the same. MIS provider initially collects the data and transmits to the central database (mainly price data) then analyzes and later disseminates to the farmer through various mediums. While this study will look into two-way information flow, i.e. from vendors to farmers and vice versa. Where MIS providers need not collect, and disseminate data. Rather they can make use of data (quantity, quality, time, contacts, etc.) that flows between vendor and farmer for policy intervention and early warning.

Therefore the objective of this study is to develop a MLS framework to help design effective and sustainable ICT based Market Linkage System (MLS) incorporated with MIS functionality to promote small-scale farmers marketing by:

a) Identifying challenges faced by small-scale farmers in marketing and digital inclusion,

b) Exploring trends of existing agriculture MIS,

c) Assessing users and their information needs and

d) Determining the implementation plan and sustainability.

1.4 Significance of the study

Having MLS combined with MIS functionalities will benefit small-scale farmers. With the information from the system, farmers can decide on what to produce, which technology to apply while producing, when to produce, whom to produce for, and what price to sell (Magesa et al., 2014; Mukhebi et al., 2007; Shepherd, 1997). Linkage components will help farmers and vendors to connect virtually. Furthermore, farmers will have a choice to do business directly with vendors reducing multi-layer of middleman resulting in a better price. Ultimately, access to the market by the small-scale farmer will promote subsistence to commercial farming, improve their income (CTA, 2006; Fafchamps & Vargas-Hill, 2005; Shepherd, 1997), food security, and provide rural employment (FAO, 2014; IFAD, 2013).

On the other hand, lack of market information can lead to farmers receiving an unfair price, and susceptible to several challenges during production, transportation, and marketing. Further trader exploits unaware farmers by paying a low price for their products (Kindness & Gordon, 2001; Magesa et al., 2014, 2015). Therefore, the focus of this study is on small-scale farmer's access to the market through an ICT approach called Market Linkage System (MLS). The MLS is a linkage system combined with the functionality of MIS to improve market linkage between small-scale farmer and vendors virtually. The system will provide timely, accurate and relevant market-related information enabling them to participate in the domestic market.

1.5 Scope and limitation of the study

The study was conducted from small-scale farmers perspective based on secondary data consisting of journal articles, conference proceeding, dissertation, and international organizations publication, mainly focused on the small-scale farmer of LDC in Sub-Saharan Africa and Asia. Articles from 1997-2017 were considered from various databases and International organizations websites.

The purpose of this thesis is to identify an issues creating gap between small scale farmers and a market, and to study on how to tackle those issues to promote small-scale farmers marketing. The studies show one way to tackle the issues is through MIS, while reviewing trends of existing MIS it was evident that a linkage component to improve small-scale farmers marketing was missing, hence need for MLS was

observed. To develop effective and sustainable MLS there is a need for MLS development framework. The MLS framework proposed in this thesis is developed based on the theory of System Analysis and Design (SAD)(Dennis, Wixom, & Roth, 2012) with the System Development Life Cycle (SDLC) concept in specific. The study is focused on the development of a MLS framework to help design specific Information System (Market Linkage System). However, based on the SDLC, the scope of this thesis will cover only planning, analysis and design components. There will be no development/implementation included as it is beyond our scope of the thesis. If development/implementation component is to be considered, the financial implication and time required will be huge as it will be a life project involving various stakeholders covering a specific country for a few seasons. Instead, a survey approach was adapted to collect views from respective stakeholders' in order to validate the MLS framework.

2. Literature Reviews

The review of the market information and linkage was focused on small-scale farmers in LDCs. The process of studying a solution of small-scale agriculture marketing can be summarized as shown in figure 2. Firstly, small-scale farmers marketing challenges has to be identified. Likewise, rural populations' digital inclusiveness needs to be reviewed since most of the small-scale farmers are from a rural area. Digital inclusion can be crucial because the effectiveness of MLS is dependent on it.

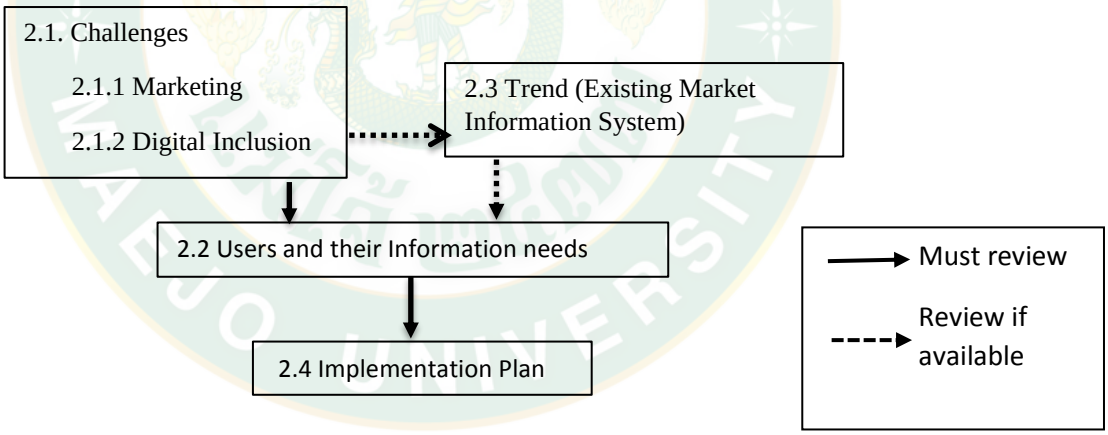


Figure 2. Review approach conceptualized focused on small-scale farmers

Secondly, users has to be identified and their respective needs has to be explored as they are important. It should be focused on how small-scale farmers market their products, as well as on stakeholders involved in both supply and demand side (supply chain). Similarly, the needs of the MLS provider should be considered too.

The trends of the existing solutions has to be studied if available. Through these review, best practices and the knowledge on limitations of the existing system can be understood. Lastly, the organizational structure of MLS provider and sustainability aspects has to be reviewed.

2.1 Challenges

2.1.1 Small-Scale farmers' marketing challenges

Agriculture activities are broadly classified into two categories: production and marketing. The production category consists of input, process, and output. The inputs can be seed seedling, fertilizers, machinery, etc. It is used to produce end products like cereal, vegetable, meat, fruits, etc. All those activities and sub-activities performed to produce end product are considered as in production categories. Rehman et al. (2012) mentioned that "Agriculture marketing can be defined as the commercial functions involved in transferring agricultural products consisting of farm, horticulture and other allied products from producer to consumer".

Agriculture Marketing has been changing and taking shape at the local, national and global arena with the development of ICT (Magesa et al., 2015). However small-scale farmers' are still confronted by some challenges. The common marketing challenges are limited market information, lack of market access, insufficient production, inconsistent supply, high transportation & transaction cost, and poor marketing infrastructure. The lists of the challenges are as shown in Table 1.

Table 1. Marketing challenges faced by the small-scale farmer.

Challenges	Author
Limited Market Information	(Bamiduro & Gbadeyan, 2011; Benfica & Mather, 2013; Delgado, 1999; King & Ortmann, 2007; Magesa et al., 2015; Matsane & Oyekale, 2014; Munyua, 2007; Rehman et al., 2012; Sylvester & Maponya, 2014; Vadivelu & Kiran, 2013).
Lack of Market Access	(Benfica & Mather, 2013; Delgado, 1999; King & Ortmann, 2007; Magesa et al., 2015; Munyua, 2007; Rehman et al., 2012; Sylvester & Maponya, 2014).
Insufficient production	(Baliyan & Kgathi, 2009; Benfica & Mather, 2013; Delgado, 1999; King & Ortmann, 2007; Matsane & Oyekale, 2014; Munyua, 2007).
Inconsistent supply	(Baliyan & Kgathi, 2009; Bamiduro & Gbadeyan, 2011).
High transportation cost	(Baliyan & Kgathi, 2009; Bamiduro & Gbadeyan, 2011; King & Ortmann, 2007; Matsane & Oyekale, 2014; Munyua, 2007).
High transaction cost	(King & Ortmann, 2007; Munyua, 2007; Poulton et al., 2010; Rehman et al., 2012)
Poor market infrastructure	(Baliyan & Kgathi, 2009; Bamiduro & Gbadeyan, 2011; Matsane & Oyekale, 2014; Munyua, 2007; Rehman et al., 2012; Sylvester & Maponya, 2014)
Lack of rural credit	(Bamiduro & Gbadeyan, 2011; Benfica & Mather, 2013; Matsane & Oyekale, 2014; Rehman et al., 2012; Sylvester & Maponya, 2014; Vadivelu & Kiran, 2013)
Multi-level of middle man	(Jari & Fraser, 2009)

2.1.1.1 Market Information:

Market information according to Vadivelu and Kiran (2013) is meant to improve market efficiency, better price formulation, guide farmers on what to produce, when to produce, and when & where to sell (Vadivelu & Kiran, 2013). Small-scale farmers of LDCs and developing countries in Asia and Sub-Saharan Africa are still constrained with information related to agriculture produce such as availability, quantity, quality, and price. This will result in an uninformed decision from both vendor and farmers' side, thus fluctuation in price and wastage of products are common. Xaba and Masuku (2013) stated that market information is important for the producer (farmers) to plan and identify what to produce, and where to market. In addition, Shepherd also mentioned that information on market condition at every point of market chain is important for deciding on where to market (Shepherd, 1997). Conventional marketing systems are still followed in these regions where stakeholders depend on their individual contacts for market information, which is not systematic and it fulfills the need of only few individuals.

2.1.1.2 Market Access

Market information is a key to market access. Without market information, the producer will have difficulty in planning on what to produce. Without production, no marketing activities will exist. This means that information is a barrier for both farmers and vendor (CTA, 2006). Without market information, farmers' will not know where

to supply their products, therefore they sell directly from the farm or at the local market (Torero, 2011). Usually, they sell to the middleman and the price is comparatively low (Fafchamps & Vargas-Hill, 2005). On the other hand, vendors without information will have difficulty in gathering products. Whereby they depend on personal connection and relationship. Hence market access is dependent on market information.

2.1.1.3 Insufficient production

The production capacity of small-scale farmers is generally low. They produce in lesser quantities due to limited landholding. Practically it is not feasible and profitable for them to market in a smaller volume. Some authors in Table 1 pointed out that insufficient production as a major hurdle that ultimately hinders commercial business viability.

2.1.1.4 High transportation and transaction cost

Insufficient production will lead to high transportation cost. Logically transporting larger volume is more economical than transporting smaller volumes separately. Ultimately for the small-scale farmer, product wastage occurs at farm level. As it is not cost-effective to transport their products to the market if they are not able to recover transportation cost. Furthermore, small-scale farmers marketing their products individually is inefficient both from sellers and buyers perspective, because it will lead to an increase in transportation cost (Delgado, 1999; Shepherd, 1997).

2.1.1.5 Inconsistent supply

An individual small-scale farmer producing on a seasonal basis without any demand information will have difficulty in meeting consumers' need. Whereas vendors to sustain their business and to meet the demand of their customer they need a continuous supply. Further unorganized market and those farmers who do not depend their livelihood solely on farming tend to sell their product at any price offered by the vendor. Which is not good for the industry in the long run, as it promotes inconsistent supply and unrealistic pricing structure (Xaba & Masuku, 2013). Insufficient production and inconsistent supply are also attributed to lack of cropping plan, soil fertility, finance, vulnerability to pest and disease, and expensive inputs (Baliyan & Kgathi, 2009).

2.1.1.6 Poor marketing infrastructure

Marketing infrastructure like storage facilities can be crucial for small-scale farmers. Harvested crops should be transported and stored in appropriate facility. It is essential for perishable goods to maintain quality before selling. To store perishable goods is a difficult task. This is because perishable goods are likely to go bad quickly and it requires technical expertise and cold storage facilities to preserve quality (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009). Researchers found that one of the reasons behind market failure in Sub-Saharan region was due to poor market

infrastructures such as lack of storage facilities (Kidane, Maetz, & Dardel, 2006), and the poor state of road infrastructure (Baliyan & Kgathi, 2009).

2.1.2 Digital Inclusion

From the previous sections, it can be seen that small-scale farmers are facing several common marketing challenges. Having an effective MLS will provide a potential solution to most of the challenges. But, MLS should be designed according to farmers' accessibility, affordability, and usability. While designing, we should be mindful that the majority of farmers are located in rural areas with limited digital literacy. Therefore digital inclusion should be studied in order to benefit from electronic MLS. Figure 3 has been conceptualized to review on digital inclusion.

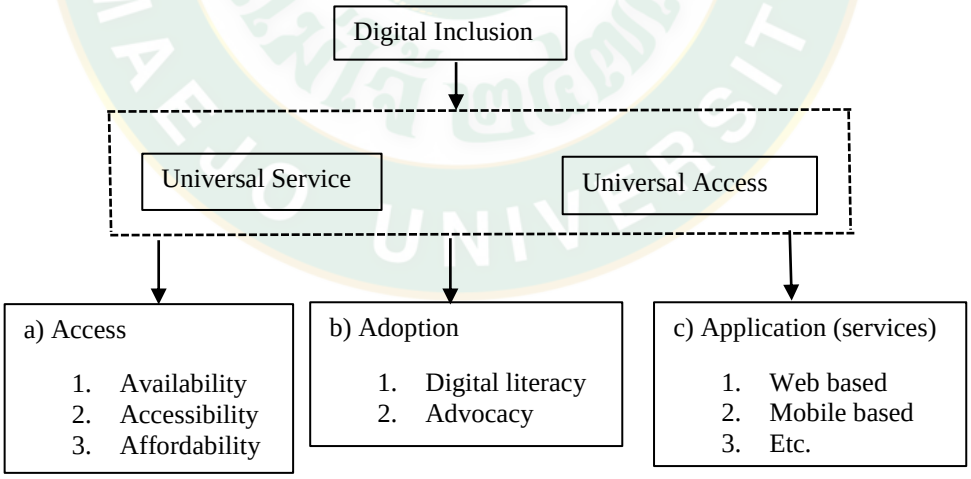


Figure 3. Digital Inclusion concept diagram

According to the International Telecommunication Union, digital inclusion means empowering people through information and communication technologies (ICTs).

And the University of Maryland College defines digital inclusion as a framework used to study the readiness of communities so that ICT applications can be used to overcome the challenges faced by a conventional process.

Universal service means anyone or any household having opportunity to ICT service and universal access means anyone in the community can have access to publicly available ICT service (Dorward, 2013; ITU, 2008, 2013). Availability, affordability, and accessibility are the key components for universal access and universal services. And with the inclusion of Internet and broadband in universal access and services, ability (digital literacy) and awareness (advocacy) are becoming inevitable in the concept of Digital inclusion (ITU, 2013).

2.1.2.1 Access

Clement and shade's conceptual model for access showcases seven interrelated layers which is necessary to accomplish proper service access (Clement & Shade, 2000). Further, Barrett and Slavova categorized these seven layers into three broader areas; access to service, appliances, and infrastructure (figure 4)

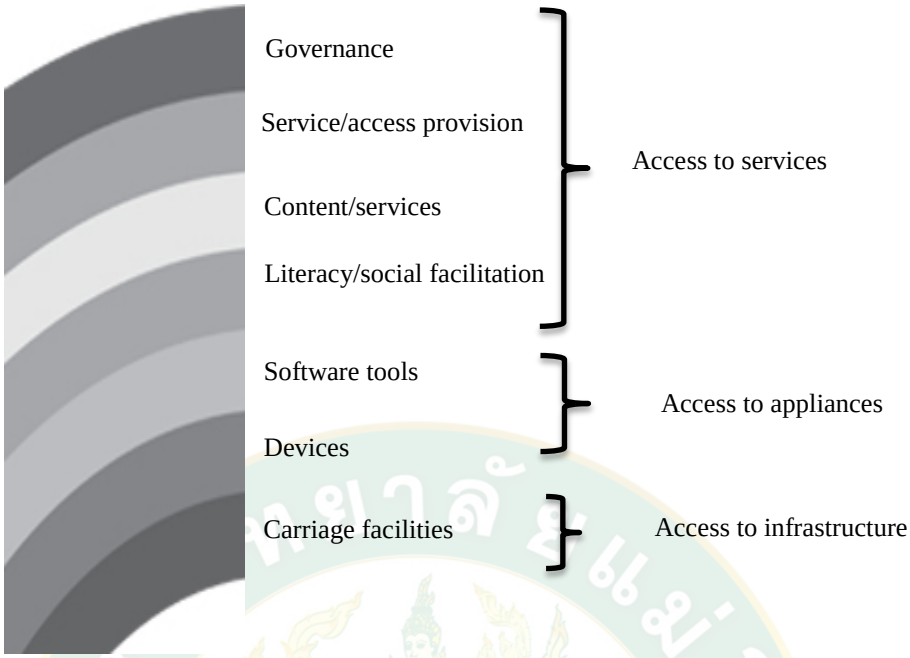


Figure 4. Access Rainbow. Source:(Clement & Shade, 2000; Mcnamara et al., 2011).

Access to services;

i) Governance represents decision-making bodies related to ICT infrastructure.

ii) Service/access provisions are those organizations (Internet Service Provider) that provide network access to the consumer.

iii) Content/Services are designed to fulfill a specific objective.

iv) Literacy/social facilitation serves as an educational and advocacy body to facilitate on complexities that arise while availing services.

Access to appliances;

i) Devices are hardware/equipment used to access the services.

ii) Software tools are software's used to access the services and

Access to infrastructure;

i) Carriage facilities are a physical network used to transfer data.

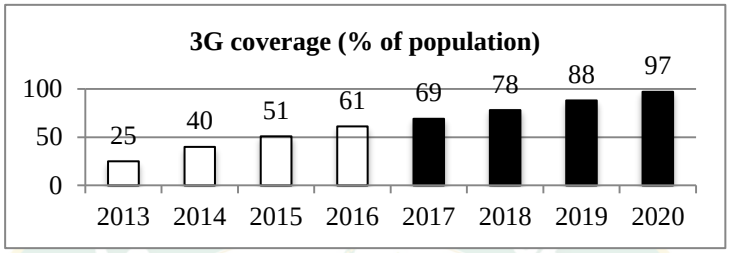
2.1.2.2 Adoption

Adoption of ICT services depends on digital literacy and affordability. ITU defines digital literacy as the ability to carry out basic tasks on the internet such as read, comprehend and to use the information on a website or ICT devices. According to a 2015 survey conducted by ITU in Malawi and Zambia, the main barrier for accessing the internet is affordability. Further study in 2018 underlined that internet accessibility and education are correlated in LDCs and Developing countries, higher the level of education attainment greater the Internet use (ITU, 2018). Table 2 shows the factors that limit small-scale farmers ICT adoption in the last two decade.

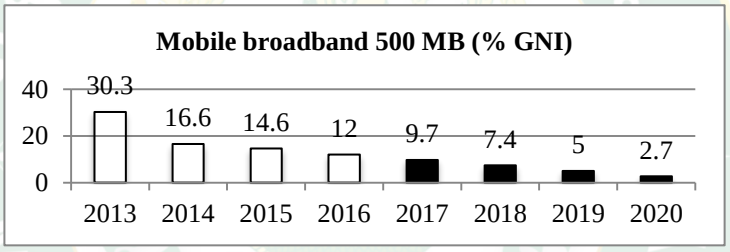
Table 2. Factors that limit the use of ICTs by small-scale farmers

Sl No	Challenges	Author
1	Lack/poor of Access to ICT infrastructure,	(Asingwire & Okello, 2011; Guislain, Qiang, Lanvin, Minges, & Swanson, 2006; Maru, 2004; Munyua, 2007; Richardson, 2006).
2	Literacy / digital literacy	(Akiiki, 2006; Asingwire & Okello, 2011; Guislain et al., 2006; Maru, 2004; Munyua, 2007; Richardson, 2006).
3	Affordability/expensive	(Asingwire & Okello, 2011; Munyua, 2007; Richardson, 2006).
4	Inadequate or/weak ICT policies	(Munyua, 2007).
5	Lack of application	(Akiiki, 2006).

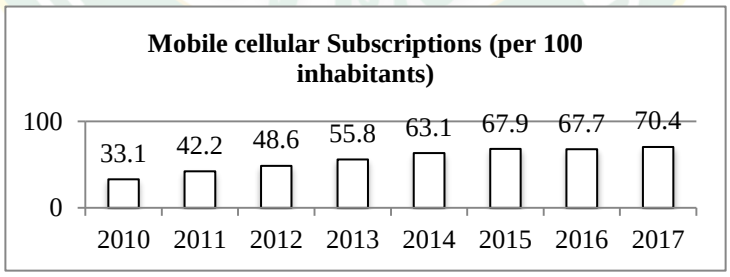
From the reviews, in the last two-decade, the main challenges faced in ICT adoption are lack of infrastructure, affordability and digital literacy. Figure 5 below shows a) the 3G coverage projection, b) mobile broadband price projection and c) mobile subscription trend in LDCs.



a) The projection for 3G coverage



b) The projection for mobile broadband price



c) Mobile cellular subscription.

Figure 5: Projection of 3G coverage, and mobile broadband price, and mobile cellular subscription in LDCs.

"Note: Projections (in black) are based on least square regression and not official estimates of the institutions from which the data is sourced". Source (ITU, 2018)

From figure 4 a) and b), Universal Access in terms of accessibility and affordability of the internet in LDCs are progressing. A per the projection 97 % of the population will have access to 3G signal by 2020. On the mobile broadband price, for 500MB it was 30.3% of monthly gross national income (GNI) in 2013 that will decrease substantially to 2.7% by 2020.

2.1.2.3 Application

An electronic system designed to fulfill a specific objective is called application. MIS is an application program designed to inform farmers on marketing aspects. As per CTA's definition "Agricultural market information system collects, analyses, packages, stores and disseminate prices and other information relevant to farmers, traders, processors, and others interested in agriculture commodities".

2.2 Users and their information needs

While designing MIS or MLS identifying users and their needs are primary. Deriving for whom it is being designed, what are their needs, how the objective will be fulfilled, and who will be involved are important. While gathering system requirement, we also have to identify, consult and involve stakeholders. Studying agriculture supply chain (considering the flow between farm and market) for gathering requirements is important, further integrating information required by the implementing institution (Binayee, 2005) and its institutional structure must be studied carefully.

Poon (2001) stressed that the main users of MIS are farmers, vendor, and policymakers and the objective of the system should focus on the information needs of these users. Table 3, 4 and 5 show the information needs of small-scale farmers, vendors, and policymakers respectively.

Table 3: Information need of Small-scale farmer

Author	Information needs of Farmers
Shepherd, 1997	Current Market Price as a reference to bargain, Market access to decide where to sell, Historical market information to decide, what and when to produce, and where to market
Poon, 2001	Historical price, price of different varieties and cost of production to decide what to plant. Seasonal variations in price to decide when to plant and sell, The current price to decide where to sell.
CTA, 2015	Commodity price at a nearby market, and transportation cost to decide where to sell.

Table 4: Information needs of the vendor

Author	Information needs of the vendor
Shepherd, 1997	Market information to help new entrant, Price information to encourage trade between different markets.
Poon 2001	Historical price of different crop to decide what crop to sell, Current price in a different market to decide where to sell.
CTA 2015	Price trends and comparison, Commodity price at a nearby market, business linkages. Quantity produced at each area.

Table 5: Information need of government (policy maker)

Author	Information needs of policymaker
Andrew W. Shepherd, 1997	Price trend to judge market performance and food security reserve management. Market information to decide on market infrastructure intervention.
Bridget Poon, 2001	Market margins and the price trend in a different market to decide what specific measures needed. Seasonal price variation to decide what improvement in a market system is needed.
CTA, 2015	Production and type of crops, Price trends and comparison, and quantities produced in each region to decide on policy intervention.

2.3 Trends of existing AMIS

Agriculture Marketing Information System (AMIS) is an information system that collects, analyzes and disseminates market-related information to the user (especially farmers). Information can be in the form of price details, quantity, vendor's contact, transportation cost, etc. Effective MIS will help farmers assure market, better transportation plan, logistic decision, and can project market trends (Magesa et al., 2015).

In the 1980s, after the market liberalization, the first Generation of MIS was promoted in developing countries (David-Benz, Galtier, Egg, lancon, & Meijerink, 2011; Galtier, David-Benz, Subervie, & Egg, 2014) whereas it has been implemented for almost a century in developed countries (FAO, 2017; Magesa et al., 2014). From the literature, MIS is known to have evolved with the development of ICTs. Nowadays, AMIS can be classified into the 1st and the 2nd Generation (Chiatoh & Gyau, 2016; FAO, 2017; Galtier et al., 2014; USAID, 2014).

2.3.1 The 1st Generation of AMIS

In the early stage of AMIS, it was mainly focused on the distribution of price information through radio, television and news bulletins. Almost all LDCs and developing countries followed the same model (CTA, 2008; Oluwatusin & Ojo, 2017). The market information was limited to a small number of markets, and a few farmers (Magesa et al., 2014). This is because radio coverage was not large enough during those days, and disseminating information in a remote area was expensive. From the

study carried out in 1996 by FAO, out of 120 first generation MIS in developing countries, only 53 satisfied the minimum operation criteria. Although the requirement of policymakers was fulfilled, it did not meet the requirements of farmers (CTA, 2008). Kizitos case study also found that most of the MIS could only provide basic market information in terms of prices. Marketing information such as market analysis, availability of transportation and cost were missing (Kizito, 2011). Similarly, the studies (Galtier et al., 2014) found that the content and information disseminated was poor, as it focused mainly on the average price in the locality and disseminated throughout the country.

2.3.2 The 2nd Generation of AMIS

Information's are no longer limited to the price of the product, but also include information on production, policy measures, and marketing such as storage facilities, credit line, buyer and sellers contact, etc. (FAO, 2017). The medium of information also shifted more towards mobile phone and internet. Despite several innovations, 2nd Generation MIS still face many challenges. The main challenge highlighted by authors are key information to decide on where and when to buy and sell is often missing or not reliable (Galtier et al., 2014). Further Agriculture MIS are categorized into 4 groups; Public MIS, Private MIS, MIS supported by NGO/donor project and Farmer Organization-Based MIS (Galtier et al., 2014; Kizito, 2011). From the review (USAID, 2014) donor supported MIS are most common but least sustainable.

2.4 Implementation and sustainability.

The ownership and financial sustainability of MIS are vital once the user and their needs are identified. The main challenge is matching the cost with its impact. Where an investment is huge and realizing its impact is difficult, because measuring the impact of MIS is not straightforward. For instance, the cost of data collection, transmission, processing, and dissemination are high, but the ability to access, afford and understand information by small scale farmers are very minimal (David-Benz et al., 2011). In this section, these issues are reviewed from the owner, users, sustainability, and stakeholders' point of view.

2.4.1 Government (as owner)

Before developing MIS, it is wise to study whether the functionality and the objective of the existing systems have an advantage. This is to avoid duplication and to help decide whether to upgrade the existing system or to collaborate with other agencies currently providing the service to fulfill the current objective. Such prior information will extremely benefit in bringing down the cost of development of a new system (Poon, 2001).

Several researchers (Chiatoh & Gyau, 2016; Mcnamara et al., 2011; USAID, 2014) mentioned that social information including market information is public goods. Therefore government agencies should be the first party to initiate and take ownership of the system fully, if not at least at the initial stage of implementation. Moreover, a study conducted by Binayee (2005) indicates that those MIS developed

for farmer communities proved difficult to sustain if they are not integrated into an existing institutional system. The example of the institutional system could be the Ministry of Agriculture. For instance, MIS impact assessment conducted in Mozambique found that farmers gain was six times more than operational costs of MIS incurred by the government (Kizito, 2011; Kizito, Donovan, & Staatz, 2012).

2.4.2 Farmers and Vendors (as main user)

Farmers are the main beneficiaries of MIS. With an effective system in place, they can benefit from being able to market their product on time. But as per the review in the previous section, it is evident that small-scale farmers possess various challenges in marketing and accessing MIS due to remoteness, educational attainment, and low land holding.

On the other hand, vendors are the final interface from whom end-consumers buys the product. In the conventional marketing system, multiple layers of middleman exist between farmers and vendors (Magesa et al., 2015; Xaba & Masuku, 2013) resulting in a higher price. With MIS focusing on linking farmers directly to the vendor, it will benefit small-scale farmers and at the same time it will indirectly benefit end-consumers through cheaper price.

2.4.3 Extension agent (as a partner)

Extension agents are the main bridge between government and farmers. Food and Agriculture Organization of the United Nation defines extension as an informal

educational process directed toward the rural population. It is a process of working with rural people in order to improve their livelihoods. This involves helping farmers to improve their productivity and to develop their abilities for future development (FAO).

Extension agent provides technical advice and information to farmers based upon the finding of researchers. At the same time, they support researchers in implementing new technologies to solve the farming problem. On the other hand, extension agents have to implement the department's development plans and report back frequently. Extension agents should focus on creating awareness related to marketing along with production services so that farmers can easily understand how marketing works. The extension agents can have a huge impact on agriculture marketing (Vadivelu & Kiran, 2013) as they can help disseminate information to the illiterate farmer who faces difficulties in using modern information dissemination mediums.

Poulton et al. (2010) states that "extension agents should act as both information "nodes" and transactions' fixer with smallholder communities facilitating market linkages (and perhaps also farmer group development) as well as technical change"

2.4.4 Sustainability

Since the development of MIS often requires huge capital investment, as mentioned earlier government agencies should initiate and take ownership of the system fully, if

not at least at the initial stage of implementation. Several papers reviewed shows that initial investments were sourced from NGOs and donor agencies in partnership with government agencies (Chiatoh & Gyau, 2016; FAO, 2017; Galtier et al., 2014; Kindness & Gordon, 2001; Magesa et al., 2014; Shepherd, 1997) and regardless of MIS type they still heavily depend on donor fund for sustainability (Kizito, 2011). Medium-term financial commitment should be secured from local, national and donor agencies before venturing into the development project. Frequent consultation and reassessment of information needs of the user should also be conducted for long-term sustainability and benefit of MIS (CTA, 2006). Collaborating with other stakeholders who can provide contents will make the system rich in information, and more cost-effective in data collection and management (Binayee, 2005). The agency planning should make sure that an institution who manages the system should be well established with its sustainability well thought (CTA, 2006). This is to avoid establishing new and unsustainable institute which are not part of local institutional set-up (Kindness & Gordon, 2001).

2.5 Summary of Gap analysis

In “theory and practice” of Shepherd (1997), MIS concept focused on the collection of market data, processing of collected data, dissemination techniques and organizational structure of MIS provider to improve agriculture marketing through market information.

Poon (2001)“Guide to the Establishment of Market Information Service” also dealt on a similar model of data collection, processing, and dissemination of information. Poon went step ahead in including supply data (commodity reaching the market), whereas the author stated it is easier said than done. This is because to estimate total supply reaching the market, there is a need for weighbridge or person stationed at all the entrance point to monitor incoming produce. Another issue was that even if the entry point can be monitored, a challenge arises from products being bought to market in mixed lots. Therefore the approach was complex and expensive.

Further in (CTA, 2015c, 2015d, 2015e, 2015f, 2015g) data were categorized into primary and secondary. Again the model for primary data collection (price and volume) was based on the same model, employing data collector to collect data, the transmission of data for processing and then disseminating to respective users through various medium.

FAO (2017) discussed issues related to the overall design, planning, and implementation of AMIS in detail. However, the implementation model was still about data collection, transfer, analysis, and dissemination. Therefore almost all followed the same model as shown in figure 6, major challenges with this model was collecting data was expensive, meeting high-quality requirement was difficult and information dissemination was not effective.

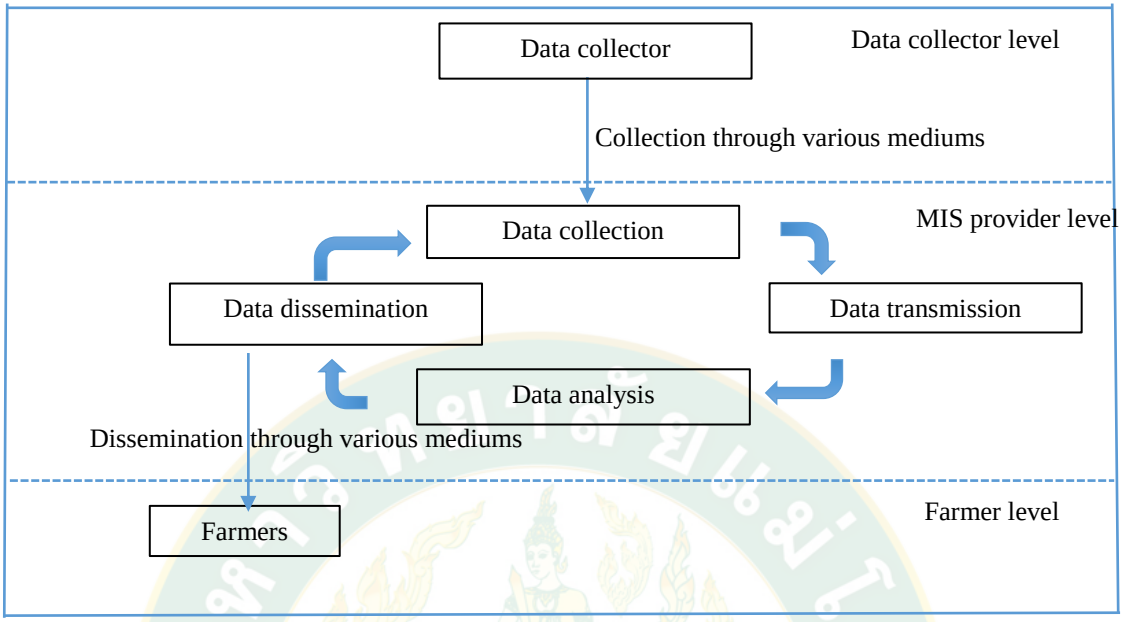


Figure 6. The implementation model of AIMS

Possible Solution

The study adopted similar approaches for planning, analysis, and design whereas proposed slightly different model when it comes to collection and dissemination of information (figure 7). The advantage behind the proposed model is that it requires only one-time investment while developing an electronic system (platform) and do not have to spend on data collection, analysis, and dissemination. It is a two-way information flow model. The reason for using this approach is to reduce the recurrent cost and solve various challenges confronted while collecting and dissemination of data for the sustainability of MLS from MIS providers view. And for farmers, it will solve their common marketing challenges. In theory, it is said that MIS should generate profit and should be independent of donor/government funding,

but in reality (practice) it has been difficult, if not impossible (FAO, 2017). The distinct feature of this model is it creates a platform where farmers and vendors can participate and exchange market information, rather than MIS provider collecting and feeding information to the farmers, which proved ineffective, and unsustainable.

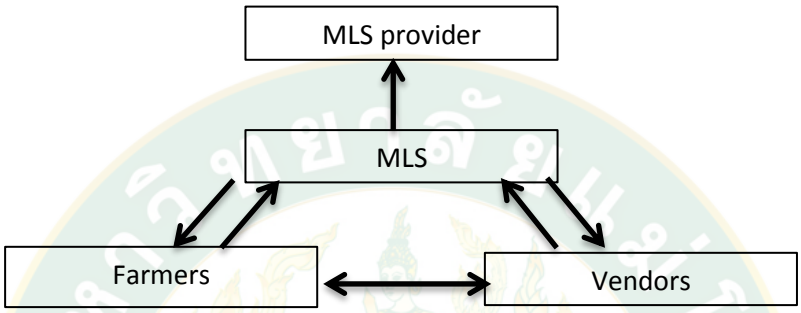


Figure 7. Possible Solution with MLS

3. Methodology

3.1 Theoretical framework

The study thematically reviewed on marketing and digital inclusion challenges faced by small-scale farmers, users of MIS and their information needs, trends of existing Agriculture MIS, Implementation, and sustainability of the system. The result of the reviews is a MLS framework that considered those aspects to tackle the challenges mentioned in the last chapter. The MLS framework is structured based on System Analysis and Design theory (Dennis et al., 2012) and adopted system development life cycle concept to design MLS framework. It is designed for small-scale farmer MIS developers and providers. The MLS framework is in line with "Framework for Accessing Agricultural Market Information" (FAAMI) (Magesa et al., 2015) which used the approaches from Making Market work for Poor (M4P) framework.

3.2 Operational definition.

The term vendor, extension agents, farmers group and contract farming used in this thesis will be defined as follows.

The vendor is referred to those who purchase agriculture products from farmers. They can be retailers, educational institutes, hotel and restaurant, military organizations, central monastic bodies, charity organizations, hospitals, etc. However, linkage with a spot market, commodity exchange, and auction activities are not included in this study.

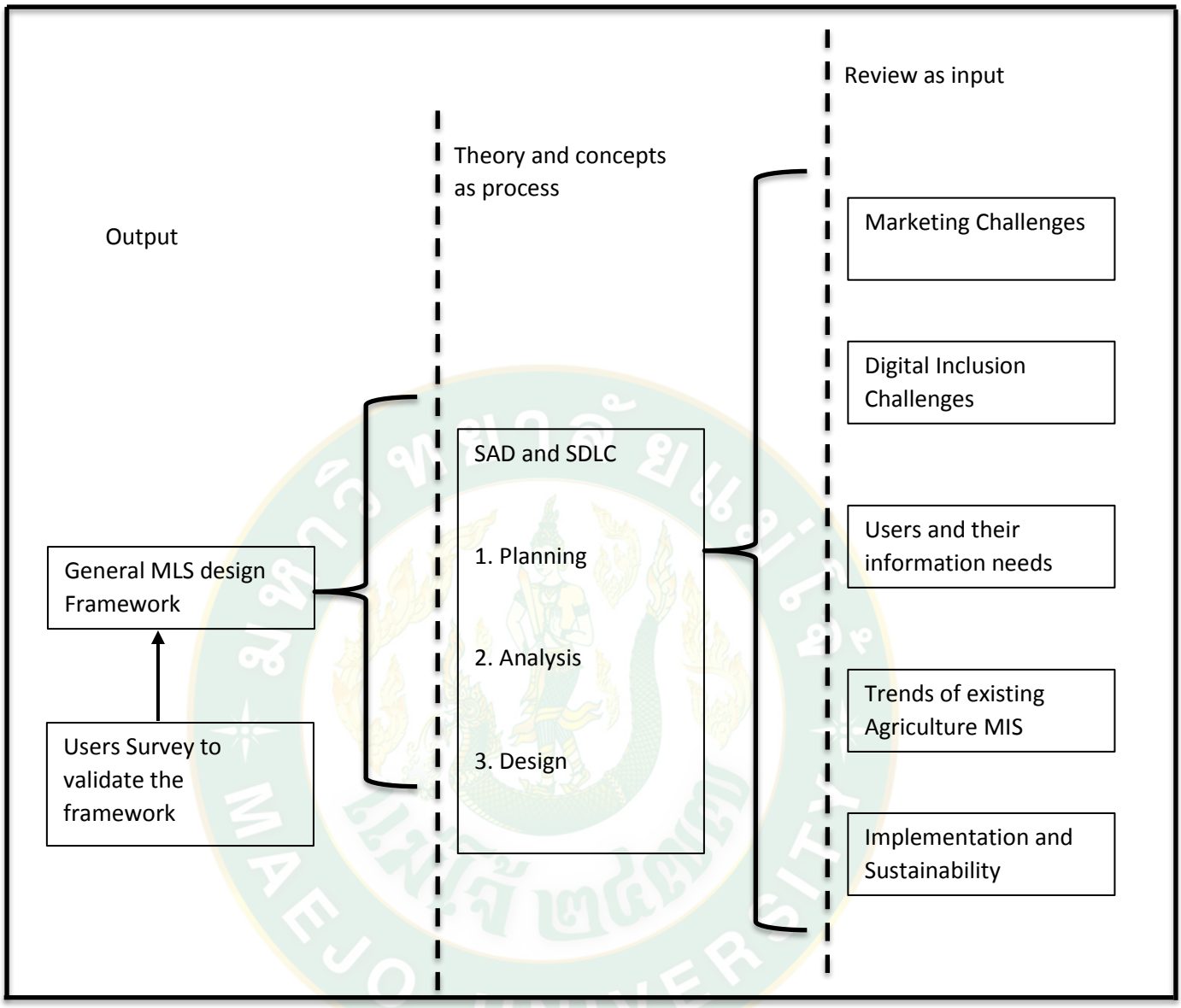


Figure 8. Theoretical framework

The extension is an informal educational process directed toward the rural population, the extension is a process of working with rural people in order to improve their livelihoods. This involves helping farmers to improve their productivity and abilities, to direct their own future development (FAO). Extension agents is

defined as an agent at the grass root level who implements activities planned by the government and disseminates new research developments from research centers.

Collective action or farmers group is defined by Stockbridge, Dorward, and Kydd (2003) as individual farmers working in-group to fulfill a common objective. Small-scale farmers can form a group and work together to participate in the market more effectively (Markelova et al., 2009)

Contract farming is defined as legal understanding between producers and buyers where quantity, quality, timing, and price are agreed before production starts (Eaton & Shepherd, 2001; Ton, Vellema, Desiere, Weituschat, & D'Haese, 2018). Further practicing contract farming is considered as a device to link small-scale farmers to domestic markets which will ultimately reduce poverty (IFAD, 2003; WB, 2007).

3.3 Research Design

The exploratory research design was adopted for this study. Qualitative content analysis was conducted on literature such as journal articles, conference proceedings, dissertations, and international publication. An inductive approach was adopted to understand the phenomenon and to conceptualize the theoretical framework, with the theoretical framework (figure 8) in place further deductive approach was adopted to analyze the content based on themes outlined.

To validate the MLS framework developed for MIS designers/developer (the result of qualitative analysis), a survey (quantitative) was conducted to collect views from MLS

users (farmers, vendors and extension agents). The main objective of the survey was to validate the usefulness and appropriateness of the MLS framework in solving the respective users' needs and challenges.

3.4 Population, Sampling, and Data Collection.

For qualitative data (secondary research): The review was conducted on secondary data both peer-reviewed article and international organizations publication. Peer-reviewed articles consist of conference proceedings and journals, and international organizations publication comprise of books, discussion papers, consultancy reports, proceeding of expert meetings, and annual reports.

An online manual search was adopted, online databases searched were IEEE explore digital library, ACM Digital Library, Elsevier Science Direct, Research gate, and Google Scholar for the peer-reviewed article. For international publication related to agriculture, telecommunication and ICTs, websites of an international organization such as Food and Agriculture Organization (FAO) of United Nation, International Fund for Agriculture Development (IFAD), World Bank, Technical Centre for Agricultural Rural Cooperation (CTA) and International Telecommunication Union (ITU) were searched.

This review covered only those articles that were published in the English language. In order to capture different generations of MIS major articles dating back two decades was also included. As the focus of the paper is on small-scale farmers of

Least Developed Countries (LDC) especially in Asia and Sub-Saharan Africa only those article related to these two region were reviewed. To capture all major publication both forward and backward snowballing method of sampling where adopted.

For survey (to validate framework): Main MLS users were identified as a farmer, vendor, and extension agents. In order to validate the proposed MLS framework, a survey was conducted to collect the views of respective users on the MLS framework. The study used a purposive sampling method to identify farmers, agriculture vendor, and extension agents, among various vendors and extension agents. And the survey was conducted using convenience sampling method on a sample size of 30 farmers, 30 agriculture vendor, and 30 extension agents. The sample consists of farmers and agriculture extension agents from the western, eastern, central and southern region of Bhutan and vendors from the capital city and western region; Bhutan is a least developed country in South East Asia with 43.9% of the population dependent on agriculture (NSB, 2018).

3.5 Method of data analysis

For qualitative data, online databases were explored, collected relevant literature to understand the phenomenon and theories on the topic, and then the theoretical framework was prepared. Based on themes further, literature was surveyed and according analyzed and structured in-line with existing theories and concept.

For survey the main purpose was to capture farmers, vendors and extension agents' views towards the proposed MLS framework so descriptive analysis was conducted. While conducting descriptive analysis, literature pointed out that mean and standard deviation was not recommended for central tendency and variance in the dataset for Likert item questions. Therefore the median and Inter Quartile Range (IRQ) were analyzed to present dispersion in the dataset. SPSS was used for statistical analysis.

4. MLS Framework

The aim of the study was to help/promote small-scale farmers marketing through farmers and vendors' market linkage system, therefore MLS framework to help design MLS is being proposed in this thesis. To develop a MLS framework, a comprehensive literature survey was conducted to get the overviews of

a) Challenges faced by small-scale farmers in marketing and digital inclusion

b) Trends of existing agriculture MIS

c) Users and their information needs

d) Implementation plan and sustainability.

The summary of the related literatures is discussed using the concept of SDLC (Dennis et al., 2012). It is categorized into planning, analysis, and design, and discussed as followed.

4.1 Planning

The planning section of MLS Framework consists of the project sponsor, business needs, business requirements, business value, and special issues or constraints.

4.1.1 Project Sponsor:

It is advisable for a government agencies to initiate MIS than a private organization. MIS developed for farmer communities proved difficult to sustain, if it is not integrated into one of the existing institutional system (Binayee, 2005; Kindness & Gordon, 2001). Since it entails huge capital while establishing, it is recommended that

the government should partner with a donor for initial setup. And for sustainability, they should further partner with other agencies such as Internet Service Provider (ISP), media agencies and those agencies that will benefit from MIS, therefore their needs have to be incorporated in the system while designing. Such prior information will benefit in sustaining (Poon, 2001) and reducing recurrent cost. While the common issue with most of the MIS is that they tend to collect lots of information, however poor in disseminating those information to farmers (Shepherd, 2011). MIS with other agriculture-related information such as pest and disease, weather forecast, advisory services, and input (seed, fertilizer, etc) will make MIS more sustainable and cost-effective (USAID, 2014) as stakeholder responsible for providing such information can share recurrent expenses.

4.1.2 Business needs:

For this study, the business need is to improve small-scale farmers marketing, which will have a positive impact in achieving food security and reducing rural poverty.

4.1.3 Business requirements

No MIS or MLS development project should start without thoroughly studying users and their needs. It has been pointed out that the common mistake made by designers is concentrating solely on technology aspects, rather than focusing on challenges that technology is used to solve (Shepherd, 2016). If MIS is developed focusing only on the technology aspect, the system might be in place but users may not need those components or may not afford it. This will lead to unnecessary

expenses and unsustainable project. On the other hand, if users are identified and their needs studied well, sometimes a simple and low-cost system can serve their needs better than a complex and expensive system.

For MIS, getting price data is easy, while getting some data such as volume and quality are easier said than done. Moreover, getting accurate data is neither possible nor necessary as these data keeps on changing from time to time and dependent on various extraneous factors. Therefore, it is important to advocate farmers and vendors that price and volume information is tentative and they can be used only as a reference to guide the current situation.

Information to promote demand-driven production seems to be the most critical information required by farmers to ease their marketing. If production is planned as per quantity and timing of demand, marketing the products will be easier. At the same time vendors also need production information in advance, so that they can plan and maintain the consistency in fulfilling end customers demand, which will have a great impact on the stability of market price. Further, Chiatoh and Gyau added additional information like historical price data and contact information of farmers and vendor is important. These historical data will be useful to vendors, farmers, and policymaker (Chiatoh & Gyau, 2016) in making an informed decision. Therefore, an electronic system that can provide demand information, production information, farmers and vendors contact should be in place to promote small-scale

farmers marketing. Since the government was identified as key MIS provider, incorporating information required by the government such as price trends to judge market performance and food security reserve management, and quantities produced in each region to decide on policy and market infrastructure intervention has to be considered.

4.1.4 Business value

While disseminating market information, selecting the proper medium will have a wider reach. Regardless of MIS types, the common mediums adopted for information dissemination are radio and mobile phone. With internet charges getting cheaper and its coverage getting wider, it will be wise and timely to shift the conventional method of data collection and dissemination to more interactive system using ICT.

From the study carried out in 1996 by FAO, out of 120 first generation MIS in developing countries only 53 satisfied the minimum operation criteria, although the requirement of policymakers was fulfilled, it did not meet the requirement of farmers (CTA, 2008). Kizito's case study found that most of the MIS provided basic market information on prices. Although most of the MIS was useful to users, product information such as quantity, quality, and standard measurement are an issue raised by vendors.

Therefore having a system that can provide information on estimated quantity, quality, time of harvests and transportation details in advance (from production

stage) through the proper medium of communication will help various stakeholders in planning, which will help in promoting demand-driven production.

4.1.5 Special issues and constraints (marketing Challenges)

Market information such as quality, quantity, price, and contact helps the farmer to plan and produce wisely. Farmers can decide what to produce, when to produce, and where to market their product. This information promotes demand-driven production. Moreover, it enables small-scale farmers to be able to compete within domestic markets, which would otherwise, be inaccessible (Shiferaw, Hellin, & Muricho, 2011; Stockbridge et al., 2003).

Sylvester et al. highlighted that small-scale farmer are willing to supply their products to provincial and national markets, but meeting quality standard was a major issue (Sylvester & Maponya, 2014). Another issue is to maintain a proper cropping plan. These means small-scale farmers production can be insufficient and inconsistent. Insufficient production leads to high transportation and transaction cost. Studies highlighted that forming farmers' group and working collectively will resolve inconsistent supply and insufficient production (Jari & Fraser, 2009; Xaba & Masuku, 2013). Additionally practicing contract farming and having low cost storage facilities with timely market information gives better edge in getting a good price (Baliyan & Kgathi, 2009; Benfica & Mather, 2013; Jama & Pizarro, 2008; Jari & Fraser, 2009; Matsane & Oyekale, 2014; Rehman et al., 2012; Vadivelu & Kiran, 2013). Furthermore

organized small-scale farmers group has the potential to access domestic markets if they act appropriately to overcome the economy of scale (Markelova et al., 2009; Shepherd, 2007). Also operating in a group will increase the opportunity to credit facilities (Benfica & Mather, 2013; Kidane et al., 2006).

In summary, market information is the root cause of all other marketing challenges mentioned above. It can be considered that marketing challenges are interrelated and interdependent. It is understandable that marketing problems remained the same for the last two decades. Therefore, an effective electronic MLS incorporated with market information may solve those problems. In general, MLS should have a component to link vendors with farmers so that farmers will know the demand ahead of production. With demand information, farmers can plan what, when and how much to produce, so that it will solve other interrelated problems too.

4.2 Analysis

4.2.1 Technical feasibility (Digital Inclusion)

Electronic MLS can be one of the solutions to provide market information. Several initiatives were practically implemented, and followed one-way information flow model (FAO, 2017; Kizito, 2011; Shepherd, 1997) MIS provider collects, analyzes, and disseminates market-related information to users (especially farmers) through various communication mediums. Effectiveness of those MIS was dependent on the data collector and the medium used to disseminate information.

To take advantages of ICT in collecting and disseminating information digitally, the target audience has to be thoroughly studied. From the review of digital inclusion and its related challenges, it is clear that accessibility, affordability, and adoption are interrelated and interdependent. Currently, ICT skills of farmers are more concerning than the availability and affordability, since majority of the farmers possess less digital literacy (Akiiki, 2006; Asingwire & Okello, 2011; Guislain et al., 2006; Maru, 2004; Munyua, 2007; Richardson, 2006). ITUs finding in Figure 5 (ITU, 2018) indicates that LDCs are well progressing towards universal access in terms of accessibility and affordability to the internet. However, the report highlights that the widespread use of the internet can be poor if the ability to use (digital literacy) does not match with the level of accessibility and affordability(ITU, 2018). So while designing MIS for farmers, their ability to use should be the prime focus. This is because no matter how accessible and affordable they are, the adoption rate will be low if they do not have the skill to use the MIS.

Studies recommended that small-scale farmers forming a group and working collectively would have greater adoption rate (CTA, 2015; Matsane & Oyekale, 2014; Rehman et al., 2012; Xaba & Masuku, 2013). Furthermore, MIS with components for extension agents will be another option to solve the adoption challenge. This is because the extension agent may be able to help farmers or farmer groups' without digital literacy in accessing and using the system. Farmers should be trained and

advocated on the availability and usage of ICT based MIS (Oluwatusin & Ojo, 2017) to increase the adoption rate.

4.2.2 Economic feasibility

Before developing MIS, it is important to explore the functionality and objective of existing systems if any. This will avoid duplication, and help decide whether to upgrade the existing system if any or to collaborate with other agencies currently providing the service to fulfill the current objective. Such prior information will benefit in bringing down the cost related to the development of a new system (Poon, 2001).

Market information is considered as public goods, therefore government agencies should be the first party to initiate and take ownership of the system fully, if not at least at the initial stage of implementation. Studies shows that initial investments were sourced from NGOs and donor agencies in partnership with government agencies (Chiatoh & Gyau, 2016; FAO, 2017; Galtier et al., 2014; Kindness & Gordon, 2001; Magesa et al., 2014; Shepherd, 1997) and regardless of MIS type they still heavily depend on donor fund for sustainability (Kizito, 2011).

For instance, MIS impact assessment conducted in Mozambique found that farmers gain through the use of MIS was six times more than MIS operational costs incurred by the government (Kizito, 2011; Kizito et al., 2012). So it is advisable for government to investment in MIS for social cause. Medium-term financial commitment should be

secured from local, national and donor agencies before venturing into the development project. Hence it is evident that having MLS will have an economic advantage for the beneficiaries.

4.2.3 Organizational feasibility:

The organizational structure should be studied for better integration and information flow. The agency planning should make sure that an institution who manages the system should be well established with its sustainability well thought (CTA, 2006). This is to avoid establishing new and unsustainable institute which are not part of local institutional set-up (Kindness & Gordon, 2001).

Using Mozambique Information System for Agricultural Markets (SIMA) as an example, they faced some coordination issues. Data collectors used a mobile phone to report directly to central MIS. This is bypassing provincial level supervisor. It created irregular dissemination of information from provincial level MIS due to lack of data at their level (Kizito, 2011). Therefore, incorporating proper integration by studying organization structure is necessary during the designing phase to avoid this kind of issue.

Further well establish organization will have a greater advantage in terms of human resource needs, which will have a major impact on financial sustainability. For example, the Ministry of Agriculture will have an advantage if they initiate MLS because it is a well-established organization with extension agents posted down to

the sub-district level. The extension agents can have a huge impact on agriculture marketing (Vadivelu & Kiran, 2013), as they can help an illiterate farmer who faces difficulty in using modern information technologies. Also, they can create awareness related to marketing along with production services so that farmers can easily understand how marketing works.

4.3 Design

4.3.1 MLS Framework

The proposed MLS framework is in line with "Framework for Accessing Agricultural Market Information" (FAAMI) (Magesa et al., 2015) which used the approaches from Making Market work for Poor (M4P) framework. FAAMI focused on improving access to market and market information. FAAMI consists of 4 components: management, infrastructure, funding, and technology. Firstly, the management component dealt with issues and its countermeasures pertaining to agriculture market access and market information. Secondly, the infrastructure component was about the needs of both physical and ICT infrastructure. Thirdly, the funding component discussed on expenses required while establishing and implementing. Lastly, the technology component was identified as an important component in delivering market information and linking farmers and markets.

4.3.2 MLS Framework Overview

MLS framework is a framework for designing an effective electronic Market linkage system (MLS) to promote small-scale farmers agriculture marketing. It is mainly to

guide MIS designer and policymakers while designing MIS for small-scale farmers. It will help small-scale farmer and farmer groups' market their product. It also considers farmers without digital literacy in accessing and using the system. The MLS here can be an independent system or it can be fit as a component within MIS.

The MLS framework has taken several aspects into consideration. These are:

a) Challenges faced by small farmers in marketing agriculture products and digital inclusion

b) Needs of stakeholders involved in marketing

c) Existing market information system

d) Implementation and sustainability

The MLS framework is designed considering the general structure of agriculture organization and current market environment in LDCs of Asia and Sub-Saharan Africa.

For the last two decade, a common problem faced by small-scale farmers in marketing their product has not changed. Common problems are limited market information, lack of market access, inconsistent supply, insufficient supply, high transportation cost, and lack of marketing infrastructure. The idea behind MLS framework is to help design electronic market linkage system that will help in solving these common challenges.

MLS here is an electronic linkage system that can be used as a medium to link farmers and vendors by providing market information to both parties. For example, farmers can get demand information, so that they can plan on what and when to produce, where to market, how much to produce, and for whom to produce.

4.3.3 MLS Framework Architecture

The architecture of the MLS framework shown in Figure 9 can be separated into 2 layers: public and government layers.

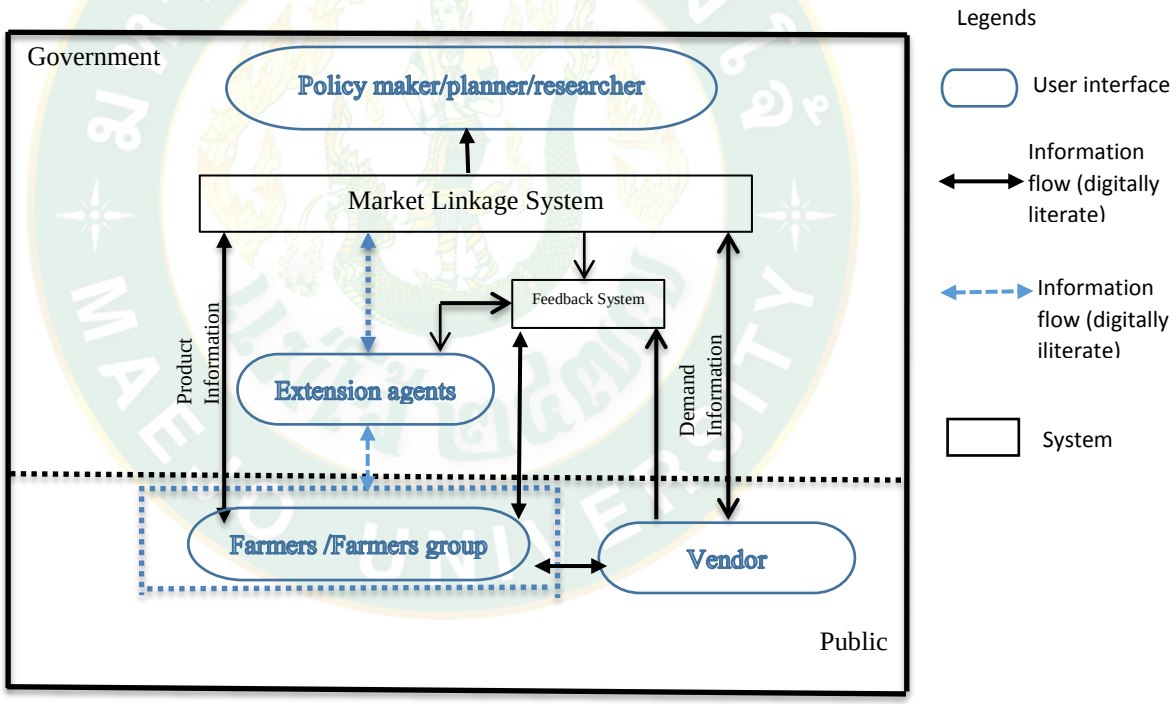


Figure 9: Framework Architecture for Market Linkage System

4.3.3.1 Public Layer

The public layer consists of stakeholders related to any public parties including farmers and vendors. Vendor here could be retailer, supermarkets, educational

institutes, hotel, restaurant, arm force, central monasteries, charity organizations, hospitals, wholesaler, etc. who purchase agriculture products from farmers. MLS provides information as well as link farmers and vendors. It acts like a middleman that will help reduce multi-level of middleman from the supply chain. Public layer mainly consists of farmer and vendor interface.

4.3.3.1.1 Farmer/farmers group Interface

It is an interface for individual farmer and farmers group. The interface provides an avenue for farmers/farmers group to compete in finding the right vendor. All farmers/farmers group who want to use MLS should register with the system so that they can access market information, or upload their products information into the MLS. In this section, there are 2 different scenarios; 1.) Farmers with digital literacy and access to ICT and 2.) Farmers without digital literacy and access to ICT.

Scenario 1. Farmers with digital literacy and access to ICT

Individual farmers/farmers group with digital literacy and access to ICT can use the system by themselves. Farmers, in this case, can provide or gather information to/from the MLS directly. This information is a two-way communication; the demand information (from vendors to farmers) and the supply information (from farmers to vendors). The demand information is information entered by vendors. The vendors state what, when and how much they need, and farmers can choose among the vendor, and then produce the product to match the vendors demand. On the other

hand, the supply information is for farmers to propose what they can produce or what they are producing. Then the vendors can select the product from farmers based on this information.

The example of the demand information can be a quantity of products required, date of requirement and expected price. Once the farmer has decided on what to produce, they can submit a) quote prices b) upload and update their products c) feedback (see 4.2.2.3).

a) Quote price: farmers/farmers group with the option to quote a price against vendors' requirement (such as quantity, quality, price, date) before starting the production process. It opens an opportunity for both farmers/farmers group and vendors to compete and choose their trading partner (see Figure 11). It reduces the risk of farmers being exploited by vendors. Such information prior to production will help farmers decide what to produce (Magesa et al., 2015), at what price, and for whom to produce. These processes get finalized by signing contract between farmers and vendors as stated in Barrett et al. (2012) in their framework, contract consist of four stages; the first stage, the firm (vendor) locate its supplier (farmers) based on geographic characteristics, in second stage vendor selects specific farmers with whom to enter into contract, third stage farmer chooses whether or not to accept the contract, and lastly both parties decides whether to honor

those terms in an agreement or not, details of four stages were explained in their paper. Further Governments assistance will ensure contract engaged are respected and enforced (Magesa et al., 2015). Such demand-driven agriculture production guarantees a market for small-scale farmers' product.

b) Upload and update product: On the other hand feature for those farmers who do not want to get into contract, to upload their products information from the date of germination/production, which can help market their product. Product information can be in the form of product type, product name, date of germination, estimated date of harvest, the estimated quantity of yield, fields distance from the nearest road point and current growth stage in the form of picture and farmers contact detail. This information can help those farmers advertise their product in advance to those vendors who are not interested in getting into contract production. Further option to update on the quantity available in the field as and when they start selling their products should benefit both farmers and vendors. An additional feature to view the record of their contract production and production without a contract can ease farmers keep track of their activities.

c) Feedback system is a system to help judge vendors and farmers at a glance though their past activities, and it will create transparency in their credibility. The details of feedback system is discussed in section 4.3.3.3.

Scenario 2. Farmers without digital literacy and access to ICT

On the other hand, farmers who are digitally illiterate and lack access to ICT, they usually need supports in accessing the system. In this case, they can seek help from extension agents' in accessing and using the system. This is further discussed under section 4.3.3.2.1 extension interface and illustrated in Figure 12.

4.3.3.1.2 Vendor Interface

It is an interface for vendors to specify their requirement in advance. This information is also known as demand information for farmers. Farmers can plan and produce based on this information. MLS with vendor interface having features like a) call quotation and b) view quotation received c) feedback (see 4.3.3.3) should stimulate linkage. Vendors have to be a registered user to use this feature.

a) Call quotation: Feature for registered vendors to upload quantity of products required, date of requirement and expected price; these are the market demand information required by registered farmers and farmers group. With this information, small-scale farmers challenge to lack of market information and access to market gets narrowed. Moreover, those farmers or farmers group interested to produce should be able to respond using "quote price" feature discussed earlier under farmers interface. Further, feature to view the record of quotations called can ease vendor keep track of their activities.

b) View quotation received: Feature for vendors to view quantity, time and price quoted by farmers/farmers group against their requirement. Vendor upon receiving the quotation can decide whom to place their order, but before placing order vendor have to contact the farmers/farmers group for a contract agreement. Then based on the contract agreement farmers should be able to plan and start their production.

With these features vendor shall be guaranteed with quantity, quality and time of supply, and farmers' access to the market will be improved.

4.3.3.2 Government layer

Under the agriculture administrative structure, based on the policy of the government, planners and researchers work towards the development of the agriculture sector. An extension agent at the grass root implements activities planned by the government and disseminates new research developments from research centers. Government Layer consists of two interfaces, extension agents' interface and policymakers' interface.

4.3.3.2.1 Extensions agents interface:

Extension agents' are a bridge between the government and farmer. Extension agents provide technical advice and information to the farmers based upon the finding of the researcher, at the same time helps the researcher with a farming problem that farmers face while implementing research findings. On the other hand, extension

agents have to implement the government's development plan and report back frequently. extension worker can play a critical role in the linkage system by supervising agriculture technology adoption, supporting group management (Shepherd, 2007), bridging ICT gaps, and help contract enforcement.

In this framework extension agents being at grass root level has an important task. In addition to their daily responsibility, they can assist illiterate farmers and farmers without access to ICT in using MLS. With their help, the farmers ICT gap will be narrowed and participation in demand driven production will be enhanced.

While signing a contract between farmers and vendors, extension agents can act as a witness. They can help in ensuring contract engaged are respected and enforced. On the other hand, extension agents acting as a witness will benefit the government with the information such as actual production volume agreed in the contract agreement.

The interface for extension agent should include these features a) Add contract production, b) Add farmers' production, and c) View report.

a) Add contract production: Extension agents with a feature to add information such as actual quantity agreed to produce in the agreement or to validate the production volume agreed between farmer and vendor, which will be useful to government for various purposes. To name few, for compiling

annual production report, predict food security status (early warning), and post-production interventions.

b) Add farmers' production: Interface for Extension agents' to upload production information on behalf of digitally illiterate farmers and farmers group, and for those who lack access to ICT (figure 12). This feature would help illiterate farmers from digital exclusion.

c) View reports Feature that will assist extension agents to keep track of activities like contract production submitted or validated and production uploaded on behalf of farmers and farmers group.

4.3.3.2.2 Policy Makers interface:

The interface is aimed to provide information to policymakers and planner of the agriculture sector. This is because policymakers and planner need the information to make a decision and plan respectively. Without information, they cannot make a informed decision and provide an appropriated intervention to any public parties. For example, with these information, a policymaker can get information on the actual production in the respective province, district, and sub-district, which may be useful in formulating policy and planning, necessary support, and intervention. This information can also provide early warning for food security problems.

The example of the reports which can be presented to policymakers is a) Contract production and b) Production without a contract.

a) Contract production: Policymakers to filter and view products produced under contract till sub-district level.

b) Production without contract: to view production information of individual farmers and farmers group who prefer producing without getting into contract.

4.3.3.3 Feedback system

The feedback system can ensure the genuineness of the public parties (farmer and vendor). With this feedback system, both vendors and farmers can see the past history of each other on their respective profile. Vendors can trust a farmer with a better positive history (called as good feedback). In some cases, while negotiating a farmer can be at advantage side, the vendor may offer a better price for a farmer with good feedback. This is because those farmers have already proofed themselves that they can deliver the products on time, or they can provide the same quality of the product all the time. On the other hand, the farmer should be comfortable to get into a contract with a vendor having good feedback.

Therefore a feedback system in MLS where farmers can rate vendors once they complete their transaction and vice versa will create transparency in their credibility. Further extension agents in individual sub-district with the option to validate vendors and farmers rating based on remarks provided by the respective user will encourage good practice.

Furthermore, MLS with another feedback option regarding features offered by the MLS will help improve the system, having a feature to obtain users feedback on systems functionalities would promote further improvement in the system (FAO, 2017).

4.3.3.4 Search option.

MLS with search feature for any user (registered/unregistered) will assist them to find right farmers in advance, who are producing without entering into a contract (for consistent supply). For example, in the case of countries with varying climatic conditions farmers in one province can produce at a particular period where another province cannot. Hence vendors with near real-time production information can focus on those provinces producing at their required time for consistent supply(Shepherd, 2007). And for insufficient supply with the search feature vendors should be able to aggregate the same products from the same locality producing at the same time.

4.3.4 Process of information flow.

In this section, the information flow of a conventional MIS and the MLS framework are compared. In conventional MIS as shown in Figure 10, data collector collects the data from the field and sends it to the central database. It is then analyzed and packaged in different forms depending on the medium used for dissemination. And then disseminates to the farmer, vendor, and other stakeholders.

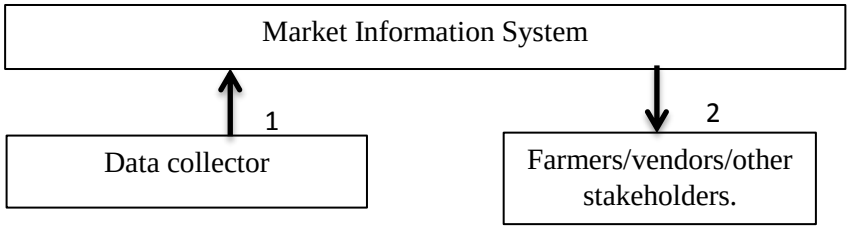


Figure 10: Information flow in conventional MIS

On the other hand, the process of information flow in the MLS framework begins with vendor uploading their requirements into MLS (figure 11). Through this system, farmers will be able to view the requirements of the vendor and accordingly quote their price and quantity. Once farmers quote their price and quantity, the vendor will be alerted by the system. Then the vendor can choose among the farmers with whom they want to enter into a contract. From this stage onwards vendor should be able to contact farmers directly through phone (linkage) for any negotiation before entering into a contract. For those farmers without digital literacy and access to ICT, they can get the help of extension agents as shown in Figure 12. On the other hand, for those registered farmers who are producing without getting into a contract, they can advertise their products right from the production stage using MLS which can be viewed/tracked crop progress by any users.

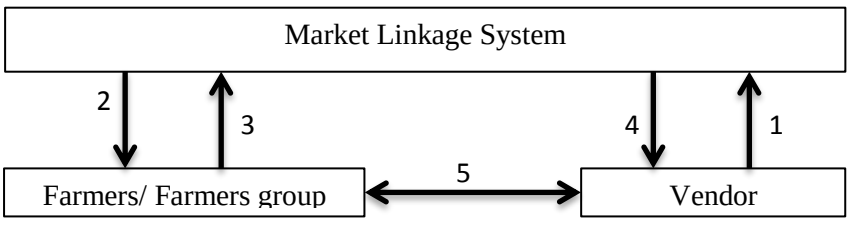


Figure 11: Information flow (Farmers with digital literacy and access to ICT)

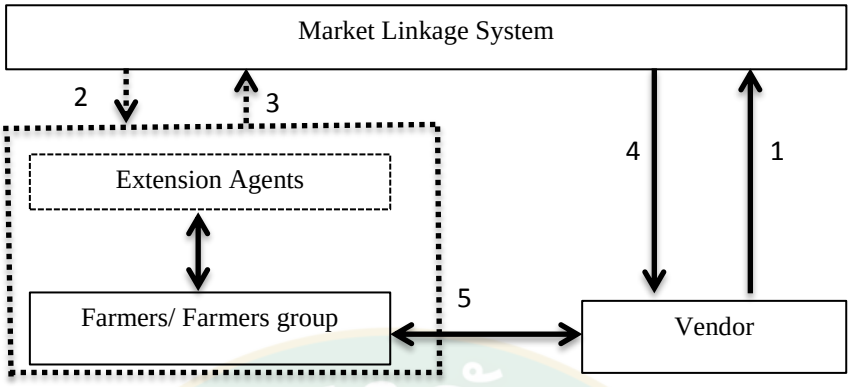


Figure 12: Information flow (Farmers without digital literacy and access to ICT)

4.3.5 Summary.

The table 6 and 7 summarizes the solution against common marketing challenges and digital inclusion using MLS.

Table 6 Marketing challenges and solution.

Challenges	Solution
Lack of market information	Through farmers and vendor interface
Lack of market access	Through farmers and vendor interface
Insufficient production	Search option
Inconsistent supply	Search option
High transportation	Related to insufficient and inconsistent production
Lack of market infrastructure	Policy makers interface

Table 7 Digital inclusion challenges and solution

Challenges	Solution
Access	By 2020 (ITU report)
Adoption	Extension agents interface
Application	MLS

5. Results

For the survey, the main purpose was to capture farmers, vendors and extension agents' views towards the MLS system design in MLS framework that has been discussed in an earlier section, so descriptive analysis was conducted. And the survey was conducted using a convenience sampling method on a sample size of 30 farmers, 30 agriculture vendors and 30 extension agents each, using five scale Likert item questions.

5.1 Farmers' perspective

To analyze the usefulness of the "farmers interface" a survey was conducted on 30 farmers using Likert item question with the scale of 1 – 5 (1.Strongly disagree, 2. Disagree, 3. Neutral, 4. Agree, and 5. Strongly agree) in order to collect their opinion. Table 8 presents, Median and Inter-Quartile Range (IQR) for respective statements, IQR values within the range of 1 to 2 and lower indicates that respondents are polarized towards the similar view, whereas inter-quartile range greater than 2 indicates that respondent deviates from similar views.

Table 8. Median and IQR values.

Variable	Min	Q1	**Q2**	Q3	**IQR**	Max
1.Provide market information on						
a) Quantity required	3	4	**4**	5	**1**	5
b) Quality required	2	4	**4**	4	**0**	5
c) Time (when required)	2	4	**4**	5	**1**	5
d) Price (at what price)	2	4	**4**	4	**0**	5
2) Improve access to the market	2	4	**4**	5	**1**	5
3) Solve inconsistent supply	2	4	**4**	5	**1**	5
4) Solve insufficient supply	2	4	**4**	5	**1**	5

The median value of 4, Q3 value of 5, and IQR value of 1 for the quantity required & time shows that majority of the respondent are polarized towards the positive view in terms of MLS providing market information on quantity and time(when required). The median value of 4, Q3 value of 4, and IQR value of 0 for quality & price shows 3/4 of the respondent had agreed that MLS will be able to provide them with quality requirement and expected price of the vendor.

Similarly Q3 value of 5 and Q1 value of 4 for access to market, inconsistent supply and insufficient supply indicates 3/4 of farmers are optimistic (agree and strongly

agree) that with the MLS it will solve their challenges regarding lack of access to market, inconsistent supply and insufficient production.

Further, the scale was deduced to positive, neutral and negative for analysis purpose, figure 13 and figure 14 shows the percentage of respondents with positive, neutral and negative views towards MLS in solving their respective challenges.

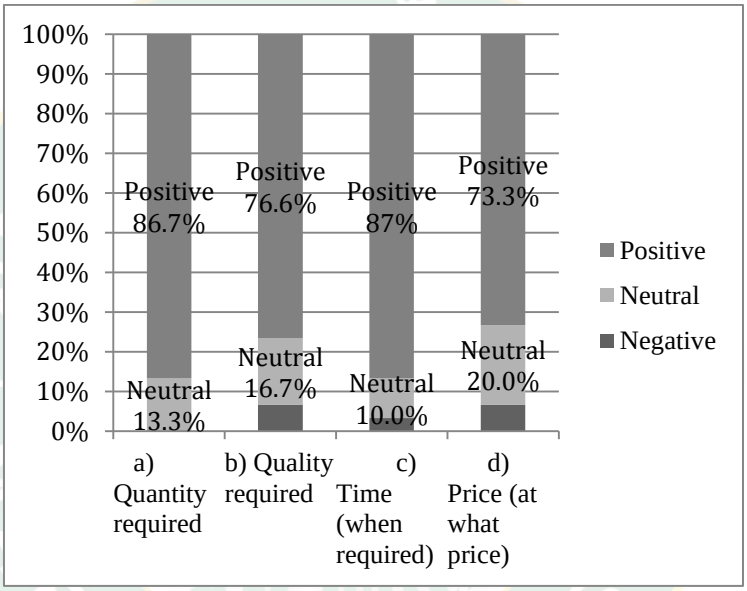


Figure 13: Respondents view on MLS providing market information

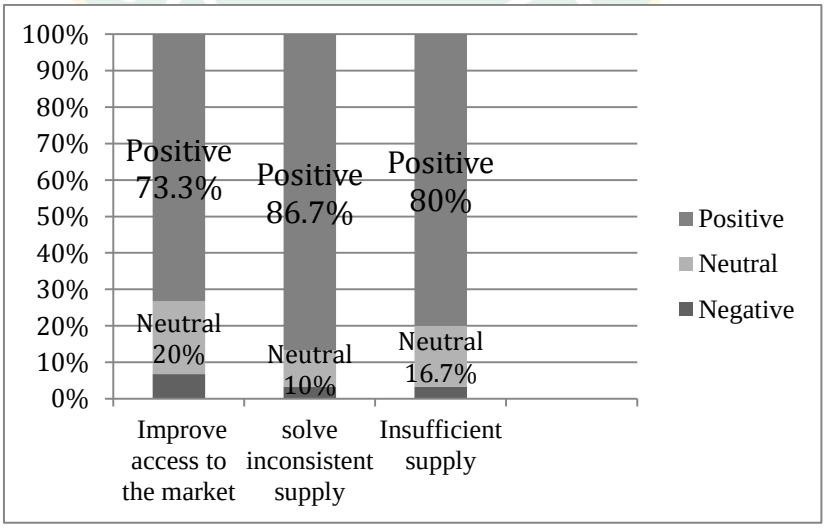


Figure 14. Respondents view on various challenges.

5.2 Extension Agents perspective

Opinions from extension agents were collected on three broad areas, namely a) the information through MLS will be helpful in providing market infrastructure intervention b) it be useful in providing early warning to food security c) the feature in MLS for them to assist illiterate farmers in overcoming digital gap will be useful, 30 extension agents from the western, eastern, central and southern region were surveyed. The median value of 4 and 4.5 with IQR value of 1 as shown in Table 9 indicates that response was skewed towards "agree and strongly agree", further Q1 value of 4 which is next to the highest possible value corroborate that at least 3/4 of the respondents agree with the statements.

Table 9. Extension agents' perspective

Variable	Min	Q1	**Q2**	Q3	**IQR**	Max
Marketing infrastructure intervention	2	4	**4**	5	**1**	5
Early warning of food security	2	4	**4.5**	5	**1**	5
Help illiterate farmers in using the system	3	4	**4**	5	**1**	5

Figure 15 shows the percentage of participants' response in terms of positive, neutral and negative views. 90% and 80% of the extension agents surveyed had a positive view on MLS providing information; on early warning for food security and market infrastructure respectively. On the other hand, none of the respondents had negative views on the feature in MLS that will assist illiterate farmers (figure 16).

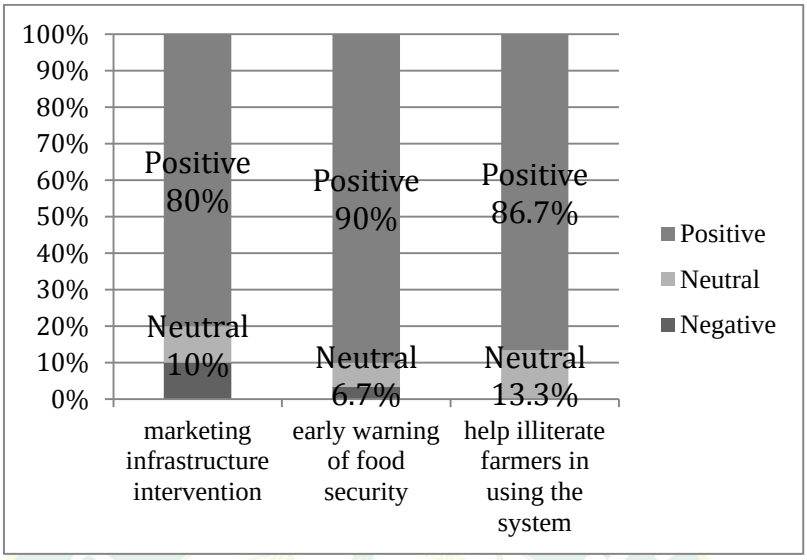


Figure 15: Extension Agents perspective.

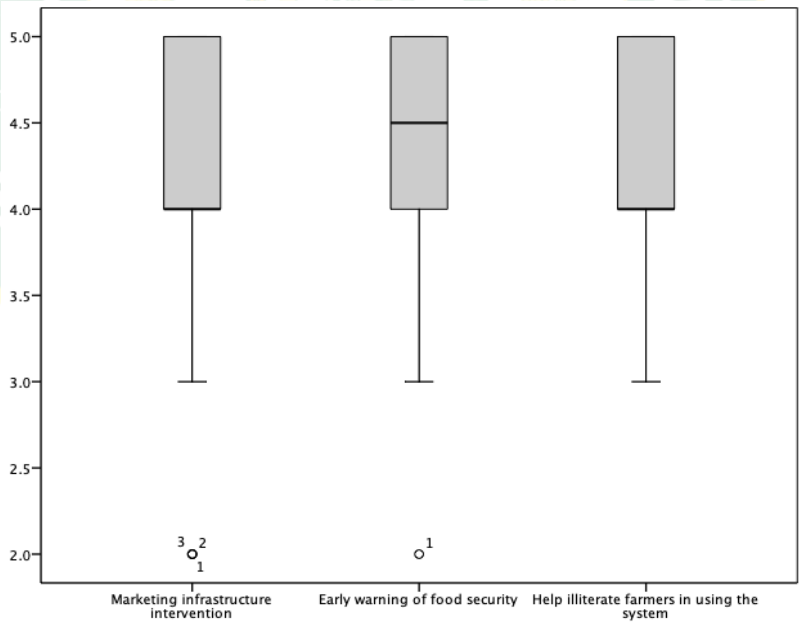


Figure 16: Box plot for Extension agents' perspective.

5.3 Vendors' perspective

To gather vegetable vendors' perspective, based on the operational definition of the vegetable vendor for this study, the survey was conducted on 10 vegetable retailers, 10 hotel and restaurant managers and 10 educational institutes' food in-charge. Table 10 shows the Q1, Q2, Q3 and IQR values of the survey data.

The median value of 4 indicates that half of the vendors surveyed are of the view that with the search feature in MLS it will help them in finding a right farmer to solve insufficient supply and inconsistent supply. Whereas Q1 value of 2 indicates that ¼ of the respondents had a negative view towards signing a contract with farmers based on the information from MLS (figure 18).

Table 10. Vendors' perspective

Variable	Min	Q1	**Q2**	Q3	**IQR**	Max
Solve insufficient supply	2	3	**4**	4	**1**	5
Solve inconsistent supply	2	3	**4**	4	**1**	5
Contract production.	1	2	**3.5**	4	**2**	5

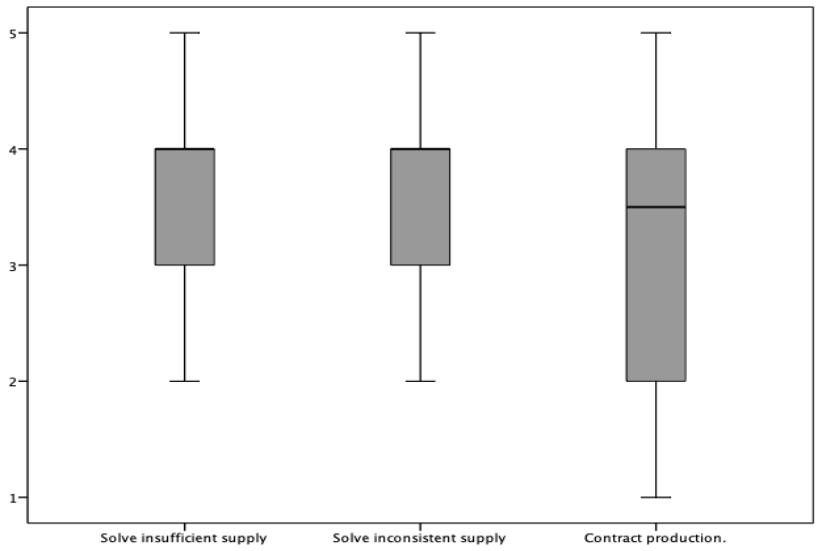


Figure 17: Box plot for vendors' perspective

Further, the scale was inferred to positive, neutral and negative view (Figure 18) to understand their opinions. Nearly 40% of the participants surveyed were neutral in their views that, the search feature in MLS it will help them in finding the right farmer to solve insufficient supply and inconsistent supply. Whereas 26.7 percent of vendors were reluctant to sign a contract agreement with farmer based on information provided by MLS.

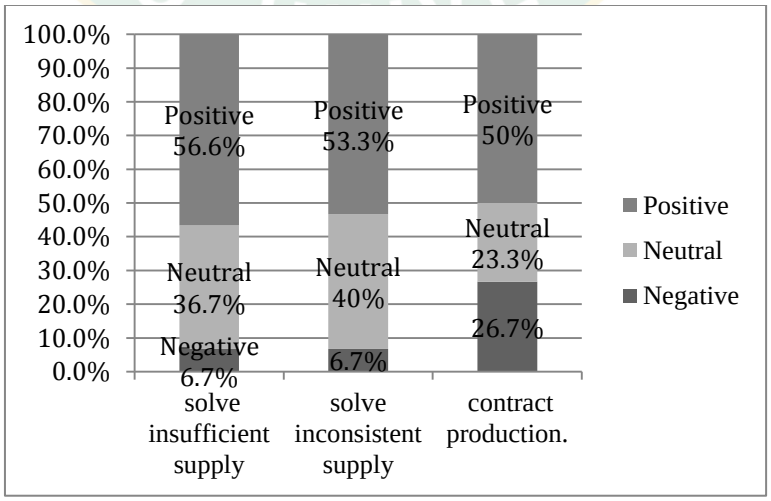


Figure 18: Vendors perspective.

Therefore in summary farmers and extension agents were of the view that MLS will be useful in solving small-scale farmer common marketing and digital inclusion challenges. On the other hand, although over 50% of the vendor was positive that MLS would be useful, almost 40% were neutral in their opinion and rest had a negative view.

Further to elaborate, this MLS design could be compared with any e-commerce and social media platform. MLS is a combination of social media and e-commerce platform. The concept of linkage is like e-commerce where customers are linked to a product through an electronic platform. And concepts of users' profile (farmers, vendors, and products) are like social media where contact details could be obtained in the form of image and text, which will help them in contacting each other. Therefore it can be concluded that with this MLS design described in MLS framework the system will be able to link small-scale farmer to market, which will promote their marketing.

6. Discussion and Conclusion

The aim of this study was to improve small-scale farmers marketing through Market Linkage System (MLS), which will have a positive impact in achieving global food security and reducing rural poverty.

Agriculture Market Information System (MIS), a well-established concept was developed and implemented for almost a century in developed countries. Whereas in the LDCs the concept was promoted in the 1980s. Although the concept was adopted in LDCs, its sustainability and effectiveness possessed some challenges, since most of the farmers were a small-scale producer.

Therefore the study focused on developing a MLS framework for designing MLS by reviewing a) challenges faced by small-scale farmers in marketing and digital inclusion, b) trends of existing agriculture MIS, c) users and their information needs and d) implementation plan and sustainability. The MLS framework was developed to guide MIS designers and MIS providers in developing effective MIS/MLS to help small-scale farmers market their product through farmers and vendor linkage system.

Within the MLS framework, MLS is considered as an electronic system with a component each for the vendor, farmer, extension agent, and policymaker. Its aim is to ease the marketing challenges faced by small-scale farmers through market information. Production information such as product type, estimated quantity, quality

in image form, and estimated time of harvest, will be available for MLS users' right from the production stage in a near real-time basis.

Vendor interface: Consist of features to upload demand information (product type, quantity, quality, time and price) before production season begins. Which will be helpful to farmers in planning what to produce, when to produce and how much to produce that will solve lack of market information and access to market challenges of small-scale farmers.

Farmer's interface: Interface for farmers to respond against vendors demand. Farmers will be able to specify what they can produce against the vendor's requirement (product type, quantity, quality, time and price). Which will be helpful in creating a vendor and farmer's linkage. This process will ease farmers in marketing their products at later stage.

Extension agent interface: Feature to upload /respond on behalf of farmers who are digitally illiterate, which will enhance the adoption rate of the system and reduce exclusion of illiterate small-scale farmers from using the system.

Policymaker interface: Feature to view reports of actual production information entered in MLS. They can filter product wise production information until the sub-district level, which will help the government in providing marketing infrastructure intervention for those necessary areas. Also, the system will provide a rough idea on

early warning of food security, as the information will be available on the system the moment farmer starts producing.

Search option: Where any user can filter their search using product type, estimated date of harvest and production area. This feature, in particular, will help vendors aggregate the same product from the same area with the same estimated date of harvest, to overcome the economy of scale. Similarly, they can search for a product from different areas produced at different period of time in advance for consistent supply.

With these interfaces and features, common challenges of small-scale farmers like lack of market information, lack of access to market, inconsistent supply, insufficient production, high transportation & transaction cost, and lack of market infrastructure will be solved directly or indirectly.

Although several MIS initiatives were implemented, almost all the solution focused on vertical integration. Where MIS provider initially collects the data, and transmits to the central database then analyzes and later disseminates to the farmer through various mediums. The model was expensive since dedicated human resources were required in data collection and analysis, and there is recurrent financial implication for the dissemination of information. Further, it faced difficulty in providing information on quantity and quality in advance. The information provided was either on past or present price and quantity of product that has reached the market.

Whereas this study focused on two-way information flow model by providing a platform where respective stakeholders can interact and share information. In this model vendors demand information will stimulate farmers supply, matching demand and supply even before production starts. With this approach need for recurrent cost on data collection, analysis and dissemination will be none and various challenges confronted with collection and dissemination of data will be solved. Moreover, the government can use information exchanged through this system as the input of planning and intervention purpose.

Further through users' survey, farmers, vendors and extension agents' perspective were collected to validate the usefulness and helpfulness of system to various user. From the survey data market information on when to produce and how much to produce had significant positive view compared to at what price to produce. Which signifies market information on when to produce and how much to produce is more important to farmers than at what price to produce. Under the vendors perspective although over 50% were of positive view on MLS solving insufficient production and inconsistent supply. Over 40% were neutral, it shows that the respondents neither agreed nor disagreed which indicates that they are least concerned about MLSs importance, therefore it warrants a further study on why almost 40% of vendors were neutral on the statement.

Future work.

The study was focused on small-scale farmers marketing to vitalize rural community using Information, Communication and Technology for Development (ICT4D) in Agriculture. While in theory it is said that small-scale farmers marketing will have a positive impact on achieving global food security, reducing rural poverty and unemployment. In general, it is totally dependent on production potential, the capacity to innovate and access to the market. Therefore further studies on using ICT to improve agriculture sector through broader Agriculture Information System (AIS) with production information(PI) and marketing information(MI) together needs to be explored, which will have a greater impact on agriculture development (figure 19)

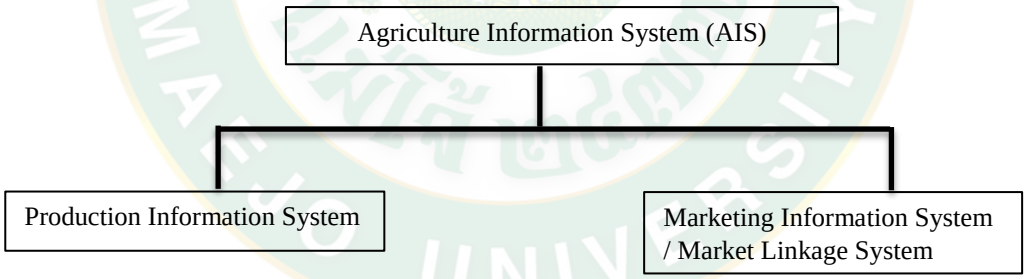


Figure 19: ICT4D in Agriculture

Production information system could have components such as information on agriculture inputs and machinery, production technologies, pest and diseases, post-harvest technologies, agro-metrology, credit information, etc. With all information related to agriculture production and marketing through a single window will benefit

agriculture stakeholders at large in terms of access to information which will have a positive impact on improving production.

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