MAKERERE UNIVERSITY

COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

ADOPTION AND EFFECT OF TRACTOR HIRE SERVICE ON CASSAVA PRODUCTIVITY AMONG E-VOUCHER BENEFICIARIES IN WEST NILE.

BY

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A SPECIAL PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF AGRIBUSINESS AND NATURAL RESOURCE ECONOMICS, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE BACHELOR'S DEGREE IN AGRIBUSINESS MANAGEMENT AT MAKERERE UNIVERSITY

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DECLARATION

I **Shimo Mpelwa Henry**, declare that all my work and material presented in this research report is entirely solely my own effort and has never been submitted to any institution for academic purposes by anyone.

Signed ……  …… Date 20/02/2023……..

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APPROVAL

This research has been submitted for examination with my approval as a university supervisor

Signed …… Date 20/02/2023

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DEDICATION

This research is dedicated to my loving father Henry Samuel Shimo. May God richly bless you. Additionally, I dedicate this book to my supervisor Dr IIukor John for his excellent effort in helping me through the entire research work process

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ACDP	Agriculture Cluster Development Project
UBOS	Uganda Bureau of statistics
NPK	Nitrogen phosphorus and potassium
NARO	National Agriculture Research Organization
MAAIF	Ministry of Agriculture Animal Industry and Fisheries

CHAPTER ONE

1 INTRODUCTION

1.1 Background

Cassava is the third-largest source of food carbohydrates in the tropics, after rice and maize. (Afedraru, 2019). Cassava is a major staple food in the developing world, providing a basic diet for over half a billion people. (FAO, 2015) It is one of the most drought-tolerant crops, capable of growing on marginal soils. Nigeria is the world's largest producer of cassava, while Thailand is the largest exporter of cassava starch. Although cassava is an established commercial crop in many tropical countries and hundreds of varieties are in existence, little is generally known of the nomenclature and identification of varieties. Various varieties are usually differentiated from one another by their morphological characteristics such as color of stems, petioles, leaves and tubers. Moreover, in many instances the same variety is known in various places by a number of names.

Sub-Saharan Africa accounts for 61.1% of the world's cassava production (FAOCAST, 2020). Although it is a perennial plant, cassava is extensively cultivated as an annual crop in tropical and subtropical regions for its edible starchy tuberous root, a major source of carbohydrates.(GRIN, 2014). Cassava is predominantly consumed in boiled form, but substantial quantities are used to extract cassava starch, called tapioca, which is used for food, animal feed, and industrial purposes.

Cassava is an important rural food for communities in Uganda. It has tolerance to poor soils and resistance to drought, a cheap and reliable source of food that fits well into the food security strategy of smallholders (Nweke, Spencer, and Lynam 2004; FAO 2003). Cassava has, therefore, served many times as food of last resort to ameliorate the effect of food deficits which occur from erratic weather conditions and reduce the yields of cereals.

Tractors can be hired for primary tillage and subsequent planting, and weeding can also be done with a combination of power sources and technologies. Application of these alternative power sources can relieve pressure on human labour at critical times of heavy demand (Sims, B. G., & Kienzle, J.,2006).

1.2 Problem Statement

Cassava as a source of household income and employment, has been promoted as a staple and food security crop in sub-Saharan Africa (Ezedinma, 2017; Githunguri et al., 2017) and for commercialization in many regions because of its high carbohydrates content and gluten-free property (Suárez et al., 2017; Muchira, 2019; Mokhtar, 2020). However, cassava production in Uganda is still low (provide statistics). The low cassava production trends is attributed to many reasons including inability of farmers to open up fresh gardens and practice deep ploughing since cassava requires deeply cultivated soils as it's a rooter. As a result, the Ministry of Agriculture, Animal industry and Fisheries through the ACDP project has promoted the use of tractors so as to open up more land to ease cassava production in the cassava growing communities of West Nile among others. Through ACDP, Cassava farmers are able to hire tractors at subsidized rates due to their inability to purchase own tractors. The challenge however is that there is no empirical evidence on whether the use of tractor hire services increases cassava production or not. Therefore, this study aims at understanding the adoption, effects of tractor hiring services on cassava productivity among E-voucher beneficiaries and their view about the program.

this study aims at

1.3 Objectives of the study

1.3.1 The general objective of this study was to;

Assess the adoption and effect of tractor hiring services on cassava productivity among ACDP project beneficiaries.

1.3.2 The specific objectives were:

1. To characterize tractor hire services by cassava farmer under the Electronic-voucher program and assessing their view about the program.
2. To determine factors that influence the adoption of tractor hiring services by E-voucher cassava farmers.
3. To examine the effects of tractor hiring service on cassava productivity among EVMS beneficiaries.

1.4 Hypothesis of the study

i. Farm size, income of the farmer and the level of production have a positive coloration on what influences the adoption of tractor hiring services by E-Voucher cassava farmers.

ii. The accessibility and cost of hiring a tractor are one of the major effects faced by cassava farmers in production.

1.5 Significance of the study

- The results of the study are expected to be used as material for consideration for policy makers in planning and implementing agricultural machinery assistance programs that are more efficient, on time and on target.
- The research will also form a foundation for different researchers to carry out more research about cassava and the productivity of cassava through tractor hire servo.
- The research will also provide more information which can be used teaching and study purposes such as Mechanization through tractor use and cassava production.

1.6 Justification of the study

The use of tractor hire services effectively is essential for influencing cassava yield and ensuring sustainability in output to keep up with the steady demand on the market. A major drawback of the cassava produced by different farmers in Uganda especially rural areas is the lack of improved technology like tractors, which causes low cassava productivity and thus low cassava production.

Therefore, this research will be beneficial to the farmers of cassava given that it will showcase implicitly how tractor hire services tends to affect cassava productivity. In furthermore, this study will delve into how famers can use tractor hire services to increase the productivity of cassava being produced, which appears to be a difficult task because of low income among cassava famers to buy tractor.

This research will indeed show how the government supports cassava producers by providing tractor hiring services and lowering the taxes that are levied on agricultural machineries, particularly tractors.

Furthermore, considering that it will serve as a literature review on tractor hire services promotes cassava yield, this work will be useful to other researchers.

CHAPTER TWO

2 LITERTURE REVIEW

2.1 Production of Cassava

In 2020, global production of cassava root was 303 million tones, with Nigeria as the world's largest producer, producing 20% of the world total. Other major growers were Democratic Republic of the Congo and Thailand. (FAO, 2019). Cassava is one of the most drought-tolerant crops, can be successfully grown on marginal soils, and gives reasonable yields where many other crops do not grow well. Cassava is well adapted within latitudes 30° north and south of the equator, at elevations between sea level and 2,000 m (7,000 ft.) above sea level, in equatorial temperatures, with rainfalls from 50 to 5,000 mm (2 to 200 in) annually, and to poor soils with a pH ranging from acidic to alkaline. These conditions are common in certain parts of Africa and South America. The success of cassava production in Nigeria partly lies in the rapid multiplication technique used, which has the potential of producing 12,000–24,000 stem cuttings per year (Leihner, 2002).

The total annual production in Africa was 169 million tonnes in 2018. This production was led by West Africa with a total production of 93 million tonnes, which represents 55% of the production of cassava in Africa and 33.5% of the world production. Every part of the crop can be utilized. (Lehmane, H et al, 2022). The leaves are relatively rich in protein and can be consumed, the storage root is consumed as a source of food and starch products and biofuels. Nigeria is the leading producer of cassava in Africa followed by Democratic Republic of Congo, Mozambique, Uganda and Tanzania in the top five. Tivana, L. (2012).

In Uganda, cassava is the second most important staple food crop, after bananas in terms of production and consumption. The traditional growing areas of cassava are West Nile, North, and Eastern parts of the country. Uganda produces over 5 million tonnes of cassava annually. However, the industrial potential of the crop is not yet fully exploited. Cassava products with significant investment opportunities include; starch, high quality cassava flour and chips for use as raw materials in bakeries, breweries, bioethanol, paperboards, bio-degradable plastics, animal feeds and textiles. Another attractive business opportunity is investment in quality cassava seed production. In Uganda, there is very high demand for certified planting material. Cassava is already

widely utilized as a commercial crop in Brazil, Thailand, China, Cambodia, Nigeria, Ghana and Mozambique in a range of applications. Today, it is increasingly becoming an important crop in the south and western areas of the country. The crop is mainly grown by smallholder farmers (on 1-2 acres of land) for food security and income generation. Most of it sold as dry cassava chips or cassava flour milled from the dried chips but gradually more and particularly in urban areas as fresh cassava roots.

There have been efforts by the government of Uganda for large scale production for the ever-increasing commercial uses of cassava in the baking industry, industrial use in the manufacture of paper board and starch, alcohol, biofuel, pharmaceutical industries. The yield from an acre of cassava ranges 4-8 MT, which translates into 1.5-4 metric tons of dried cassava chips and 1.2 -2.5 metric tons of cassava flour. (NAADs, 2022). ACDP aimed to raise farm productivity of five agricultural commodity cassava included by providing subsided agricultural inputs like tractors hire services, seeds, fertilizer and pesticides to farmer's though electronic voucher

2.2 E-voucher system under the Agriculture Cluster Development Project (ACDP)

According to (MAAIF, 2019). The Agriculture Cluster Development Project is a 6-year partnership project supported by the World Bank under the Ministry of Agriculture, Animal Industry, and Fisheries. On January 23, 2017, the Ministry fully implemented the project, with the overall goal of increasing on-farm productivity, production, and marketable volumes of selected agricultural commodities in specified geographical clusters. This followed the approval by the Ugandan Parliament on September 15, 2016, which followed the signing of the financing agreement on September 26, 2016. Coffee, rice, beans, cassava, and maize are among the five commodities chosen. The project was designed with the following components in mind as channels for increasing production and productivity of the five priority crops in 42 districts across Uganda. The first component was to Support for Increased On-Farm Production. Value Addition and Market Access was the second. The third category was Policy, Regulatory, and Institutional Support. The fourth component is Coordination, Management, and ICT Platforms. 450,000 farmers benefit from approximately 300 Area-based Commodity Cooperative Enterprises representing approximately 3,000 Rural Producer Organizations. While the World Bank's total

investment in ACDP is $150 million USD, the total contribution from the Government of Uganda through the Matching Grant Scheme and the farmers through the purchase of Agro-inputs is 28 million USD and 70 million USD, respectively. This contribution is made by the three main stakeholders in 42 districts, which are also divided into 12 clusters based on the five priority crops. The Ministry of Trade Industry and Cooperatives, the Ministry of Works and Transport, the Ministry of Water and Environment, the Ministry of Local Government, the Ministry of ICT, the Finance Ministry, and the Ministry of Gender, Labor, and Social Development collaborate to carry out this project.

2.2.1 How E-voucher operates

An E-Voucher is an electronic number that is typically delivered to the customer via e-mail or SMS and can be printed and redeemed in-store or online using a PIN code. (MAAIF, 2019). E-vouchers are a popular option because they are delivered in real time and, in many cases, can be redeemed immediately and E-Voucher Management System developed, maintained, and managed this electronic system. Mulozi, M. (2018). It generates e-vouchers for all enrolled farmers and sends each one a unique user profile with access rights and a four-digit PIN code via SMS. This PIN code should be kept private and used each season to order and pay in the system. E-voucher was intended to increase smallholders and emerging farmers. Farmers' access to agricultural inputs (such as seeds and fertilizers) agrochemicals) and improving their understanding of the cost-effectiveness of their application the strategy was founded on underlying assumption that increased access to and Smallholder and emerging farmers' use of agricultural inputs contribute to increased agricultural productivity and yields production and possibly improving food access through increased earnings. El-Huni, E. M. (2015)

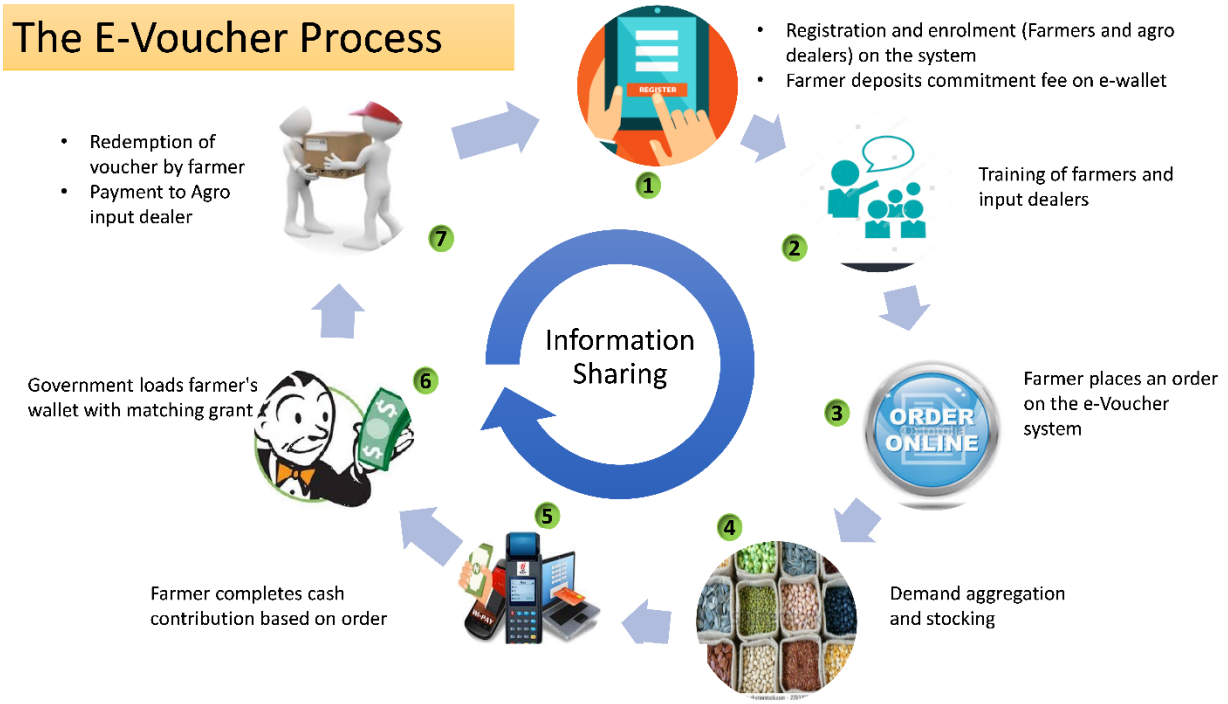

Figure 1 E-voucher system process

2.3 Tractor use in agriculture in Uganda

A tractor is a piece of technical equipment created primarily to provide a high tractive effort (or torque) at low speeds in order to tow a trailer or heavy equipment like that used in agriculture, mining, or construction. The phrase is most frequently used to refer to a farm vehicle that has the power and traction to mechanize agricultural chores, particularly tillage, as well as a variety of other duties. Agricultural implements can be pulled behind the tractor or placed on it; if the implement is automated, the tractor may also function as a power source.

During the 1960s, the Ugandan government made substantial efforts to build a nationwide network of tractor and implement maintenance and repair facilities under the then-government-managed "Tractor Hire Services." The government also trained a large number of technicians and craftsmen for equipment management and maintenance. A total of 66 Class 1 workshops (mostly for tractor service and minor repairs) and 17 Class 2 workshops (for more difficult equipment repairs) were created. Segirinya, J

Cassava is often farmed on tiny pieces of land in tropical regions, however in some (like. Mexico. Brazil and Nigeria). Huge plantations have begun, and automation is becoming more popular. The quantity of land, the labor force in the area, and the overall attitude toward the usage of manual labor all influence the level of automation. According to Volza's Uganda import data for farm tractors, Pakistan accounted for the largest percentage with 10 shipments, followed by India with 9 and the United States in third place with 8 shipments. According to the United Nations COMTRADE database on international commerce, Uganda's imports of tractors from India were US$4.53 million in 2020. Uganda Tractor Imports from India - data, historical chart, and statistics - were last updated in November of 2022.

Figure 2 Uganda imports of tractors from India According to COMTRADE database

Hire services, be they rental, custom or leasing services, can commonly be found in many countries and concern production, harvest, post-harvest and marketing operations. In rural areas of many developing countries, consumers of hire services are typically smallholder farmers within village communities cultivating less than one hectare of land. Providers of hire services in this context are primarily farmers themselves who have invested in equipment, both for their own use and because they have identified a potential for hiring services to their local markets

Small farm size and seasonality have often been seen as a major limitation to the use and ownership of agricultural machines (Pingali et al. 1987; Pingali 2007; FAO 2006; Ji et al. 2012). The use of machinery for land preparation is preferable to manual labor to ensure the best possible seed bed for tuber development. Subsequent operations of planting. Weeding, topping and harvesting can be done by hand as well as by machinery. (FAO, 2016)

According to FAO, some of the activities that involve the use of tractor in cassava production include;

- Basic operations such as ploughing and harrowing, may be done by tractor.
- A topping machine consisting of a heavy screen mounted on the front of a tractor has been developed to push down the tops: then a rotary mower on the back of the same tractor can cut the downed top to make harvesting by hand possible. The height at which the tops are cut back can be easily regulated with any rotary mower.
- A mechanical planter made in Brazil is in use there and in Mexico. It is a two-row planter using a tractor driver and two men on the machine to feed cuttings from the reserve bins into the rotating planting turntable. In operation, the cuttings fall in succession through a hole into a furrow opened by a simple furrower. A pair of disks throw dirt into the furrow and floats pulled by chains pack the soil over the cuttings. The planter is able to cover about 5 hectares per day.

The main response to the shortage of food production in developing countries has been to invest in increased food production. Many years of investment in crop production technologies have generated a great number of innovative technologies for crop production and protection. However, the food crisis in Africa has persisted (Rusike et al. 2010).

Mechanization of Agriculture in Uganda is mostly done using ox plough, because it's the cheapest and simplest method of mechanization. But a few farmers use tractors to open and till the land.

In the earlier years many farmers were able to use tractors to plough their fields because the agricultural system then was well managed by the Ministry of Agriculture, and they would access them. The failure by farmers to mechanize production or to hire tractors has led to most of them growing crops on small plots of land. (Farm Uganda, 2022)

2.4 Characteristics of farmers who use tractors on cassava production in Uganda

The national average cassava yield in Uganda is 5059 kg per acre compared to 16,187 to 20,235 kg/acre achievable in good growth conditions. The main cassava growing regions based on production volumes as of 2008/ 9 fiscal year were the eastern at 37%, northern (34%), western (15%) and the central (14%) regions. (FAO, 2019). Usually, fields with poor soil nutrients are considered for cassava planting by farmers. Cassava is cultivated on small farms often in fields to be set aside as fallow and often cropped on marginal soils, replacing crops that require greater soil fertility and cultivation. Cassava also is associated with mixed cropping systems.

Farmers expand their farm size when they acquire a tractor, but not to such an extent as to fully utilize the capacity of the machine. They engage in hiring-out tractor services to increase the scale of tractor use and make profits. Medium-scale farmers offer the bulk of tractor services. (Houssou et al, 2015).

Most of the farmers only do primary clearing of the land like cutting trees or tall grasses using pangas (machetes, long knives) or axes and then the field becomes ready for planting cassava. Only a few farmers cultivate the field for cassava planting using ox-plough or tractors. Most of the farmers carry cassava in basins or sacks on their heads from gardens to home, factories or local markets. Others use bicycles, wheelbarrows, or motorcycles and only a few use tractors to transport cassava. (Buyinza, 2018)

Over the years, various mechanized harvesting options have been developed for use in different parts of the world to overcome these challenges. Earlier attempts at mechanizing cassava harvesting have been challenged mainly by inappropriate method of planting, field topography and scale of cultivation. A review of various harvesting options for cassava is crucial to ensure proper adaption and adoption of improved harvesting methods applicable to farmers from different parts of the globe. There have been some significant attempts made in the research on mechanical harvesting of cassava. For example, some researchers developed cassava digger suitable for a 50 hp tractor, while others attempted to integrate cassava digger and conveyer unit. Recent research includes a harvesting machine hitched to a tractor and popularly known as Digger; the Digger has also been modified with provision of a conveyor unit. However, all these have several

disadvantages such as loss of cassava root in the field, smaller working width, higher breaking loss, greater power requirement, and field cleaning requirement. (Sahapat, 2018)

Agricultural mechanization service providers tend to be medium and large-scale farmers who invest in tractors both for their own use and to provide hiring services. For example, in Thailand, Malaysia, and Pakistan, the majority of the tractor service providers were farmers with landholdings about twice that of tractor-hiring farmers (Chancellor 1971; FAO 2015)

Asses farmer's view on tractor hire services under the E-voucher program.

Uganda has used rudimentary techniques and tools of production from time immemorial. The heavy reliance on such primitive and low productive tools has curtailed the country's capacity to propel its agriculture beyond subsistence levels. The government of Uganda has designed an e-voucher program which eases smallholder farmers access to tractor hire services so as to improve on farm mechanization (Feyertag, *at,.el* 2020).

Agricultural mechanization embraces the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural development, farm production, crop harvesting and primary and secondary processing(Two, n.d.). Innovation in public service provision related to e-vouchers services by hello Tractor in Nigeria and Trotro Tractor in Ghana connect and Oakar Services ltd in Kenya, Geo Gecko in Uganda provided tractor services at an affordable rate to farmers through e-voucher program in these countries hence increasing on farmers positive perception to use tractor services from these companies because of easy access to tractor services (Kienzle *at,.el*. 2016).

According to Benin, S. (2015) stated that Ghana's AMSEC program on various farm household in different districts around the country to provide tractor hiring services to farmers trough **e**-Voucher system increased on accessibility of farmers to use tractors in their gardening's which increased on agricultural productivity through mechanization by use of tractors.

Luchen, S. (2016 asserted that farmers who were supported with tractor services through e-voucher system gave them a lead in access to tractor higher services hence increasing on smallholder agricultural mechanization in Zambia. E- voucher system was the ideal solution for provision of tractor hire service to farmers as it could ease government process to provide the service to smallholder farmers. Thapa, S. (2019) observed that use of e-voucher program among farmers on tractor hire services provided a positive view to farmers to increase on the use of tractors for agriculture mechanization through easing access to farm machinery.

2.5 Factors influencing the adoption of Tractor hiring services

Farm power in African agriculture, especially Sub-Saharan Africa (SSA), relies on human and animal power based on operations that depend on the hoe and other hand tools (FAO and UNIDO, 2008). Moreover, agricultural mechanization in sub-Saharan Africa has largely ignored the role of the capital service market in spreading the use of mechanical technologies (Adamade & Jackson, 2014; Houssou, 2015). In most African countries, draught animal power has been used for centuries. The African farmers are generally referred to as "hoe farmers". FAO estimated that, in the late 1990s, 65% of cultivated area in sub-Saharan Africa was prepared by hand, 25% by draught animals and 10% by tractor (FAO, 2013). Sub-Saharan Africa continues to have very low levels of mechanization with declining levels of adoption (Pingali, 2007).

Custom hiring services have been essential for the widespread use and ownership of tractors and other agricultural machines in many countries where small farms are dominant. For example, draft animals and manual labor were unable to cope with the work load of intensive agriculture on the small farms of India, but the use of tractors on these single farms was not economically viable (Sharma et al. 1998). It was only through hiring that tractor service charges could be reduced sufficiently to enable most farmers to adopt mechanized technologies, encouraging many to invest in private tractor service provision.

Smallholder cassava farmers in Uganda lack the funds to purchase tractors. Furthermore, the small size of the field precludes the employment of these equipment's with economic efficiency if the cost of operation is considerable. As a result, employing tractor hire services has become a viable choice. Because the majority of farmers run small-scale farms in many developing nations, ownership of tractor is extremely limited (Gego et al., 1986). Furthermore, the economic feasibility of tractors is the primary motivator for many farmers in developing nations to acquire it (Singh and Kingra, et al., 2013). Furthermore, it necessitated capital expenditure and is dependent on farmer financing availability (IRRI, 1986). This aspect frequently leads to the collaborative usage of tractors by farmers or individuals in groups or organizational form (Gego, et al., 1986). In general, these organizational structures are divided between public and private sectors, however some are structured by both sides. Oakley, P., & Garforth, C. (1985)

Tractor power in Uganda ranges from 8-14 h.p. for walking tractors to 45-90 h.p. for two-axle tractors, depending on area and soil type. Higher tractor power is typically employed in large farms, such as sugar cane cultivation and hauling.(Segirinya, J. 2008). The cost figures for a 90 h.p. 4-wheeled tractor are provided below for typical farming activities.

Inputs hire services in agriculture are commonly provided by human energy, but also, and preferably, by animal or mechanical power. It is the latter two that have most potential to reduce drudgery, even though some muscle powered tools may be needed. However, there has been limited focus on the governance challenges of agricultural mechanization. Some studies draw attention to challenges such as the need to access credit and to limited knowledge and skill levels, but often these factors are mentioned in passing, and existing studies have not analyzed these challenges and their underlying dynamics comprehensively.(Houssou et al. 2014a). One possible chief factor affecting production efficiency is the machinery use and associated costs; uprooting cassava requires labor, as tubers are heavy and well-rooted. Abass et al. showed that the mechanization of cassava processing in Uganda motivated the efficient management and utilization of resources in cassava production

The Ministry of agriculture, animal industry and fisheries (MAAIF) experimented with tractor rental services. These tractors and implements can be hired for hire at a reduced cost of UGX 40,000 per acre for ploughing, harrowing, spraying, and other agricultural tasks, as opposed to the UGX 120,000/Acre paid by private equipment owners. Smallholder farmers are, by definition, resource poor, and they frequently struggle to invest in physical assets in general, and agricultural equipment in particular. (Hunter, M. C., et el 2017). Small-scale farmers frequently have poor productive output per hectare due to a lack of access to inputs, resulting in low pricing for their food, and hence lack financial means to hire services. Some farmers are required to pay in kind for mechanized services.

2.6 Models Used to Analyze Factors Affecting Adoption and Use of Tractor Hire Services

Empirical studies on agricultural technology adoption, including tractor hire services, have employed a range of econometric and statistical models to identify factors influencing farmers' adoption decisions and intensity of use (Greene, 2012; Wooldridge, 2010). While these models are

widely cited in the literature, not all of them were applied in the present study. Rather, they are reviewed to provide a methodological background and to justify the choice of the analytical model adopted. Each model has specific strengths and limitations, which are discussed below.

2.6.1 Linear Regression Model

The Linear Regression Model is used where the dependent variable is continuous. However, it is inappropriate for binary adoption decisions because it may predict probabilities outside the 0–1 range (Gujarati & Porter, 2009). The Linear Regression Model is typically applied when the dependent variable is continuous. In adoption studies, it has occasionally been used to estimate relationships between socioeconomic variables and technology use. However, its application to binary adoption decisions is inappropriate, as it may generate predicted probabilities outside the logical range of 0 to 1. Additionally, the model assumes homoscedastic and normally distributed error terms, assumptions that are often violated in adoption data, leading to biased and inefficient estimates (Gujarati & Porter, 2009).

2.6.2 Logit Model

The Logit model is commonly used when the dependent variable represents a binary outcome, such as whether a farmer adopts tractor hire services or not. It assumes a logistic distribution of the error term and ensures predicted probabilities lie within the 0–1 range. Despite these advantages, a major weakness of the Logit model is that its coefficients are expressed in log-odds, making direct interpretation difficult. As a result, marginal effects must be computed to obtain meaningful economic interpretations, which can complicate analysis for non-technical audiences (Maddala, 2001; Long & Freese, 2006).

2.6.3 Probit Model

The Probit model is another widely used approach for analysing binary adoption decisions and assumes that the error term follows a normal distribution. While the Probit and Logit models often produce similar results, the Probit model shares a key limitation in that its estimated coefficients

do not directly represent marginal effects. Furthermore, the normality assumption may not always hold in practice, potentially affecting the robustness of the estimates (Greene, 2012).

2.6.4 Tobit Model

The Tobit model is applied when the dependent variable is censored, such as when many observations take a value of zero for technology use intensity. Although it allows simultaneous estimation of adoption and usage intensity, its main limitation is the restrictive assumption that the same set of factors and coefficients jointly determine both decisions. This assumption may not reflect reality, as the factors influencing the decision to adopt tractor hire services may differ from those affecting the level of use, leading to potential estimation bias (Tobin, 1958; Wooldridge, 2010).

2.6.5 Double-Hurdle Model

The Double-Hurdle model addresses the limitations of the Tobit model by separating the adoption decision from the intensity of use. This flexibility allows different factors to influence each decision stage. However, the model requires larger datasets and more complex estimation procedures, increasing data and computational demands. In addition, misspecification of either hurdle can result in biased estimates, making careful model selection and validation essential (Cragg, 1971; Burke, 2009).

2.7 Summary of data variables

Variable	Description	Relevance to Study
District	Local government administrative unit where the ACDP beneficiary farmer is located.	Controls for geographical differences in access and adoption

Gender	Sex of the farmer. Research shows men benefit more from mechanization due to wealth and access disparities (CGIAR, 2018).	Examines gender disparities in mechanization adoption
ACDP commodity supported	Commodity supported under the ACDP cluster. This study focuses on Cluster 12 (Cassava).	Ensures focus on cassava beneficiaries
Training on system use (EVMS)	Training provided on how to enroll, order, and redeem inputs using the e-voucher system.	Improves likelihood of successful input access
Training on input use	Training on identification, application, and utilization of agricultural inputs and good agronomic practices.	Enhances productivity and effective technology use
Agro-input dealers	Access to national or local agro-input dealers contracted under ACDP to supply quality inputs.	Affects input quality and availability
Location input received	Location where inputs were delivered (village, subcounty, district).	Influences transaction costs and ease of access
Varieties used	Cassava variety received under the project, appropriate to the cluster.	Reflects technology awareness and adoption
Challenges faced	Difficulties encountered during enrollment, ordering, and redemption under the e-voucher system.	Identifies constraints affecting adoption
Purpose of growing cassava	Primary reason for growing cassava in cycle one.	Indicates farmer investment orientation
Land size	Size of land (in acres) used to grow cassava under the project.	Influences scale of production and mechanization use
Input received	Inputs ordered using the e-voucher, including seeds, fertilizer, pesticides, tools, and tractor hire services.	Measures utilization of project support

Quantity harvested	Amount of cassava harvested by the farmer.	Used to measure productivity outcomes
Soil fertility rate	Farmer-reported soil fertility based on soil's ability to support plant growth (FAO, 2020).	Controls for natural productivity differences

Table 1 Summary of data variables

CHAPTER THREE

3. METHODOLOGY

3.1 Introduction.

This chapter specifies the study area, the research design, data types and sources, different methods of data collection that were used to obtain the data for the study, data analysis and presentation and the ethical consideration.

3.2 Research Design

This study adopted a cross-sectional research design employing both quantitative and qualitative approaches. The cross-sectional design was appropriate because data were collected from respondents at a single point in time. The combination of quantitative and qualitative approaches enabled comprehensive analysis of the adoption of tractor hire services and their effect on cassava productivity among ACDP e-voucher beneficiaries.

3.3 Data Collection Methods

The study employed a survey method to collect primary data from cassava farmers who were beneficiaries of the Agricultural Cluster Development Project (ACDP) e-voucher system in the West Nile region. The survey method was suitable as it allowed the collection of standardized information from a relatively large number of respondents within a limited time.

3.4 Data Collection Instruments

This study used both structured and semi-structured questionnaires as the main data collection instruments. The use of these instruments enabled the collection of both quantitative and qualitative data necessary to address the study objectives. The questionnaires were administered to cassava farmers who were beneficiaries of the ACDP e-voucher system in the West Nile region.

The instruments were developed in line with the study objectives and informed by relevant literature on agricultural technology adoption.

3.4.1 Structured Questionnaire

The structured questionnaire comprised mainly closed-ended questions with predefined response options. It was designed to collect quantitative data that could be coded and analyzed using statistical software. The questionnaire captured measurable variables such as farmers' socio-demographic characteristics, farm size, training received, access to agricultural inputs, adoption of tractor hire services, and cassava output. The use of structured questions ensured uniformity in responses, minimized interviewer bias, and facilitated comparison across respondents

3.4.2 Semi-Structured Questionnaire

The semi-structured questionnaire consisted of both closed-ended and open-ended questions. This approach allowed respondents to provide detailed explanations of their experiences, perceptions, and challenges.

The semi-structured questions were particularly useful in eliciting farmers' views on the e-voucher system, challenges encountered in accessing tractor hire services, and perceptions of the effectiveness of the ACDP intervention. The qualitative data complemented the quantitative data and provided deeper insights into issues that could not be adequately captured using structured questions alone.

3.4.3 Structure of the Questionnaire

The questionnaire was divided into six sections, each addressing a specific aspect of the study as outlined below:

Section A: Socio-Demographic Characteristics

This section collected information on respondents' background characteristics, including district of residence, gender, age, and level of education. These variables were important for analyzing differences in the adoption of tractor hire services among various categories of farmers.

Section B: ACDP Participation and Commodity Supported

This section captured information on the commodity supported under ACDP, cluster affiliation, and whether the respondent was a beneficiary of cassava support under Cluster 12. This ensured that only eligible respondents were included in the study.

Section C: Training and Institutional Support

This section focused on training received by farmers, including training on the e-voucher management system (EVMS) and training on the use of agricultural inputs. It also captured information on access to agro-input dealers and locations where inputs were obtained.

Section D: Input Access and Technology Adoption

This section collected data on the types of inputs accessed through the e-voucher system, including seeds, fertilizers, pesticides, farm tools, and tractor hire services. Information on cassava varieties used and adoption of tractor hire services was also obtained.

Section E: Production and Productivity

This section gathered information on land size allocated to cassava production, soil fertility status, and quantity of cassava harvested. These variables were used to assess the effect of tractor hire services on cassava productivity.

Section F: Challenges and Farmers' Perceptions

This section mainly comprised semi-structured questions that allowed respondents to explain challenges faced during enrollment, ordering, and redemption of inputs under the e-voucher system. It also captured farmers' perceptions of the effectiveness of tractor hire services and the overall ACDP intervention.

3.5 Justification for the Questionnaire Design

The use of both structured and semi-structured questionnaires enabled the collection of comprehensive data suitable for both quantitative and qualitative analysis. Structured questions facilitated statistical analysis of technology adoption and productivity outcomes, while semi-

structured questions provided in-depth qualitative insights into farmers' experiences, perceptions, and constraints. This combination enhanced the validity and robustness of the study findings.

Consent process: ACDP employs a number of measures to guarantee that survey work complies to ethical research standards, which will include the elements listed below.

The monitoring and evaluation Unit's technical personnel and the World Bank have approved a general methodology and survey instrument. Staff education on human subject protection. Consent after being informed. Every tool's introduction includes an informed permission form for the recipients. The statement covers all of the important aspects of informed consent. Interviewers will be taught on the purpose and substance of informed consent, as well as how to read the informed consent statement to respondents and answer queries regarding the survey or informed consent. Only the organization's members who have provided informed consent will be questioned or measured. The interviewer will record these oral consent indications from household members.

Confidentiality protections. Throughout the survey procedure, respondents' personal information will be kept secret. Enumerators shall be prohibited from interviewing anyone they know or discussing any identified respondent's information with anyone other than a field team member or a field supervisor. Only the focal personnel will have access to the data transferred to the servers.

3.6 Target population.

The target population was mainly ACDP cassava farmer beneficiaries from cluster 12-westnile region who enrolled, redeemed and ordered tractor hire services as one of the subsidies inputs from this program.

3.7 Sampling Procedures and Sample Size.

The study was conducted using secondary data from the Agriculture Cluster Development Project (ACDP which is a partnership project of the Ministry of Agriculture, Animal Industry and Fisheries and the World Bank, financed by the International Development Assistance (IDA) of the World Bank. The sample of respondents were drawn from cluster 12 from three districts (YUMBE,

MARACHA and PAKWACH) Northern region of Uganda. A total of 332 cassava farmers were selected for the study.

3.8 Data types and sources

Secondary data from the Agriculture Cluster Development Project (ACDP) was used to conduct this research. The development objective of the project was to raise on-farm productivity, production and marketable volumes of five selected agricultural commodities, viz. maize, rice, cassava, beans and coffee in specified geographic clusters though.

3.9 Data Analysis

This section describes the procedures followed in processing and analyzing the data collected for the study. The analysis was guided by the study objectives and involved both descriptive and econometric techniques.

3.9.1 Data Processing and Management

Following the receipt of data extracts from the ACDP e-voucher management system, the dataset was initially reviewed to gain an understanding of its structure, variables, and overall completeness. This preliminary assessment guided subsequent data preparation procedures.

Data cleaning was then undertaken to enhance data quality and suitability for analysis. This process involved checking for missing values, correcting inconsistencies, removing duplicate records, and ensuring that all variables were correctly coded.

Categorical variables such as gender, district, training received, adoption of tractor hire services, and purpose of growing cassava were transformed into dummy variables where necessary to facilitate econometric analysis. Continuous variables, including land size and quantity of cassava harvested, were examined for outliers and assessed for plausibility. In addition, units of measurement were standardized to ensure consistency across all observations.

Upon completion of the cleaning and coding processes, the final dataset was imported into STATA software, which was used to perform all descriptive and econometric analyses for the study.

3.9.2 Analysis of objectives

To address objective one, descriptive statistical techniques were employed to summarize farmers' participation in tractor hire services and their perceptions of the e-voucher program. Frequencies and percentages were computed for categorical variables, while means and standard deviations were calculated for continuous variables. Key variables analyzed included adoption of tractor hire services, training received, types of inputs accessed, and locations where inputs were obtained. Cross-tabulations were conducted to examine differences in the adoption of tractor hire services across selected socio-demographic categories, particularly gender and district.

In addition, graphical presentations such as bar charts and pie charts were used to visually illustrate patterns of participation and farmers' responses. Data obtained from semi-structured questions were analyzed using thematic analysis to summarize farmers' perceptions and to identify key challenges associated with tractor hire services and the e-voucher management system.

Probit regression was used to analyze Objective Two, which examined the factors influencing the adoption of tractor hire services by E-voucher cassava farmers. Studies involving binary dependent variables commonly employ discrete choice models such as Logit or Probit, and the choice between the two is often not critical since they produce similar results (Cao et al., 2009).

The Probit model is a statistical probability model in which the dependent variable assumes two possible outcomes: adoption (1) or non-adoption (0) (Peel et al., 1998). The model assumes that the error term follows a normal distribution, and the cumulative normal probability distribution is used in estimation (Aldrich & Nelson, 1984).

Model Specification

Equation (1): Probit adoption model

$P(Y_i = 1 \mid X_i) = \Phi(\alpha + \beta X_i)$

where:

- $P(Y_i = 1 \mid X_i)$ = probability that farmer *i* adopts tractor hire services

- $\Phi(.)$ = cumulative normal distribution function
- Y_i = adoption of tractor hire services (1 = yes, 0 = no)
- X_i = vector of explanatory variables
- α and β = parameters to be estimated
- ε_i = error term

For estimation, the latent variable model is expressed as:

Equation (2): Empirical specification

$$Y_i^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_{12} X_{12} + \varepsilon_i$$

where:

$Y_i = 1$ if $Y_i^* > 0$, otherwise $Y_i = 0$.

Definition of Variables

Y = Adoption of tractor hire services (1 = yes, 0 = no)
X_1 = Quantity of cassava harvested in the previous season
X_2 = Cassava variety used
X_3 = Training on input use (1 = yes, 0 = no)
X_4 = Training on e-voucher management system (EVMS) (1 = yes, 0 = no)
X_5 = Land size under cassava production
X_6 = District (Yumbe, Maracha, Pakwach)
X_7 = Location where tractor hire services were received
X_8 = Gender (1 = male, 0 = female)
X_9 = Soil fertility rating
X_{10} = Provider of tractor services
X_{11} = Purpose of growing cassava
X_{12} = Access to other agricultural inputs
ε_i = Error term

Objective Three examined the effect of tractor hire services on cassava productivity using a multiple linear regression model. Cassava productivity was measured by the quantity of cassava harvested. The model is specified as:

Equation (3): Productivity model

$$Y_i = \beta_0 + \beta_1 TractorHire_i + \gamma Z_i + u_i$$

where:

- Y_i = quantity of cassava harvested by farmer *i*
- $TractorHire_i$ = 1 if farmer *i* adopted tractor hire services, 0 otherwise
- Z_i = vector of control variables (land size, soil fertility, training, cassava variety, district, and access to other inputs)
- β_1 = effect of tractor hire services on cassava output
- γ = vector of coefficients for control variables
- u_i = error term

Diagnostic tests were conducted to assess multicollinearity (Variance Inflation Factors), heteroskedasticity, and normality of residuals. Results were interpreted based on the sign, magnitude, and statistical significance of the estimated coefficients.

3.10 Description of variables

Dependent variable: The dependent variable is tractor hire services as one of the inputs received by cassava famers under ACDP.

The independent variables are: Size of the land, Location tractor hire services received, variety used, other inputs (seeds), soil fertility rate, who delivered tractor, Gender, district, Training: Input use, Training on System use (EVMS), purpose of growing cassava and Quantity harvested last season

CHAPTER FOUR

4. DATA ANALYSIS AND PRESENTATIONS

4.1 Characterizing E-voucher participation in tractor hire services by cassava farmer in Westnile – Uganda and assessing their view about the program.

This section describes the participation of cassava farmers in tractor hire services under the e-voucher program in West Nile, Uganda. It highlights the characteristics of participating farmers and examines how they accessed and used tractor hire services through the program. The section also assesses farmers' perceptions of the e-voucher system, including its effectiveness, accessibility, and challenges faced. This analysis helps to understand the level of participation and farmers' views on the program.

4.1.1 Distribution of selected E-Voucher beneficiaries' farmers by districts

It was observed that Yumbe District had the highest proportion of cassava farmers (68.67%), followed by Maracha (24.7%) and Pakwach (6.63%) as shown in Table 1. This could be attributed to the high number of cassava farmers who used tractor hire services during production in Yumbe district, which was the target group for this study.

DISTRICT	Freq.	Percent
MARACHA	82	24.7
PAKWACH	22	6.63
YUMBE	228	68.67
Total	332	100

Table 2 Distribution of E-voucher cassava farmers beneficiaries by districts

4.1.2 Distribution of cassava farmers by Tractor Hire Services

Cassava farmers were classified into two groups according to the use of tractor hire services. The findings indicate that the majority of the cassava farmer didn't hire tractors. Farmers who hired tractor were only (44.58%) among cassava farmers in all three districts, as seen in the table 2 below. The major hindrance to the usage of tractor hire services in the study areas might be the land size, scarcity of hiring places, the high cost of renting the tractors, and land boundary disruption during agricultural activities, particularly land tillage operations. Ajah, J.. (2014).

Hired Tractor	**Freq.**	**Percent**
NO	184	55.42
YES	148	44.58
Total	332	100

Table 3 Distribution of tractor hire services by farmers

4.1.3 Distribution of tractor hire services by districts

Table 3 shows Most farmers (134) from YUMBE hired tractor compared to the rest districts this is attributed to being having large number of farmers growing cassava selected in this district as shown in table 1. It is also related to the land type and size of their farms. Due to a lack of tractor hire services in Yumbe area, many farmers including Aupi Community Cooperative Credit and Savings Society Limited has been unable to utilize more than 200 acres of agricultural land purchased by members three years ago (Okaba, 2021).

Tractor Hire Services	**DISTRICT**			
	MARACHA	**PAKWACH**	**YUMBE**	**Total**
NO	82	8	94	184
YES	0	14	134	148
Total	**82**	**22**	**228**	**332**

Table 4 Distribution of tractor hire services by districts

4.1.4 Tractor hire services by gender

Results from the figure 3 below shows that male were 66.27% and female were 33.73%. Out of 66.27% of male 34.94% did not (No) order tractor hire services and 31.33% ordered while in female gender out of 33.73% farmers 20.48% did not order and 13.25% ordered tractor hire services. In Ghana, approximately 10,000 tractors are owned by medium-large scale farmers who are men, for their own use and for hire (Diao et al. 2018). According to Takeshima et al. (2015), men outnumber women in tractor ownership due to their disproportionately large assets, while women lack financial and technical capability. According to the World Bank (TWB) et al. (2009), a critical constraint preventing women from using technology or mechanization is a lack of access to training and technical skills.

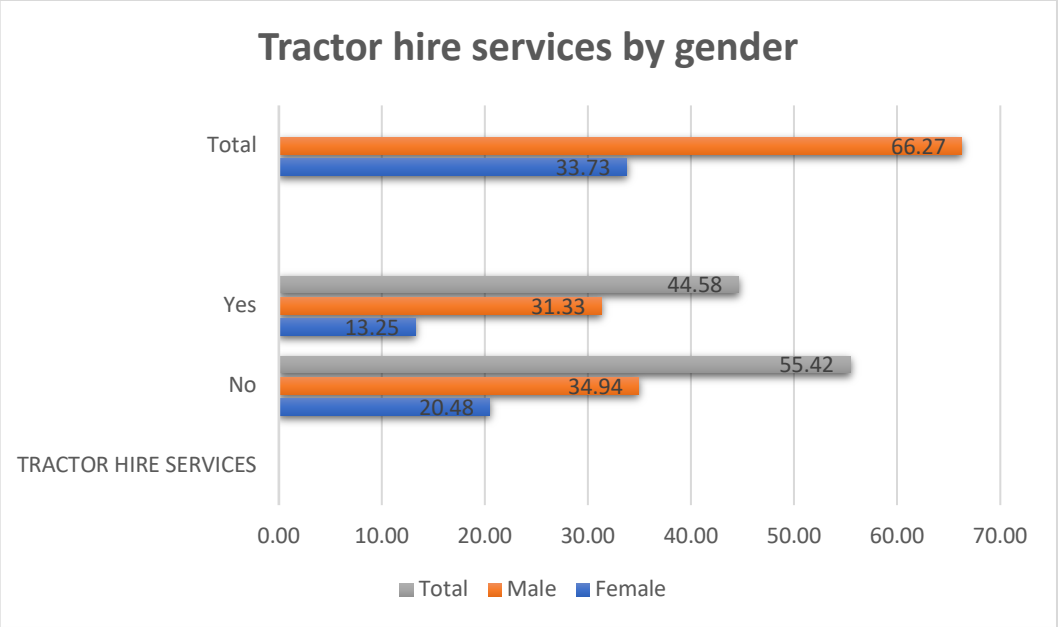

Figure 3 Percentage distribution of tractor hire services by gender

4.1.5 Main reason for growing cassava

Out of 229 farmers who answered this question, 98 farmers used tractor hire services and out of 98, 88 farmers the main reason for growing cassava was for commercial purpose and 10 farmers the reason was for subsistence purpose. For farmers who didn't use tractor hire services out of 131, 104 farmer's reason was for commercial purpose, 10 for seed multiplication and 17 farmers for subsistence purpose. According to (NAADS 2019), The Ugandan government has made efforts to increase cassava production on a large scale to meet the ever-increasing commercial uses of cassava in the baking industry, industrial use in the manufacture of paper board and starch, alcohol, biofuel, and pharmaceutical industries.

Tractor Hire services	Commercial purpose	Seed multiplication	Subsistence purpose	Total
NO	104	10	17	131
YES	88	0	10	98
Total	192	10	27	229

Table 5 Purpose for growing cassava by E-voucher farmers

4.1.6 Source of tractor hire services

The farmers were asked where they received tractors from, and the results are shown in Figure 5. With 81.63%, the most common source of tractors for hire was a tractor hire services provider. 14.3% was provided by neighbors and the village chairman. Only 4.08% of the tractors were hired from an ACDP tractor service provider. ACDP was projected to have more tractors available for hire to farmers than other tractor service providers. This might be because the ACDP tractors are inadequate and inaccessible to farmers.

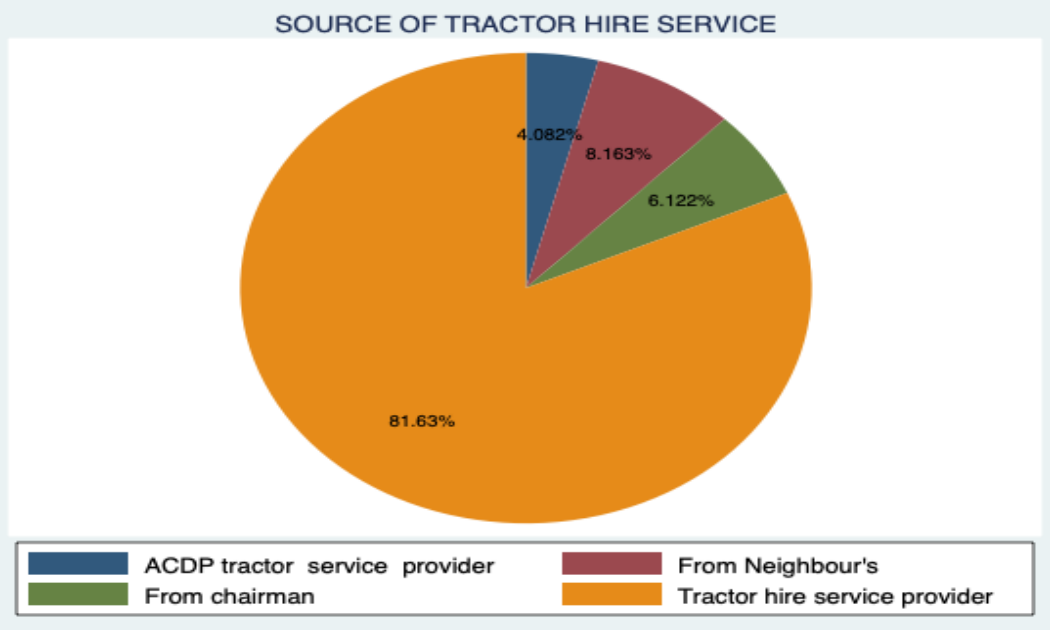

Figure 4 Source of tractor hire service

4.1.7 Location to redeem the tractor hire services received

One of the bottlenecks the project is addressing is the inaccessibility to Quality inputs by bringing inputs closer to the farmers. Access to agricultural inputs is critical in increasing productivity of agricultural produce. The closer the source of agricultural inputs, the lesser the transaction costs and higher the chances of farmer getting the right inputs. According to Table 5, Findings indicate that 50% of cassava farmers received tractor from villages, and 44.58% from sub-county while only 0.6% received tractor from districts. This might be attributed to the fact that most famers are found in the village and sub-county. According to the World bank, Agriculture employs 70% of Uganda's population and is the backbone of the country's economy. Raising agriculture revenues is important since the majority of Ugandans live in rural area.

Location	**Frequency**	**Percent (%)**
District	1	0.3
Parish	15	4.52
Sub-county	148	44.58
Village	166	50
Others	2	0.6
Total	332	100

Table 6 Location where farmers received tractor hire services

4.1.8 Other Inputs received by cassava farmer

Apart from tractor hire services cassava famers in these three districts received other inputs as shown in table 5 below. The findings revealed that 100% of cassava farmers for seasons one and three didn’t receive pesticides, while for postharvest materials, 1.8% received them, 98.2% didn’t receive them, and 62.6% received seeds as an input, and 37.4% were the ones who didn’t receive seeds. 208 Farmers received seed input which make it to be the most ordered input among other input received by cassava farmers selected in this study. For agriculture to prosper, farm inputs need to be available, affordable, accessible, and good quality. Seeds, fertilizers, and agro-

chemicals, are essential for improving the productivity and incomes of smallholder farmers in developing countries (World Bank, 2007, 2013; Rosegrant et al., 2001; AGRA 2013; FAO, 2013).

Input received	Response	Frequency	Percent (%)
Pesticides	No	332	100
	Yes	0	0
Postharvest materials	No	326	98.2
	Yes	6	1.8
Seed input	No	124	37.4
	Yes	208	62.6
Total		332	100

Table 7 Other input received by cassava farmers

4.1.9 Seed input: Cassava varieties

The findings revealed that 82.53% farmers used NAROCASS 1, 7.86% for NASE 19 and 0.87% used NASE 14 as shown in figure 5 below. There are various cassava varieties in Uganda, although according to NARO, NAROCASS 1, NASE14 and NASE 19 are one of the best varieties. NAROCASS 1, NASE 19 and NASE14 have comparable characteristics such as drought tolerance, resistance to mosaic and cassava brown streak diseases, and high yields. Although NASE varieties were launched in 2011, it is the latter that is more popular because to its high productivity. NAROCASS 1 is more popular than the more disease resistant.

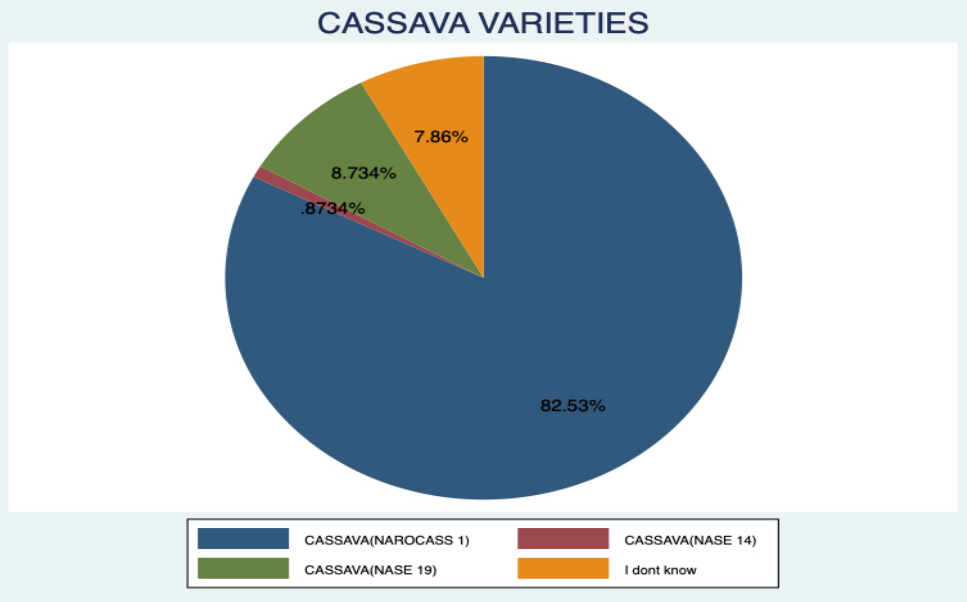

Figure 5 Cassava varieties

4.1.10 Who delivered the tractor

ACDP project has contracted National Agro-input dealers to supply but also build the capacity of the local agro-input dealers to supply good quality inputs and provide aftersales services to the farmers. According to the results shown in figure 6 below, the majority of farmers received tractors from the truck, followed by a local agro input shop they know, a local agro input shop they don't know, other agro input dealers and from storage facility with percentages of 50.66, 16.16, 14.85, 11.35 and 6.98 respectively. According to Staudacher, P.et el (2021) Small, often independent stockiest or distributors of agricultural inputs such as tractor and other input are known as agro-input dealers.

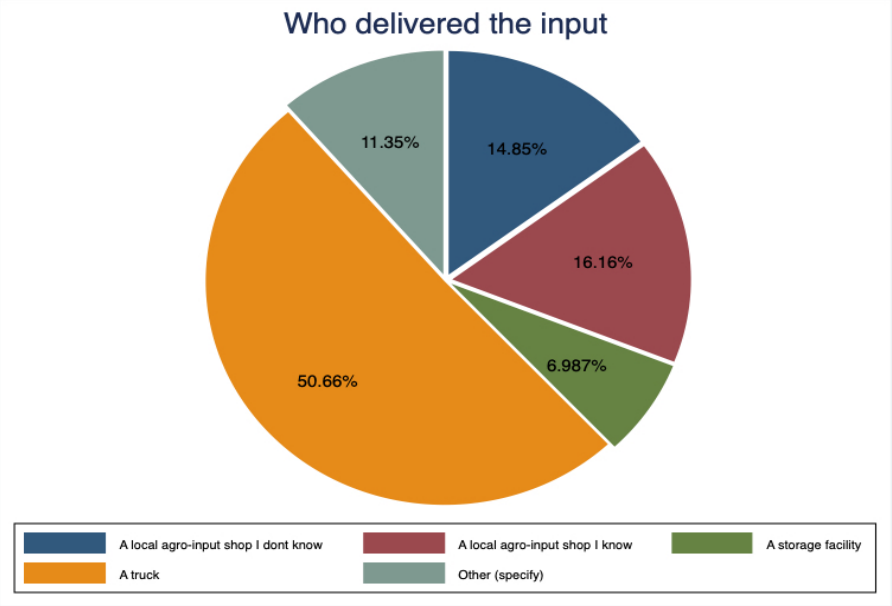

Figure 6 Agro- input dealers

4.2 Assessing farmer's view on tractor hire services under the E-Voucher program.

Assessing farmers' views on tractor hire services under the e-voucher program helps to understand beneficiaries' perceptions of the accessibility, affordability, and effectiveness of mechanization support. Farmers' views influence both adoption and continued use of tractor hire services. In this study, farmers' perceptions were captured through structured and semi-structured questions, providing insights into perceived benefits and challenges associated with accessing tractor hire services through the e-voucher system. These views complemented the quantitative analysis and informed the evaluation of the effectiveness of the program.

4.2.1 Plan to participate in the subsidy program in the next season

The farmers who did not use tractor hire services in the last season but were planning to participate in the subsidy program the following (next) season were 172 and those that used tractor hire services and were willing to participate in the subsidy program the following(next) season were 140 farmers. While 12 farmers who did not use tractor hire services and were not planning to participate in the subsidy program the following season. Seven farmers used tractor services but were not planning to participate in the subsidy program the following (next) season.

Tractor hire services	Response		
	No	Yes	
Didn't use	12	172	184
Used	7	140	148
Total	19	312	332

Table 8 Farmer's response about their plan to participate in the subsidy program in the next season

4.2.2 Reason for not participating in ACDP next season

42.11% of the respondents never wanted to participate in ACDP the next season because of inadequate funds and this was the major reason followed by other reasons with 31.58%, 10.53% of the respondents were not willing to participate in ACDP because use of input was not profitable and also it was not necessary. 5.26% of the respondents were not willing to participate in ACDP next season because inputs were expensive on the market.

Response	Freq.	Percent
Expensive inputs on the market	1	5.26
Inadequate funds	8	42.11
Not necessary	2	10.53
Other reasons	6	31.58
Use of inputs was not profitable	2	10.53
Total	19	100

Table 9 Reason for not planning to participate in ACDP next season

4.2.3 Area for improvement EVMS program

The beneficiary farmers suggestions to improve participation were as follows; 69.95% suggested that they should be provided with extension services, 13.25% suggested that they should be timely delivery of inputs and increased acreage of land support.7.23% of the beneficiary farmers suggested improvement on the stability of mobile money function for easy access to finances and 3.31% asked for provision of subsidy over a longer period of more than three seasons.

Response	Freq.	Percent
Improve the stability of the mobile money function	24	7.23
Increase the acreage of land supported	44	13.25
Provide extension services to beneficiaries	209	62.95
Provide the subsidy over a longer period more than 3 season	11	3.31
Timely delivery of inputs	44	13.25
Total	332	100

Table 10 Area for improvement EVMS program

4.2.4 Challenges with input

Understanding challenges helps in improving performance of the project and e-voucher system because the solutions can be derived following prescription of the challenges. There were many challenges that farmers faced in accessing inputs but the majority faced the challenge of limited information about how the voucher system operates with 33.15% of farmers, followed by delayed processing due to system failure with 29.28% .The third major challenge faced by farmers was long distances in accessing inputs with 21.55% and the least challenge faced were incomplete deliveries of inputs and limited capacity to use the e-voucher system with 0.55%.

What challenges did you experience in accessing the inputs	Percentage (%)
Delayed processing due to system failure	29.28
High cost of transport to receive the remaining inputs	1.66
Incomplete/partial deliveries of input	0.55
Late delivery of inputs by agro-input dealers	7.18
Limited capacity to use the e-voucher system	0.55
Limited information about the way the e-voucher system operates	33.15
Long distances in accessing the inputs	21.55
Not able to complete my payment in time	1.1
Not accessing evma staff	1.1
Other (specify)	3.87
Total	100

Table 11 Input challenges faced by cassava farmers

4.2.5 Crop production problems faced by E-Voucher cassava farmers in west Nile

This study identified seven major challenges faced by cassava farmer during production in these three districts are Diseases, Drought, Floods, Low soil fertility, Pest, Stray animals and Theft. Stray animal was listed by farmers as the main problem especially in Yumbe districts. However, drought was raised as the second in agreement with ROOTHAET, R. L., & MAGADO, R (2011) and third was theft followed by Floods, Diseases, pests and soil fertility in agreement with KATONGOLE (2021)

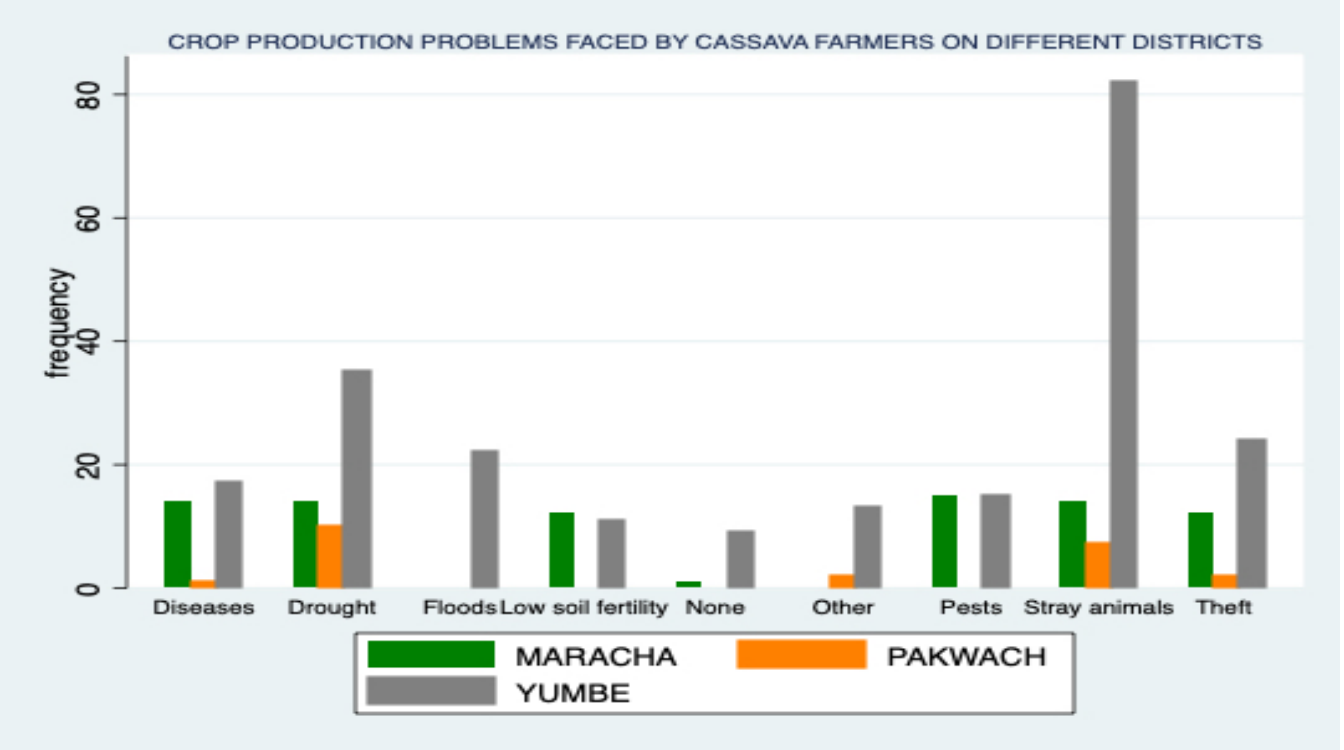

Figure 7 Crop production problems faced by cassava farmers on different districts

4.3 Factors that influence the adoption of tractor hiring services by cassava farmers.

Results from the regression table 4 below shows that Land size, Gender, Quantity harvested last season and location tractor hire services received were significant factor influencing the use of tractor hire services on cassava among E-voucher beneficiaries because their P-values are less than 0.05 level of significance while variety used, other inputs (seeds), soil fertility rate, who delivered tractor, Training on Input use, Training on System use (EVMS) and purpose of growing were not significant factors to influence the use of tractor hire services because their P-values are greater than 0.05 level of significance.

Land size had a positive correlation with Tractor hiring services adoption among E-voucher cassava farmers and it is a significant factor influencing tractor hire services adoption because its P- value is less than 0.05 ($0.008p<0.05$) level of significance. A unit increase on land size increase the probability level of tractor hire services adoption by 6.029683. The annual usage of tractors according to farming type, mechanization indicator, number of fields and land size were

determined through a survey conducted with 185 farmers, who owned a total of 253 tractors, in Thrace region of Turkey. Saglam, Cihangir & Akdemir, Bahattin. (2002).

Location tractor hire services received (Village) had a negative correlation with tractor hire services adoption among cassava farmers and it is a significant factor influencing tractor hire services adoption among cassava farmers because its P-value is less than 0.05 ($0.044p<0.05$) level of significance. A unit increase on location tractor hire services received (Village) reduced the probability of tractor hire services adoption by 0.0516305. According to (Okaba, 2021) Due to a lack of tractor hire services in Yumbe district, Aupi Community Cooperative Credit and Savings Society Limited has been unable to use more than 200 acres of agricultural land purchased by members three years ago. The land was purchased in order to practice commercial agriculture as a means of generating funds and financially strengthening the cooperative.

Gender (Male) had a negative correlation with tractor hire services adoption among cassava farmers and it is a significant factor influencing tractor hire services adoption among cassava farmers because its P-value is less than 0.05 ($0.026p<0.05$) level of significance. A unit increase of being male reduced the probability of tractor hire services adoption by 3.539586. According to the World Bank (TWB) et al. (2009), a critical constraint preventing women from using technology or mechanization is a lack of access to training and technical skills.

Quantity harvested last season had a negative correlation with tractor hire services adoption among cassava farmers and it is a significant factor influencing tractor hire services adoption among cassava farmers because its P-value is less than 0.05 ($0.0038p<0.05$) level of significance. A unit increase of Quantity harvested last season reduced the probability of tractor hire services adoption by 3.787208. According to Sims, B. G., & Kienzle, J. (2006 Mechanization is an important component of any farming system. It aims to increase productivity per unit area by improving farm operation timeliness and expanding the area under cultivation where land is available, which is common in SSA.

Probit regression analysis for the Factors that the influence the adoption of tractor hiring services by cassava farmers.

Tractor hire services	**Coef.**	**Std.Err.**	**z**	**P>z**
Varieties	-0.0084164	0.3571389	-0.02	0.981
Seed input	-6.514187	6.035502	-1.08	0.28
Who delivered tractor	1.082392	0.5907954	1.83	0.067
Soil fertility rate	0.2309348	0.2977682	0.78	0.438
Gender				
Male	-3.539586	1.586001	-2.23	0.026
Land size	6.029683	2.264913	2.66	0.008
Quantity harvested last season	-3.787208	1.8211	-2.08	0.038
Training on input use	0.6780477	0.7686425	0.88	0.378
Training on system use	0.0008937	0.0004646	1.92	0.054
Purpose of growing cassava	-0.4496658	0.4730096	-0.95	0.342
Location tractor hire services received				
Village	-0.0516305	0.0256217	-2.02	0.044
_cons	-11.96805	8.646098	-1.38	0.166

Table 12 Showing probit regression analysis for the factors that influence the adoption of tractor hire services by cassava farmers

4.4 To examine effects of tractor hiring service on cassava productivity among E-voucher beneficiaries.

From the results in table 3 below, Tractor hire services with Training on system use (EVMS), Soil fertility rate, Seed input, gender of respondent (Male), district (YUMBE and PAKWACH), Purpose of growing and Location tractor hire services received (Village and Subcounty) were significant effects of tractor hiring service on cassava productivity among EVMS beneficiaries because their P-values are less than 0.05% level of significance while Training on input use, varieties, Crop production problem and tractor hire services alone were not significant effects of tractor hiring service on cassava productivity among EVMS beneficiaries because their p-values are greater than 0.05 level of significance.

The use of tractor hire services with farmers who received training on system use (EVMS) had a negative relationship with cassava productivity among EVMS beneficiaries and significant at 0.00% level of significance. A unit increase on training on system use (EVMS) reduced cassava output by (13145.927) kgs. More than just information transfer is required for effective farm machinery utilization. Farmers must learn new skills, especially those who are introducing machinery for the first time. Sharan, G. (1988).

Soil fertility rate had a negative relationship with the effects of tractor hiring service on cassava productivity among EVMS beneficiaries and it's significant at 1% level of significance. A unit increase in the soil fertility reduced the cassava output 1648.147kg. The mechanization technologies of soil works have a major impact on physical state of soil. This situation is generated by the mechanical action of working parts which are involved in soil works and by the traffic of running systems of tractors and agricultural machines. Tenu, I et el. (2009).

District (YUMBE and PAKWACH) had a positive relationship with the effects of tractor hiring service on cassava productivity among EVMS beneficiaries and it's significant at 0% level of significant for Pakwach and 1.3% for Yumbe. A unit increase in tractor hire services in Yumbe district led to an increase in cassava output by 5836.811kgs and 53155.703kgs in Pakwach..

Farmers who ordered other input (Seed input) had a negative relationship with the effects of tractor hiring service on cassava productivity among EVMS beneficiaries and it's significant at 0.00% level of significance. A unit increase in the seed input reduced the cassava output 46889.21kg.

Purpose of growing cassava had a positive relationship with the effects of tractor hiring service on cassava productivity among EVMS beneficiaries and it's significant at 3.6% level of significant. A unit increase in the number of farmers who grow cassava for commercial purpose leads to an increase in the cassava output by 1377.205kg.In agreement with Deshar, B. D. (2013) Most of the seed user farmers used the machine so the SRR of machine user and bullock user was found to be statistically significant at 1 percent level of significance.

Location where tractor hire services received had positive relationship with tractor hiring service on cassava productivity among EVMS beneficiaries for Subcounty and negative relationship for village with 0.00% level of significance for farmers who received tractor hire services from village and significance level of 1% for subcounty. A unit increase on location tractor hire services received (village) by cassava farmers reduced cassava output by (35995.205) kgs and increased cassava output by 7482.55 kgs for farmers who received from subcounty.

Linear regression for effect of tractor hire services on cassava productivity among EVMS beneficiaries

Cassava Output (kgs)	Coef.	St. Err.	t-value	p-value	Sig
Training: Input use					
Yes	418.528	1235.573	0.34	.735	
Training: System use (EVMS)					
Yes	-13145.927	2288.516	-5.74	0	***
Soil fertility rate	-1648.147	485.067	-3.40	.001	***
District:					
PAKWACH	53155.703	4095.311	12.98	0	***
YUMBE	5836.811	2317.558	2.52	.013	**
Varieties	341.291	481.262	0.71	.48	
Seed input					
Yes	-46889.21	1844.567	-25.42	0	***
Purpose of growing	1377.205	649.764	2.12	.036	**
Gender of respondent					
Male	-556.358	891.636	-0.62	.534	
Location tractor hire services received					
Subcounty	7482.55	2273.836	3.29	.001	***
Village	-35995.994	3297.384	-10.92	0	***
Crop production problem	100.414	125.193	0.80	.424	
Tractor hire services					
Yes	-1131.137	2240.344	-0.50	.615	
Constant	45398.742	2812.264	16.14	0	

*** p<.01, ** p<.05, * p<.1

Table 13 showing linear regression for effect of tractor hire services on cassava productivity among EVMS beneficiaries

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY AND CONCLUSION

The study was conducted in West Nile region in the districts of Yumbe, Maracha and Pakwach. The major purpose of the study was to assess the adoption and effect of tractor hire services on cassava productivity among E-voucher beneficiaries which involved comparing cassava farmers who hired tractor and who didn't hire. The study was also intended to to characterize E-voucher participation in tractor Hire services by cassava farmer in West nile, determining factors that influence the adoption of tractor hiring services by E-voucher cassava farmers, effects of tractor hiring service on cassava productivity among EVMS beneficiaries and farmer's view on tractor hire services under the E-Voucher program. The study based on a sample size of 332 cassava farmers, 44.58% respondents ordered tractor hire services as an input and 55.42 % didn't order. Out of the 332 respondents, 68.67% were from Yumbe district, 24.7% from Maracha district and 6.63% were from Pakwach. Cassava farmers in the region ordered other inputs such as fertilizers, Pesticides, farm tools post-harvest materials and Seeds. 100% of cassava farmers for seasons one and three didn't receive pesticides, while for postharvest materials, 1.8% received them, 98.2% didn't receive them, and 62.6% received seeds as an input, and 37.4% were the ones who didn't receive seeds. 208 Farmers received seed input which make it to be the most ordered input among other input received by cassava farmers selected in this study. Farmers received input from different agro-input dealers. With 81.63%, the most common source of tractors for hire was a tractor hire services provider. 14.3% was provided by neighbors and the village chairman. Only 4.08% of the tractors were hired from an ACDP tractor service provider. By gender, male gender, cassava farmers who did not (No) access tractor hire services had the highest percentage (52.27%) while in female gender farmers who accessed tractor hire services had the dominant percentage (60.71%). Farmers who did not access tractor higher services had the highest overall percentage (55.42%). The respondents received tractor hire services from different location such as district, sub-county and parish level. 50% of cassava farmers received tractor hire services from villages, and 44.58% from sub-county while only 0.6% received tractor from districts.

The majority of farmers received tractor hire services from the truck, followed by a local agro input shop they know, a local agro input shop they don't know, other agro input dealers and from storage facility with percentages of 50.66, 16.16, 14.85, 11.35 and 6.98 respectively. The findings revealed that most of the respondents used NAROCASS 1, 7.86% for NASE 19 and 0.87% used NASE 14

This study identified seven major challenges faced by cassava farmer during production in these three districts are Diseases, Drought, Floods, Low soil fertility, Pest, Stray animals and Theft. Stray animal was listed by farmers as the main problem especially in Yumbe districts. However, drought was raised as the second.

The majority faced the challenge of limited information about how the voucher system operates with 33.15% of farmers, followed by delayed processing due to system failure with 29.28%. The third major challenge faced by farmers was long distances in accessing inputs.

The farmers who did not use tractor hire services in the last season but were planning to participate in the subsidy program the following (next) season were 172 and those that used tractor hire services and were willing to participate in the subsidy program the following(next) season were 140 farmers. While 12 farmers who did not use tractor hire services and were not planning to participate in the subsidy program the following season. Seven farmers used tractor services but were not planning to participate in the subsidy program the following (next) season

5.1.1 Correlation Between Tractor Hire Services, Other Inputs, and Cassava Productivity

This section presents an analysis of the relationship between tractor hire services and other agricultural inputs, as well as the combination of inputs associated with improved cassava production among ACDP e-voucher beneficiaries in West Nile. The analysis is based on descriptive statistics, probit regression results, and linear regression estimates presented earlier in this study.

5.1.2 Relationship Between Tractor Hire Services and Other Inputs

The relationship between tractor hire services and other agricultural inputs was found to be significant in shaping both adoption and productivity outcomes. Farmers who accessed quality

seed inputs through the E-voucher system were more likely to use tractor hire services, particularly for land preparation. This suggests that farmers who were more commercially oriented and input-intensive were more inclined to adopt mechanized services.

Nevertheless, the study identified several constraints affecting the combined use of tractor hire services and other inputs. These included delayed input delivery, limited information on how the E-voucher system operates, high transport costs, and insufficient financial resources. Such challenges reduced the efficiency of input utilization and, in some cases, discouraged farmers from fully participating in the program.

5.1.3 Relationship Between Tractor Hire Services and Cassava Productivity

Results from the regression analysis indicated that the effect of tractor hire services on cassava productivity was mixed. While tractor hire services were expected to improve productivity by enhancing timely land preparation and expanding cultivated area, the results showed that these benefits were not uniform across all farmers.

Productivity gains associated with tractor hire services were more evident in districts where access to tractor services was relatively better and where complementary factors such as soil fertility and farmer training were favorable. In contrast, in areas with limited access to tractor services or poor soil conditions, the effect of tractor hire services on productivity was less pronounced.

5.1.4 Optimal Combination of Inputs for Higher Cassava Volumes

The study concludes that higher cassava output is achieved through an optimal combination of tractor hire services, adequate land size, improved seed varieties, good soil fertility, and effective training and extension services. Tractor hire services are most beneficial when used as part of an integrated production system rather than as a standalone intervention.

Strengthening extension services and improving coordination among tractor service providers, agro-input dealers, and farmers would enhance the effectiveness of the E-voucher program. Improving the reliability of the E-voucher Management System would also reduce delays and increase farmers' confidence in the program.

The study concludes that tractor hire services alone do not significantly improve cassava productivity among ACDP e-voucher beneficiaries. However, when combined with supportive inputs and institutional factors such as sub-county-level access, adequate land size, soil fertility management, and a commercial production orientation, tractor hire services contribute positively to increased cassava volumes. This underscores the importance of promoting integrated input use rather than isolated mechanization interventions.

5.2 RECCOMENDATION

The study on the adoption and effect of tractor hire services under the e-voucher program among cassava farmers in West Nile Uganda revealed several critical insights and challenges that warrant targeted interventions. Participation in tractor hire services remained limited, with only 44.58% of the 332 sampled farmers utilizing the service, while the majority (55.42%) did not, primarily due to factors such as small land sizes, high rental costs, scarcity of service providers, and land boundary issues during tillage. Yumbe district recorded the highest participation, likely owing to a larger number of cassava farmers and relatively suitable farm conditions, whereas Maracha and Pakwach showed lower engagement. Gender disparities were evident, with male farmers exhibiting higher overall non-adoption rates, although women demonstrated relatively better proportional uptake when services were accessed. Most farmers sourced tractors from private providers (81.63%), with only a small fraction (4.08%) relying on ACDP-supplied services, highlighting the inadequacy and inaccessibility of project-provided tractors. Village-level delivery negatively influenced adoption, while sub-county locations showed more positive outcomes. The majority of farmers grew cassava for commercial purposes, yet challenges such as limited information about the e-voucher system (33.15%), delayed processing due to system failures (29.28%), and long distances to input redemption points (21.55%) significantly hindered participation. Farmers also faced production constraints including stray animals, drought, theft, floods, diseases, pests, and low soil fertility. Looking ahead, a substantial number expressed willingness to participate in future seasons, though inadequate funds emerged as the primary reason for non-participation. To address these issues, farmers overwhelmingly recommended the provision of extension services (69.95%), timely input delivery, increased land acreage support, improved mobile money stability, and extended subsidy periods. These findings underscore the

need for MAAIF and the Agriculture Cluster Development Project to enhance information dissemination through awareness campaigns and training, increase the availability and reliability of ACDP-contracted tractors, prioritize accessible delivery points at sub-county and village levels, promote gender-inclusive access through targeted support for women, introduce flexible financing and group ownership models to improve affordability, and integrate comprehensive extension services to link mechanization with improved agronomic practices, ultimately fostering higher adoption rates, greater farmer satisfaction, and sustainable improvements in cassava productivity across the region.

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