SOCIO-ECONOMIC IMPACT OF ADVANTA HYBRID SUNFLOWER SEEDS TO SMALLHOLDER FARMERS IN DODOMA, SINGIDA AND MANYARA REGIONS, TANZANIA

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EXTENDED ABSTRACT

Agriculture is considered an important sector in achieving the improvement of wellbeing and poverty reduction for the majority of smallholder farmers in the rural areas. However, with the absence of productivity-boosting technologies such as improved seeds, such improvement in smallholder farmers' wellbeing and povery reduction may be hard to achieve. Moreover, for smallholder farmers to be compelled to adopt an agricultural technology they will need to feel the impact of such technology on their wellbeing. This study assessed the socio-economic impact of Advanta sunflower hybrids seeds on smallholder farmers' wellbeing. The specific objectives of this study were to (i) determine production performance of Advanta Sunflower Hybrid seeds and the rest of the seeds used in the study areas, (ii) analyze the economic performance of the Advanta Sunflower Hybrid seeds and the rest of the seeds used in the study areas, (iii) assess the small-scale farmers' perceptions on Advanta Sunflower Hybrid seeds, (iv) determine factors influencing the adoption of the sunflower hybrid seeds and (v) determine the effect of Advanta Sunflower Hybrid seeds on smallholder farmers' wellbeing.

A multistage sampling technique was applied in which villages were selected randomly and a sample of 270 smallholder sunflower farmers was also randomly selected. The household survey questionnaire, focus group discussions (FGDs) and key informant interviews were used to collect primary data. Descriptive statistics were used to profile the farmers in the study areas to their socio-economic characteristics. Productivity and profitability of various sunflower seeds used in the study areas were analyzed through yield per acre and gross margin per acre, respectively. The perception was measured using a Likert scale containing perception statements about Advanta Sunflower Hybrid

seeds, and specifically the Hysun33 variety. A binary logistic regression model helped to determine the factors that influence farmers' decisions on whether to adopt or not adopt Advanta Sunflower Hybrid seeds. Propensity score matching was used to isolate the impact attributable to Advanta Sunflower Hybrid seeds among smallholder farmers. Results indicate that Hysun33 seeds had the highest productivity of 579.8Kg/acre and profitability of TZS 263 559.5 per acre compared to other seeds. Just over two-thirds (67.3%) surveyed farmers in the study area strongly agreed with all the positive statements stated about Hysun33 seeds where most agreed that seeds are high yielding. On contrary, 11.4% of surveyed farmers in the study area strongly agreed with the negative statements and most agreed that the seeds have a high price. The general implication isthat farmers perceive positively the seeds except that they are expensive. Factors such as sunflower yield per acre, smallholder farmer‘s education level (number of years spent in school), seed price, household size, geographical location and oil content were significantly associated farmers decision to adopt the Advanta Sunflower Hybrid seeds in the study areas. Furthermore, results indicate that adopting Advanta Sunflower Hybrid seeds improves smallholder farmers' productivity and income. There is a significant impact of Advanta sunflower hybrid on the yield per acre obtained by smallholder farmers hence they contribute to the improved productivity of sunflower in the study areas. Although there is no significant difference between income obtained from the use of Hysun33 seed and the rest of the seeds, income per acre for adopters is still above that of non – adopters,implying that adopters have improved their wellbeing when compared to non-adopters. Therefore, this study recommends that agricultural development initiatives should promote productivity-enhancing agricultural technologies because they have the potential to improve smallholder farmers' wellbeing. Secondly, to promotethe use of improved seeds such as Advanta Sunflower Hybrid seeds, an effective

way is to seriously look into own seed price with consideration of production costs of the seeds to ensure there are mutual benefits between farmers and seeds producers.

DECLARATION

I, Wendy Malkias Mombo, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor is concurrently being submitted in any other Institution.

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Dr. Emmanuel T. Malisa **Date**

(Supervisor)

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Special thanks to my parents who believed in me, facilitated my education and prayed for me each time, may God grant all their heart desires.

DEDICATION

To all sunflower farmers in Tanzania.

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LIST OF ABBREVIATIONS

AMDT	Agricultural Marketing Development Trust
ASDPII	Agricultural Sector Development Program Phase Two
ATT	Average Treatment Effect on The Treated
EUT	Expected Utility Theory
FAO	Food and Agriculture Organization
GM	Gross Margin
ICT	Information and Computer Technology
NNM	Near Neighbour Matching
OPV	Open Pollinated Varieties
PSM	Propensity Score Matching
SDG	Sustainable Development Goals
SSA	Sub-Saharan Africa
TDV	Tanzania Development Goal
ToC	Theory of Change
TR	Total Revenue
TVC	Total Variable Cost
UPL	United Phosphorous Limited
URT	United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture is considered an important sector in achieving the improvement of livelihood and poverty reduction for the majority of smallholder farmers in the rural areas of Africa (John and Alban, 2018). About 80% of the land used for agriculture production in sub-Saharan Africa (SSA) is occupied by smallholder farmers (OECD/FAO, 2016). There are various accepted definitions of smallholder farmers. Donatti *et al.* (2018) define smallholder farmers as those who depend on their farm production for both food security and income, cultivate small areas (less than 10 ha) and often use family labour, they often have limited resources to maintain or increase agricultural productivity, live in environmentally fragile and remote locations.

Sunflower falls under edible oil subsector in agriculture that offers a range of livelihood opportunities. It is one of the oil plants that contributes about 13% of the total production of high-value edible oil worldwide (Gabagambi and George, 2010). Moreover, sunflower has high oil and economic potentials to improving livelihood and reduce poverty among the smallholder farmers who are vital actors in agriculture (Torimiro *et al*., 2014).

In Tanzania, sunflower is grown countrywide but mostly in the central zone; it is estimated that about 4 million smallholder farmers in Tanzania are engaged in sunflower production (Mgeni *et al*., 2019). The mean yield of sunflower is estimated to be 0.7 metric tonnes/ ha with the use of local seeds for production but there is reported

potential production of up to 2 or 3 metric tonnes per ha with the use of improved seeds or hybrids (Gabagambi and George, 2010). According to Mgeni *et al*. (2019), sunflower yields averaged 1.4 t/ha for farmers using hybrid seeds and an average yield of 0.6 t/ha for farmers using local seeds.

Sunflower production in Tanzania is highly associated with market production and input constraints. While the marketing constraints can be solved by factors associated with obtaining quality products, the input constraints can be solved by acquiring quality and certified seeds. Other constraints include shortage of capital and/or inability to buy new seeds due to limited incentive, low skills to re-plant the old seeds, less bargaining power and knowledge on the available market (Larsson, 2018).

The Tanzanian Government has made several efforts to improve agriculture production in the country including increasing the budget allocated to the sector from TZS 3.3 billion in 2016 to 7.85 billion in 2021; improving crops value chains including that of sunflower; and encouraging various actors to increase seed production and certification to improve the yield (URT, 2021). Likewise, the government has formulated strategies, policies and laws governing the agriculture sector including the sunflower sub-sector. One example is the Seeds Act of 2003, amended in 2007, which governs seed production and certification andcontrols and regulates all standards related to agricultural seeds inclusing the sunflower seeds (URT, 2016).

The actors in seed production include private companies, such as Advanta and organizations performing interventions with the ultimate goal to facilitate dissemination of improved agricultural inputs such as seeds which have potentials to increase

production and help the smallholder farmers improve their wellbeing. The status of smallholder farmers' wellbeing in this study is assessed directly using income as proxy indicator for wellbeing. In most cases a household with adequate income can easily meet its needs and acquire assets that maybe be valuable in the production process (Mushi, 2019; Ahmed and Mesfin, 2017; Adebayo, 2016).

Advanta Seeds Company holds fifth place in the 2019 seed index (Spielman *et al*., 2019). Advanta and its parent company United Phosphorous Limited (UPL) offers a range of capacity building activities such as smallholder farmer training and ICT-driven services (Spielman *et al*., 2019). Advanta's relatively wide portfolio covers many index crops in Research and Development. The company partners with Farm Input Promotions (FIPS) Africa to support demonstration farms and field days in Tanzania. More than 47 field days have been organized around sunflower hybrids, showcasing the advantages of the hybrid variety and approximately 35 000 farmers have been reached through the distribution of free sample seed packets (Advanta, 2019).

In 2017, the Agricultural Marketing and Development Trust (AMDT) implemented a sunflower value chain project whose strategic objective was to increase the incomes of at least 150 000 smallholder farmers by 50% by the end of 2020. AMDT's interventions in the sunflower value chain were implemented in 11 regions which were Dodoma, Mbeya, Rukwa, Katavi, Songwe, Singida Lindi, Mtwara, Manyara, Iringa and Njombe. To achieve this, AMDT intended to facilitate pro-poor systemic changes in selected markets systems within the value chain, specifically the seed market, the core market where there is weak collaboration, and selected service markets. For the seed market AMDT through Faida Mali and Farm Africa in Dodoma, Singida and Manyara regions

distributed Advanta sunflower hybrid, i.e. Hysun33 seeds to smallholder farmers and offered training of good agronomic practices. Important traits of Advanta Sunflower Hybrid seeds specifically Hysun33 seeds include high yielding, high oil content, short maturity length, drought tolerance and disease resistance (Ogutu, 2018).

The basic question guiding this study is whether Advanta Sunflower Hybrid seeds have a socio-economic impact to the wellbeing of smallholder farmers. Assuming that farmers behave rationally, they will decide to adopt improved technologies such as hybrid seeds that have a positive impact on their lives.

1.2 Problem Statement

Sunflower production has been for many years one of the important sources of income among smallholder farmers and a source of foreign currency in Tanzania (Mgeni *et al*., 2018). Sunflower cultivation stands a better chance for improving livelihood outcomes among smallholder farmers, unlike other economic activities. For instance, Mchopa and Jeckoniah (2018) revealed that the proportion of smallholder farmers with higher-level livelihood outcomes improved from19.2% before engaging in sunflower cultivation to 54% after engaging in sunflower cultivation.

Sunflower yields remain low (518.2 Kg/acre) in Tanzania compared with European and Central Asian producers (between 809 Kg/acre and 1214.1 Kg/acre, respectively) even when there is a good growing condition (Isinika and Jeckoniah, 2019). The reason for this situation may include the limited availability of high-quality, high yielding certified seeds, as well as a low awareness on the part of some farmers of the benefits and value of paying for such high-quality seeds (URT, 2016).

A report by Farm Africa (2020) showed the efforts that were made to facilitate smallholder farmers to adopt the best practices in commercial sunflower production. One of those efforts includes the introduction of improved seed varieties like Advanta Sunflower Hybrid seeds. However, no evidence has been established to show what socio-economic impact these efforts have on smallholder farmers. Hence a reason why this study was conducted.

In order to increase productivity, farmers are expected to behave rationally and may need to opt for better seeds that enhance productivity hence improved profitability. In the process of improving productivity, farmers are constrained by income and therefore need to choose a combination of resources subject to their income (FAOSTAT, 2015). This study argues that farmers will compare the impact from the hybrid with the impact from local seeds and adopts improved seeds if the expected impact from adopting exceeds the expected impact of the local seeds. But research in sunflower seeds has focused on the drivers and barriers of adoption of hybrid seeds (Tibamanya, 2021), rather than the impact of these seeds on the wellbeing of smallholder farmers or yield and income in particular.

Therefore, this study focused on how sunflower hybrid seeds such as Advanta hybrid impact the smallholder farmers producing sunflower. It has attempted to bridge the knowledge gap left by researchers on the socio-economic impact of hybrid seeds using the propensity score matching method (PSM). PSM was used establish the impact of improved agricultural technologies such as Advanta's sunflower hybrid seed to the smallholder farmers in Dodoma, Singida and Manyara Regions.

1.3 Justification of the Research

This study aims at understanding the socio-economic impact of using Advanta hybrid seeds on the smallholder farmers in the study area. The findings from this study provide beneficial information to various stakeholders in development projects, policymakers and practitioners in reducing poverty through increased agricultural productivity. The study is also in line with the first Sustainable Development Goal (SDG 1) and Tanzania Development Vision (TDV) 2025 which aim at alleviating poverty and improving livelihoods, respectively. Moreover, in Tanzania sunflower is mentioned to be a priority crop in the central zone in the second phase Agricultural Sector Development Program (ASDP II) in the criteria; viability of commercialization, scaling up and scaling out, and availability of technology to improve productivity and profitability (URT, 2017).

1.4 Objectives

1.4.1 Overall objective

The overall objective of the study was to assess the social and economic impacts of sunflower production using Advanta hybrid seeds on the smallholder farmers.

1.4.2 Specific objectives

The specific objectives of the study were to:

i. Determine production performance of Advanta Sunflower Hybrid seeds and the rest of the seeds used in the study areas.
ii. Analyze the economic performance of the Advanta Sunflower Hybrid seeds and the rest of the seeds used in the study areas.
iii. Assess the small-scale farmers' perceptions on Advanta Sunflower Hybrid seeds.
iv. Determine factors influencing the adoption of the sunflower hybrid seeds.

v. Determine the effect of Advanta Sunflower Hybrid seeds on smallholder farmers' wellbeing.

1.4.3 Research questions

i. What is the yield obtained through the use of Advanta Sunflower Hybrid seeds and the rest of the seeds?
ii. What is the profitability from the use of Advanta Sunflower Hybrid seeds and the rest of the seeds?
iii. How do the smallholder farmers perceive Advanta Sunflower Hybrid seeds?
iv. What factors determine the decision of the smallholder farmers on whether to adopt or not adopt Advanta Sunflower Hybrid seeds?
v. What is the contribution of the hybrid seeds to the yield and income of the smallholder farmers?

1.5 Theoretical Framework

The study was guided by the Theory of Change (ToC) and the Expected Utility Theory (EUT). The ToC is a statement of how the inputs being provided (funds, people, and changes in regulatory or policy environment) lead to intended outcomes and impacts. The theory identifies the steps in the causal chain and underlying assumptions which need to hold in order for the theory to operate as expected (White and Raitzer, 2017). In this study the theory was related to the intervention made by seed companies, such as Advanta, which supply sunflower hybrid seeds so as to achieve a desired sunflower yield and ultimately improve the smallholder farmers' wellbeing.

Expected Utility Theory (EUT) states that a farmer compares the innovation with the traditional technology and adopts it if the expected utility from adopting exceeds the

expected utility of the traditional technology (Borges *et al.*, 2015). For this study if behaving rationally, farmers compare improved technology (Advanta's sunflower hybrid seeds) with the rest of technologies and decides to adopt the improved technology if the expected utility is greater compared to the utility from the rest of technologies. Utility in this context is yield and profitability that is obtained from either the improved technology (Advanta hybrid seeds) or the rest of technologies.

These two theories have been used in this study because of the hybrid seeds were disseminated in the study areas so as to lead to the desired wellbeing outcomes with the assumptions that farmers behave rationally and therefore they will opt to use these hybrid seeds in expectation of improved wellbeing (yield and income).

1.6 Conceptual Framework

The conceptual framework shows the relationship between dependent and independent variables. The wellbeing of smallholder farmers in the study area depends on crop production were one of the crops produced is sunflower. These farmers have been using local seeds to cultivate sunflower, which may be one among the reasons to why there is still low productivity.

The conceptual framework (Figure 1.1) shows how adoption of hybrid seeds such as Advanta seeds expected to impact directly the wellbeing of smallholders. The wellbeing outcomes in this regard include yield and income. In this context therefore if farmers are behaving rationally they decide to adopt sunflower hybrid seeds where they perceive that they will improve wellbeing outcomes through the two key indicators, yield and income.

Moreover, the decision to adopt hybrid seeds is related or associated to various factors such as institution context, seed characteristics, natural factors and farmer's characteristics. The conceptual frameworks indicate that factors like institution context and natural factors also have direct relationship with farmer's wellbeing.

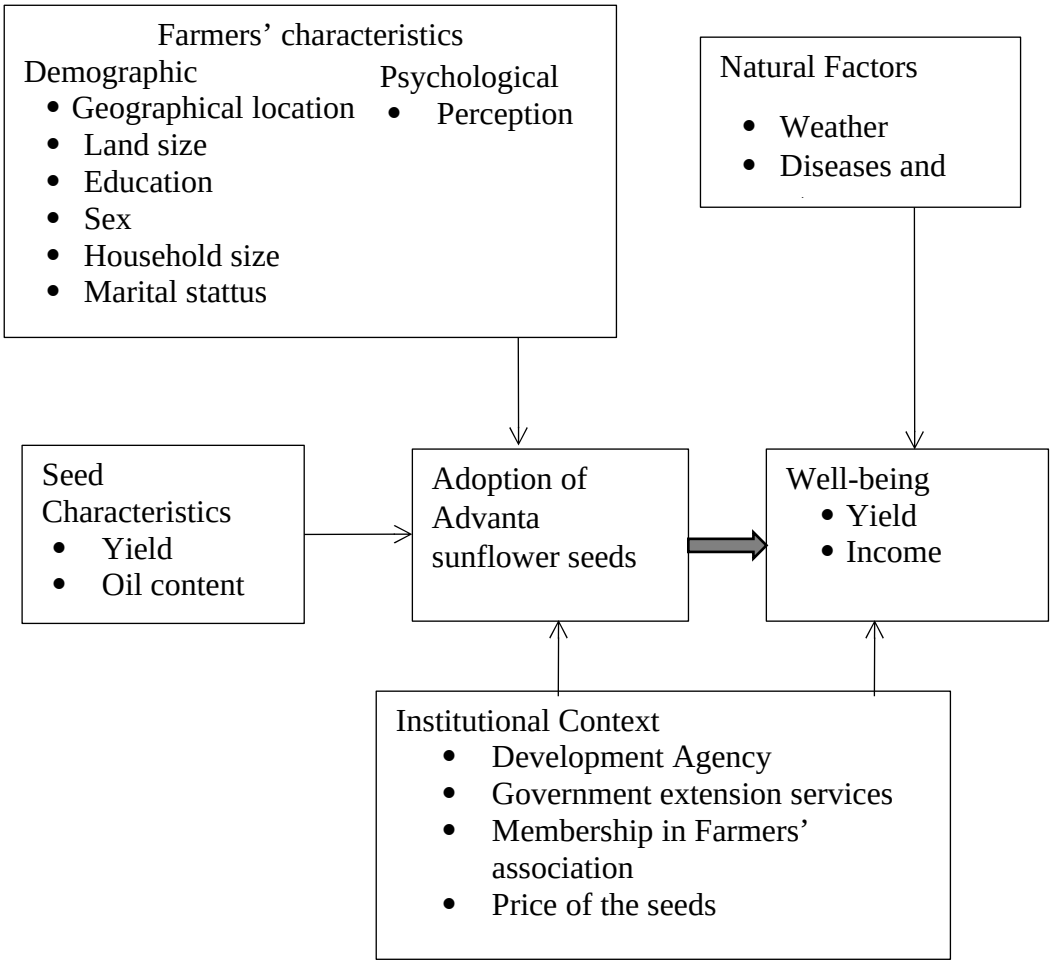

Figure 1.1: Conceptual Framework

1.7 Methodology

The study was conducted in Singida, Manyara and Dodoma Regions in Tanzania. These areas have been selected because Singida region with 67 682 tonnes and yield of 0.5 tonnes/ha is the second highest in sunflower production followed by Manyara region with 63 612 tonnes and yield of 0.7 tonnes/ha and Dodoma region was selected because it has the largest area (227 901 ha) in the country planted with sunflower (URT, 2017).

The study used a cross-sectional research design which allows the collection of data at one point in time (Bhattacherjee, 2012). A mixed approach was used in the study where both quantitative and qualitative data were collected, qualitative data was used to complement the qauantitative data (Cresswell, 2014).

Multiple stage sampling procedure with three stages was used in this study where as it also involved purposive selection of districts and wards in Singida, Manyara and Dodoma Regions where Advanta sunflower hybrid seeds were introduced. Household survey questionnaires, key informant interviews and focus group discussions were the tools used for data collection.

Data entry was done using SPSS, later data was analysed using both SPSS and STATA. Descriptive statistics, binary logistic regression and Propensity score matching wer used to for analysis so as to answer the research questions of this study.

1.8 Organization of this Dissertation

This dissertation is organized in four chapters. The abstract gives the preliminary of the study while first chapter is an introduction of the overall theme studied. Chapter two contains publishable manuscript one which covers objectives i, ii and ii which also provide answers for research questions i, ii and iii. Chapter three contains the second publishable manuscript which covers objectives iv and v which also provides answers for research questions iv and v. Lastly, chapter four presents the study's general conclusions, recommendations and policy implications.

1.9 Limitations of the Study

This research study was conducted during the Covid-19 pandemic era and data was collected when the second wave hit so it was risky for health. Preventive measures were taken to minimised the risk of the disease. For instance, enumerators and respondents were provided with face masks and sanitizersand distance was maintained between an enumerator and the respondent during the household survey questionnaire interview.

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CHAPTER TWO

2.0 ECONOMIC PERFORMANCE OF ADVANTA SUNFLOWER HYBRID SEEDS AND SMALLHOLDER FARMERS' PERCEPTION TOWARDS THESE SEEDS IN DODOMA, SINGIDA AND MANYARA REGIONS

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Abstract

Sunflower fall under edible oil subsector in agriculture that offers a range of livelihood opportunities; it is one of the oil plants that contributes about 13% of the total production of high value edible oil worldwide. Sunflower production is still dominated by smallholder farmers who may not afford the prices of improved seeds and ultimately end up using local seeds because they are cheap. This study explored the economic performance of Advanta Sunflower Hybrid seeds and how farmers perceive these seeds. A multistage sampling technique was applied and a sample of 270 smallholder sunflower farmers was selected randomly. Household survey questionnaire, focus group discussions (FGDs) and key informant interviews were used to collect primary data. Descriptive statistics were used to profile the farmers in the study areas with respect their socio-economic characteristics. Productivity and profitability of various sunflower seeds used in the study areas were analyzed through yield per acre and gross margin per acre respectively. Perception was measured using a Likert scale containing perception statements about Advanta Sunflower Hybrid seeds specifically Hysun33 variety. Results indicate that Hysun33 seeds has the highest productivity of 579.78Kg/acre and the highest profitability of 263 559.5Tshs/acre compared to other seeds. Perception scores indicate that majority of farmers 81.4% perceive the seeds moderately. This study therefore recommends farmers to use improved sunflower seeds because they increase productivity which in turn have an effect of increased profitability but also a reduction in price should be made. The study also recommends processors to work close to farmers through contract farming so that farmers can easily access the seeds by entering into a contract with processors who will provide seeds by credit.

Keywords: Sunflower, Hybrid seeds, Productivity, Profitability and Perception.

2.1 Background

Sunflower falls under the edible oil subsector in agriculture that offers a range of livelihood opportunities; it is one of the oil plants that contributes about 13% of the total production of high value edible oil worldwide (Gabagambi and George, 2010). Moreover, sunflower has high oil and economic potentials to improving livelihood and reduce poverty among the smallholder farmers who are vital actors in agriculture (Torimiro *et al*., 2014).

Tanzania ranks tenth among sunflower producers in the world and second in Africa, after South Africa. Within East Africa, Tanzania is the leading producer, having the highest area under production and the highest output of sunflower seed (FAOSTAT, 2015). In Africa, Tanzania is the second largest producer of sunflower oil with approximately 23.1% of total oil production in the continent. According to RLDC (2008), sunflower is one of the key sub-sectors of agriculture in Tanzania. URT (2016) affirms that sunflower cultivation in Tanzania occupies an estimated area of 1.7 million hectares, with the average yield for local varieties of 1.6 tons per hectare.

In the 1990s, the government extension services cooperated with various non-governmental organizations (NGOs) and development agencies to promote sunflower production in order to reduce poverty in the central zone of Tanzania by facilitating improvement of agronomic practices and introducing simple processors . Sunflower is now produced in almost all regions of mainland Tanzania but this is a precedence of efforts made by research stations under the Ministry of Agriculture which came up with higher-yielding sunflower seed varieties and since then sunflower production has shown an upward trend afterwards (Mgeni *et al.,* 2018).

The Tanzanian Government has made several efforts to improve agriculture production in the country including increasing the budget allocated to the sector from TZS 3.3 billion in 2016 to 7.85 billion in 2021; improving crops value chains including that of sunflower; and encouraging various actors to increase seed production and certification to improve the yield (URT, 2021). Likewise, the government has formulated strategies, policies and laws governing the agriculture sector including the sunflower sub-sector. One example is the Seeds Act of 2003, amended in 2007, which governs seed production and certification andcontrols and regulates all standards related to agricultural seeds inclusing the sunflower seeds (URT, 2016).

The actors in seed production include private companies, such as Advanta Seeds Company which holds fifth place in the 2019 seed index (Spielman *et al*., 2019). Advanta and its parent company, the United Phosphorous Limited (UPL), offer a range of capacity building activities such as smallholder farmer training and ICT-driven services. Advanta's relatively wide portfolio covers many index crops in research and development (Spielman *et al.*, 2019). The company partners with Farm Input Promotions (FIPS) Africa to support demonstration farms and field days in Tanzania. More than 47 field days have been organized around sunflower hybrids, showcasing the advantages of the hybrid variety and approximately 35 000 farmers have been reached through the distribution of free sample seed packets (Advanta, 2019).

The yield from sunflower hybrid seeds is typically 5–8t/ha and the oil content is higher ranging from 43–48 per cent (Isinika and Jeckoniah, 2021). While it was found that the use of improved seeds was important for increased productivity and profitability majority of smallholder farmers could not afford the prices of improved seeds and used

local seeds because they are cheap (Mushi, 2019). Sunflower production is still dominated by smallholder farmers who account for nearly 95 per cent of all producers cultivating 2ha or less, 4 per cent are medium (5–40ha) and only 1 per cent are large scale farmers cultivating over 40 ha (URT, 2016). There are various accepted definitions of smallholder farmers. According to Donatti *et al.* (2018) most of the smallholder sunflower farmers depend on their production for both food security and income, cultivate small areas (less than 10 ha) and often use family labour, they often have limited resources to maintain or increase agricultural productivity, live in environmentally fragile and remote locations.

In 2017, the Agricultural Marketing and Development Trust (AMDT) implemented a sunflower value chain project whose strategic objective was to increase the incomes of at least 150 000 smallholder farmers by 50% by the end of 2020. AMDT's interventions in the sunflower value Chain were implemented in 11 regions which were Dodoma, Mbeya, Rukwa, Katavi, Songwe, Singida Lindi, Mtwara, Manyara, Iringa and Njombe. To achieve this, AMDT intended to facilitate pro-poor systemic changes in selected markets systems within the value chain, specifically the seed market, the core market where there is weak collaboration, and selected service markets. For the seed market AMDT through Faida Mali and Farm Africa in Dodoma, Singida and Manyara regions distributed Advanta sunflower hybrid, Hysun33 seeds to smallholder farmers and offered training of good agronomic practices. Important traits of Advanta Sunflower Hybrid seeds specifically Hysun33 seeds include high yielding, high oil content, short maturity length, drought tolerance and disease resistance (Ogutu, 2018).

This study seeks to explore the economic performance of Advanta Sunflower Hybrid seeds and how farmers perceive these seeds, assuming that farmers will perceive these seeds positively because they are high yielding and therefore hold the potential of increasing profitability. Mgeni *et al.* (2019), explains that hybrid seeds have the potential to improve the productivity of farmers but does not indicate the specific seed variety that have the potential to improve productivity, which may mean that Advanta seeds could be one of these productivity-improving varieties. A study by Tibamanya (2021) shows the drivers and barriers of adoption of improved sunflower seeds such as Hysun33 and Aguara4, whereas risk aversion and liquidity constraints are significant barriers to the adoption of improved sunflower varieties, while radios, extension service and farmers' groups are important channels for farmers for receiving information about new technologies. Justin (2012) showed that factors that affect the acceptance of innovation in sunflower production at the household level include the level of experience in farming, contact frequency with the extension officer, size of the family, market availability for sunflower and the level of education of the farmers. Several studies have been conducted on improved seed varieties but still, less is known about the economic performance of sunflower hybrid seeds such as Advanta sunflower seeds and the way farmers perceive them. Therefore this study has attempted to fill the knowledge gap on the economic performance and perception of farmers on these seeds.

2.2 Methodology

2.3 Description of the Study Area

The study was conducted in Singida, Manyara and Dodoma Regions in Tanzania. These areas have been selected because Singida Region, with 67 682 tonnes and a yield of 0.5 tonnes/ha, is the second-highest in sunflower production followed by Manyara Region

with 63 612 tonnes and yield of 0.7 tonnes/ha. Dodoma Region was selected because it has the largest area (227 901 ha) in the country planted with sunflower (URT, 2017). The mentioned study areas were purposively selected because, in the area, Agricultural Marketing Development Trust AMDT through Faida Mali and Farm Africa implemented a sunflower value chain project intending to increase the incomes of smallholder farmers. To achieve this objective one of the key things was promoting the use of Advanta Sunflower Hybrid seeds so as to improve productivity.

2.4 Sampling Procedure and Sample Size

Multistage sampling procedure with three stages was used in this study. The first stage involved the purposive selection of districts and wards in Singida, Manyara and Dodoma Regions where Advanta Sunflower Hybrid seeds were introduced. One district was selected purposively from each region (i.e Kongwa, Mkalama and Hanang for Dodoma, Singida and Manyara, respectively) and 3 wards were also selected purposively from each district. The second stage involved the random selection of two village from each of the selected wards whereas the third stage involved the random selection of respondents (farmers) from the selected villages. These districts and wards were selected based on their use of Advanta Sunflower Hybrid seeds. From the same villages, a random selection of farmers who do not use hybrid seeds was done. In this regard, a list of farmers using Advanta Sunflower Hybrid seeds and another one entailing farmers not using hybrid seeds were obtained, followed by a random selection of farmers from the two lists.

Furthermore, people who are well informed on the subject matter of interest were selected for key informant interviews. These included agricultural extension officers,

Advanta officials, project officers, and sunflower processors. Focus Group Discussions (FGDs) were used in this study whereby 3 FGDs were conducted each with 12 participants selected based on their use and experience on the improved seeds (Advanta Sunflower Hybrid seeds) and the rest of the seeds in sunflower production.

A sample size of 90 (15 farmers from each village) smallholder sunflower farmers was used for each region, which makes a total of 270 farmers from all three regions. The sample size of 270 farmers (90 from each region) is considered sufficient and can allow most statistical analyses to be conducted. According to Healey and Donoghue (2020), for data to be normally distributed the sample size has to be 30 and above.

2.5 The Data

Quantitative data were collected from sampled farmers using household surveys. The data include yield, costs of production, price of sunflower and farmer's socio-economic characteristics. Moreover, key informant interviews generated information from well knowledgeable people about the subject of interest whereas focus group discussions were conducted so as to enrich the data from the household surveys. Both qualitative data and quantitative data were used for this study because qualitative data in such a study is used to complement the quantitative data (Cresswell, 2014).

2.6 Data Analysis Techniques

Data entry and analysis was done with the use of a statistical package SPSS. Qualitative data from key informants was transcribed and then analysed using content analysis.

2.6.1 Descriptive statistics analysis

Descriptive statistics such as frequencies, means, standard deviations, minimum, maximum and percentages were primarily used to analyze the socio-economic characteristics for households in the study areas. Apart from farmers' profiles, descriptive statistics were also used to analyze productivity, profitability and farmers' perception towards Advanta Sunflower Hybrid seeds.

2.6.1.1 Productivity and profitability analysis

Productivity was analyzed through yield per acre. The average yield of sunflower per acre obtained by farmers using Advanta Sunflower Hybrid seeds and the rest of the seeds that are used in the study area was computed to measure the productivity with the use of each specific seed.

The profitability of Advanta hybrid seeds, local seeds, open-pollinated varieties (OPVs) and other hybrids was analyzed using gross margin, which in this case is a proxy for profit obtained through the production of sunflower. Margins were obtained by computing the difference between revenue and cost incurred by smallholder sunflower farmers.

Gross margin was used to represent profit whereas the gross margin equation is given as follows;

$$GM_t = \sum_{i=1}^{n} (TR - TVC) = \sum P_y Y - \sum P_x X_i \quad \text{.....(1)}$$

Where:

TR is the total revenue from sunflower harvested (monetary value of sunflower harvested) given by $\sum P_y Y$ Where P_y is the price of sunflower and Y is the quantity of sunflower.

TVC is the total variable costs of producing sunflower are cost of sunflower seeds and other inputs respectively. These costs of production include the cost of labour, cost of materials, costs of farm mechanization and transportation costs. TVC is given by $\sum P_x X_i$ where P_x is the price of input and X_i is the input used for sunflower production, these inputs include labour, seeds, fertilizer, chemicals (pesticides, herbicides and boosters), packaging materials, means of transport and means of mechanization.

2.6.1.2 Perception analysis

Likert scale was used to assess and present findings of farmers' perceptions on the Advanta Sunflower Hybrid seeds impacts in sunflower production systems. For each perception measuring statement farmers were asked to state whether they agreed, strongly agreed, disagreed, strongly disagreed or were neutral (Undecided). In analyzing the responses, perception scores and index were computed so as to categorize perception into negative moderate and positive.

2.7 Results and Discussion

2.7.1 Farmers' socio-economic characteristics

Out of the 270 sampled sunflower farmers used for this research study, 68.5% are male and 31.5% are female whereas 6.3% of the farmers are single, 86.3 of the farmers are married. From the study sample size, only 8.5% of sunflower farmers were entirely not formally educated that is they spent zero years in school and 78.5% have acquired

primary level education which is equivalent to 7years of formal education. This means 91.5% of sunflower farmers in the study area can at least read, write and count therefore if they are educated on the advantages of using hybrid seeds they are more likely to choose to adopt than otherwise.

Just over two-third (66.7%) of the sampled sunflower farmers responded that farming is their source of income while 2.6% of the total sampled sunflower farmers mentioned formal employment as their source of income. This implies that most sunflower farmers in the study area depend on farming as their main source of income therefore these people have the potential of producing more sunflower with the use Advanta hybrid seeds ifsensitized about the benefits of using these hybrid seeds.

When asked about the land ownership status, especialy for land that is used for sunflower cultivation, out of the 270 sample sunflower farmers 61.5% mentioned that they used their own land for sunflower cultivation and the rest use rented land n (Table 2.1). This means a majority of the sunflower farmers do not incur the cost of renting land for sunflower cultivation, hence stand in a position to make more margins because the cost of renting land is deducted from the overall costs of production unlike those who use rented land.

Table 2.1: Farmers' socio-economic characteristics, n=270

Sex of the farmers	**Frequency**	**Per cent**
Female	85.0	31.5
Male	185.0	68.5
Total	**270**	**100.0**
Marital status		
Single	17	6.3
Married	233	86.3
Widow/widower	12	4.4
Separated	8	3.0
Total	**270**	**100.0**
Education (years spent in school)		
School years		
No formal education	23	8.5
Primary education	212	78.5
Secondary education	28	10.4
Tertiary education	7	2.6
Total	**270**	**100.0**
Source of income		
Farming (crop cultivation)	180	66.7
Livestock keeping	57.0	21.1
Craftsman	1.0	0.4
Formal employment	7	2.6
Business	25	9.3
Total	**270**	**100.0**
Type of land ownership		
Own land	166	61.5
Renting	104	38.5
Total	**270**	**100.0**

The mean age of sunflower farmers is 46 whereas the minimum and maximum age are 20 and 78 respectively; this implies that most of the sunflower farmers in the study area are within the working group population therefore there is enough labour force availability in the study area. The household size was a a number of people in the household where a mean number of people within a household was 6. The mean size of land used for sunflower cultivation for the last production season was 2.75, this means most of the sunflower farmers in the study area are small scale farmers (FAOSTAT, 2015). The farming experience of the sampled sunflower was interpreted as the number

of years a farmer has been cultivating sunflower where the mean number of years that farmers have been cultivating sunflower is 12.59 years (Table 2.2). This may imply that sunflower is one of the main crops produced within the study areas.

Table 2.2: Farmers' socio-economic characteristics, n=270

	Minimum	Maximum	Mean	Std. Deviation
Age of the farmer	20	78	46.3	11.9
Education (years spent in school)	0	15	7.1	2.9
Household size	1	32	6.5	3.1
Amount of land used for sunflower cultivation	0.25	20.00	2.8	2.5
Farming experience (Years)	1	49	12.6	9.9

2.7.2 Productivity of Advanta hybrid seeds, local seeds, open-pollinated varieties and other hybrids

The production performance for the last production season (2019/2020) for different seeds were analyzed by computing the mean yield per acre. Results show that there were two types of Advanta sunflower hybrid seed varieties, namely Hysun33 seeds and Aguara4 seeds, which are used by sunflower farmers in the study areas. Local seed varieties used by farmers in the study area include Zebra (Pundamilia), Lulu and Serena whereas open-pollinated varieties (OPVs) include Record and Kenyafedha. Other sunflower hybrid seed varieties used by farmers in the study areas include Supersun64 and Michelle; these varieties were categorized as other hybrid seeds during analysis because very few farmers among the sampled ones used such seeds.

The average yield per acre for farmers that used Hysun33 seeds and Aguara4 seeds was 579.78 Kg/acre and 555.00 Kg/acre respectively. Yield per acre for local seeds in the last production season was also computed. In this regard, the mean yield per acre for the

farmers that used the local seeds was 278.02 Kg/acre. For the farmers that used the open pollinated varieties in the last production season (2019/2020) the average yield per acre for these sunflower farmers was 492.41 Kg/acre. Similarly, for the farmers that used the other hybrid varieties in the last production season the mean yield per acre was 376.03Kg/acre. The information on production performance (yield/acre) of all seed varieties used by farmers in the study areas is presented in Table 2.3 as follows:

Table 2.3: Yield per acre of sunflower with respect to the seeds used in the last production season (2019/2020)

Yield per acre	n	Minimum	Maximum	Mean	Std. Deviation
Hysun33 seeds	144	70.0	1 205.0	579.8	337.8
Aguara4	4	180.0	1 120.0	555.0	425.3
Local seeds	126	15.0	910.0	278.0	164.6
OPV	16	91.0	962.5	492.4	237.6
Other hybrid seeds	32	45.0	1 120.0	381.2	218.7

From the information obtained during the field survey (Table 2.3), Hysun33 seeds had the highest production performance for the last production season (2019/2020) with an average yield of 579.78 Kg/acre while local seeds had the lowest production performance for the last production season with the yield of 278.02 Kg/acre. Studies by Rossman *et al.* (2018), Abro *et al.* (2019), Mushi (2019) and Abdoulaye (2018) confirm the current study because they looked at productivity with the use of improved seeds and found that farmers using improved seeds had higher productivity compared to farmers using local seeds just like in this study where farmers that used Hysun33 seeds had more yield compared to farmers using other seeds.

Despite the fact that Hysun33 has the highest yield, still, this yield is low because these seeds have the potential to bring about higher yields than the ones acquired. Implying

that farmers could do better if recommended agronomic practices were adopted, a key informant said:

> *"Hysun33 seeds have the potential of producing 1200 Kg per acre if all the recommended agronomic practices for sunflower farming are followed properly but most of the farmers fail to achieve that since they do not adhere to the agronomic principles of sunflower cultivation*".

Moreover, Hysun33 farmers were able to specify the reasons for harvest loss in the last production season which also explains why they did not achieve the potential yield of 1200 Kg/acre. These reasons included weather conditions (high rainfall), pests and diseases, poor post-harvest handling, bird invasion and use of second-generation Hysun33 seeds (Figure 1).

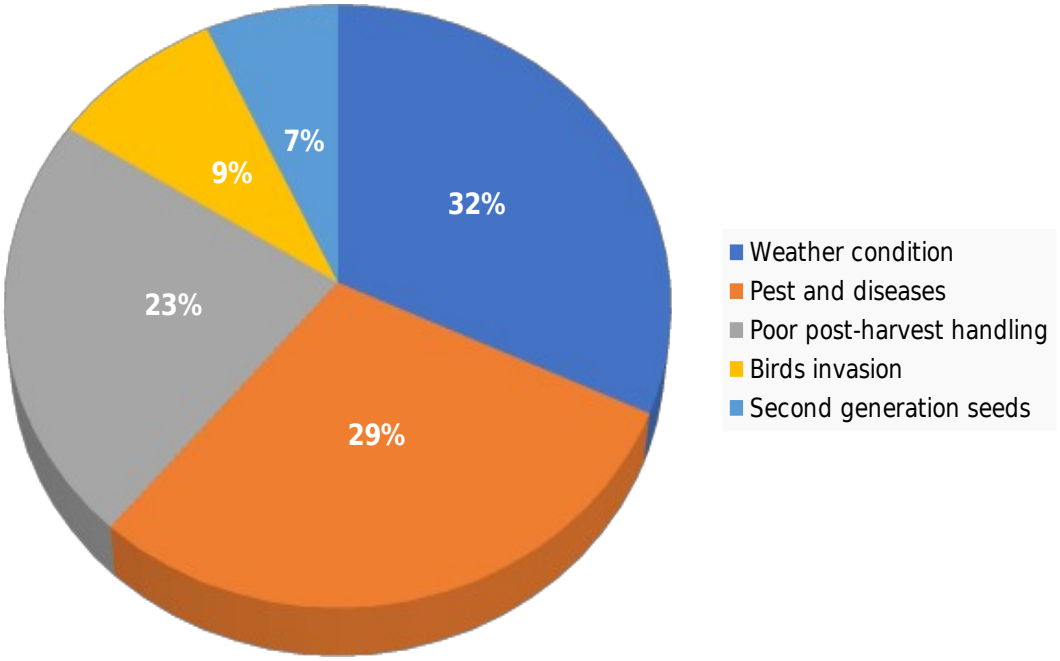

Figure 2.1: Reasons for Hysun33 harvest loss in the last production season

2.7.3 Profitability of Advanta hybrid seeds, local seeds, open-pollinated varieties and other hybrids

The results presented in Table 2.4 show that smallholder sunflower farmers who used Hysun33 sunflower seeds in the last production season recorded an average gross margin of TZS 263 559.52 per acre whereas those who used Aguara4 sunflower seeds recorded an average gross profit of TZS 139 157.14 per acre (Table 2.4). The gross profit per acre for smallholder sunflower farmers who planted their plots with local seeds in the last production season was TZS 87 414.59 per acre. Smallholder sunflower farmers who used the open-pollinated varieties and other hybrid seed varieties recorded mean gross profit of TZS 139 078.13 per acre and TZS 128 577.98 per acre respectively (Table 2.4).

This study indicate more than twice as much gross margin from sunflower production than a gross margin attained from a study done by Kamugisha and Mhanga (2020). The latter revealed the gross margin of up to Tanzanian shillings 41 540.78 per acre as they were trying to conduct an investment analysis on sunflower farming and its prospects to raise the income of smallholder farmers. Furthermore, farmers that used Hysun33 seeds had a high average gross margin meaning that using improved seeds lead to a realization of higher profits compared to the use of other sunflower seeds. These results also conform to the results obtained by Mpogole and Kadigi (2012), Abdoulaye (2018), and Mushi (2019) which indicated that farmers that used improved seeds achieved higher profits compared to those that used local seeds.

There is a potential for a higher gross margin from Hysun33 seeds than the one that is revealed in this study because the yield obtained is still low. Hysun33 has the potential

of producing 1200 Kg per acre therefore if farmers attain the potential yield the gross margin may rise to be higher than the one obtained in this study.

Table 2.4: Gross margin per acre realized from sunflower production for the seeds used in the last production season (2019/2020), n=270

Gross margin per acre	n	Minimum	Maximum	Mean	Std. Deviation
Hysun33	144	-388 900.0	1 210 800.0	263 559.5	219 925.7
Aguara4	4	-3 571.4	254 200.0	139 157.1	125 747.8
Local seeds	126	-236 087.5	426 400.0	87 414.6	105 440.8
OPV	16	111 300.0	492 250.0	139 078.1	161 725.7
Other hybrid seeds	32	-195 500.0	390 000.0	128 578.0	116 969.7

2.8 Perception of Farmers Towards Advanta Sunflower Hybrid seeds

Based on the Likert scale perception statements, shown in Table 2.5, the study findings show that majority (67.3%) of the sampled farmers strongly agreed to all the positive statements about Hysun33 seeds whereas 19.3% were neutral (they neither agreed nor disagreed with all the statements) and 56.1% strongly disagreed to the negative statements about these seeds.

Table 2.5: Farmers' perception on Advanta Sunflower Hybrid seeds (n=220)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Hysun 33 seeds increase the level of the yield of sunflower per bag	0	0	45(16.7%)	27(10%)	198(73.3%)
Sunflower produced from Hysun 33 seeds have higher oil content	1(0.4%)	0	48(9.3%)	25(9.3%)	196(72.6%)
Hysun 33 increase income among farmers as compared to the rest of the seeds	0	1(0.4%)	51(18.9%)	30(11.1%)	188(69.6%)
Hysun 33 seeds are more preferable as compared to other seeds.	0	1(0.4%)	57(21.1%)	29(10.7%)	183(67.8%)
You earn more respect in the community after you adopted Hysun 33	1(0.4%)	5(1.9%)	60(22.2%)	37(13.7%)	167(61.9)
Farmers are to be encouraged to use Hysun 33 seeds	0	2(0.7%)	53(19.6%)	28(10.4%)	187(69.3)
You easily get technical support because you are using Hysun 33 seeds	4(1.5%)	6(2.2%)	79(29.3%)	27(10%)	154(57%)
Hysun 33 mature after a long period of time	186(68.9%)	26(9.6%)	57(21.1%)	0	1(0.4%)
Hysun 33 seeds have poor outcome as compared to other seeds	186(68.9%)	29(10.7%)	49(18.1%)	2(0.7%)	4(1.5%)
Hysun 33 seeds are not tolerant to drought and diseases	169(62.6%)	40(14.8%)	51(18.9%)	4(1.5%)	6(2.2%)
Hysun 33 seeds are too expensive for the farmer to afford.	15(5.6%)	16(5.9%)	50(18.5%)	24(8.9%)	165(61.1%)
It is hard to sell sunflower produce from Hysun 33 seeds	167(61.9%)	37(13.7%)	52(19.3%)	9(3.3%)	5(1.9%)
Hysun 33 seeds have a soft shell	151(55.9%)	26(9.6%)	54(20%)	6(2.2%)	33(12.12)
There is low demand for sunflower produce from Hysun 33 seeds	186(68.9%)	33(12.2%)	48(17.8%)	2(0.7%)	1(0.4%)

The mean perception score was 45.2 and when the scores were categorized 78.5% of the sample fell under the category of moderate perception that is it ranged from 42.2- 48.2 (Table 2.6). This means farmers do not perceive the seeds negatively nor do they perceive them positively. The moderate perception may be due to the price of the seeds because most of them agreed that the seeds are high yielding and have the prospect to increase income except for the fact that they are expensive.

A participant of a focus group discussion conducted in Dodoma stated that:

> *"Modern seeds specifically Hysun33 is a very nice seed because it gives higher yields compared to local seeds when you process the sunflower you get more oil, it is drought-resistant and disease resistant. You can easily cultivate Hysun33 seeds on any soil except for the fact that the price of the seed is high so most people cannot afford"* [FGD Participant, Dodoma. 05/03/2021]

Furthermore, a key informant in Manyara said:

> *"As a processor, I prefer sunflower produced using Hysun33 seeds because it produces more oil and less sunflower cake. Also oil produced from Hysun33 is more attractive, it is clear and has a better taste compared to the oil produced by local seeds"*

The perception results relate to Expected Utility Theory because farmers are more likely to adopt Advanta sunflower seeds because they are high yield and have the prospects of increasing income but they are constrained by the price of the seed. Hence adoption will increase steadily when they have learned from the adopters of Advanta seeds regarding the potential of the seeds. This finding is in line with Timsina and Shivakoti (2018) who stated that a high yielding variety could be a significant incentive for farmers to choose the variety.

Table 2.6: Levels of perception of farmers towards Advanta Sunflower Hybrid seeds

Perception level	Perception score	Frequency	Percent
Negative	<42.2	23	8.5
Moderate	42.2-48.2	212	78.5
Positive	>48.2	35	13

The findings of this study are in line with the findings of a similar study by Teshome and Tegegne (2020), whereby farmers' perception of the better yielding character of improved seed varieties was positive; this study showed that if farmers perceive that new varieties are superior in terms of yield as compared to the local varieties, they will more likely adopt and widely use them. A study by Sanchez *et al.* (2017) has contrary results to this study because farmers have a negative perception towards improved seeds due to limited contact with the extension systems. Therefore, a positive perception toward improved seeds can also be achieved when farmers have a better relationship and frequent come into contact with the extension service providers.

2.9 Conclusions and Recommendations

In conclusion, Advanta seeds have higher productivity and they are more profitable than the rest of the seeds considered in this study (produced in Manyara, Singida and Dodoma). Therefore, in line with the expected utility theory, there is the likelihood of increased adoption of Advanta seeds with time as farmers continue to learn about their superiority in terms of yields and profitability. This is further supported the positive perception of farmers towards Advanta seeds.

This study, therefore, recommends the following;

i. Farmers to seriously consider sunflower production as one of the major sources of income and use improved sunflower seeds such Advanta Sunflower Hybrid

seeds because of they have potential to increase productivity which in turn have an effect of increased profitability.

ii. Reduction in price of Advanta Sunflower Hybrid seeds because their adoption by farmers are discouraged are constrained by higher price which increase the cost of production

iii. Sunflower oil processors should work closely with farmers through contract farming and provide farmers with improved seeds (credit) with the expectation to source sunflower grains from these farmers for processing into oil. This will encourage farmers to use these seeds because they are sure of accessibility of the seeds despite the price of the seeds.

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CHAPTER THREE

3.0 ADOPTION OF ADVANTA SUNFLOWER HYBRID SEEDS AND ITS WELL-BEING IMPACT ON SMALLHOLDER FARMERS IN DODOMA, SINGIDA AND MANYARA REGIONS

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Abstract

Recently interventions have focused on rising agricultural productivity through the promotion of improved agricultural technologies such as seeds because these determine the income obtained from farming activities. This study assesses the adoption of, and impacts of using Advanta sunflower hybrids seeds on smallholder farmers' wellbeing. A multistage sampling technique was applied and a sample of 270 smallholder sunflower farmers was selected. The household survey questionnaires, focus group discussions (FGDs) and key informant interviews were used to collect primary data. Descriptive statistics were used to profile the farmers in the study areas with respect to their socio-economic characteristics. A binary logistic regression model helped to determine the factors that influence farmers' decisions on whether to adopt or not adopt Advanta Sunflower Hybrid seeds. Propensity score matching was used to isolate the impact attributable to Advanta Sunflower Hybrid seeds among the smallholder farmers. Yield per acre, smallholder farmer's education level (number of years spent in school), seed price, household size, region (geographical location) and oil content statistically and significantly influenced farmers decision to adopt theAdvanta Sunflower Hybrid seeds. There is a significant impact in terms of yield and income from the use of Hysun33 seed and the rest of the seeds. This study recommended that agricultural development initiatives should promote productivity-enhancing agricultural technologies effectively. Secondly, a serious look should be taken into own seed price with consideration of production costs of the seeds as to ensure there are mutual benefits between farmers and seeds producers.

Keywords: Sunflower, hybrid seeds, impact, income, yield and adoption

3.1 Background

Rural development interventions have a major goal of improving beneficiaries' wellbeing and that is because wellbeing is one of the important indicators of development in many societies. Wellbeing is measured in many ways but income still is a direct measurement because a household with enough income can easily meet its needs (Ahmed and Mesfin, 2017; Bilan *et al*., 2020). Wellbeing however depends on the way people practice various activities as means to obtain their day to day needs such as food, shelter and clothing (De haan, 2017).

The wellbeing of people in Sub-Saharan Africa largely depends on agriculture therefore steps taken to improve agriculture are automatically set to improve farmers' wellbeing (Adebayo *et al.,* 2017). With regard to the benefits of agriculture, the perspective of many agriculture development interventions has focused on rising agricultural productivity through the promotion of improved agricultural technologies such as seeds because these determine the income obtained from farming activities.

In 2017, the Agricultural Marketing and Development Trust (AMDT) implemented a sunflower value chain project whose strategic objective was to increase the incomes of at least 150 000 smallholder farmers by 50% by the end of 2020. AMDT's interventions in the sunflower value chain were implemented in 11 regions which are Dodoma, Mbeya, Rukwa, Katavi, Songwe, Singida, Lindi, Mtwara, Manyara, Iringa and Njombe. To achieve this, AMDT intended to facilitate pro-poor systemic changes in selected market systems within the value chain, specifically the seed market, the core market where there is weak collaboration, and selected service markets. For the seed market AMDT through Faida Mali and Farm Africa distributed Advanta sunflower hybrid,

Hysun33 seeds to smallholder farmers in Dodoma, Singida and Manyara Regions, and offered training of good agronomic practices. Important traits of Advanta Sunflower Hybrid seeds, specifically Hysun33 seeds, include high yielding, high oil content, short maturity length, drought tolerance and disease resistance (Ogutu, 2018).

In Tanzania, sunflower is mentioned to be a priority crop in the central zone in the second phase Agricultural Sector Development Programme (ASDP II) in the criteria; viability of commercialization, scaling up and scaling out, and availability of technology to improve productivity and profitability (URT, 2017). Moreover, the government has mentioned sunflower to be a strategic crop and aims to advance the cultivation of this crop by empowering seed breeders and agricultural institutes to engage in massive research, invention and production of improved and certified seeds, hence this study has been conducted in the right time.

The basic question guiding this study is whether Advanta Sunflower Hybrid seeds have an impact on the wellbeing of smallholder farmers. Assuming that farmers behave rationally, they will decide to adopt improved technologies such as hybrid seeds that have a positive impact on their lives. Studies have focused on socio-economic factors that influence the decision of farmers to adopt improved sunflower seeds (Tibamanya *et al.*, 2021; Mujama and Izumida, 2019). However, there is a paucity of information regarding the impact of these seeds on smallholder farmers' wellbeing. While the Government of Tanzania is determined to promote sunflower production (URT, 2017), there are improved seeds, including Hysun33, whose impacts on smallholder farmers' wellbeing is not known empirically. This study has attempted to establish the wellbeing impact of Advanta Sunflower Hybrid seeds, namely Hysun33 and Aguara4.

3.2 Methodology

3.2.1 Description of the study area

The study was conducted in Singida, Manyara and Dodoma Regions in Tanzania. These areas have been selected because Singida Region with 67 682 tonnes and yield of 0.5 tonnes/ha is the second-highest in sunflower production followed by Manyara Region with 63 612 tonnes and yield of 0.7 tonnes/ha and Dodoma region was selected because it has the largest area (227 901 ha) in the country planted with sunflower (URT, 2017). The mentioned study areas were purposively selected because AMDT through Faida Mali and Farm Africa implemented the sunflower value chain project with an objective to increase the incomes of smallholder farmers. To achieve this objective, one of the key activities was to promote the use of Advanta Sunflower Hybrid seeds so as to improve productivity.

3.2.2 Sampling procedure and sample size

Multistage sampling procedure with three stages was used in this study. The first stage involved the purposive selection of districts and wards in Singida, Manyara and Dodoma Regions where Advanta Sunflower Hybrid seeds were introduced. One district was selected purposively from each region (Kongwa, Mkalama and Hanang) and 3 wards were also selected purposively from each district respectively. The second stage involved a random selection of two villages from each of the the selected wards whereas the third stage involved a random selection of respondents (farmers) from the selected villages. These districts and wards were selected based on their use of Advanta Sunflower Hybrid seeds. From the same villages, a random selection of farmers who do not use hybrid seeds was done. In this regard, a list of farmers using Advanta Sunflower

Hybrid seeds and another one entailing farmers not using hybrid seeds were obtained, followed by a random selection of farmers from the two lists.

Furthermore, people who are well informed on the subject matter of interest were selected for key informant interviews. These included agricultural extension officers, Advanta officials, project officers, and sunflower processors. Focus Group Discussions (FGDs) were used in this study whereby 3 FGDs were conducted each with 12 participants selected based on their use and experience on the improved seeds (Advanta Sunflower Hybrid seeds) and the rest of the seeds in sunflower production.

A sample size of 90 (15 farmers from each village) smallholder sunflower farmers was used for each region, which makes a total of 270 farmers from all three regions. The sample size of 270 farmers (90 from each region) is considered sufficient and can allow most statistical analyses to be conducted. According to Healey and Donoghue (2020), for data to be normally distributed the sample size has to be 30 and above.

3.2.3 The data

Cross-sectional data were collected from sampled farmers using semi-structured household survey questionnaires; the data include yield, costs of production, price of sunflower and farmer's socio-economic characteristics. Moreover, key informants' interviews were used to obtain more information from well knowledgeable people about the subject of interest and focus group discussions were also conducted so as to enrich the data from household surveys. Both qualitative data and quantitative data were used for this study because qualitative data in such a study is used to complement the quantitative data (Cresswell, 2014).

3.2.4 Data analysis techniques

Data entry and analysis was done with the use of a statistical package SPSS. Qualitative data from key informants was transcribed and then analysed using content analysis.

3.2.4.1 Establishing smallholder sunflower farmers' socio-economic profile

Descriptive statistics that is frequencies, means, standard deviations, minimum, maximum and percentages were primarily used to profile the farm households in the study areas. Apart from farmers profile descriptive statistics were also used to analyze farmers' awareness of Advanta Sunflower Hybrid seeds and the adoption level of these seeds.

3.2.4.2 Determination of the factors influencing the decision of farmers to adopt the sunflower hybrid seeds

A binary logistic regression model was used to determine the factors that influence the decision of farmers to adopt the sunflower hybrid seeds because the dependent variable-adoption decision is binary (decision on whether to adopt or not adopt hybrid seeds) (Healey and Donoghue, 2020). The logistic regression model is based on the logit probability function given as;

$$P_i = f ¿) = \frac{1}{1+e^{-Z}} \text{ ……………………………………………………………}(1)$$

Where P_i is the probability of success, the probability that a farmer adopts the Advanta hybrid seeds, and Z_i represents exposure to factors that may influence adoption, $Z_I = \alpha + \beta X_i$ and its probability is expressed below;

$$Z_i = \ln\left(\frac{P_1}{1-P_1}\right) \text{……………………………………………………………….}(2)$$

Thus;

$$Z_i = \ln\left(\frac{P_1}{1-P_1}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where Z_i is Advanta hybrid seeds and $X_1, X_2, X_{3,} \ldots X_n$ are factors determining adoption, which include yield per acre, age, education, seed price, land size, household size, marital status, geographical location (region), oil content, membership in an association and non-farm sources of income (Table 3.1). ε_i is the error term.

Table 3.1: Description of variables used in the logit regression model

Variable	Description	Measurement
Yield/acre	Quantity of sunflower yielded for an acre	Kilograms
Age	The age of the respondent	Number of years
Education	The length of time the respondent spent informal school	Number of years
Land size	Size of farm allocated for sunflower production	Acres
Household size	Number of the member within a household	Number of people
Sex	The sex of the respondent	D=1 if male D=0 if female
Seed price	The price of the seeds per Kilogram	Tanzanian Shillings
Marital status	Whether the household is married or otherwise	D=1 if married D=0 if otherwise
Region	The region in which the household resides	1= Dodoma (reference category) 2= Singida 3= Manyara
Oil content	Whether sunflower has high or low oil content	D=1 if high oil content D=0 if low oil content
Association membership	Whether a respondent is a member of farmers' association group	D=1 if yes D=0 if no
Source of income	Whether a farmer has non – farm income sources	D=1 if yes D=0 if no
Source of information about Advanta hybrid seeds	Where the farmer obtained information about Advanta Sunflower Hybrid seeds	1= Neighbours and relatives (reference category) 2= Extension service 3= Development agency

3.2.4.3 Propensity Score Matching (PSM)

The study used PSM to show the impact of adopting Advanta Sunflower Hybrid seeds by looking at the contribution of these seeds to smallholder farmers’ wellbeing. In this study, a comparison on yield and income between adopters and non-adopters of Advanta hybrid seeds is made to establish the farmers' situation on the two variables if the seeds were not introduced in the study area.

Other studies such as Mushi (2019), Adebayo *et al.* (2016) and Msuta and Urassa (2015) used income as a direct measurement of wellbeing of smallholder farmers but income which is a proxy of profitability (gross margin) relates to yield therefore it is important to look past yield analysis because of the differences in production costs between adopters and non-adopters. Implementation of PSM involves four steps namely: propensity score estimation, checking overlap, selection of matching algorithm, estimating ATT.

3.2.4.3.1 Estimating propensity scores

Propensity scores are conditional probabilities of exposure to a program on a set of observable characteristics attributable to the program which are constructed using logit regression. The probability of each farmer to adopt the improved technology (Advanta’s hybrid seeds) given their observable characteristics is computed in order to create a counterfactual group while assuming that farmers are adopting the technology or not adopting the technology but cannot do both. This is illustrated in the following equation;

$$p(X) = p(Z=1|X) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

Where $p(X)$ is the propensity score, Z is the binary dependent variable for adoption decision ($Z=1$ if farmer adopts and $Z=0$ if otherwise) and X are observable socio-economic characteristics of farmers that may influence adoption decisions.

The binary logit model as a function of observable characteristics influencing adoption was used to estimate the propensity scores as specified in the following equations;

$$p(X)=Z=\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\ldots+\beta_n X_n+\varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

3.2.4.3.2 Checking overlap or balance

Once units are matched, the characteristics of the constructed treatment and comparison groups should not be significantly different. The balancing property explains that conditional distribution of observable characteristics (X) given propensity score $p(X)$ is the same in both; the new technology adopters group and non-adopters group (Raitzer and White, 2017). The aim of checking overlap or balance is to make sure groups are comparable and to avoid comparing the incomparable groups.

3.1.4.3.3 Selecting a matching algorithm

After estimating propensity scores, estimated units in the treatment group (adopters) were matched with counterfactual or control group (non-adopters) with similar propensity scores. Nearest Neighbor Matching (NNM) and Caliper matching algorithm. NNM involves matching adopters to the non-adopters units with the closest propensity score. Caliper matching g involves establishing a maximum propensity score radius (caliper) and all non-adopters within the given radius of an adopter are matched to that adopter (Awotide *et al.,* 2015).

3.2.4.3.4 Estimating the Average Treatment Effect on the Treated (ATT)

3.2.4.3.4.1 Yield effect

A production function was specified to determine the productivity effect from adopting the improved technology (Advanta's hybrid seeds) in terms of sunflower yield. The following equation indicates how the production function was specified.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 D_1 + \ldots + \beta_n X_n + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where Y_i is the productivity impact (yield in Kg/acre), X_i are determinants of yields Y_i these are such as farm size, household size, sex age and education. $D_1$is the dummy variable for the adoption of hybrid seeds (D_1= 1) if the farmer has adopted the improved technology and D_1=0 if the farmer has not adopted the improved technology and their yields denoted by Y_1 and Y_0 respectively

The adoption effect on yield was given by the following equations;

$$Y = Z\,Y_1 + (1\text{-}Z)Y_0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$ATT = E¿|Z=1) - E(Y_0|Z=0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where Y_1denotes the level of Productivity of a sunflower farmer who adopts technology ($Z=1$); and Y_0 is the level of productivity of sunflower farmers who do adopt Advanta Sunflower Hybrid seeds.

3.2.4.3.4.2 Income effect

Gross margin was used to represent profit or income attributable to the adoption of Advanta Sunflower Hybrid seeds. The gross margin equation is given in the following equation;

$$GM_t = \sum_{i=1}^{n} (TR - TVC) = \sum P_y Y - \sum P_x X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where TR is the total revenue of selling sunflower, TVC is the total variable costs of producing sunflower and P_y and P_x are prices of sunflower and inputs respectively while Y and X_i are quantities of sunflower harvested and inputs respectively.

The average treatment effect on profit is given by the following equation;

$$ATT = \left(E\left(\left(P_1 Y_1 \middle| Z=1\right) - P_x X\right)\right) - E\left(\left(P_0 Y_0 \middle| Z=1\right) - P_x X\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Therefore $ATT = E\left(GM_1\right) - E\left(GM_0\right)$, where GM_1 and GM_0 are gross margins for adopters (using improved technology) and non-adopters respectively.

3.3 Results and Discussion

3.3.1 Farmers' socio-economic profiles

Results of this study indicate that 68.5% are male and 31.5% are female in which 6.3% of the farmers are single, 86.3 of the farmers are married. The marital status of the sunflower farmers may have an implication on the adoption of Advanta Sunflower Hybrid seeds since married couples can advise each other on whether to decide on adopting or not adopting Advanta hybrid seeds.

Only 8.5% of sunflower farmers were entirely not formally educated and 78.5% have acquired primary level education which is equivalent (Table 3.2) implying that 91.5% of sunflower farmers in the study area can at least read, write and count and may be likely to choose to adopt than otherwise.

Aproximately two-third (66.7%) of the sampled sunflower farmers depend on farming as their main source of income while 2.6% of the total sampled sunflower farmers mentioned formal employment as their source of income. This implies that most sunflower farmers in the study area depend on farming as their main source of income

therefore these people have the potential of producing more sunflowers with the use Advanta hybrid seeds, especially, if they are sensitized on the benefits of using these hybrid seeds.

Out of the 270 sample sunflower farmers 61.5% mentioned that they used their own land for sunflower cultivation and the rest use rented land for sunflower cultivation. Hence majority of the sunflower farmer do not incur the cost of renting land for sunflower cultivation, hence stand in a position to make more margins because the cost of renting land is deducted from the overall costs of production unlike those who use rented land.

Table 3.2: Farmers' socio-economic characteristics, n=270

Sex of the respondents	**Frequency**	**Percent**
Female	85	31.5
Male	185	68.5
Total	**270**	**100.0**
Marital status		
Single	17	6.3
Married	233	86.3
Widow/widower	12	4.4
Separated	8	3.0
Total	**270**	**100.0**
Education (years spent in school)		
School years		
No formal education	23	8.5
Primary education	212	78.5
Secondary education	28	10.4
Tertiary education	7	2.6
Total	**270**	**100.0**
Source of income		
Farming (crop cultivation)	180	66.7
Livestock keeping	57	21.1
Craftsman	1	.4
Formal employment	7	2.6
Business	25	9.3
Total	**270**	**100.0**
Type of and ownership		
Own Land	166	61.5
Amount of land rented	104	38.5
Total	**270**	**100.0**

The average age of sunflower farmers is 46 whereas the minimum and maximum age are 20 and 78 respectively; therefore most of the sunflower farmers in the study area are within the working group population therefore is enough labour force availability in the study area. The average number of people within a household (household size) is 6 people. The mean size of land used for sunflower cultivation for the last production season was 2.75, implying of sunflower farmers in the study area are small scale farmers (FAOSTAT, 2015). Farming experience interms of number of years a farmer has been cultivating sunflower where the mean number of years that farmers have been cultivating sunflower is 12.6 years (Table 3.3). Thus sunflower is one of the main crops produced within the study areas.

Table 3.3: Farmers' socio-economic characteristics, n=270

	Minimum	Maximum	Mean	Std. Deviation
Age of the respondent	20	78	46.3	11.9
Education (years spent in school)	0	15	7.1	2.9
Household size	1	32	6.5	3.1
Amount of land used for sunflower cultivation	.25	20	2.8	2.5
Farming experience (Years)	1	49	12.6	9.9

3.3.2 Awareness of farmers and adoption level of Advanta sunflower hybrid seeds

Study findings show that most sunflower farmers are well aware of Advanta Sunflower Hybrid seeds. More than three-quarters of the total sample (81.5%), when asked if they are aware of the Advanta Sunflower Hybrid seeds or not, responded that they are aware whereas 18.5% of the total sample responded that they are not aware of the seeds (Table 3.4).

Table 3.4: Awareness and adoption status of Advanta sunflower hybrid seeds, n=270

	Frequency	Percent
Advanta seeds awareness status		
Not aware	50	18.5
Aware	220	81.5
Total	**270**	**100.0**
Adoption status of hybrid		
Non-Adopters	126	46.7
Adopters	144	53.3
Total	**270**	**100.0**

Out of the farmers who were aware of the seeds, 67.3% had adopted the seeds whereas 32.7% of those who were aware had not adopted the seeds. Among the Advanta hybrid seeds adopters, 97.3% had adopted Hysun33 and only 2.7 % have adopted Aguara4 which are hybrid varieties from Advanta Seed Company. Figure 3.1 Indicates the level of adoption of Advanta seeds with respect to regions in which farmers reside. Lack of awareness about Advanta seeds explains why those who were not aware had not adopted the seeds. In addition to that, the price of these may be a major reason why those who are aware have not adopted the seeds because a focus group discussion conducted in Manyara explained that:

> "*Most farmers prefer local seeds because they are sold at a low price and some people do not even buy because they reuse the seeds from previous years but for the modern seeds like Hysun33 which is sold at 35 000Tshs per Kg, that is very expensive for us and it increases the cost of production*." [FGD Participant, Manyara. 04/03/2021]

These results are in line with the expected utility theory, where the farmers have compared the costs of the seeds and have opted not to adopt because they find it not to benefit them as the cost of production increases.

Moreover, the cross-tabulation indicated that there is a positive relationship between awareness of Advanta Sunflower Hybrid seeds and geographical locations. In this regard, Singida Region farmers were more aware of the seeds compared to the other regions (Table 3.5).

Table 3.5: Advanta seeds awareness by region, n=270

Name of region	Advanta seeds awareness status		Total
	Not aware(%)	Aware(%)	
Dodoma	28.9	71.1	100
Singida	1.1	98.9	100
Manyara	25.6	74.4	100

This may be due to the fact that there were different project coordinators in each region therefore even the strategies of spreading awareness are different leading to different awareness outcomes. Furthermore, based on their observation, most farmers in Dodoma seem to not be motivated to learn about improved seeds, this information links to the explanation by one of the key informants who stated that

> *"……farmers in Dodoma are quite different from farmers in other regions, most of them are not interested and for the ones that are interested wish to get seeds for free.*

Figure 3.1 illustrates further the level of awareness among farmers with respect to the regions in which they are found.

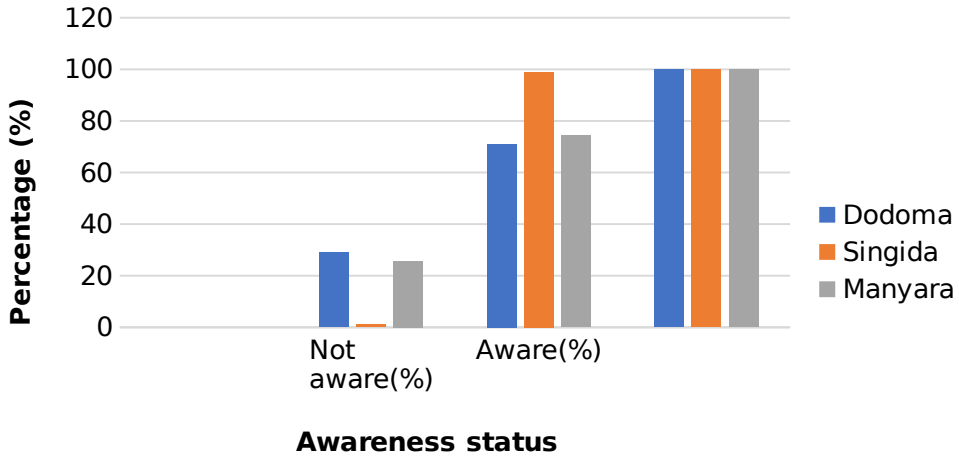

Figure 3.1: Awareness status of advanta sunflower seeds

Farmers' awareness plays an important role in the decision to adopt improved sunflower seed varieties. It is under the expectation that when farmers understand and appreciate the innovation of the improved sunflower seed varieties they would accept it.Kimathi *et al*. (2021) have argued that smallholder farmers will adopt the improved seed when they view the innovation as beneficial to them.

3.3.3 Factors influencing adoption of Advanta sunflower hybrid seeds

This study adds up to other studies such as ones conducted by Tibamanya *et al.* (2021) and Liu *et al.* (2018) that already exist on the knowledge about the determinants of adoption of agricultural technologies such as hybrid seeds. Table 3.6 shows the regression results that indicate eight variables; Yield per acre, education level (number of years spent in school), seed price, household size, region, oil content, extension service and development agency are significant determinants of the adoption of Advanta Sunflower Hybrid seeds in the study areas.

Table 3.6: Factors influencing the adoption of Advanta Sunflower Hybrid seeds

	Odds Ratio	Std. Err.	Z	P>z	95% Interval	Confidence
Yield/acre	1.003742	.0007489	5.01	0.000***	1.002275	1.005211
Age	1.061078	0.041164	1.53	0.126	0.9833886	1.144904
Education	1.67817	0.308817 9	2.81	0.005***	1.170031	2.406992
Land size	-0.9968857	0.114778 9	-0.03	0.978	0.7955	1.249254
Household size	-0.7662263	0.121568 7	-1.68	0.093*	0.5614438	1.045702
Seed price	-1.000225	0.000046 1	-4.88	0.000***	1.000135	1.000316
Male	2.525715	2.60348	0.9	0.369	0.3349458	19.04557
Married	-0.4332162	0.491567 7	-0.74	0.461	0.0468653	4.004586
Singida	11.31399	11.08579	2.48	0.013**	1.657992	77.20558
Manyara	26.76947	32.64258	2.7	0.007***	2.452948	292.1401
High oil content	932.1216	1362.316	4.68	0.000***	53.14022	16350.15
Extension services	13.95603	15.99293	2.30	0.021**	1.476818	131.8855
Development Agency	9.926887	13.85707	1.64	0.100*	.6435909	153.1145
Farmer Association	0.4984988	0.514081 6	-0.68	0.500	0.0660472	3.762476
Non-farm sources of income						
Yes	2.656969	2.226645	1.17	0.244	0.514098	13.73179
_cons	1.35E-07	4.87E-07	-4.39	0.000	1.17E-10	0.000156 9

Note: Number of obs:270, Pseudo R^2: 0.2727, Chi-square: 101.75, Prob > chi2: 0.000. ***, **, * implies significance at p< 0.01, p< 0.05 and p< 0.1 probability levels, respectively

Yield per acre has a significant influence on farmers decision to adopt at p < 0.01 and a positive implication that means farmers with high productivity have a higher probability to adopt Advanta Sunflower Hybrid seeds. These results conform to the results from a study by Mushi (2019) which focused beyond socio-economic characteristics of farmers as factors influencing adoption, in his yield had a significant influence and a positive implication on the decision of farmers to adopt bean hybrid seeds.

The variable education is significant at p < 0.01 has a positive implication on the probability of the farmers to adopt Advanta hybrid seeds that is the higher the education

level or the more the years a farmer spent in school the higher the probability of the farmer to adopt Advanta Sunflower Hybrid seeds. This is because it is easy to educate farmers who are educated on the importance of using improved seeds so that they can adopt them. A study by Lunduka *et al.* (2019) has similar results that indicate education to have a significant influence on the adoption of improved maize seeds variety.

The average household size of the farmers in the study areas is 7, therefore according to the regression results, farmers with higher household sizes are less likely to adopt the seeds and household size is significant at $p < 0.1$. This can be explained in the sense that large households usually have more dependents compared to small households hence posing a constrain in the probability of adoption decision, these results are contrary to the results by Tibamanya (2021) where household size had a positive implication on the binary adoption decision, it was further explained that more members of the household potentially get information about the improved seed varieties.

Seed price is also significant at $p < 0.01$, but has negative implications in influencing the decision of a farmer to adopt Advanta Sunflower Hybrid seeds. A study by Mwalongo *et al.* (2020), had similar results, this means farmers are not adopting the seeds because of their own price of seeds which leads to an increase in the cost of production. The region in which the farmer is located is also a significant influence on the adoption of these seeds. In this regard, Singida is significant at $p < 0.05$ and Manyara is significant at $p < 0.01$ that is farmers residing in Singida and Manyara are more likely to adopt Advanta hybrid sunflower hybrid seeds than farmers located in Dodoma. These regions are significant at different P-levels because there are different project coordinators in each specific region hence different strategies of influencing farmers to adopt the seeds. This

aligns with the results by (Tibamanya, 2021) who also indicated how the area in which the farmer is located relates to the adoption of improved seeds.

Oil content also has a positive implication on the decision of the farmer to adopt or not to adopt these seeds meaning that farmers are likely to adopt these seeds because of the high oil content, oil content is a significant factor at $p < 0.01$. Oil content may attract farmers to adopt these seeds because they can benefit from processing the sunflower into oil rather than selling it as it is. These results conform to the results from a study by Justin (2012), which showed that oil content had a positive and significant association with the adoption of sunflower innovation.

Extension service has a significant relationship with the adoption of Advanta sunflower seeds at $p<0.05$ and a positive implication. Extension services may influence adoption due to the fact that extension officers spread information about improved technologies and encourage farmers to use these technologies. The results are similar to the results of a study conducted by Chandio and Yuansheng (2018), where extension services had a positive and significant implication to improved seeds.

The variable development agency also has a significant and positive relationship with the adoption of Advanta sunflower seeds at a 90% confidence interval. this is because development agencies play a great role in agricultural interventions and introduce improved agricultural technologies with the purpose of improving productivity. This aligns with a study by Gairhe *et al.* (2017), which also indicated that a development agency had an implication towards the adoption of improved seeds.

3.3.4 Contribution of Advanta Sunflower Hybrid seeds to farmers' wellbeing

The covariates used to compare farmers in this study are presented in Table 3.7 and the summary of probabilities indicate that the average probability is 0.533.

Table 3.7: Farmers' probabilities of adopting Advanta Sunflower Hybrid seeds used in estimating propensity scores

Adoption	Coef.	Std. Err.	Z	P > z	[95% Conf. Interval]	
Sex	.6613135	.3074723	2.15	0.031	.0586789	1.263948
Age	-.0227464	.0131184	-1.73	0.083	-.048458	.0029652
Marital status	.1947386	.2987902	0.65	0.515	-.3908795	.7803566
Education	.1392195	.052367	2.66	0.008	.036582	.241857
Household size	-.0010308	.0444481	-0.02	0.981	-.0881476	.0860859
Income sources	.0315929	.117848	0.27	0.789	-.199385	.2625707
Land size	.0937508	.0611221	1.53	0.125	-.0260463	.2135479
Ownership of land	-.2700876	.280497	-0.96	0.336	-.8198516	.2796764
Processing/ selling	.139868	.2076851	0.67	0.501	-.2671874	.5469234
Farmer's group membership	.8158169	.2888654	2.82	0.005	.2496511	1.381983
Farming experience	.0254092	.0152578	0.096	1.67	-.0044955	.055314
_cons	-1.493803	1.064657	-1.40	0.161	-3.580491	.5928859

According to White and Raitzer (2017), covariate balancing property score has to be estimated by weighting to propensity score estimates so as to ensure covariates are balanced before propensity scores are applied in matching. This helps to avoid comparing incomparable groups. Therefore, a balance check was done first by visual inspection, using histogram, on the distribution of propensity scores between adopters and non-adopters of Advanta Sunflower Hybrid seeds whereas the histogram showed a similar distribution of propensity scores between the adopters (the treated group) and non-adopters (counterfactual). The histogram presented below shows that the densities

of probabilities lie within the same region of common support (a range where the propensity score lies) (Figure 3.2).

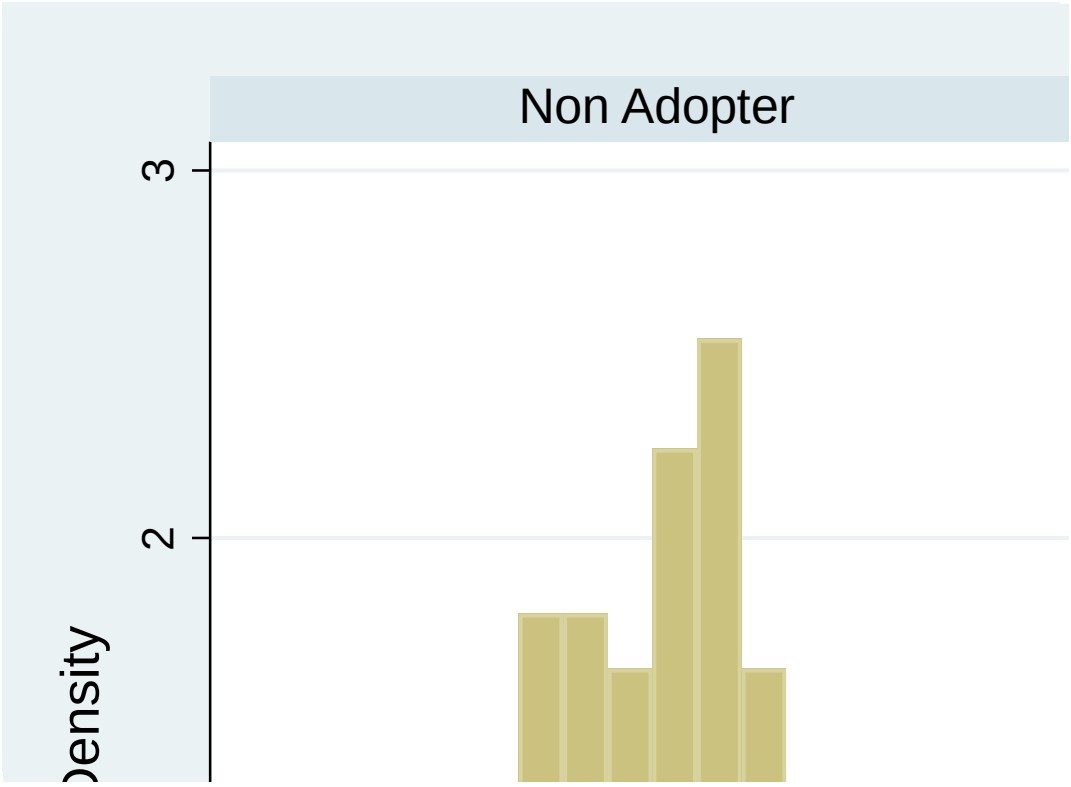

Figure 3.2: Distribution of propensity scores among adopters and non-adopters of Advanta sunflower hybrid seeds

To make sure that there is a propensity score balance between the treated and untreated group, a test for each variable in the logit model specified was conducted so as to estimate the probabilities to see if their means are comparable. The results from the test Table 3.8, indicated that the propensity scores range between (region of common support) 0.068 and 0.917. For the adopters, the region of common support lied between 0.187 and 0.917. For the non-adopters, propensity scores ranged between 0.068 and 0.837. After the balancing property is satisfied it was then possible to compute the mean output differences between adopters and non-adopters of Advanta Sunflower Hybrid seeds.

Table 3.8: Distribution of the estimated propensity scores

Variable	Obs.	Mean	Std. Dev.	Min	Max
Adopters	144	0.589	0.149	0.187	0.917
Non-adopters	126	0.470	0.178	0.068	0.837
Overall	270	0.173	0.068	0.0678	0.917

3.3.4.1 Yield impact of using Advanta Sunflower Hybrid seeds

The results from Nearest Neighbor Matching (NNM) algorithm show that farmers who adopted Advanta hybrid seeds had higher crop productivity than sunflower farmers who did not adopt. The NNM results indicate that the average yield per acre for the treated group (adopters) was 531.25 Kg/acre compared to 329.92 Kg/acre for non-adopters which presents a difference of 210.32 Kg/acre (Table 3.9). Similarity is seen in the unmatched group of farmers where there is a difference of 217.80 Kg/acre between the adopters and non-adopters. The t-statistics is 6.48 and 4.12 for matched and unmatched respectively, which means that the difference in yield estimated between adopters and non-adopters is statistically significant at a 99% confidence interval because t-statistics is greater than 2.58 (Healey and Donoghue, 2020). In this case, the results suggest that smallholder sunflower farmers who use Advanta Sunflower Hybrid seeds have higher sunflower productivity compared to non-adopters because these seeds are improved seeds and hence they are high yielding.

Similarly, the Caliper Matching results also show that the adopters of Advanta Sunflower Hybrid seeds experience a higher yield by 155.97 Kg/acre (Table 3.9). The t-statistics is 2.67 implying that there is a statistical significance at a 99% confidence interval in the difference between adopters and non-adopters (ATT).

Table 3.9: NNM and Caliper matching results of the impact of using Advanta Sunflower Hybrid seeds on yield

Yield (Kg/acre)	Sample	Treated	Controls	Diff.	Std. Error	t-stat.
NNM	Unmatched	522.10	304.30	217.80	33.63	6.48
	ATT	531.24	330.00	201.32	48.81	4.12
Caliper matching	Unmatched	522.10	304.30	217.80	33.63	6.48
	ATT	476.45	320.50	155.97	58.37	2.67

The results of this study are similar to the results of studies conducted by Mushi (2019), Lunduka *et al.* (2017) and Adebayo *et al.* (2016) of the impact of improved seeds on the yield of smallholder farmers which indicated that farmers who used improved seeds had more yield compared to those who did not use improved seeds.

3.3.4.2 Income impact of Advanta sunflower hybrid seeds

The gross margin, which is a proxy for profit, was used to indicate the impact of Advanta sunflower hybrids seeds on the income of sunflower farmers. The NNM results indicate that the ATT in terms of income is 95 161.12 Tshs/acre for the matched individual and 122 875.95 Tshs/acre (Table 3.10) for the unmatched individuals. Furthermore, the ATT on farmers' gross margin income effect of adopting Advanta Sunflower Hybrid seeds is positive and significant for both matched and unmatched individuals. The Caliper results also show that there is an impact on the income of smallholder farmers since the ATT is 108171.76 Tshs per acre and the t-statistics is significant (t-statistics = 3.00) at a 99% confidence interval since it is above 2.58.

Table 3.10: NNM and caliper matching results of the impact of using Advanta sunflower hybrid seeds on income

Income per acre	Sample	Treated	Controls	Diff.	Std. Error	t-stat
NNM	Unmatched	232 836.223	109 960.28	122 875.95	21 953.54	5.60
	ATT	241 595.37	146 434.25	95 161.12	28 005.46	3.40
Caliper matching	Unmatched	232 836.23	109 960.28	122 875.95	21 953.54	5.60
	ATT	228 857.16	120 685.41	108 171.76	36 080.28	3.00

These results are similar to results from studies conducted by TerAvest *et al*. (2019), Lunduka *et al.* (2017), Adebayo *et al.* (2016), Smale and Mason (2014) and Mpogole and Kadigi (2012) which used income as a direct measurement of wellbeing and indicated that farmers that used improved seeds had more income compared to farmers who did not use the hybrid seed. This means with the increase in income preceding the use of Advanta seeds, farmers can increase more assets, expand the income-generating activities, diversify dietary consumptions, send their children to school and meet many other needs.

Furthermore, the results concerning the impact in this study relate to the theory of change which is a statement of how the inputs being provided (funds, people, and changes in regulatory or policy environment) lead to intended outcomes and impacts. In this case, the inputs are the improved seeds that lead to improved wellbeing in terms of yield and income.

3.4 Sensitivity Analysis

Rosenbaum sensitivity analysis was done to check if there were hidden biases caused by unobservable covariates between adopters and non-adopters of hybrid seeds.

Table 3.11: Rosenbaum Sensitivity analysis for average treatment effect on the treated

Rosenbaum bounds for sunflower yield (n=270, matched pairs)			**Rosenbaum bounds for sunflower income (n=270, matched pairs)**		
Gamma	Sig+	Sig-	Gamma	Sig+	Sig-
1	0	0	1	0	0
2	0	0	2	0	0
3	3.6e-12	0	3	1.1e-16	0
4	8.5e-09	0	4	5.2e-13	0
5	8.7e-07	0	5	9.3e-11	0
6	8.7e-07	0	6	3.0e-09	0
7	.00016	0	7	3.6e-08	0
8	.000795	0	8	2.4e-07	0
9	.002705	0	9	1.0e-06	0
10	.007081	0	10	3.3e-06	0

***Gamma-log odds of differential assignment due to unobserved factors, Sig+ - upper bound significance level; Sig- - lower bound significance level.**

The P-critical values of all outcome variables estimated at various levels of critical values of gamma are significant at $p < 0.05$ (Table 3.11). This implies that the main covariates which are affecting the probability of adoption of hybrid seeds and outcome variables have been considered and changes in gamma values did not change the study inferences. Therefore, the positive impact of hybrid seeds on sunflower yield and income is not sensitive to potential hidden biases due to unobserved confounders.

3.5 Conclusions and Recommendations

The decision on whether to adopt or not to adopt is significantly influenced by variables; yield per acre, education, household size, seed price, geographical location, oil content, extension services and development agency. Coefficients of household size and seed price are negative while the coefficients of the rest variables are positive, this means as household size decreases then the probability of a farmer to adopt increases and vice versa is true this could be because higher household size indicates higher dependency ratio. The price of the seeds also has the negative implication of the decision to adopt which means farmers are less likely to adopt Advanta due to the price. On the other

hand, all other variables had positive coefficients meaning that the probability of farmers adopting these seeds increases with these variables.

Furthermore, results indicate that adopting Advanta Sunflower Hybrid seeds improves smallholder farmers' productivity and income. There is a significant impact of these seeds on the yield per acre and income per acre obtained by smallholder farmers hence they contribute to the improved productivity of sunflower in the study areas. During the group discussion with farmers, however, the major complaint was about the higher price of the improved seeds compared to the local ones. These complaints confirmed that farmers still use local seeds because they are cheap.

Based on the interpretation and discussion of the findings of this study, the following are the recommendations: Firstly, the study recommends that there should a promotion of the use and/or adoption of Advanta sunflower hybrid because they improve the wellbeing of smallholder farmers because the result of this study shows that the adoption Advanta Sunflower Hybrid seeds have improved the smallholder farmers' yield and income.

In addition to that, in further increasing the seeds accessibility, the study recommends that the distribution channels of the Advanta Sunflower Hybrid seeds be revisited, in particular the linkage between the seed producers, contractors (for the case of contract farming), agro-dealers and farmers who are the final consumer of the seeds. The study found an information gap along the distribution channels as some farmers reported to have no information about the seeds and where they can buy particular seeds. Since the majority of farmers both adopters and adopters obtained information about the Advanta

Sunflower Hybrid seeds through the organizations which implemented the project through their farmer association groups, then it is suggested that if farmers are encouraged to join these groups and seeds producers deliver seeds to farmers association groups farmers will easily access the seeds.

Moreover, the study recommends that processors should work closely with farmers through contract farming and provide farmers with improved seeds (credit) with the expectation to source sunflower seeds harvest from these farmers for processing into oil. This will encourage farmers to use these seeds because they are sure of the accessibility of the seeds despite the price of the seeds.

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CHAPTER FOUR

4.0 SUMMARY OF FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND POLICY IMPLICATIONS

4.1 Summary of Findings

4.1.1 Economic performance of Advanta Sunflower Hybrid seeds and smallholder farmers' perception toward these seeds

The first objective aimed to determine the production performance of conventional sunflower seeds and Advanta sunflower seeds respectively. The second objective aimed to determine the economic performance of conventional sunflower seeds and Advanta sunflower seeds respectively. The third objective was to assess the perception of farmers towards Advanta Sunflower Hybrid seeds. Generally, the productivity of Advanta hybrid seeds specifically Hysun33 seeds was higher for the production season of 2019/2020 compared to other seeds but when it comes to profitability farmers that used open-pollinated varieties (OPV) had a higher average gross margin compared to other seeds such Advanta Sunflower Hybrid seeds. Advanta hybrid sunflower seeds had higher productivity than open-pollinated varieties but lower comparative profitability which may be due to the price of the hybrid seeds hence raising the cost production making the profit lower than that of Open-pollinated varieties. Moreover, smallholder farmers have a moderate towards Advanta sunflower seeds only that they are very expensive and most of the wish to use these seeds but they are constrained because the own seeds price is high for them to afford.

4.1.2 Adoption of Advanta Sunflower Hybrid seeds and its wellbeing impact of these seeds to smallholder farmers

Objective four aimed at determining factor that influence the adoption of Advanta sunflower hybrid seed and the fifth objective aimed at assessing the effect of Advanta Sunflower Hybrid seeds on smallholder farmers' wellbeing. The results show that farmers' decision on whether to adopt or not to adopt these seeds is significantly influenced by variables; yield per acre, education, household size, seed price, geographical location and oil content. Coefficients of household size and seed price are negative while the coefficients of the rest variables are positive, this mean as house hold size decreases then the probability of a farmer to adopt increases and vice versa is true this could be because higher household size indicate higher dependency ratio. The price of the seeds also has negative implication of decision to adopt that means farmers are less likely to adopt Advanta due to the price. On the other hand, all other variable had positive coefficients meaning that the probability of farmers to adopt these seed increases with these variables.

Furthermore, results indicate that adopting Advanta Sunflower Hybrid seeds improves smallholder farmers' productivity and income whereas these are the indicators of wellbeing that have been used for this study. There is significant impact of these seeds on the yield per acre and income per acre obtained by smallholder farmers hence they contribute to the improved productivity of sunflower in the study areas. During the group discussion with farmers however, the major complains was about the higher price of the improved seeds compared to the local ones. These complains are confirmed that farmers still use local seeds because they are cheap.

4.2 Conclusion

To conclude, Advanta seeds had the highest productivity and profitability than the rest of the seeds considered in this study (produced in Manyara, Singida and Dodoma). This means according to the expected utility theory, it is probable that more farmers will adopt the seeds as because they bring about higher yields and profit. In addition to that majority of farmers have a moderate perception towards the seeds.

The decision on whether to adopt or not to adopt is significantly influenced by variables; yield per acre, education, household size, seed price, geographical location (region), oil content, extension services and development agency. Household size and seed price are have a negative influence on the probability to adopt while all other mentioned variables have positive influence on the probability to adopt Advanta hybrid seeds.

Moreover, Advanta hybrid seeds had a positives impact on the well being of smallholder sunflower farmers because farmers that used the seeds had more yield and more income compared to those who did not use the seeds.

4.3 Recommendations

Based on the interpretation and discussion of the findings for each specific objective of this study, the following are the recommendations: Firstly, the study recommends that there should be a promotion of the use and/or adoption of Advanta sunflower hybrid because they improve the wellbeing of smallholder farmers. Results of the first two objectives indicate that Advanta Sunflower Hybrid seeds, specifically Hysun33 variety, has higher productivity and profitability. Results of the third objective of this study show that the adoption Advanta Sunflower Hybrid seeds have improved the smallholder farmers' yield and income.

Secondly, the price of Advanta Sunflower Hybrid seeds should be reduced so as to attract more farmers to use these seeds because from the results of the fourth objective farmers already perceive these seeds positively except for the fact that they have a high price. This could perhaps be made possible if breeders opt to produce the seeds within the country rather than importing them.

Thirdly, there should be an indicative price of sunflower produce set by the government. If possible, the price should be different on the basis of the seeds used during production because sunflower that is produced from hybrid has a higher quality in terms of oil content and weight compared to the one produced by local seeds. This will encourage farmers to use hybrid seeds since they will earn more income. Results of the third objective also indicate there is a small difference in income between adopters and non-adopter, this could be due to the fact that when it comes to the market sunflower is not categorized using the seed that was used for production causing farmers to be discouraged to use hybrid seeds despite the fact that they are high yielding.

Fourthly, in further increasing the seeds accessibility, the study recommends that the distribution channels of the Advanta Sunflower Hybrid seeds be revisited. In particular the linkage between the seed producers, contractors (for the case of contract farming), agro-dealers and farmers who are the final consumer of the seeds. The study found an information gap along the distribution channels as some farmers reported to have no information about the seeds and where they can buy particular seeds. Since the majority of farmers obtained information about the hybrid seeds through their farmer association groups, then it is suggested that farmers should be encouraged to join these groups where they can easily access the seeds.

4.4 Policy Implications

The first policy implication is that there should be more efforts dedicated by rural agricultural development interventions in promoting the adoption of improved agricultural technologies such as the hybrid seeds because it is clear that these technologies have an impact on the improvement of farmers' wellbeing. Results of the current study indicate that the adoption of improved bean seeds has improved the productivity and income of farmers.

Another policy implication with regard to the seeds' price is that policymakers can use the price of seeds as a tool to promote adoption of the seeds because the result indicates that the price has a negative influence on adoption. Therefore, for policymakers, the entry point of intervening adoption of hybrid seeds is the price. But, before implementation of any seed price adjustment schemes, it is important to assess the actual cost of producing seeds along the value chain so as the policy and decision-makers can have evidence-based decision making that benefits both the producers and consumers (farmers) of the seeds.

In addition to that, to reduce the price of seeds; the government may cooperate with the seeds producers so that seeds can be produced within the country rather than importing them from abroad because importation of the seeds has an implication on the price of seeds. Therefore, producing seeds within the country could lead to a decrease in seeds price and encourage more farmers to use these seeds.

APPENDICES

Appendix 1: Household survey questionnaire

Title of the study: Socio-Economic Impact of Advanta Hybrid Sunflower Seeds to Smallholder Farmers in Dodoma, Singida and Manyara.

Introduction of research student

My name is **Wendy Mombo**, a researcher at Sokoine University of Agriculture (SUA). I am here to kindly request you to assist me so that my studies can be successful. The assistance that I need from you is that you spare your time and respond to my questions, which I have written in a questionnaire. I have got permission from SUA, Regional office, District office and from Advanta hybrid seeds producers to conduct interviews with you for my research.

The general objective of the research is to examine Social economic impact of Advanta hybrid seeds in Dodoma, Singida and Manyara regions. I will ask you about how Advanta hybrid seeds has been helpful in your daily agricultural activities. All the answers and comments you will give me will be kept confidential and used only for my studies. Therefore, please respond to all questions truthfully and sincerely.

Instructions to enumerators

Make brief introduction to each farmer before starting any question. Introduce yourself to the farmers (greet them in the local way) and let them introduce themselves to you; tell them the institution you are working for and make clear the purpose and objective of the study (build rapport). Please fill up the questionnaire according to the farmers reply (do not record your own words/feelings). Please ask each question clearly and patiently until the farmer understands clearly. Please do not use technical terms while discussing with the farmers (use simple Swahili language for better communication). Also, explain to the farmer that information collected shall be private, confidential and only used for the purpose and benefit of the study.

Are you willing to participate in the research by responding to the questions I will ask you?

1 = Yes ( ), 2 = No ( )

Date of interview:

FARMER'S IDENTIFICATION DETAILS

ID1	**Region**	
ID2	District	
ID4	Ward	
ID5	Village	
ID6	Name of farmer	
ID7	Sex 0. Female 1. Male	
ID8	Mobile number	

A: Social economic characteristics of the Farmers

A1. Age (years)	**A2**. Marital Status 1=Single 2=Married 3=Widow/widower 4= Divorced 5=others(specify)	**A3**. Education level 0= Not educated 1=Primary 2=Secondary 3= University 4=Other(specify)	**A4**. Household size	**A5**. Source of income 1=Farming (crop cultivation) 2= Animal husbandry 3=Crafts man 4=Employed (salary) 5=Trading 6=Other (Specify)

A6. Landholding status (acres):

1. Total land used for sunflower production……

2. Form of ownership of the land

1. Inherited 4. Borrowed

2. Purchased 5. Rented

3. Allocated by village government

3. If your answer is (ii) above please mention the average cost of renting land per acre……

B: Production economics of conventional seeds and Advanta hybrid seeds

B1. What did you do with the sunflower produce?

1. Selling the sunflower

2. Processing it into sunflower oil

	Sunflower oil	**Sunflower cake**
B2. Amount (Litres/Kg)		
B3. Selling price (TSH)		
B4. Marketing place (*Mention a place***)**		

B5. How did you spend the money gained from selling sunflower produce?

1. Sending kids to school
2. Use it as a capital
3. Bills payment
4. Others (***Mention***)……

B6. Kindly mention the crops you produced last season (2020), farm size and yields obtained.

CROPS GROWN	**Acreage assuming monocropping (acres)**	**Amount of harvests (bags)**	**Quantity consumed (bags)**	**Quantity sold**	**Quantity retained for seeds**	**Quantity lost post-harvest**	**Price per unit**
Sunflower Hysun 33							
Sunflower conventional							
Sunflower other hybrid							
Crop 2 …….							
Crop 3……..							
Crops 4……							

B7. If you did not use Hysun33, why?

1.Hysun 33 seeds accessibility

2.Lack of information on Hysun 33 seeds

3.Price of Hysun 33 seeds

4.other……

B8. If you experienced any harvest losses in the last production season, what are the main reasons for the losses?

1.Pests and diseases

2.Weather condition

3.Birds

4.Lack of extension services

5.other……

B9. How did you address the above challenges?

1. ….……

2. ….……

3. ….……

B10. Production cost for sunflower

Cost item	**Conventional Farm size (… acre)**			**Hysun 33 Farm size (acre)**			**Other hybrid Farm size (…..acres)**		
	No of units		**Unit cost**	**No of units**		**Unit cost**	**No of units**		**Unit cost**
Labour:	**Hired**	**Household**		**Hired**	**Household**		**Hired**	**Household**	
Land preparation									
Fertilizer/manure application (kupandia)									
Planting									
Fertilizer application (kukuzia)									
Insecticide/fungicide spraying									
Weeding									
Bird scaring									
Harvesting (kukata)									
Winnowing (kupiga na									

kupeta)								
Transportation cost								
Storage cost								
Material:								
Seeds								
Fertilizer								
Insecticides/fungicides								
Packaging material								
Mechanization:								
Tractor Hiring								

B11. How did you finance your farm input costs during the last sunflower production season?

1. Money lenders
2. Own finances
3. Loans from banks
4. Other sources (specify)……

B12. Does your household have access to any sunflower storage facility? *(put a tick where appropriate)*

1. Yes
0. No

B13. Which are the storage facilities you have access to? *(put a tick where appropriate)*

1. In House
2. Public

B14. How did you store the crops in the production season? *(put a tick where appropriate)*

1. In locally made traditional structure
2. In modern store

B15. Where did you sell your sunflower harvests during the last production season? *(mention)*

……

……..……..……..

B16. What difficulties did you face when trying to sell your sunflower harvest? *(mention)*

……

……..……..…

B13. What is the distance from your homestead to your most commonly used output market place? (Give one-way estimate in walking mins)

	Favourable Weather	**Unfavourable weather**
B14. Amount of Sunflower yield (bags)		

C: Contribution of Advanta seeds to wellbeing of smallholder farmers

C1. How many meals do you take per day?

1. 1
2. 2
3. 3
4. 4
5. 5

C2. Why?

……

……

i. Assets

C3. What asset did you buy using the money obtained from selling the sunflower produce?

……

…….

C4. Does your household own any of the following assets? [Tick as appropriate]

SN	**Assets**	**1 = Yes**	**0 = No**	**Amount owned**	**Estimated value/cost**
1	Radio				
2	Solar panel				
3	Bicycle				
4	Motor bike				
5	Car/ tractor/ power tiller				
6	Mobile phone				
7	Television set (TV)				
8	Sewing machine				

9	Satellite dish				
10	Foam mattress				
11	Water pump				
12	Land (acres)				
13	Bed				
14	Livestock (specify)				

ii. Social capital

C5. How many years have you been living in this village?

C6. How many sunflower traders do you know within this village who could buy your sunflower?

C7. How many sunflower traders do you know outside this village who could buy your sunflower?

C8. Which type of traders do you trust the most *(put a tick all that apply)*? 1= Wholesaler 2=Retailers 3= Processors 4= Brokers 5=Other

C9. Are you a member of any sunflower associations? 1= Yes 0= No

C10. If yes kindly mention the name of the association?

C11. How long have been a member of the association?

C12. Can you rely on sunflower association for support in your production activities? 1= Yes 0= No

C13. If yes which type of support can you get from sunflower associations?

D: Perception of Smallholder Farmers Towards Advanta Hybrid Seeds

With respect to Hysun33 seeds, please indicate your level of agreement with respect to the following traits (put a tick where appropriate)

1= Strongly agree, 2= Agree, 3=Neutral, 4= Disagree, 5=Strongly Disagree

Item	**1.**	**2**	**3**	**4**	**5**
D1. Hysun 33 increase the level of yield of sunflower per bags (+).					
D2. Sunflower produced from Hysun 33 seeds have higher oil content (+)					
D3. The Hysun 33, more income is earned than the case where other seeds are used (+)					
D4. Hysun 33 seeds are more preferable as compared to other seeds (+).					
D5. You earned more respect in the community after you adopted Hysun 33 (+)					
D6. Farmers should be encouraged to use Hysun 33 (+)					
D7.You easily get technical support because you are using Hysun 33 (+)					
D8. Hysun 33 mature for a long period of time (-)					
D9. Hysun 33 seeds have poor outcome as compared to other seeds (-)					
D10. Hysun 33 seeds are not tolerant to drought and diseases (-)					
D11. Hysun 33 seeds are too expensive for the farmer to afford (-).					
D12. It is hard to sell sunflower produce from Hysun 33 (-)					
D13. Hysun 33 seeds have soft sunflower shell (-)					
D14. There is high demand for sunflower produce from Hysun 33 (-)					

E: Factors Influencing Adoption

E1. Did you use hysun33 seeds for sunflower production in the last production season?

0. No 1. Yes

E2. Did you receive information about any of these seeds?

0. No 1. Yes

	Hysun 33	**conventional**	**Other hybrids**
E3. If yes, from which source do you receive the information from? 1. Government extension agent 2. Development partners organizations 3. Cooperatives/ unions 4. Mass media(radio/television) 5. Neighbors/ relatives 6. Other (*specify)*			

E4. How often do you get into contact with the source of seeds information? 1. weekly 2. monthly 3. Annualy 4. at each cultivation season…….			
E5. Where did you get your seeds? *(put a tick where appropriate)* 1. Research center 2. Government supply 3. Purchase from input supply market 4. Supply of development partners (e.g. NGO) 5. Retained seeds from the last production season 6. Neighbors			

E6. What is the mode of payment from where you obtain the seeds?

……

……..…….

E7. If you purchased sunflower seeds, what was the price per bag/tin/kg?

..

……

…….

E8. How long have you been cultivating sunflower (number of years)?

….

……

……..,……..……..……..

E9. For each of the following traits show whether is Hysun33 seeds, conventional or other hybrids which is better.

S/N	**Traits/Characteristics**	**Hysun 33**	**Conventional seeds**	**Other hybrids**
1	High Yield (0.No, 1. Yes)			
2	Black Color (0. No, 1. Yes)			
3	Good taste (0. No, 1. Yes)			
4	Drought resistance (0. No, 1. Yes)			

5	Storability/durability (0. No, 1. Yes)			
6	Short maturity length (0. No, 1. Yes)			
7	Pest/ diseases resistance (0. No, 1. Yes)			
8	Tall plant (0. No, 1. Yes)			
9	Big size of the achene (0. No, 1. Yes)			
10	More oil (0. No, 1. Yes)			
11	Hard sunflower shell (0. No, 1. Yes)			
12	Flower small in size (0. No, 1. Yes)			
13	Flower face upward (0. No, 1. Yes)			

E10. Do you expect any risks to be driven due to the use of Hysun 33 seeds in sunflower production? *(put a tick where appropriate)*?

1.No 1. Yes

E11. If yes, what are the failures (risks) noticed in the adopting Hysun 33 in the sunflower production?

……

……..……

THANK YOU FOR YOUR COOPERATION

Appendix 2: A checklist for focus group discussion

Title of the study: Socio-Economic Impact of Advanta Hybrid Sunflower Seeds to Smallholder Farmers in Dodoma, Singida and Manyara.

Introduction of research student

My name is **Wendy Mombo**, a researcher at Sokoine University of Agriculture (SUA). I am here to kindly request you to assist me so that my studies can be successful. The assistance that I need from you is that you spare your time and participate in this discussion. I have got permission from SUA, Regional office, District office and from Advanta hybrid seeds producers to conduct discussion with you for my research.

Region ……

District ……

Ward ……

Village ……

S / N.	Name of participant	Gender	Age	Mobile phone number
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

SECTION B: QUESTIONS

1. List the crops grown in this area

2. List sunflower seeds used in this area and group them under hybrid, OPV (open pollinated varieties) and local/indigenous seeds

3. Rank the seeds by farmers' preference and give reasons. Show also disadvantages of each variety

4. Can you give an estimate of quantity harvested using hybrid including Hysun 33, OPV (open pollinated varieties) and local/indigenous seeds? You would need to ask for estimated harvests in good season (adequate rains etc), bad seasons and an average (normal) season. Remember the categories specified above.

5. Differences between Hysun33 seeds and other hybrid seeds (production costs, yields, oil content, time to maturity, extent of bird invasion, market (customer preference), weather, ability to resist diseases, taste etc)?

6. How do you get access to OPV, hybrid including Hysun33 and local/indigenous seeds?

7. What is the price of Hybrid seeds including Hysun 33 seed, OPV such as record, local/indigenous seeds and other hybrids? (Focus on seeds highly prioritized/those preferred by the majority. You could take few varieties from each category (hybrid, OPV and indigenous/local), without forgetting Hysun33)

8. What is the overall cost of sunflower production using Hysun33 seeds, OPV, local/indigenious seeds and other hybrids?

9. Changes resulting from the use of Advanta hybrid seeds (Hysun 33)

10. Any Comments on Hysun33 seeds

THANK YOU FOR YOUR COOPERATION

Appendix 3: A Checklist to be Used for Faida Mali and Farm Africa Programme Officers, Sunflower Processors, Extension Officers and Advanta Officer Key Informant Interview

Title of the study: Socio-Economic Impact of Advanta Hybrid Sunflower Seeds to Smallholder Farmers in Dodoma, Singida and Manyara.

Introduction of research student

My name is **Wendy Mombo**, a researcher at Sokoine University of Agriculture (SUA). I am here to kindly request you to assist me so that my studies can be successful. The assistance that I need from you is that you spare your time and participate in this interview. I have got permission from SUA, Regional office, District office and from Advanta hybrid seeds producers to conduct interview with you for my research.

SECTION A

Name of interviewee:……..……

Sex:……..…….

Mobile number…….……

Region:……

District:……

Ward:……..

SECTION B: QUESTIONS

1. What is the story behind Advanta hybrid seeds in this area?
2. What is the purchase price of the Hysun 33 seeds per bag/kg?
3. Is the price for Hysun 33 seeds favourable to the smallholder farmers?
4. What are the market opportunities and limitations associated with Hysun 33 seeds?
5. Do processors prefer sunflower produced from Hysun33 seeds or other seed?
6. How many people adopted Hysun 33 seeds in your area in 2020 season? What about 2019 season? Any explanations for the trend depicted?

7. What is the performance of the hybrids including Hysun 33 seeds, OPV and local indigenous seeds in terms of yield?
8. How do the farmers perceive Hysun 33 seeds?
9. What could be the reasons for adopting or not adopting the seeds?
10. Does the agricultural policy promote the dissemination of improved seed or does pose a barrier?
11. What are the wellbeing differences between Hysun 33 adopters and non-adopters?
12. What efforts are needed to improve production of sunflower with the use of Hysun 33 seed?
13. What are your recommendations on the use of Hysun 33 seeds?

THANK YOU FOR YOUR COOPERATION

Appendix 4: A list of villages from which sample was drawn and the number of farmers selected

S/N	Village Name	Sample
1	Nghumbi	15
2	Iyumbwi	15
3	Tubugwe Kibaoni	15
4	Tubugwe Juu	15
5	Chang'ombe	15
6	Iduo	15
7	Ilunda	15
8	Nkungi	15
9	Iambi	15
10	Kidarafa	15
11	Mwanga	15
12	Msisai	15
13	Dumbeta	15
14	Gichbod	15
15	Gehandu	15
16	Mwahu	15
17	Gisambalang	15
18	Waranga	15