Farmers` adoption of improved avocado technologies through Farmers Field School (FFS): the case of selected districts in Jimma zone, Oromia, Ethiopia

M.Sc. Thesis

By
Dereje Gire

June 2024
Jimma, Ethiopia

Farmers` adoption of improved avocado technologies through Farmers Field School (FFS): the case of selected districts in Jimma zone, Oromia, Ethiopia

By Dereje Gire

A Research Thesis Submitted to Jimma University,
College of Agriculture Veterinary and Medicine for the partial fulfillment of MSc in Rural Development and Agricultural Extension (Rural Development)

Advisors
Major advisor: Tamiru Chalchisa (MA; Assist. Prof)

June 2024
Jimma, Ethiopia

SCHOOL OF GRADUATE STUDIES

JIMMA UNIVERSITY

COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

MSc THESIS APPROVAL SHEET

We, the undersigned, member of the Board of Examiners of the final open defense by **Dereje Gire** have read and evaluated his/her thesis entitled entitled **"Farmers Adoption Of Improved Avocado Technologies Through Farmers Field School Extension Approach In Seka Chokorsa And Mana Districts, Jimma Zone, Oromia Region, Southwest Ethiopia"** and examined the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree Master of Science in **Rural Development**

Ms Marta H/mariam	-----------------------------	6/14/2024
Name of the Chairperson	Signature	Date
Mr.Tamiru Chalchisa	-----------------------------	6/14/2024
Name of Major Advisor	Signature	Date
Dr. Dereje Hamza	_____________	6/14/2024
Name of the Internal Examiner	Signature	Date
Dr.Dereje Dereso	_____________	6/14/2024
Name of the External Examiner	Signature	Date

DEDICATIONS

I dedicate this thesis manuscript to my Father Gire Bedesa and my sons, Yerosan Dereje for their affections and love in my academic success.

DECLARATIONs

First, I declare that this thesis is my work and that all sources of materials used for thesis have been duly acknowledged. This thesis is submitted in partial fulfillment of the requirements for a Master of Science degree at Jimma University in Rural Development and is deposited at the university library and available for users and borrowers under the rules of the library.

I confidentially declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree or diploma to the best of our knowledge and belief. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of the source is made.

Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author of the thesis.

Name: Dereje Gire Bedesa

Signature: _______________

Place: Ethiopia, Oromia Region ,Jimma Zone, Jimma University

AUTHOR’S BIOGRAPHY

The author was born in Oromia, West Shawa Zone, Ilfata Woreda in 1976. He attended his primary and high school education at Ambo primary school and Ambo comprehensive Senior Secondary School, found in the Ambo town. He then joined the then Haramaya University in September 2000 and graduated with B.Sc. degree in Rural Development and Agricultural Extension in July 2002. After his graduation, he worked in Governmental and Non-Governmental Office as expert until he joined Jimma University for his postgraduate study in 2021.

ACKNOWLEDGMENTS

First, I would like to thank my Lord Jesus for being with me in all aspects during my stay at Jimma University. I would like to extend my heartfelt thanks to my major advisor **Mr. Tamiru Chalchisa (MA, Assistant Professor)** for his valuable advice, insight and guidance starting from proposal development to the completion of the research work. I would like also to express my sincere gratitude to SNV Ethiopia, Horti-LIFE project for giving me chance to pursue my post graduate study. I would like also to thank Atrsaw Anteneh and Mohammed Husen for their hospitality, kindly cooperation, and immediate response on technical issues.

I would like to extend my heart felt gratitude to Hawi Mohammed, for helping every arrangement required for my study. Really, without their cooperation I could not complete my research work. I also remain thankful to all the enumerators who helped me in data collection with patience, commitment, and dedication. Their cooperation was not based on their material benefit but is really their own commitment to help me.

I am grateful to farmers of Seka Chokorsa and Mana woreda who responded to all questions with patience and gave necessary information for this research work. I would like also to thank Seka Chokorsa and Mana woreda office of agriculture and rural development staff for providing me with all the relevant secondary information.

Contents

LIST OF TABLES

List of figures

LIST OF APPENDIX TABLES

ABBREVIATIONS AND ACRONYMS

AESA	Agro ecological system analysis
ATA	Agricultural Transformation Agency
CAADP	Comprehensive African Agriculture Development Programme
EARI	Ethiopian Agricultural Research Institute
FAO	Food and Agricultural Organization
FFS	Farmer Field Schools
FGD	Focus Group Discussion
FSR	Farming System Research
GDP	Gross Domestic Product
GDPG	Growth Domestic Plan
GTP	Growth Transformation Plan
HH	Household
HORTI-LIFE	Horticultural livelihood innovation and food safety project of Ethiopia
IFPRI	International Food Policy Research Institute
IPM	Integrated Pest Management
MOA	Ministry of Agriculture
NGOs	Non-Governmental Organizations
PRA	Participatory Rural Appraisal
RSBOA	Regional State Bureaus of Agriculture
SD	Standard Deviation
SHFs	Smallholder Farmers
SNV	Stichting Nederlandse Vrijwilligers ("Foundation of Netherlands Volunteers") Netherland Development Organization
SPSS	Statistical Package for Social Sciences
VEO	Village Extension Officers

ABSTRACT

Avocado is the game changers of smallholder farmers' income constraint in sub-Sahara Africa. Ethiopia is one of the top five avocado producers in sub-Saharan Africa. Smallholder farmers are high contributor to the total avocado production of the country. The contribution of adopting improved avocado production technology/ies for high productivity is indispensable. However, some farmers are not adopting the recommended avocado innovation packages. Hence, this study targeted to assess the determinants to adopt avocado production technologies in Seka Chokorsa and Mana Districts, Jimma zone, Oromia Region, Southwest Ethiopia. In this study 257 sample respondents (Male180 and Female 77) were selected using multistage random sampling technique. The data were collected from these sample respondents, who are at the same time the members of avocado Farmers field school The data were collected using structured interview and it was supported by Focus Group Discussion and key informant interviews. For data analysis, Descriptive statistics such as Frequency, percentage, mean standard deviation, Chi-square, t-test, and One-way ANOVA were employed to describe the respondents' household demographic, socio-economic and institutional variables, and characteristics. Multivariate probit model was employed to identify the determinants of adoption of improved avocado production technologies by respondent farm households. The model result revealed that, sex of the respondent household head, radio ownership, farming experience, training participation, social capital, and livestock ownership, contacts with development agents, plot distance, annual income, education status, labor availability, and non/off-farm participation plaid significant roles in the adoption of improved avocado technology package components. The joint adoption 16.73% and joint rejection 9.73% of improved avocado technologies showed that Adopters is higher than non-adopters Hence, efforts should be made to increase access to interest free credit services for farmers, particularly in areas where cultural and religious beliefs may discourage credit and saving interest habits. Extension services should be strengthened to provide farmers with information on production techniques and market information, especially through radio programs and frequent contact with development agents. Infrastructure development, such as improving access to input markets should be prioritized to facilitate agricultural activities

Key words: Adoption; Avocado; FFS; Improved Technology; Multivariate

1.INTRODUCTION

1.1. Background of the Study

Agriculture is the most dominant sector in the Ethiopian economy. It contributes about 36% of the country's GDP, 75% of the export earnings and 73% of the employment opportunities (Anteneh et al, 2020). Crops take the highest share of total production and area coverage and contribute 68% of the agricultural GDP. The sector, further, supplies 70% of input to geoprocessing industries (NPDC, 2020).The 2017 Agricultural Extension Strategy of Ethiopia is a national sectoral strategy for the period 2017-2030.

Its main objective is to transform Ethiopia's agriculture, from the subsistence agricultural production to a commercialization, through the implementation of a pluralistic extension system, by providing a strong market-oriented, demand-driven, and well-functioning agricultural extension system to male, female and youth farmers, pastoralists and agro pastoralists. For instance, the Ethiopian government has allocated more than 16% of its annual budget to agricultural development and attained an annual mean agricultural growth rate of more than 8% for the last 8 years. This is significantly higher than the agreement among CAADP member countries to allocate 10% of their national budgets to the agricultural development and attain a mean annual agricultural growth rate of 6% (Brüntrup, 2011).

An effective and efficient agricultural extension system can enhance the agricultural productivity and production of smallholders through the development of innovative, systematic, and farmer owned agricultural extension. Currently, Farmers Training center (FTC) and Farmers Field School (FFS) are the powerful extension delivery modalities to address most smallholder farmers. Farmer Field School (FFS) is a widely used extension method in rural development seeking to educate farmers to adapt their agricultural decisions to diverse and variable field conditions FAO (2016a).

The methodology focuses on experimental learning, meaning that it focuses on group learning by discovery, experimentation and observation, group analysis of results and making better decisions (FAO, 2010 and Aguilar et al., 2011). FFS are platforms and "schools without walls" for improving decision-making capacity of farming communities and stimulating local innovation for sustainable agriculture (Braun et al, 2000). FFS offers community-based, non-formal education to groups of 20-25 farmers through self-discovery and participatory learning principles. Some authors advocate for group sizes of 25-50 (Matata and Okech, 1998). The learning process is based on agro ecological principles covering a cropping cycle. The school brings together farmers who live in the same village/catchment and thus, are sharing the same ecological settings and socioeconomic and political situation. FFS provides opportunities for learning-by-doing. Extension workers, subject matter specialists or trained farmers facilitate the learning process, encouraging farmers to discover key agro ecological concepts practiced in the field.

According to Asfaw et al.(2020) Ethiopia has the right agro-ecology to grow temperate and tropical fruits. Fruit growing plays an important role in the local economy, providing livelihoods for nearly five million farmers, creating jobs, and generating foreign exchange earnings in Ethiopia (FAO (Food and Agriculture Organization), 2019). As a result, in its second Growth and Transformation Plan (GTP) covering the period 2015-2020, the Ethiopian government has placed greater emphasis on increasing the production of fruit crops by almost 50% of the existing ones (National Planning Commission (NPC), 2016) Among the fruits, banana, mango, orange, avocado and papaya are the main fruits grown in the country of great importance.

According to the data from (FAO, 2022) the global fruit production was about 8,685,672 metric tons in 2021 and total avocado harvested area was 858,152 hectares. And avocado production in Ethiopia reached 245,336 metric tons in 2021 and total harvested area was 30585.70 hectares. Ethiopia exported 604.5Qt of avocados in 2021. The main avocado destinations in Ethiopia are the United Kingdom (UK), United Arab Emirates (UAE), Singapore, France, Saudi Arabia, and Djibouti. Avocados are second only to bananas in total production volume in Ethiopia. Bananas, Mangoes, Avocados, Papayas, and Oranges took up 63.30%, 12.49%, 12.39%, 6.16% and 3.52% of the fruit production, respectively.

Avocado production plays a crucial role in the agricultural sector of Ethiopia, particularly in the Jimma Zone. However, farmers in this region face numerous challenges that hinder the adoption of improved avocado technologies. These challenges include limited knowledge about modern farming techniques, lack of access to quality inputs, inadequate extension services, and poor post-harvest management practices. To address these issues, the Farmers Field School (FFS) was established in the Jimma Zone. The school aims to introduce and promote improved avocado technologies to enhance the productivity and profitability of avocado farming in the region.

The justification for conducting research on the farmers' adoption of improved avocado technologies introduced by the Farmers Orchard School in the Jimma Zone is twofold. Firstly, understanding the factors influencing farmers' adoption of these technologies is crucial for effective technology transfer and sustainable development in the agricultural sector. Identifying these factors can help policymakers, agricultural extension workers, and other stakeholders to design and implement targeted interventions to promote the adoption of improved avocado technologies.

Secondly, the adopters can implement different avocado production practices. Assess the status of adopters in the study area can help extension workers, development actors and other stakeholders to strengthening improved avocado production practices. To investigate the farmers' adoption of improved avocado technologies introduced by the Farmers Field School, this thesis analyzed the key factors influencing farmers' decision-making process and assess the level of adopters. The findings of this research will not only contribute to the existing knowledge on technology adoption but also provide valuable insights for policymakers, agricultural practitioners, and development agencies working towards sustainable agricultural development in Ethiopia. Give background information on Avocado crop production, Avocado technologies package adoption, FFS, etc.

1.2. Statement of the Problem

The share of Ethiopian agriculture sector to GDP is decreasing overtime due to the sector is constrained by reliant on rainfall, traditional farming methods and minimal application of modern agricultural technologies (Belay & Mengiste, 2021). As a result, food production shortage, food insecurity and massive poverty are still the major development challenges in the country. Following this, the country has been implementing different extension approaches to promote the adoption of improved agricultural practices (Tefera et al., 2016).

Since land is scarce in the country; the feasible way to improve agricultural productivity in the country is through adoption of modern agricultural technology (Mohammed, 2014). Nevertheless, agricultural technology adoption remains very low in the country even though adoption has a direct impact on increasing yield and income generation as well as nutrition level.

In Ethiopia, different studies have been conducted on the status and determinants of adoption of agricultural technology; However, Avocado innovation packages have not been systematically investigated. The farmers in Jimma area have been facing various challenges, including low productivity, limited access to improved technologies, and inadequate knowledge on Avocado cultivation techniques. These issues have hindered the potential growth and development of the Avocado industry in the area. Therefore, understanding the status and major determinants of adoption of improved Avocado technologies is essential to promote sustainable agricultural practices and enhance the livelihoods of farmers.

It is important to understand the factors that influence the adoption rates. Several studies have highlighted the significance of socio-economic factors in determining the adoption of agricultural technologies (Ayenew, et al., 2020). They identified factors such as education levels, access to credit, and farm size have been recognized as major determinants of technology adoption. Additionally, the role of extension services and farmers' knowledge and awareness about the benefits of adopting these technologies cannot be overlooked.

Various other researchers like Meshesha, G. B. (2022), have identified the major determinants that influence the adoption of these technologies by farmers. One of the primary factors is the farmers' perception of the benefits and advantages they can gain from implementing the new technologies. Additionally, access to information and training through the FFS program plays a crucial role in facilitating the adoption process.

By examining the current situation, we can gain insight into the challenges and opportunities that exist in the area. Additionally, identifying the key factors that drive farmers' decision-making process can help develop effective strategies to promote the adoption of these technologies. Moreover, understanding the existing gaps and constraints will enable us to address them appropriately and enhance the overall adoption rate.

1.3. Objectives of the Study

1.1.1. General objective

The general objective of the study is to explore the major determinants of adoption of improved Avocado technologies that include grafting, composting, mulching, and pruning practices by the farm households participated in Farmers Field School (FFS) extension service in Seka Chokorsa and Mana Districts, Jimma zone, Oromia Region, Southwest Ethiopia.

1.3.1.Specific objectives, Hypotheses, and research Questions

1.1.1.1. **The specific objectives of the study are**:

- To assess farmers Field School participant farmers adoption status of grafting, composting, mulching, and pruning practices of avocado technologies in the study area.

- To analyze the determinants and their effects on adoption of grafting, composting, mulching, and pruning practices of avocado technologies by the Farmers Field School (FFS) extension approach participants in the study area.

1.1.1.2. Hypotheses

- Ho (Null Hypothesis): There is no adoption of grafting, composting, mulching, or pruning practices of avocado technologies by the Farmers Field School (FFS) extension service participant farmers in the study area.

- H_1 (Alternative Hypothesis): there is an adoption of grafting, composting, mulching, or pruning practices of avocado technologies by the Farmers Field School (FFS) extension service participant farmers in the study area.

- Ho (Null Hypothesis): there are no determinants affecting adoption of grafting, composting, mulching, or pruning practices of avocado technologies by the Farmers Field School (FFS) extension service participant farmers in the study area.

- H_2 (Alternative Hypothesis): there are determinants affecting adoption of grafting, composting, mulching, or pruning practices of avocado technologies by the Farmers Field School (FFS) extension service participant farmers in the study area.

1.3.2.Research Questions

This study attempts to address the following main research questions.

- What is the adoption status of grafting, composting, mulching, and pruning practices of avocado technologies in the study area?
- What are the determinants and their effects on adoption of grafting, composting, mulching, and pruning practices of avocado technologies in the study area?

1.4.Significance of the Study

Identification of factors that influence the adoption of improved avocado technologies are critical for removing or at least reducing adoption barriers. By identifying factors that promote technology adoption, it is possible to improve the creation and implementation of technology dissemination initiatives. Thus, the study is assumed to produce very important information related to determinants of adoption of the improved avocado technologies in the study area.

Finally, the findings of this research would be useful to technology developers, extension agents, and policymakers. Even though it's designed to earn degree but can also be used for those agencies as the future references through provisions of basic information about the subject under investigations. Those that are interested in undertaking further research in a relevant subject may find the findings useful in determining future research directions.

1.5.Scope and limitation of the Study

This study covers range of geographical, spatial and temporal scopes. Geographically, the study was limited to Manna and seka chokorsa districts, which were purposefully selected, based availability of FFS. The study was focused on ten randomly selected kebeles, with a sample size of 257 drawn from the selected sample kebeles. In terms of the subject matter, this study was focused on the identification of the status of improved avocado technologies adoption and its major determinants in the study area. The target population of the study from which respondents were selected is the population of farmers who are involved in use of improved avocado technologies through the support of Farmers Field School extension services.

The study is limited to two woredas and ten kebeles. It may not represent the whole woredas in Jimma zone. In the other case, the study focused only on four Avocado technology practices that include grafting, composting, mulching, or pruning practices of avocado technologies. . Lastly, it's also subjected to cross- sectional data and may not clearly indicate the long-time history of improved avocado technologies through FFS. This may affect the generalizability of the study.

1.6.Organization of the research

This research thesis is organized into Five chapters. The first chapter introduces the background of the study, statement of problem, objectives, research question, and significance of the study, and scope of the study. The second chapter provides an overview of the literature review on the subject matter and explained empirical studies. The third chapter deals with the research methodology. The fourth chapter deals with result and discussion. The last chapter describes conclusion and recommendation.

2.LITERATURE REVIEW

2.1.Definition of basic concepts and terminologies)

The Farmer Field School (FFS)**:** It is an experiential training methodology grounded in the principles of adult education (FAO, 2010)

Technology Adoption: Commonly adoption defined as the degree of use of a new technology in a long run equilibrium when a farmer has full information about the new technology and its potential (Feder *et al*., 1985). Loevinsohn *et al*., (2013) describes adoption as the incorporation of a new technology into existing practice, which is typically preceded by some degree of "trying" and adaptation. Bonabana-Wabbi (2002) describes adoption as a conceptual process that an individual goes through from first hearing about an innovation through its final implementation.

Technological Innovation: Rogers (1995) described an innovation as any new idea, practice, or object considered new to an individual. Primarily discussed technological innovations. It explained that "a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (Rogers, 1995, p. 35).

Diffusion of Innovations: Diffusion of innovations is a theory that seeks to explain how, why, and at what rate new ideas and technology spread. Rogers argued that diffusion is the process by which innovation is communicated over time among participants in social system (1995, p. 35).

The Farmer Field School Extension Model: Farmers Field School (FFS) model is a community-based learning system that was introduced in Asia in the eighties as an imaginative response to the overuse of insecticides in irrigated rice fields in Asia in the wake of the Green Revolution. In East Africa, FFS networks, associations and federations have emerged that are farmer owned and financed Braun, (2006). The overall objectives of FFS is to bring farmers together to carry out collective and collaborative inquiry with the purpose of initiating community action and solving community problems Oduori, (2002).

The foundation of FFS method is "farmers first" philosophy, which is in direct contrast to the transfer of technology approach. "Farmers first" concept is essential to empower farmers to learn, experimentation and technology generation and decision-making. To date, Farmer Field Schools have turned out about 4 million graduates. The FFS model has facilitated the spread of Integrated Pest Management (IPM) practices in Asia over the past 15 years, and more recently in Africa.

The FFS model is an important institutional and organizational innovation that needs to be studied in different agro-ecological zones, different institutional arrangements and over time. Because of the lack of baseline data and adequate monitoring of ongoing FFS activities at the farmer and community levels, the available evidence suggests that it is premature to promote the FFS model as the "best model" for developing countries. Clearly there is a need for an expanded research program on alternative extension model in developing countries, and yet research on extension is chronically under – funded Anderson, (2007).

Field schools and other successful programs had the common characteristics of group interaction among farmers, regular meetings, discovery-based learning in the field and regular follow up encounters with individual farmers Paredes, (2001). The FFS methodology is based on farmer participatory environmental education and purposefully seeks to change the paradigm of IPM that often centers on simple rules such as 'economic thresh holds 'and transfer of single element technologies within a framework of ongoing use of pesticides Gallagher, (2000).

Adult non -formal education: According to**,** Mwaseba et al., (2008) Field schools assume that farmers already have a wealth of experience and knowledge. FFS harnesses this knowledge through the process of participatory agro-ecological analysis and learning by doing. The focus is on effective communication at field level and not marketing of extension packages. Field issues are dealt within dialogue with farmers. Therefore, the FFS are oriented to providing basic agro-ecological knowledge and skills, but in a participatory manner so that farmers' experience is integrated into the Programme (FAO, 2000).

One key factor in the success of the FFS has been that there are no lectures – all activities are based on experiential (learning-by-doing), participatory, hands-on work. This builds on adult learning theory and practice. Each activity has a procedure for action, observation, analysis, and decision making. The emphasis is not only on "how" but also on "why". Experience has shown that structured, hands-on activities provide a sound basis for continued innovation and local adaptation, after the FFS itself has been completed. It is also one of the main reasons that farmer facilitators can easily run FFSs-once they know how to facilitate an activity, the outcomes become obvious from the exercise itself Gallagher, (2003).

The group dynamics exercises are part of the non-formal education methods used in the field school to enhance learning and development of capacity for collective action. Khisa (2000**)** has underscored major non-formal education methods used in farmer field schools as sharing, case study, role play, problem solving exercises, panel discussions, small group, and large group discussions, brainstorming and simulation games.

Participative group study/learning: FFS are organized for groups of about 25 persons with common interest. The group of participants is roughly the quantity that can comfortably work together with one facilitator. The groups are often divided in smaller subgroups, so that members can better participate in field observations, analysis, and discussion and presentations. The FFS participants can have different backgrounds; sometimes they are merely farmers, but also students, employees etc. Active participation of the FFS-crop, specific topic and curriculum is fundamental for the success of the FFS.

Social learning is a process in which action and reflection play an important role in a study on community- based and co-management development. Schusler (2001) found that engaging in social learning process does not only generate information about different frames, problems, opportunities and areas of agreement and disagreement. A constructive learning process also reveals the opportunities for developing alternative actions, strategies, capacity, and possibilities for working together.

Basic science and learning plots**:** FFS try to focus on basic processes through field observations, season long research studies and hands on activities. The field is the learning environment. In each FFS there are two main learning plots: the conventional plot and the modern plot. In the conventional plot, farmers work based on 'what they always do'. Decisions and actions are based on habits and traditions. In the modern plot the groups work based on analysis.

The curriculum: The FFS curriculum follows the natural cycle of its subject, be it crop, animal, etc. The approach allows all aspects of the subject to be covered, in parallel with what is happening in the FFS fields Sones and Duveskog, (2003). FFS follows a curriculum, where crops, livestock, silviculture, land husbandry, socioeconomics and education are integrated to form a holistic approach for addressing farmer's needs. The curriculum is based on local conditions, problems and needs of participating farmers.

Agro-ecological system analysis: In general, the corner stone of the FFS approach is the Agro ecological system analysis (AESA), which is a field, based analysis of the interactions observed between crop/livestock and other biotic and a biotic factor co-existing in the crop/livestock field. The purpose of using AESA is to learn and make regular field observations, analyze problems and opportunities encountered in the field and to improve decision making skills regarding farm management. The analysis follows a cycle of observation, analysis, and action.

By carrying out AESA regularly in the FFS, farmers develop a mental check list of indicators to be observed when monitoring their farm practices (Gallagher, 2003). Using the framework of agroecosystem analysis, improved farmers decision-making emerges from an iterative process of analyzing problems and situations from multiple viewpoints, synthesizing the analyses, making decisions, and implementing them accordingly. It also involves observing the outcomes of the implemented decisions and evaluating their overall impact. Learning in the field school is experiential and discovery based, and agro ecosystem analysis is done in small groups of 4-5 farmers on the activities being carried out in the central plot. Appropriate indicators are used to measure system health during the learning process.

The analyses and proposals emanating from the small groups are presented in a plenary for discussion and for reaching a consensus on the next course of action. Since most relationships among agroecosystem components are usually unknown to most farmers, mechanisms for identifying and filling such gaps need to be put in place Bentley, (1994**).** Special topics are included in farmer field schools to cover unknown agro ecosystem relationships e.g., using insect zoos. The topics also develop farmer's research capacity by stimulating comparison of treated (IPM plots) and non-treated plots and by providing regular opportunities for data gathering and analysis through the testing, validation, and evaluation of technologies (PTD).

During the learning cycle, participants' capacity for collective action is stimulated through group dynamics exercises. The exercises help to strengthen teamwork spirit and problem-solving skills, promote creativity and awareness on the importance and role of collective action and the need for mutual support. They also help the group members to learn about individual's role and behavior that makes teamwork successful in addition to establishing a conducive climate for learning. Group dynamics is built through a process of problem-solving exercises, mental puzzles, brainteasers, simulation games, physical exercises etc.

Experiential learning of FFS: In experiential learning concrete experience is the center; however, the experience does not have to be real life experience developed especially for learning situation, such as a case study or a role play, or an exercise involving the leaner in actual experimentation on the skills to be learned. In FFS concrete experience through active hands-on activities forms the basis of learning. However, simulated experiences are also applied, especially when the proposed learning topics by farmers relate to issues where it is difficult to set up actual experiments.

Such topics include, in the agricultural domain, issues such as pasture or larger water shed management or animal health. The FFS provides a space for people to reflect actively. Participants could conceive solutions to problems with a degree of clarity often difficult to accomplish in the rush and clutter of day-to-day lives. As group members struggle to realize a collective vision/version of their world, they will discover perspectives that reveal new possibilities for resolving their problems Stringer, (1999).

A learning process that banks on the intelligence, creativity, and competence of farmers, extension workers and researchers are required for effective change. This condition is met under farmer field schools. Farmers do not become experts by adopting science-based technologies or memorized body of knowledge acquired from others, but by becoming better learners. They internalize underlying principles (pest management, crop interactions, soil productivity improvement etc.) in diverse situations and adapt their activities when circumstances change with new situations. Experiential learning or learning by discovery promoted in farmer field schools empowers farmers to become better learners and to cope with new challenges; a fact which has been demonstrated under IPM based FFS (Deugad, 1998**).**

2.2.Theoretical Framework of the Study

The term “theoretical framework” comprises two words, “theory” and “framework”. It is therefore appropriate to start by giving definitions of what a theory is and what a framework is. A theory, according to Kerlinger (1986:9), is “a set of interrelated constructs, definitions, and propositions that present a systematic view of phenomena by specifying relations among variables with the purpose of explaining and predicting phenomena”. A framework is “a set of ideas that you use when you are forming your decisions and judgements”. According to Kerlinger (1986), a theory can be used to successfully make predictions and this predictive power of the theory can help guide researchers to ask appropriate research questions. On the other hand, a framework provides structure within which the relationships between variables of a phenomenon are explained.

2.2.1.Theory of Planned Behavior (TPB):

in this theory, perceived behavioral control (PBC) as a new variable is added to extend TRA theory PBC is determined by the availability of resources, opportunities, skills, as well as the perceived significance of those resources, opportunities, and skills to achieve outcomes White *et al.*, (2015). Although both TPB and TRA assumed person's behavioral intention (BI) is affecting individual's behavior, TPB is using the PBC for individual's actions which are not under volitional control. By adding PBC, not only realistic limitations are composed but also, a self-efficacy type factor is achieved (Taherdoost H., M. Masrom, 2009 & Taherdoost *et al.*, 2012).

Moreover, PBC has the direct influence on actual behavior as well as the indirect affect through the behavioral intentions. Therefore, in TPB theory l, three main factors are affecting BI including perceived behavioral control, subjective norm, and behavioral attitude. However, there are two main problems with TPB model (Taherdoost *et al*., 2011). First, the one's attitudes towards information technology will not be largely relevant if a computer system is not accessible. Second, the revised TPB may be viewed as the more suitable theoretical framework which is influenced the degree of individual's voluntariness that choose or not to choose the use of information technology.

2.2.2.Technology acceptance model (TAM),

Technology Acceptance Model, first proposed by Davis (1985), comprises the core variables of user motivation (*i.e.*, perceived ease of use, perceived usefulness, and attitudes toward technology) and outcome variables (i.e., behavioral intentions, technology use). of these variables, perceived usefulness (PU) and perceived ease of use (PEU) are considered key variables that directly or indirectly explain the outcomes (Marangunić & Granić, 2015). These variables are often accompanied by external variables explaining variation in perceived usefulness and ease of use; among others, subjective norms (SN), self-efficacy (CSE), and facilitating conditions (FC) were significantly related to the TAM core variables however, to different degrees (Abdullah & Ward, 2016; Schepers & Wetzels, 2007).

These external variables represent personal capabilities next to contextual factors and their conceptualizations vary across studies. Overall, perceived ease of use and perceived usefulness, the most important factors in the TAM, refer to the degrees to which a person believes that using a technology would be free from effort (cf. PEU) and that using a technology would enhance their job or task performance (cf. PU). Since many technologies adoption studies have used this model, it can also be used to study the adoption of soil and water conservation measures.

2.2.3.Diffusion of Innovations Theory (DOI):

DOI theory examines a diversity of innovations by introducing four factors (which are the time, channels' communication, innovation, or social system) which influence the spread of a new idea. DOI not only has been used at both organizational and individual levels but also, offers a theoretical foundation to discuss adoption at a global level. DOI theory integrates three major components: adopter characteristics, characteristics of an innovation, and innovation decision process. In innovation decision step, five steps namely confirmation, knowledge, implementation, decision, and persuasion have taken place through a series of communication channels among the members of a similar social system over a period.

In characteristics of an innovation step, five main constructs; relative advantage, compatibility, complexity, trial ability, and observability have been proposed as effective factors on any innovation acceptance. In adopter characteristics step, five categories; early adopters, innovators, laggards, late majority, and early majority are defined (Sila, 2015). In conclusion, DOI more focus on the system characteristics, organizational attributes, and environmental aspects, it has less power in explanatory and less practical for prediction of outcomes compared to other adoption theories (Rogers (2003)

1.1.2. Adoption of innovation theory by Rogers (2003) and Diffusion of Innovations Theory (DOI) was the theory guiding this study. According to Medlin (2010), the adoption of innovation theory is the most appropriate for investigating the adoption of technology in higher education and educational environments. In fact, Rogers, E. M. (2003) used the words "innovation" and "technology" as synonyms. The main objective of this theory is to understand the adoption of innovation that can be realized through four elements that include innovation, communication channels, time, and social systems, and the five stages of adoption processes that include (i) knowledge stage, (ii) persuasion stage, (iii) decision stage, (iv) implementation tage, and (v) confirmation stage.

The above four theories are employed in this study as a guide to analyze the farm households' adoption behavior, the characteristics of the technologies that determine their diffusion and different stages required to adopt those technologies of improved avocado production in the study areas. The theories in this study help the researcher to understand why farmers vary in their adoption of improved avocado technologies. As observed, in this study some farmers adopt two technologies, while others three or more, and others not adopted, which is due to the variations of farmers' acceptance and decision behavior, due to the characteristics of the technologies to understand and practice and other social, institutional, environmental, and economic factors, which all affect the farmers acceptance and decision behaviors as explained in the theories. Therefore, the different level of adoption of improved avocado technologies is supported by those theories.

2.3.Empirical Research

Empirical review of the literature on technology adoption in developing countries reveals that the various factors that influence technology adoption can be grouped into the following three broad categories. Factors related to the characteristics of producers i.e., the farmers; factors related to the characteristics and relative performance of the technology and. program and institutional factors (Teklewold, *et a*l., 2013).The factors related to the characteristics of producers include education level, experience with the activity, age, gender, level of wealth, farm size, plot characteristics, labor availability, resource endowment, risk aversion, etc.

The factors related to the characteristics and performance of the technology and practices include food and cash generation functions of the product, the perception by individuals of the characteristics, complexity and performance of the innovation, its availability and that of complementary inputs, the relative profitability of its adoption compared to substitute technologies, the period of recovery of investment, local adoption patterns of the technology, the susceptibility of the technology to environmental hazards, etc. (Shiferaw *et al*., 2009).

The institutional factors include availability of credit, the availability and quality of information on the technologies, accessibility of markets for products and inputs factors, the land tenure system, and the availability of adequate infrastructure, extension support, etc. Enabling policies and programs, market linkages, access to institutional support and credit were found to play a positive role in stimulating farmer investment in and adoption of sustainable use of technologies (Shiferaw*et.al*, 2009)

2.3.1. ***Demographic factors***

Sex difference between household heads is a very important explanatory variable in studying factors of adoption. The prevailing social set up of rural households placed a varying responsibility among male and female members. In most parts of rural Ethiopia women are disfavored groups of the society who couldn't easily access technology information. Thus, numerous adoption studies had come up with results showing being a female headed negatively influencing technology adoption decisions.

Consequently, those males headed households who have more access to information to use innovation than female-headed households, which have a capacity to influence by the cultural norms and traditions. The existence of wealth difference among female headed and male headed households could be also the possible reason forwarded for the difference in adoption of agricultural new technologies. Those males headed households who do have more wealth can easily accord the price of agricultural new technologies (Melesse, 2018).

Age of the household head is another variable in explaining farmers' technology adoption behavior which plays an important role through influencing farmers' information access and shaping their ability to change the available information into action. Older farmers may have experience and resource that would allow them more possibilities for trying a new technology. On the other hand, younger farmers are more likely to adopt new technology because they have had more schooling than the older generation. Different agricultural technology adoption studies revealed conflicting results on the influencing of age in adoption. Some of the finding confirmed that age negatively influencing adoption behavior of farmers. On the other hand, other agricultural technology adoption studies by other researchers indicated that age positively accepted adoption. But the reviewer supports the argument if age has a negative relationship with adoption of agricultural new technologies. When we see the adoption category of farmers in adoption of agricultural new technology, younger farmers categorized under the first category, and they are characterized as innovative which enables them to make decision on adoption of agricultural new technologies (Melesse, 2018).

2.3.2. Socio-economic factors

Education status of the household head is the most common and important variable that is found to explain farmers' agricultural technology adoption behavior. Various studies confirmed that it has a significantly positive influencing on adoption of technologies. For instance, Mahadi et al. studied factors accepting adoption of improved sorghum varieties in Somali Region of Ethiopia. They found out that more educated farmers are more likely to adopt improved sorghum varieties in the study area.

Availability and family labor size plaid a vital role in determining adoption and intensity of use of agricultural technologies. The existence of active work force in rural households usually encourages them to show interest in trying some agricultural technologies, since use of technologies required higher labor. Off course, the influencing of labor availability on adoption depends on the characteristics of the technology to be adopted. Plenty of adoption studies found out a positive impact of family labor on technology adoption such as (Asfaw, et al., 2012).

The impact of farm size on adoption and intensity of use agricultural technologies on the other hand, is not consistently similar in various adoption studies. Some of the studies showed a positive influencing of the variable on adoption decision. For instance, studied determinants of adoption and intensity of use of improved Maize varieties in the Central Highlands of Ethiopia and found a positive significant (Ogada, *et al*., 2014).

According to Diiro, 2013; off-farm income is expected to provide farmers with liquid capital for purchasing productivity enhancing inputs such as improved seed and fertilizers. In another study conducted by Ibrahim et al. annual income of the respondent had a significant positive relationship with the adoption of recommended technologies in Bangladesh i.e., the higher the annual income of the respondents, the more they adopted recommended technologies. The influence of annual gross income was robust in our analysis and statistically significance in the adoption of teff, maize, wheat, barley, and sorghum technology package (Diiro, 2013).

2.3.3. Institutional factors

Institutional factors deal with the extent or degree to which institutions impact on technology adoption by smallholders. Institutions include all the services to agricultural development, such as finance, insurance, and information dissemination. They also include facilities and mechanisms that enhance farmers' access to productive inputs and product markets. Extension service is a very crucial institutional factor that differentiates adoption status among farmers. In the existing situation much of agricultural technology delivery is undertaken by the extension system.

Access to participate in training, demonstration, fled day and other extensions services therefore creates the platform for acquisition of the relevant information that promotes technology adoption. Several studies have used difference variable to measure farmers' access to extension services. A study conducted in four regions of Ethiopia show that farmers who had more frequent contact with extension agents were more likely to adopt tef technology as compared to farmers who had low frequent contact (Tefera, *et al*., 2016).

Similar study conducted by Mahdi has also found a negative influence of distance from farmers' residence to DAs office on technology adoption. Another important measure of extension is farmers' experience in extension service. Farmers' experience with agricultural extension is expected to increase their demand for yield. The introduction of new technologies creates demand for information useful in making decisions. Therefore, agricultural extension organizations supply useful information about new agricultural technologies. Access to such sources of information can be crucial in adoption of improved varieties (Egge,2005).

Market distance of the respondents is important for the producers to get attractive market price through reduction of transportation cost. The increase in market distance makes farmers to get out-dates market information and becoming out of adopting agricultural new technologies. The finding (Tefera, et al., 2016) showed that maize and tef technology package adoption improved as the households' residences became closer to market while the reverse held true for wheat technology package adoption. The market pulled technology adoption, and these finding agreed with results of (Bayissa, 2014).

The negative relationship between distance of the residence from an all-weather road and fertilizer adoption was reported by other studies. For instance, (Gebreselassie & Bekele, 2015) found that distance to market centers was negatively and significance related to adoption of fertilizer. Decreasing the distance from the market decreased the transportation cost of agricultural inputs. Hence market distance and use of inorganic fertilizer had a negative relationship (Ogada, etal.,2014).

Access to credit service is the source of finance for the medium and lower income households to buy inputs for agricultural production. In Ethiopia, the credit service given in kind and cash form especially credit services delivered for agricultural production system. Different Authors conformed that farmers who have access to credit service had more probability to adopt the agricultural new technologies than otherwise. Daniel and Kefale confirm access to credit can increase the probability of adoption of agricultural new technologies by offsetting the financial shortfall of the households (keffle, 2011).

2.3.4. Adoption of Improved Avocado Production practices through FFS extension approach.

Ministry of Agriculture Ethiopia collaboration with SNV, Ethiopia Horti life (2019), the followings is the key recommended innovation packages for improved avocado demonstrations in Ethiopia.

Suitable production site selection:

Avocado is cultivated in a wide range of altitudes (0-2500m above sea level) globally but cultivated from 1000 to 1800masl in Ethiopia. It requires 13-28oC temperature, 1200-1600mm annual rainfall, 70-80% relative humidity, and fertile, deep (1-2m) and well-drained soil. The site should be free from frost, strong wind, hail and root-rot and collar-rot causative agents. The site should have salt free water for supplementary irrigation.

Improved Varieties:

Over 220 improved avocado varieties are growing globally. However, only six improved varieties are recommended for production in Ethiopia. Hass &Fuerte are the most popular varieties in the export market. Characteristics of improved avocado varieties are given below. *Propagation:* Avocado can be propagated by seed, layering, stem cutting, budding, and grafting methods. However, it is usually propagated by cleft grafting method and grafting steps described using the following picture. However, it is better to advise smallholder farmers to buy certified grafted seedlings from commercial nurseries.

Table 1Types and Characteristics of improved avocado varieties

Varieties	Flower type	Fruit weight (g)	Pulp Oil content (%)	Fruit Shape	Fruit skin color at maturity
Bacon	B	250-300	16-18	Round	Green
Ettinger	B	250-350	18-22	Pear	Bright green
Fuerte	B	250-400	16-25	Pear	Green

Hass	A	140-350	18-23	Pear	Brown
Nabal	A	300-500	05-Dec	Oval	Dark green
Pinkerton	A	270-400	18-25	Pear	Dark green

Source: Ministry of Ethiopian Agriculture, 2019

Land preparation: Deep plough the field about 2-3 times ahead of the on-set of the rainy season to break hardpan & improve drainage. Spread organic fertilizer & incorporate into the soil. Level the field to facilitate the flow of irrigation water & drain excess water. Prepare raised bed (mound) in waterlogging fields or construct terraces in sloppy areas.

Planting hole preparation: Planting pit size is 60cm x 60cm x 60cm. Dig planting pits 2 months prior to the date of transplanting. Keep the topsoil (the first 15cm) in one side & the subsoil in another side. Mix the topsoil with decomposed FYM at equal proportion & add DAP at the recommended rate to the mixture. Fill the pit with the mixture 6-8 weeks before transplanting.

Spacing: Recommended spacing ranges from 6m to 10m. Plant A & B type varieties in alternate rows**.**

Transplanting: Transplant at the beginning of rainy season & coolest time of the day. Dig planting hole from the center of previously prepared planting pit. Place the seedling at the center of the planting hole. Return the soil to the planting pit & gently press the soil around the seedling. Support the seedling with two stakes. Irrigate seedlings & rub off suckers emerging on the rootstock regularly with your fingers or use clippers if already bigger. If left to grow, the rootstock sucker will compete for nutrients and kill the scion.

***Windbreak*:** plant hardy, less competent and fast-growing trees (not eucalyptus) as windbreak around the orchard.

Irrigation: susceptible to drought and waterlogging. The amount of water and irrigation frequency is influenced by soil type & prevailing climate. Irrigate at 5-7 days interval. Apply 15lt water per seedling twice per week after transplanting, 30lt water per week after establishment, 50lt water per week in the second year, & increase the quantity by 50lt every year and reach 200lt per week by the fifth year. Drip and ring or basin irrigation methods are preferred for avocado irrigation. Use salt free irrigation water.

Soil fertility management/ fertilizer: Avocado requires fertile soil. Apply 25, 50, 100, & 200g nitrogen per tree per year for 1, 2, 3, & 4-year-old tree. Apply 300-800g of N, 450g of K2O, and

130g P2O5 /tree/year for fruit bearing or ≥5 years old tree. Apply in 2-3 splits, half immediately after harvesting & the other half 2-3 months later. Broadcast under the canopy 50 cm far from the trunk. Incorporate the fertilizer up to 15cm soil depth since feeder roots found in the top 15cm. Do not add undecomposed FYM.

Hoeing/ cultivation: Lightly hoe irrigation basin once per month & the space between rows and trees twice per year, at the on-set & cessation of the rainy season.

Mulching: Use organic or inorganic (plastic sheet) mulch. Apply at least 10cm thick chopped mulch 30-50cm away from the trunk. Organic mulch serves for 1-3 months. Avoid mulching in the rainy season.

Intercropping: Intercrop for the first 3-4 years. Crops such as cucurbits, groundnut, cowpea, maize, strawberry, and papaya can be intercropped. Avoid crops that host diseases & pests & compete to soil moisture & nutrients such as tomato, pepper, potato, eggplant, cinnamon, cassava, taro, yam etc.

Pruning: Two types of pruning practiced in avocado. Heading back: Cutting the terminal shoot to manage the tree height to 3m - 6 m (80% of the row width). Done in the first 3 years during the dry season. Thinning out pruning: A complete removal of a branch from a lateral or main trunk. Done to remove dead, crowded & branches touching the ground. Maintain canopy at 70% of its row width & done upon completion of harvesting. For the latter Hass, Fuerte, Puebla are popular varieties.

Postharvest handling

Cleaning: Fruit cleaning is important to remove mud or dust, insect pests or disease-causing organisms found on the skin of the fruit and any pesticide residue. It can be carryout manually using a brush and a sink of water or a water spray.

Trimming**:** Avocado fruits should be harvested not by pulling but by cutting the stalk 3cm above the fruit. Trim or shorten the fruit stalk to 0.5 to 1cm long.

Hot water treatment: This treatment is used to kill fungal spores on and in the skin of the fruit. The avocadoes should be immersed in water heated to a temperature of 50°C for 3-5 min. Treatment of fruit using fungicides such as Bavistin improves the effectiveness of this treatment.

Grading: Grading is usually done by fruit diameter or weight. The grade is defined as the number of fruits required to fill a carton containing 4 to 4.5 kg of fruit.

***Precooling*:** After harvesting, avocadoes must be cooled as quickly as possible to the optimum storage temperature of 5oC for Fuerte and Hass varieties within 5 hours of harvesting.

Packing: Avocado fruits are usually packed in various size cartons Carton weights vary from 44.5kg to 15-15.5kg and contents from 8 to 42 avocados according to capacity and grade. The preferred numbers of fruits per box or carton are 12, 14, 16, 18 or 20. Do not use rough surface wooden boxes for fruit packaging-use plastic box.

***Storage*:** The storage condition determines the shelf-life the avocado fruit either by delaying or enhancing the ripening process. The lower the temperature, the longer the fruit will take to ripen. However, too low temperature will cause chilling damage on the fruit.

***Transport*:** Avocado fruit is highly perishable. Therefore, it should have to be transported with refrigerated trucks. Avocado from production field to the local market is transported by human being and pack animals. Unrefrigerated trucks are used to transport avocado to distant market. This transportation practice contributed for the short shelf-life and high postharvest loss.

2.4.Conceptual Framework

The direction and degree of impact of adoption determinants are not uniform; the impact varies depending on the type of technology and the conditions of the areas where the technology is to be introduced Morkunas, *et, al*, (2019). Farmers' decisions to adopt or reject new technologies can also be influenced by factors related to their objectives and constraints. These factors include farmers' resource endowments as measured by (1) size of family labor, farm size, and oxen ownership, (2) farmers' socio–economic circumstance (age, and formal education), and (3) the institutional support system available for inputs. Hence, the following theoretical structure shows the most important variables expected to influence the adoption of improved Avocado varieties in the study area specifically.

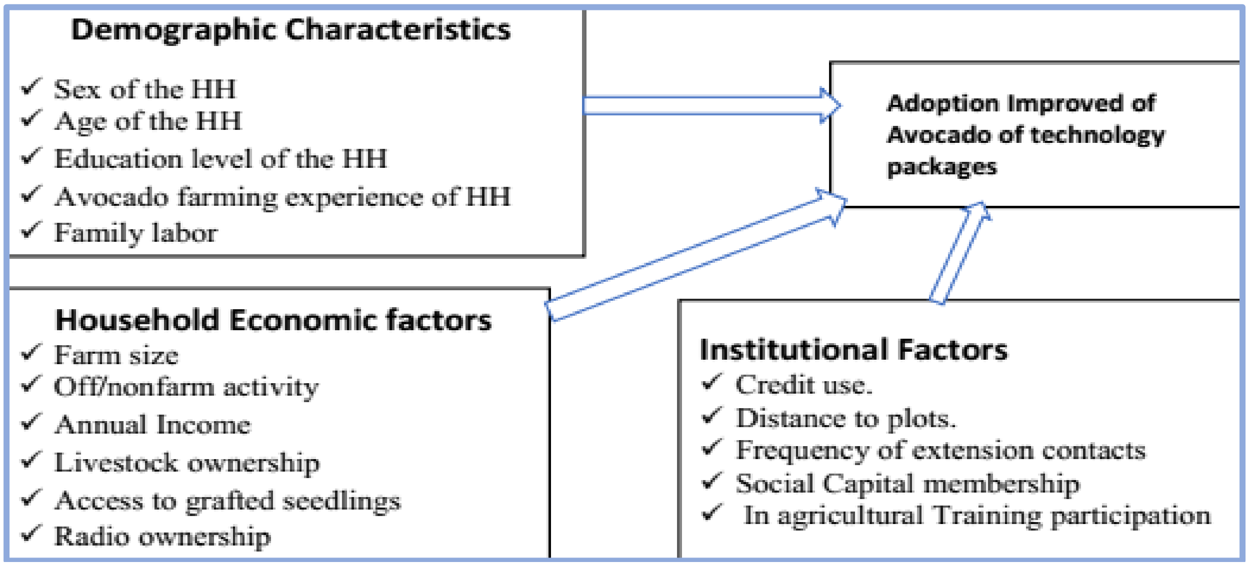

Figure 1 Conceptual framework of the study

Source: Developed by the author after thorough review of different literature, 2023

3.RESEARCH METHODOLOGY

3.1.Description of the Study Area

This study has is conducted in the two major avocado growing districts, namely, Mana and Seka Chokorsa districts of Jimma Zone, Southwest Ethiopia. The reasons for selecting the two districts were due to the presence of numerous functional and viable Farmers' Field Schools (FFS). The other reason was the fact that it was an area where FFS were first introduced in the Zone on avocado improved practice by the help of SNV, Ethiopia, *Horti LIFE project* Jimma Cluster in 2020.

Mana is one of the woredas in the Oromia Region of Ethiopia. It is bordered on the south by Seka Chekorsa, on the west by Gomma, on the north by Limmu Kosa, and on the east by Kersa. The administrative center of this woreda is Yebu. The landscape of Mana includes mountains, high forests and plain divided by valleys. Based on Mana District Administrative Office, 89.1% of the district is arable land, 2.7% pasture, 2.8% forest, and the remaining 5.4% is considered swampy, degraded or otherwise unusable. Coffee and *Khat* are the important cash crop smallholder farmers in the districts, according to Mana District office, (2022).

Based on the 2007 national census report, the total population of the district was 146,675, of whom 74,698 were men and 71,977 were women. Most of the inhabitants were Muslem with 90.23% of the population reporting they observed this belief, while 8.44% of the population practiced Ethiopian Orthodox Christianity, and 1.15% were Protestant.

The other district is Seka Chokorsa. The Woreda is one of the woredas in the Oromia Region of Ethiopia. Seka Chekorsa is bordered on the south by the Gojeb River which separates it from the Southwest Ethiopia region, on the west by Gera, on the northwest by Gomma, on the north by Mana, on the northeast by Kersa, and on the east by Dedo. The altitude of this woreda ranges from 1580 to 2560 masl. Based on Seka Chekorsa District

Administrative Office 45.3% of land is arable (44.9% was under annual crops), 6.1% pasture, 25.8% forest, and the remaining 22.8% is considered swampy, degraded or otherwise unusable.

Khat, peppers, fruits and teff are important cash crops. Based on 2007 national census report the total population of the district was 208,096, of whom 104,758 were men and 103,338 were women; 7,029 or 3.38% of its population were urban dwellers. Most of the inhabitants were Muslim

(86.66%), while 10.93% of the population practiced Ethiopian Orthodox Christianity, and 2.27% were Protestant.

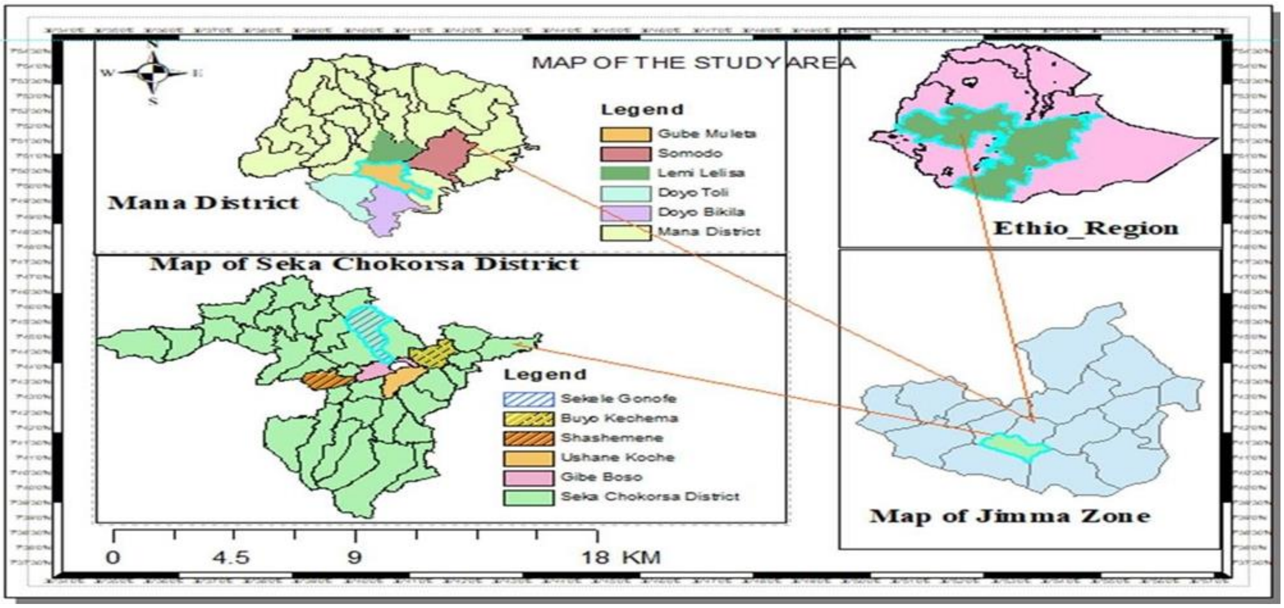

Figure 2 Map of the study area

Source: Ethio Geospatial data

3.2.Research Approaches and Design

This research used descriptive research approach and cross-sectional design. Both qualitative and quantitative information collected from the field were analyzed and interpreted.

3.3.Data Type and Source

The study used both quantitative and qualitative data types collected from primary and secondary sources. Both quantitative and qualitative data were collected through interview schedule, Focused group discussion and Key informant interview.

3.3.1.Sampling Procedures and Sample Size Determination

The population of the study was taken from Farmers Field School (FFS) participants who have been actively involved in grafted Avocado production between the 2019 to 2022 cropping seasons and decided to continue in avocado production in the area. Multi-stage sampling procedures were employed in selecting sample respondents. Accordingly, in the first stage, from Jimma Zone, out of

21 districts, Seka Chokorsa and Mana districts were purposively selected based on availability of FFS initiatives and their potentials in avocado production.

In the second stage, five kebeles in which FFS has been functionally practiced will be selected purposely from each District. In the third stage, about 257 sample respondents were selected through employing simple random sampling techniques. Sample distribution for each district and kebeles were done based on probability proportional to size (PPS) (see Table 2). For this study, the total sample size was determined based on the sampling formula provided by (Yamane, 1967). The formula used for sample size determination with a 95% confidence level, degree of variability = 0.5, and level of precision of 5% (0.05) was:

$$n= \frac{N}{1+N(e)^2} \quad \ldots 1$$

Where: n=Sample size, N=Population size, which is 730, and e=level of precision. Based on the above formula a total of 257 households were interviewed. Hence, out of the target population 36%was selected for this study.

Table 2 Sample size of the study

№	Districts	Sample kebeles	Total population (FFS members)	Sample size
.	Seka Chokorsa	Buyo Kechema	78	**30**
		Gibe Boso	74	27
		Shashamane	74	26
		Ushane Koche	73	28
		Sekele Gonofe	71	24
.	Mana	Doyo Toli	70	27
		Doyo Bikila	71	25
		Dube Muleta	75	27
		Somodo	73	21
		Lemi Lelisa	71	22
	Total	**10**	**720**	**257**

Source: Seka Chokorsa and Manna Districts Agricultural office (2022)

3.4.Methods of Data Collection

To achieve the objectives of the study, interview schedule, focus group discussions, and key informant interviews. The next section briefly describes each method that use for data saturation techniques.

Interview Schedule: To generate qualitative information at the household level, a household survey was undertaken by developing an interview schedule. The interview schedule designed based on the objectives of the study; specifically on the status of adoption of improved avocado innovation packages, and factors affecting the adoption of improved avocado technologies through FFS. Before the actual data collection, all the enumerators have obtained training on the methods of data collection, the content of the household survey, and how they approach the interviewee. Thus, the survey was conducted by selecting one enumerator for each study kebele and awareness was given to respondents before actual data collection. The prepared questionnaire was translated to *Afan Oromo*, and pre-teste was conducted on at least 5% of the sample size.

Focus Group Discussion (FGD): Qualitative information was collected through employing FGD. The FGD participants were selected from innovative farmers who have already adopted the improved avocado technologies through FFS initiatives. Accordingly, about 8-10 participants selected in each kebele and discuss on the key issues under investigations and Five (5) FGD was conducted per one woreda and a total of ten(10) FGD were conducted. The checklist was prepared and used to guide the discussions.

Key informant interview (KII): As the strategy for data augmentations and triangulation, key informant interview was held both at kebele and district level, in which a total number of six(6) key informants were conducted (four at kebeles level and two at districts level). Accordingly, qualitative data was collected through employing KII. The key informants are the resource persons who have close observation and experience on improved avocado technologies in the study area. The purpose of key informant interviews is to collect information from a wide range of people-including community leaders, professionals, or residents-who have first-hand knowledge about the community which is to support the quantitative data collected.

3.5. Methods of Data Analysis

The study employed both qualitative and quantitative methods of data analysis. Qualitative data were analyzed through narration and synthesis. Quantitative data were analyzed through employing descriptive statistics (Mean, standard deviation, frequency, and percentage), inferential statistics (Chi-square test and T-test), and econometric model (Multivariate Probit). Statistical packages for social science (SPSS) version 23 were used as analytical tools.

3.5.1. Descriptive statistics

These were done after appropriate coding, edit, and managed of the collected data. To describe the overall avocado technology adoption status with respect to the desired characteristics, descriptive statistics such as mean, standard deviation, percentages and graphs were used. Furthermore, test statistics such as t-test for continuous variables and chi-square ($\chi 2$) test for dummy/discrete variables were employed to compare means of socioeconomic characteristics among improved avocado technology adopters and non-adopters. One way ANOVA was employed for testing the overall significance differences of avocado adoption levels using adoption index.

3.5.2. Adoption index of improved avocado technologies

Adoption index was used to measure the status of adoption of improved avocado technologies at the time of the survey. In this study, four main avocado practices were used to assess the level of adoption of avocado production technologies which are grafting avocado seedling, mulching, pruning, and composting. The actual adoption index score ranges from 0 to 1. Adoption index score of zero point implies non-adoption of the improved avocado innovation packages and greater than zero (>0 and ≤ 1) implies adopters. The index for each respondent farmer were estimated as:

$$\boldsymbol{AI} = \frac{\sum_{n}^{\infty}\left(\frac{NgA}{NtA}+\frac{NmA}{NtA}+\frac{NpA}{NtA}+\frac{NcA}{NtA}\right)}{TNP} \quad \ldots 2$$

Where: AI is adoption index.

NgA is number of grafted avocado tree.

NmA number of mulched avocado tree

NpA number of pruned avocado tree.

NcA is number of composts applied tree.

NtA number of total avocado trees of the household

TNP is total number of avocado technology packages included in this study.

3.5.3.Econometrics Analysis and Model Specification

1.1.3. Diagnosis test

Multicollinearity Test: Before running the econometric model, the data was tested against econometric problems. Accordingly, the data was checked for multicollinearity test for all variables was done using Variance Inflation Factor (VIF). the Variance Inflation
Factor (VIF) is calculated as follows:

VIF(Xi) $=\frac{\mathbf{1}}{\mathbf{1-Ri2}}$………………………………………………….………………………….... 3

Where, Ri2 is the multiple correlation coefficients between explanatory variables, the larger the value of Ri2 is, the higher the value of VIF (Xi) causing higher collinearity in the variable (Xi). When VIF>10 then it shows there is a problem of high multicollinearity among the explanatory Variables otherwise the problem is not serious.

3.5.4.Model specification.

The specification of econometrics model depends on the nature of a data and objective of the study (Wooldridge, 2020). In econometrics analysis the outcome variables could have binary or multiple choices. For unordered binary choice outcome variables binary probit and binary logit models are appropriate. Whereas for unordered multi-choice outcome variables multi-choice models such as multivariate and multinomial models are appropriate (Greene, 2018).

In multivariate analysis model individuals applied or choose more than one choice from the given non-mutually exclusive alternatives whereas in multinomial analysis model individuals can choose only one choice from among the set of mutually exclusive alternatives (Cappellari & Jenkins, 2003). In agricultural technology adoption multivariate analysis models such as multivariate probit and multivariate logit models are common because technologies are provided in packages (including a number single technology and not mutually exclusive). There was complementarity among all the improved avocado production technologies that considered in this study. Hence, in this study, **multivariate probit model** was employed to identify the adoption determinants of avocado production technology package practices.

In this study four technology components of improved avocado technologies were selected that include (grafting avocado production *i.e.*, grafting seedling, mulching, pruning and compost application). Therefore, the study has four dependent binary variables $y\boldsymbol{ij}$ for household i and plot

$\boldsymbol{y^{*}ija = \beta a\, Xija + \ \varepsilon ija}$ ($\boldsymbol{a}$= grafting seedling, mulching, pruning and compost application) ……. 4

$$\boldsymbol{yija = 1\ if\ y^{*}ija > 0} \quad \ldots\ldots \quad 5$$
$$= 0\ if \text{ otherwise}$$

Where $\boldsymbol{y^{*}ija}$, is a latent variable and defined as a farmer $\boldsymbol{i}$ applied avocado technology. This latent variable is assumed to be a linear combination of observed plot and household characteristics $\boldsymbol{Xija}$ and unobserved characteristics captured by the stochastic error term, $\boldsymbol{Xija}$. The vector of parameters to be estimated is denoted by $\boldsymbol{\beta a}$. Given the latent nature of $\boldsymbol{\beta a}$, estimation is based on observable binary variables $yija$, which indicate whether a farmer used a particular avocado technology in the survey year. The error terms $\boldsymbol{\varepsilon ija}$ ($\boldsymbol{a}$ = 1, 2 . . . 4) is distributed multivariate normal each with mean 0 and a variance-covariance matrix Φ, where Φ has 1 on the leading diagonal, and correlations μij = μji as off-diagonal elements.

$$\boldsymbol{\Phi} = \begin{bmatrix} \mathbf{1} & \mathbf{\mu GM} & \mathbf{\mu GP} & \mathbf{\mu GC} \\ \mathbf{\mu MG} & \mathbf{1} & \mathbf{\mu MP} & \mathbf{\mu MC} \\ \mathbf{\mu PG} & \mathbf{\mu PM} & \mathbf{1} & \mathbf{\mu PC} \\ \mathbf{\mu CG} & \mathbf{\mu CM} & \mathbf{\mu CP} & \mathbf{1} \end{bmatrix} \ldots\ldots \quad 6$$

μ is the pairwise correlation coefficient of the error terms with regards to any two of the estimated adoption equations in the model. The correlation between the stochastic/having random Variables/ components of different improved technologies adopted is represented by the off-diagonal elements (e.g., μij, μji) in the variance-covariance matrix. The correlation is based on the principle that adoption of a particular improved practice may depend on another (complementarity or positive correlation) or maybe influenced by an available set of substitutes (negative correlation).

3.5.5.Definition of Variables and Hypothesized Relationships

3.8.1. Dependent variables

The dependent variables consist of dummy variables indicating the adoption of a particular technology such as grafted avocado seedling, mulching, pruning and compost application. The **multivariate probit model** takes binary variables, which indicate whether a farmer used a particular technology. In this study adopters are farmers who consistently applying the packages and are willing to use that practice otherwise non-adopter.

Table 3 List of dependent variables

Technologies	Measurement	Description
Grafted seedling	Dummy	1= if farmers used grafted avocado seedling 0= otherwise
Mulching	Dummy	1= if farmers applied mulching 0= otherwise
Pruning	Dummy	1= if farmers applied pruning 0= otherwise
Compost	Dummy	1= if farmers applied compost 0= otherwise

3.5.6. Independent variables

The independent variables of this study listed and selected based on review of related literature, technology adoption theories, and from the experience of the farming system of the study area. The list of variables to be included in the model (multivariate probit) was finalized after detecting econometrics problems.

Sex: It is a dummy variable that takes the value of 1 if the household head is male and 0 if the household head is female. According to Haregu (2018) male-headed households would have a better opportunity to adopt improved agricultural technology since they are exposed to new information and tend to be risk-takers. Therefore, if the household head is male there would be a high probability of adopting improved potato varieties.

Age: It is a continuous variable measured in years from birth. Studies showed that older farmers were more risk-averse than younger farmers and have a lower likelihood of adopting new technologies (Brown *et al.*, 2019). In contrast, older farmers may have experience and resource that could allow them more possibilities for trying a new technology (Gedefa, 2014). Therefore, it was hypothesized that age of the household head either negatively or positively affects adoption of improved Avocado innovation packages.

Education level: It is a dummy variable that takes the value 1 if household head is literate and 0 otherwise. Education increases the ability of farmers to use their resources efficiently and enhances the farmer's ability to obtain and interpret information. More educated household heads could have the capacity to acquire, process, and interpret information and tend to adopt agricultural technologies (Asfaw and Admassie, 2004; and Feleke and Zegeye, 2006). Therefore, it was hypothesized that Education has a positive influence on the adoption of improved Avocado innovation packages.

Family size: This variable is a continuous variable, which refers to the number of family members in an adult equivalent. Family size is an important factor for the adoption of technologies since farming activities and avocado needs intensive management. On the other hand, households with a high family size are at risk and may not have the confidence to allocate their plot for new varieties. The larger the size of the household the better to adoption of improved technology, same authors indicated the positive effect of family size on adoption of variety of wheat technologies Gebre, *et, al*, (2019). Therefore, it was hypothesized that family size of household positively affects adoption of improved Avocado innovation packages.

Farm size: It is a continuous variable that the household currently owns and cultivated land (measured in hectares). The larger plot size allows farmers to diversify crops and to reduce their fear of crop loss due to limited land holdings and an uncertain outcome of technology. Many studies have reported that there is a positive relationship between land size and adoption of agricultural technology (Uaiene *et al.*, 2009; and Wiggins, 2009). Thus, land size was hypothesized positively affect the adoption decision of farmers practice improved avocado technologies.

Total Livestock holdings: it is a continuous variable. It refers to the number of livestock the household currently owns in TLU, and livestock size is an important factor for accessing cash and purchasing inputs. However, households with a larger livestock size prefer to produce cereal crops for their residue to feed their animals. Crop residue is the major source of livestock feed in the dry season, and households with many livestock produce high biomass crops. Thus, households endowed with a larger number of oxen and available family labor for farming could adopt improved maize technologies more intensively Feleke and Zegeye, (2006). It was hypothesized that livestock holding positively affected adoption of improved Avocado innovation packages in the study area.

Farming experience: It is a continuous variable measured in years. A household with better farming experience is expected to have better adoption of technologies. Uaiene *et al.* (2009) reported a positive influence of farming experience on agricultural technology adoption. Therefore, it is hypothesized that farming experience is positively influence the adoption of an improved Avocado innovation packages.

Credit Use: It is a continuous variable, and it is measured in terms of the amount of money they received per year. The availability and accessibility of credit facilities to purchase complementary inputs could also affect the adoption of agricultural technologies (Beke, 2011). Credit services can relax farmers' financial constraints and, in some cases, are tied to a particular avocado production; therefore, it was hypothesized to influence smallholder farmer's adoption positively.

Distance to plot: It is a continuous variable measured in kilometers that the household travelled to reach the avocado plot. The short distance to the avocado plot is important for contribution to the adoption of improved avocado innovation packages. As plot distance increases, adoption is expected to decrease. Therefore, it is hypothesized that distance to market is negatively affect adoption of improved avocado innovation packages.

Annual income: It is a continuous variable measured in Ethiopian birr. According to Mikias Dawit (2020), annual income had positively influence on adoption of improved wheat technology. Households with relatively higher farm income are expected to better adopt technology and farm income is expected to positively influence adoption (Leggese, 1998). It is hypothesized that access to non-farm activity positively affects the adoption process.

Social membership: It is a continuous variable that is measured in terms social score (*i.e.,* Idir, Iqub, religious club, avocado marketing Union, Farmers' cooperative membership, kebele leader, Saving & credit group, school council and Others). As stated by Jamal (2006) that, farmers who have social membership can have information and the probability of adoption in technologies increases than those who don't have social membership. Similarly, Dereje (2006) reported that, social membership influences, the smallholders' adoption of technology. Thus, in this study, it was expected that social membership has positively influenced to adopt improved avocado technology packages.

Off/non-farm participation: It is a dummy variable take 1 if farmers participate and 0 otherwise. Farmers may engage outside their farm (off-farm) and outside agriculture (non-farm) activities to earn additional income. This is believed to raise financial position to purchasing agricultural inputs. On the other hand, a farmer who participated in off/non-farm activities may give less attention for on farm activates (Gedefaw Abebe and Sisay Debebe, 2019). Hence, it is hypothesized that off/on-farm participation has positive or negative effect on the decision of improved teff technology adoption.

Radio ownership: Radio communication is recognized as the most accessible and potentially means of disseminating information related to agricultural technologies. Radio owner farmers may have high probability of using improved technologies. Hence, it is hypothesized radio ownership influenced positively the farmers adoption decision of avocado production technology. It is a dummy variable taking value1 if farmers have radio and 0 otherwise.

Extension contacts: It is a continuous variable measured in number of contacted days per year. Newly improved technologies in the agriculture sector introduced and distributed through agricultural extension agents for farmers. Hence, frequency of extension contact between farmers and extension agents may create awareness and build the necessary knowledge to adopt the avocado technology packages. According to Endeshaw Gedefaw (2019), frequency of agricultural extension contacts shows positively influence adoption decision BH540 maize varieties.Therefore, it was hypothesized positively influence the adoption decision of avocado production technology.

Training participation on agricultural activities **:** Its dummy variables, which takes the value of 1 if the sampled respondents took training on improved avocado packages or 0 otherwise. Various literatures, contended as training is one of the important sources of information for rural areas. Hence, those who have access to training were hypothesized as better adopters in this study.

Farmers' cooperative membership: Its dummy variables, which takes the value of 1 if the sampled respondents are members of any local cooperative societies or 0 otherwise. Various literature, contended as cooperative provide various inputs like improved seed, fertilizers, and other technical advice. Hence, those who are a member were hypothesized as better adopter in this research.

Table 4 Explanatory variables and hypotheses/presumptions

N°	Variables	Category	Measurement	Hypotheses/expectations/presumtions
1	Sex	Dummy	1= Male 0 = otherwise	+
2	Age	Continuous	Completed year	+/-
3	Education	Dummy	1= Literate 0= otherwise	+
4	Farming experience	Continuous	Year	+/-
5	Family size	Continuous	Man-day equivalent	+
6	Farm size	Continuous	Hectare	+
7	Extension contacts	Continuous	Number of days per year	+
8	Livestock Ownership	Continuous	TLU	+
9	Plot distance	Continuous	Km	-
10	Credit use	Dummy	1= Use 0 = otherwise	+
11	Annual income	Continuous	In ETB	+
12	participation on Agricultural Training	Dummy	1=yes 0=otherwise	+
13	Farmers' cooperative membership	Dummy	1=Member, 0= otherwise	+
14	Non/Off-farm activities	Dummy	1=Participated 0=otherwise	+/-
15	Social membership	Continuous	Social score	+
16	Radio ownership	Dummy	1= Yes 0=No	+

Source: Own survey, 202

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

4.1.1. Demographic characteristics

As shown in Table 5, from the total sample respondents, 76.26 % were male headed, while the remaining 23.74% were female headed. Another notable result is that the mean age of the sample household head found 43.90 years with standard deviation 11.83. This shows that in most of the household heads found at the active productive age for agriculture activities. From the total respondents 36.96% were able to read and write and they obtained either from formal or informal education. This indicated that in most of the farmers are unable to read and understand technological information's from printing materials. The Mean labour force based on the conversion factor of man day equivalent (see Append c5iix Table 1) was 2.77 with standard deviation 0.88. In the study area, most farmers engaged in their own farming practice at early stage 16-18. As a result, the average avocado farming experience of the household head were 23.75 years with standard deviation 8.88 years. This shows that farmers in the study area have highly participated in avocado production.

4.1.2. Wealth indicator variables

As obtained information from the study area, the communities are undertaking number of livestock ownership, total land size, annual income and participated in trading and other non-agricultural activities as an indicator of wealth. By considering this Table 2 shows that the wealth characteristics of the respondents.

As depicted in Table 6, on average livestock ownership was 5.32 TLU with standard deviation 1.78. This implies that in the study area farmers have engaged both in crop production and livestock rearing. Total land is one of the key indicators of wealth in the study area. As shown in the table, the average total land size of the respondents was 1.78 ha land size. It is much greater than from national average (less than one hectare) and Oromiya region (1.03 ha) land size of smallholder farmers (Dorosh & Rashid, 2012). From the total respondents 19.07% were participated on non-farm activities. This implies that majority of farmers are engaged on on-farm activities. On average sample respondents were gain 24,414 ETB annual from different agricultural and non-agricultural activities.

4.1.3. Communication and extension service

Farmers who have access to radio, training and frequently contact with DA have better exposure to information about production techniques and market information. As depicted in Table 7, 51.75% respondents have radio and 56.81 % have obtaining training in avocado production season. Surprisingly, the average contacts of avocado producers' farmers with DA were 2 times (frequency) per month.

4.1.4. Social capital variables

The nature and extent of social capital and networking in and outside the community is important in the diffusion of new agricultural production practices. For instance, farmers' primary cooperatives are one of the strongest public agricultural input providers and main source of market information. Other membership such as Dado/Wonfel has very crucial to cover labor shortages by sharing family labors each other. As displayed in Table 8, from the total respondent 69.65% were members of primary cooperative, while the remaining 30% were non-members. The index value of social capital indicated that the average value of the respondent was 0.45. This implies that farmers have participated in 45% of the given socially constructed memberships.

4.1.5. Institutional variables

Distance to input market, credit use and distance to plot are key factors in the process of practicing agricultural activities. As depicted in Table 9, from the total respondents only 24% were use credit from formal credit service providers. The result shows that, in the study area the number of credit user farmers are very low because most of the communities are Muslim religion follower, and the doctrine are not appreciated credit and saving habits in government institutions. The average distance to the nearest input market and plot distance were 7.2 km and 3.01 km, respectively.

Table 5 Socio-economic characteristics of the respondents'

Variables	Freq / mean	% / SD	Min	Max
Sex (Male)	(196)	(76.26)	-	-
Age (year)	43.90	11.83	18	73
Education (Literate)	(95)	(36.96)	-	-
Labor (Man-day Equivalent)	2.77	0.88	1	7.7
Avocado farming experience (year)	23.75	8.88	4	54
Annual income (ETB)	26414.07	15148.23	3800	154100
Non-farm participation (Yes)	(49)	(19.07)	-	-
Total land size (ha)	1.78	0.79	0.25	7
Livestock ownership (TLU)	5.32	1.78	0.80	11.21
Training participation (yes)	(146)	(56.81)	-	-
DA contact (frequency)	2.03	1.25	0	5
Radio ownership (yes)	(133)	(51.75)	-	-
Primary cooperative membership (yes)	179	69.65	-	-
Social capital (index)	0.45	0.17	0.125	0.875
Distance to market (km)	7.205447	4.512999	2	25
Credit use (yes)	(62)	(24.12)	-	-
Distance to plot (km)	3.01	1.84	0.3	11.5

NB: ***NS, not significant, *, **, ***, significant at 10%, 5% and 1% probability level***

Relationship between Household Characteristics and Improved Avocado Practices

In this study nine continuous and seven categorical explanatory variables were included into multivariate probit model. The mean difference between adopters and non-adopters' household with related to continuous explanatory variables were computed using independent t-test. Whereas independent Chi-square test was used to test whether there is a statistically significant association between adoption decision on avocado production technology package and the categorical explanatory variables.

As shown in Table , there is no significance mean difference between adopters and non-adopters of mulching in avocado farming experience, labor, livestock ownership, annual income, and total land size. However, there is a significance mean difference between adopters and non-adopters in relation to frequency to DA contact (5%), plot distance (1%) and age (1%) of the household head. This implies that mulching adopters are old, have frequent contact with extension and plots were near to their residence than non-adopters.

As shown in Table , the Chi-square test revealed that there is statistically significant relationship (dependency) between adoption decision of mulching and sex of household head at 1% level of significance. The result also shows that the proportion of male-headed households that were adopter of mulching is 57.65%, whereas only 36.07% of female-headed were adopter. Likewise, radio ownership, non/off farm participation and training participation have significant relationship between adoption decision of mulching. However, there is not statistically significance relationship between adoption decision of mulching and educational status of household head, credit use and primary cooperative membership.

Table 6 Summary of t-test analysis results of probit model by adoption category for continues explanatory variables.

S.No.	Continues Independent Variables	Categorical Dependent Variables			
		Adoption of mulching (t-test values)	Adoption of grafted avocado seedling (t-test values)	Adoption of composting (t-test values)	Adoption of pruning (Canopy Management) (t-test values)
1	Age (year)	2.85***	1.6 (ns)	1.1 (ns)	0.3 (ns)
2	Labor (man day equivalent)	-0.6 (ns)	-0.05 (ns)	-2.05**	-1.55 (ns)
3	Experience (year)	-0.55 (ns)	-2.2**	-0.05 (ns)	-0.55 (ns)
4	Livestock ownership (TLU)	-0.8 (ns)	-0.2 (ns)	-8.15***	0.05 (ns)
5	DA contact (frequency)	-2.1**	-2.7***	-1.25 (ns)	-1.4 (ns)
6	Annual income (ETB)	-0.1 (ns)	-0.85 (ns)	-0.2 (ns)	-1.1 (ns)
7	Total land size (ha)	-0.2 (ns)	-1.45 (ns)	0.5 (ns)	-0.3 (ns)
8	Plot distance from Home (in km)	9.25***	3.4***	1.65 (ns)	3.6***
9	Social capital (index)	-0.85 (ns)	-2.1**	-1.65*	-0.5 (ns)

*Source: Own survey, 2023. NS, not significant, *, **, ***, significant at 10%, 5% and 1% probability level*

This part focused on the comparison between adopters and non-adopters of avocado grafting seedling. As shown in Table 12, there was significant difference in the avocado farming experience of adopters (24.75 years) and non-adopters (22.27 years). There was a significant difference between farmers' frequency to development agent contact and adopters (2.20) and non-adopters (1.77) of grafted Avocado seedling. Social capital of the household and plot distance has significance mean difference between adopter and non-adopters of grafting avocado.

As depicted in Table 13, sex of the household head, radio ownership and training participation have significance association with adoption decision of grafting avocado seedling at 1% significance level. On the other hand, educational status of the household head and non/off farm participation of the household have significance association with adopter and non-adopter at 10% significant level.

As the result showed, there was no significant difference in the age of adopters (45.05 years) and non-adopters (45.13 years). The other variable was the total family size of the household head and there was a significant difference between the total family size of adopters (6.88) and non-adopters (5.24). The farm income of adopters (38,290 ETB) was significantly higher than the farm income of non-adopters (21,334 ETB). The livestock holding of adopters (5.99 TLU) is significantly higher than livestock holdings of non-adopters (4.95 TLU). The household asset of adopters (101,331 ETB) was highly significant than the household asset of non-adopters (54,681 ETB).

As indicated by Table 15, the association between categorical explanatory variables and adoption decision of avocado compost application practice were compared using chi-square test. As the result showed, there was no significance association between adoption decision of compost application in avocado farm and educational status, non/off farm participation, credit use and primary cooperative membership. Whereas there were a significance association between sex of the household head (at <1%), radio ownership (at 5%) and training participation (at 5%). This result indicated that there is interdependence between information access and adoption decision on agricultural technology practices.

This part focused on the mean comparison (Table 16) and interdependency (Table 17) between adopters and non-adopters of avocado producer farmers on pruning. As the result indicated that, there is no significance mean difference between adoption decision and age of the household head, labor, experience, and livestock ownership, frequency to development agent contact, annual income, total land size, and social capital. Whereas there was significance mean difference in plot distance of adopter (2.56 km) and non-adopter (3.35 km) household at 1% significance level. The result indicated that adopters avocado plot is close to their residence than non-adopters.

As shown in Table 17, the Chi-square test revealed that there is statistically significant association between adoption decision of pruning and sex of the household head at 1% level of significance. The result also shows that the proportion of male-headed households that were adopter is 46.94%, whereas only 24.59% of female headed were adopter. Likewise, educational status, non/off farm participation, and training participation have significance relationship between avocado pruning adoption decisions. However, there is not statistically significance relationship between pruning

Table 7 Summary of chi-square test analysis results of probit model by adoption category for categorical explanatory variables

S.N	Categorical Independent Variable	Adoption of mulching (X^2-test values)	Adoption of grafted avocado seedling (X^2-test values)	Adoption of composting (X^2-test values)	Adoption of pruning (Canopy Management) (X^2-test values)
1	Sex	8.69***	9.49***	7.12 ***	9.56***
2	Education status	2.49 (ns)	2.88*	0.58 (ns)	10.65***
3	Radio ownership	12.49***	7.57***	5.06**	0.84 (ns)
4	Non/off farm participation	6.90***	3.56*	0.02 (ns)	7.67***
5	Training participation	9.63 ***	11.26***	5.59**	8.21***
6	Credit use	1.00 (ns)	2.29 (ns)	0.05 (ns)	0.06 (ns)
7	Primary cooperative membership	0.08 (ns)	0.01 (ns)	1.26 (ns)	0.46 (ns)

Source: Own survey, 2023

*NS, not significant, *, **, ***, significant at 10%, 5% and 1% probability level*

4.1.6. Joint Probabilities of Improve Avocado Technology Adoption

The probability distribution of the joint adoption of grafting avocado seedling, compost application, mulching and pruning practices is depicted in Table 14. Of the total respondents, all four technologies were adopted by 16.73% of the sample households whereas 9.72% of the respondents benefited from none of the four improved management practices. Only avocado pruning, compost application, and mulching adopters were 6.62%, 2.33%, 11.28% and 2+.33% of the sample households, respectively.

Table 8 Joint probability of improved avocado technology adoption

Technology packages adoption	**Abbreviation**	**Freq.**	**%**
All four non-adopter	$M_0G_0C_0 P_0$	25	9.73
All four adopter	$M_1G_1C_1 P_1$	43	16.73
Only grafting avocado	$M_0G_1C_0 P_0$	17	6.62
Only mulching	$M_1G_0C_0 P_0$	6	2.33
Only composting	$M_0G_0C_1P_0$	29	11.28
Only pruning	$M_0G_0C_0 P_1$	6	2.33
Mulching & grafting adopter	$M_1G_1C_0 P_0$	13	5.05
Mulching, compost & pruning adopter	$M_1G_0C_1 P_1$	11	4.29
Mulching & pruning adopter	$M_1G_0C_0 P_1$	4	1.56
Mulching and compost adopter	$M_1G_0C_1 P_0$	8	3.11
Grafting & compost adopter	$M_0G_1C_1 P_0$	13	5.06
Grafting & pruning adopter	$M_0G_1C_0 P_1$	4	1.56
Grafting, compost & pruning adopter	$M_0G_1C_1P_1$	13	5.06
Compost & pruning adopter	$M_0G_0C_1 P_1$	15	5.83
Mulching, grafting & pruning adopter	$M_1G_1C_0 P_1$	11	4.29
Mulching, grafting & compost adopter	$M_1G_1C_1P_0$	39	15.17
Total		257	100

Source: Own survey, 2023 *Note: M= mulching. G=grafting avocado seedling, C=compost and P=pruning. subscript ‘0‘denotes non-adoption, while ‘1‘denotes adoption of technology packages.*

4.2. Adoption Status of Improved Avocado Management Practices

Improved avocado production technology packages comprises different agronomic practices such as using grafting avocado seedlings, applying organic fertilizer, applying in organic fertilizer, spacing, site selection, pruning and mulching. However, in this study not all packages were included to calculate adoption index and included only four components such as grafted avocado seedlings, application of organic fertilizer, mulching and pruning.

In this study the adoption categories were grouped in to four groups such as non-adopter, low adopter, medium adopter, and high adopter based on adoption index using lower limit 0.01 and upper limit 1.00. The index scores 0.00, 0.01-0.33, 0.34-0.66, and 0.67-1.00 gives for none, low, medium, and high adopters, respectively. Similar studies, Neguse Siyum (2019); Mikias Dawit (2020) and Atrsaw Anteneh (2022) were used this category.

4.2.1. Aggregate adoption levels of avocado producer farmers

As depicted in Table 19, from the total 257 sample households 38 (14.73%), 65 (25.19%), 79 (30.62%) and 76 (29.46%) were categorized as non, low, medium, and higher adopter of improved avocado production management practices, respectively. This indicated that average adoption index of avocado producer farmers was 0.47 with standard deviation 0.28. The result indicated that, in the study area avocado producer farmers are low adopter of improved management practices. The result also indicated that there is a significant mean difference between adoption levels of avocado producers at 1% level of significance.

Table 9 Adoption status of avocado producer farmers in Mana district (aggregate)

Level of adoption of improved practices	**AI interval**	**Mea n AI**	**Fre q**	**%**	**Std**	**F**
Non-adopter	0.00	0.00	38	14.73	0.00	
Low adopter technologies)	0.01-0.33	0.22	65	25.19	0.062	
Medium-adopter	0.34-0.66	0.51	79	30.62	0.088	
High adopter Technologies)	0.67-1.00	0.78	76	29.46	0.059	
Total	0.00-1.00	0.47	257	100.00	0.289	182.20***

Source: Own survey, 2023Note:AI represents Adoption Index. ***NS, not significant, ***, significant at 1% probability level***

4.2.2. Adoption levels of avocado producers in each improved management practice

As shown in Table 20, in the study area the mean adoption index of grafting avocado seedling, compost application, mulching and pruning practices were 0.43, 0.50, 0.51, and 0.33, respectively that introduced by farmers orchard school. The result implies that except avocado pruning (low adopter) adopters, in the study area grafting seedling, compost application and mulching adopters are categorized under medium adopter. The result also indicated that there was a significant mean difference in each improved avocado management practice adopters at 1% level of significance whereas there is no significance mean difference between adoption levels of avocado pruning adopters. Evidence from key informant interview confirmed that in mana and Seka districts avocado producer farmers are not widely practice pruning because farmers haven't scissor and technical knowledges how they prune.

Surprisingly, all mulching adopter avocado farmers were categorized under higher adopter. Evidence from key informant and focus group discussion confirmed that mulching in an easy practice for avocado producers because mulching materials are easily accessible (died/dried weed & leaf). Table 20 also indicated that the number of low adopters of grafting seedling and compost application were 1 (0.39%) and 3 (1.17) whereas there is no low adopter in mulching and pruning management practices. This implies once they had started to apply improved management practice they addressed and applied the practices in many avocado trees. Evidence from focused group discussion and key informant interview confirmed that, in Mana district farmers have small number of avocado trees as a result if they are deciding to apply the improved avocado management practices; they did in their farm vastly.

Table 10 Adoption level of avocado producer farmers in Mana and Seka Chokorsa district (each practice)

Improved Practices	**Level of adoption**	**AI interval p-value significant level)**	**Mean AI**	**Freq.**	**%**	**Std**	**F**
Grafted (Improved Avocado Seedling?)	Non-adopter	0.00	0	104	40.47	-	
	low adopter	0.01-0.33	0.19	1	0.39	-	**2547.15*** **
	Medium-adopter	0.34-0.66	0.61	46	17.90	0.059	
	High adopter	0.67-1.00	0.79	106	41.25	0.097	
	Total	**0.00-1.00**	**0.43**	**257**	**100.00**	**0.377**	
Composting (Organic fertilizers)	Non-adopter	0.00	0	86	33.46	-	
	low adopter	0.01-0.33	0.19	3	1.17	0.044	
	Medium-adopter	0.34-0.66	0.57	47	18.29	0.093	**1495.80*** **
	High adopter	0.67-1.00	0.83	121	47.08	.0116	
	Total	**0.00-1.00**	**0.50**	**257**	**100.0**	**0.384**	
Mulching	Non-adopter	0.00	0	122	47.47	-	
	low adopter	0.01-0.33	0	-	-	-	
	Medium-adopter	0.34-0.66	0	-	-	-	**28513.64*** **
	High adopter	0.67-1.00	0.97	135	52.53	0.063	
	Total	**0.00-1.00**	**0.513**	**257**	**100.0**	**0.491**	
Pruning	Non-adopter	0.00	0	150	58.37	0	
	low adopter	0.01-0.33	-	-	-		**2.28 (ns)**
	Medium-adopter	0.34-0.66	0.60	27	10.51	0.080	
	High adopter	0.67-1.00	0.86	80	31.13	0.120	
	Total	**0.00-1.00**	**0.33**	**257**	**100.0**	**0.407**	

Source: Own survey, 2023 ***NS, not significant, *, **, ***, significant at 10%, 5% and 1% probability level***

As depicted in Figure 1, from the total sample households, 59.53%, 66.53%, 52.53% and 41.63% were adopters of grafting avocado seedlings, compost application, mulching, and pruning, respectively. Compost application is the highest adopted management practices whereas avocado pruning is the least adopted practices from the four management practices that included in this study. Evidence from key informant interview and focused group discussion confirmed that in Mana and Seka districts farmers grow avocado in their backyards. As a result, they applied animal dug and other decomposed materials in their avocado plots.

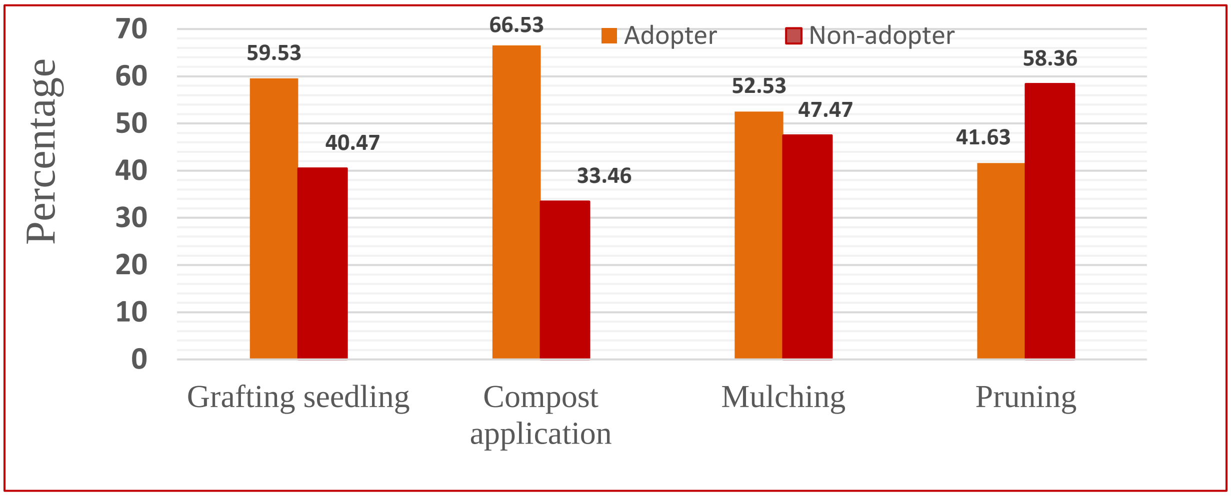

Figure 3 Seedling

4.3. Determinants of improved avocado technology packages adoption in the study area

Several drivers can influence avocado producing farmers' decision to adopt a particular technology. In this study five four dependent variables (grafting avocado, composting, mulching, and pruning) over 16 explanatory variables in the multivariate probit regression model (see Table 21). Before running the models, the explanatory variables fitted to multivariate probit model were tested for the existence collinearities, Heteroscedasticity, and outliers were tested for explanatory variables. Based the results the Variance Inflation Factor (VIF) of all variables were less than 21, which indicated that there is no serious collinearity problem in the MVP model.

The model results revealed that the Wald test (Wald $\chi 2$ (64) = 246.10**,** Prob > $\chi 2$=0.000) is significant at the 1% level, which indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the factors included in the model is satisfactory. Furthermore, the likelihood test applied to test the dependency of improved management practices of avocado on the selected explanatory variables in MVP model. The maximum likelihood method of estimation results suggested a positive and significant interdependence between household decisions to adopt grafting avocado, composting, mulching, and pruning.

4.3.1. Grafted avocado seedling adoption.

Sex of household head (Male) (0.465), Radio ownership (0.371), Avocado farming experience (year), (0.022), Plot distance (Km) (-0.097), Training (0.348), Social capital (index) (1.045)--

The MVP result showed that six variables were significantly affecting the decision of farmers to use grafted avocado seedlings. Sex of household head, radio ownership, avocado farming experience, receive training and social capital of the household were positively and significantly influenced. In contrast, average plot distance was negatively and significantly affecting the adoption decision of grafting avocado seedling.

Sex of a household head has positively and significantly influenced the adoption of grafting avocado seedling at 5% significant level. As depicted in Table 21, the positive sign of the coefficient indicated that male headed households are more adopter than their counter female headed in the study area. This might be due to male farmers may have large land size, information access and control over farming resources and they might invest in grafting avocado production. In the study area women farmers substantially engaged in cash crop like garden vegetables and khat. Furthermore, fruit production like mango, avocado and banana have need high field scouting to protect from wild ape. Hence, male farmers have a likelihood to adopt grafting avocado.

The positive significance effect of **radio** ownership is expected given the importance of awareness and access to information from radio and other ICT tools, which enhance farmers' willingness to use of grafted avocado seedlings. Notwithstanding, the coverage of agricultural programs in radio is little, various farming technology information are transmitted. As shown in Table 21, the positive association between grafting avocado seedling adoption and radio ownership indicated that being the owner of radio increases the likelihood of adopting grafting avocado seedling.

The MVP result indicated that avocado farming **experience** of the household has a positive and significance effect at on the adoption decision of grafting avocado seedling. In the stud area avocado production is very high and different marketing chains are there. Hence, experienced farmers might have benefited from the previous avocado production, and they might be eager to use grafting avocado seedlings. As depicted in Table 21 the positive association between avocado farming experience and grafting avocado adoption means that the likelihood of adopting grafting avocado seedlings increases as the experience of avocado production.

Potential avocado farm **plot distance** to home in kilo meters has a negative and significance influence on the adoption decision of grafting avocado seedlings. This might be walking distance increases the cost of production because of time spent on travelling to the plot and difficult to scout and manage farms. In the study area, majority of farmers practice garden avocado plantation methods to follow-up close to the farm; because, at the early stage of the plant intensive farm management practice is required. Therefore, it is true that farmers who have potential lands for avocado nearest to their residence home increase the likelihood of adopting grafting avocado seedlings (see Table 21).

Training Participation on Agricultural activity is one of a means by which farmers get information and knowledge about improved avocado production technology. The MVP result revealed that attend in avocado training positively and significantly influenced adoption decision at 10% level of significance. The result shows that when compared to non-participation, being participant in avocado training increase the adoption of grafting avocado seedlings. The result implies that providing training for farmers related to packages of avocado production technology might enabling them more confidence and have enough information about the technology.

Membership in social institutions helps the farmers to get labor and information about the production of avocado. Sometimes, when there is a need for more labor, such as at peak times of rice planting, weeding, and harvesting, lower and medium-income households often require support of relatives and members of social institutions (neighbors, friends, etc.) for exchange labor. Exchange labor is a practice by which neighboring households' team up and works in turns on each other's farms until all the members receive similar labor services. In addition, such kinds of social networks can help farmers to access information about improved production packages and share their experiences. The result is consistent with previous studies reported by Abebaw *et al.,* (2023) suggested that social capital is important for explaining the adoption decision of rice technologies.

Table 11 Results of multivariate probit model analysis of improved management practices of avocado

S.No.	Explanatory variables		Grafting avocado		Composting		Mulching		Pruning	
			Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE
1	Age of household head (year)		-0.008	0.009	-0.017*	0.009	-0.008	0.010	0.002	0.853
2	Sex of household head (Male)		0.465**	0.206	0.555**	0.227	0.124	0.242	0.467**	0.028
3	Radio ownership (Yes)		0.371**	0.175	0.004	0.011	0.003	0.011	0.013	0.941
4	DA contact (frequency)		0.106	0.076	0.298	0.194	0.641***	0.198	0.052	0.486
5	Educational status of HH (Literate)		0.150	0.180	0.037	0.078	0.053	0.084	0.451***	0.009
6	labor (in man day equivalent)		0.043	0.120	0.159	0.194	0.066	0.197	0.179*	0.085
7	Livestock number (TLU)		0.003	0.048	0.298**	0.119	0.146	0.127	-0.006	0.911
8	Avocado farming experience (year)		0.022**	0.010	0.420***	0.064	0.038	0.052	0.002	0.815
9	Plot distance (Km)		-0.097*	0.055	-0.009	0.062	-0.673***	0.095	-0.141**	0.012
10	Non/off farm (yes)		0.309	0.220	0.106	0.245	0.086	0.238	0.409*	0.070
11	Primary cooperative (yes)		-0.271	0.217	0.017	0.238	0.128	0.225	0.086	0.686
12	Credit use (yes)		0.134	0.207	-0.106	0.220	0.142	0.238	-0.134	0.514
13	Total land holding (ha)		0.101	0.119	-0.163	0.126	0.171	0.126	-0.072	0.541
14	Annual log income (ETB)		0.133	0.153	-0.129	0.190	0.387**	0.177	0.173	0.280
15	Training (yes)		0.348*	0.180	0.358*	0.204	0.372*	0.196	0.393**	0.033
16	Social capital (index)		1.045*	0.576	0.577	0.678	0.445	0.699	0.215	0.724
	_cons		-2.621*	1.535	-1.382	1.909	-3.584**	1.811	-3.082*	0.058
	Number of Variables	Significant	6 (…%)		5 (…%)		4(…%)		6 (....%)	
		Insignificant	10 (..%)		11(…%)		12(…%)		10(….%)	
	Wald test of overall coefficient significance χ2 (64) *= 246.10*, ***Prob > χ2=0.000, NS, not significant, *, **, ***, significant at 10%, 5% and 1% probability level***									
	Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0, chi2(6) = 28.0925 Prob > chi2 = 0.0001									

Figure 3: Summary of Improved Avocado Technology Package Adoptions in the study Area
Source: Own survey, 2023

4.3.2. Composting (organic fertilizers adoption).

Adoption of grafting avocado seedlings alone is not sufficient to successful in avocado production unless combined with the application of organic fertilizer (manure & compost). As depicted in Table 21 MVP result indicated that sex of the Age of household head (year) -0.017, Sex of household head (Male) 0.555, Livestock number (TLU) 0.298, avocado farming experience (year) 0.420, Training (yes) 0.358 have positively and significantly influenced the adoption decision of avocado producer farmers on compost application; conversely, age of the household head has negatively and significantly influenced.

The result of the study indicated that age of the household head has a significant and negative influence on the household decision to adopt compost technology in avocado farm at 10% level of significance. Compost preparation and application is a tedious and time-consuming job. In many activities that needs high labor and techniques are covered by the head of household. The result indicated that as the household head age increases the likelihood of adopting compost application will be decrease. This might be that extension service or advice helps the farmers to have awareness and knowledge about compost application.

Sex difference between household head is a key factor of decision of compost application. The result shows that sex of the household head has significant and positive effect on the adoption decision of compost application at 5% level of significance. This is mainly because females are disfavored groups of the society who could not easily access technology information. This might be due to cultural barriers, workload and belief, women might not participate in training, demonstration, and field day events. The result is like the finding of Almaz (2019).

Livestock number has also a significance and positive influence on the household decision of compost application at 5% level of significance. This indicated that having a lot of livestock increases the likelihood of adoption of compost application. This is mainly because livestock waste is a main raw material for compost preparation, and this might be fixing the problem raw materials to prepare compost.

Avocado farming experience has positively and significantly influenced the adoption of compost application at 1% level of significance. The result implies that farmers who has more experience in avocado production increases the probability of adopting compost application in avocado farm.

This might be experienced on avocado production has paramount importance to enhancing farmers" skill and knowledge on its production system. The result is in line with Bayissa (2014).

Participation on training also has a significance and positive effect to the adoption of compost application at 10% level of significance. The result implies that participating on agricultural training increases the likelihood of adopting compost application in avocado farm. This due to that agricultural training might be enabling farmers to get technical information and knowledge on importance and preparation and application of compost. The result is consistent with Debelo (2015) and Regasa (2018).

4.3.3. Mulching adoption

The result of the study indicated that frequency of the households to contact development agents 0.641 (Frequency) has a positive and significance effect on the household decision to adopt mulching on their avocado farm at 1% level of significance. Mulching application is not an easy task, and it needs technical and conceptual support from trained development agents. The result implies that a farmer who has more contact with development agents has a probability to adopt mulching. This is because of extension service is a necessary instrument to adopt agricultural technologies as they are the main source of agricultural information. The result is in line with Tigist *et al.* (2015).

Plot distance (Km) -0.673, is negatively and significantly influenced the adoption of mulching practice in avocado farm at 1% level of significance. An increase in distance to avocado plot, farmers might be unable to travel, manage and supervise their plots. This might be due to that avocado farm distance to home in km increases the cost of production because of time spent commuting to the plot.

Annual income (ETB) 0.387 has a positive and significantly influenced the adoption decision of mulching practice at 5% level of significance. Income helps the farmers to adopt mulching practices by reducing the financial constraints of the households to purchase and transport mulching materials. The result is in line with the finding of Mikias (2020), annual income had positively influence on adoption of improved wheat technology.

Agricultural participation (yes) 0.372 has positively and significantly influenced the adoption decision of mulching practices at 10% level of significance. Training may enable farmers to get technical information, knowledge, shape their insight, and hasten the adoption decision of farmers on the mulching practices. The result is like the finding of Bayissa (2014), farm training positively and significantly influences the adoption decision and intensity of improved teff technologies.

4.3.4. Pruning practice (canopy management) adoption

Gender Sex of household head (Male) 0.467 has positively and significantly affected the adoption of pruning at 5% level of significance. The positive result has indicated that male households are more adopters of pruning than female household heads, which might be due to male, has more access to trainings, field day and information sharing. Therefore, the male household heads have more likelihood to adopting avocado pruning than females.

The result of the study showed that education status of the household educational status of HH (Literate) 0.451 has a positive and significant effect on household's decision to apply pruning at 1% level of significance. Education enhances decision-making and use of information sources effectively. Able to read and write is believed to be associated with the ability to understand printing production guidelines and manuals. The result is consistent to the result of Atrsaw (2020), Mekonnen (2021), and Abebaw (2023).

labor (in man day equivalent), 0.179 has positively and significantly affected the adoption decision of avocado grower farmers to practice pruning at 10% level of significance. Since avocado production process are labor intensive, family labor has enormous contribution to practice improved avocado technologies. A large labor size might assist avocado producing farmers for better participation in pruning avocado tree, because avocado production requires high labor.

Plot distance (Km), -0.141 has negatively and significantly affected the adoption decision of avocado farmers pruning practice at 5% level of significance. An increase in distance to avocado farm unable households to manage and applied improved practices. The result implies that, adoption of avocado pruning declines as the distance of avocado plots increases. Other study conducted by Teame (2011) found that average plot distance negatively determines the adoption of fertilizer.

Non/off-farm participation (yes) 0.409 has positively and significantly affected the adoption of avocado production at 10% level of significance. The result implies that farmers who are participated in non/off-farm activities increase the likelihood of avocado pruning adoption. This might be due households who participated in non/off-farm activities are less risk-averse than farmers without sources of non/off-farm income. Non/off-farm activities have tremendous contribution for avocado grower households to get additional income to purchase farm materials and new technologies.

Agricultural training (yes) 0.393 has positively and significantly affected the decision of avocado producer farmers to adopt pruning at 5% level of significance. The result implies that participation to farm training increases the likelihood of adoption of avocado pruning. This might be due to households who participated in farm training would enable them to enhance their understanding on the improved avocado management practices.

Table 12 The probability estimation of individual and joint avocado technologies adoption using multivariate probit model

Dependent variables	Obs (respts)	Mean values	Std. Dev.	Adopters	Rank based on the number of Significant explanatory variables
Only grafting avocado	257	0.062	0.377	17	2nd
Only mulching	257	0.088	0.384	16	3rd
Only composting	257	0.059	0.491	29	1st
Only pruning	257	0.289	0.407	6	4th
Joint adoption of all technologies	257	0.219	0.373	43	1st
Joint rejection of all technologies	257	0.478	0.173	25	2nd

Source: own computation from own survey data 2023/24 year)

5. CONCLUSION AND RECOMMENDATIONS

Overall, the study provides valuable insights into the demographic characteristics, wealth indicators, communication and extension services, social capital, and institutional variables that influence the adoption of improved avocado production practices. The conclusions and recommendations drawn from the thesis can help guide future interventions and policies aimed at promoting sustainable and efficient avocado production in the study area.

5.1. Conclusions

Most of the sample respondents in the study area were male-headed households. The mean age of the household heads was 43.90 years, indicating that most of them were at an active productive age for agricultural activities. The level of education among the respondents was low, with only 36.96% able to read and write. The average labor force based on the conversion factor of man-day equivalent was 2.77, indicating that farmers relied heavily on their own labor for farming activities.

The average avocado farming experience of the household heads was 23.75 years, showing that farmers in the study area had extensive experience in avocado production. The average livestock ownership was 5.32 TLU, indicating that farmers in the study area were engaged in both crop production and livestock rearing. The average total land size of the respondents was 1.78 ha, which was higher than the national and regional averages for smallholder farmers. Most of the respondents had access to radio and had received training in avocado production. The social capital index value indicated that farmers in the study area were actively participating in socially constructed memberships such as primary cooperatives. The average distance to the nearest input market was 7.2 km, and the average distance to the plot was 3.01 km.

The adoption decision of grafting avocado seedlings is positively influenced by the sex of the household head, radio ownership, avocado farming experience, receiving training, and social capital of the household. Male-headed households are more likely to adopt grafting avocado seedlings compared to female-headed households due to factors like larger land size, information access, and control over farming resources. Radio ownership increases the likelihood of adopting grafting avocado seedlings as it provides access to information on farming technologies. Avocado farming experience positively influences the adoption of grafting avocado seedlings as experienced farmers benefit from previous avocado production. The distance of the avocado farm plot from home negatively affects the adoption of grafting avocado seedlings, as it increases production costs and difficulty in managing the farm.

The adoption decision of compost application in avocado farming is positively influenced by the sex of the household head, livestock ownership, avocado farming experience, and participation in training. Older household heads are less likely to adopt compost application, possibly due to the labor-intensive nature of compost preparation and application. Female-headed households face cultural barriers and workloads that limit their access to technology information, resulting in lower adoption rates. Livestock ownership increases the likelihood of adopting compost application, as livestock waste is a key raw material for compost preparation. Avocado farming experience and participation in training positively influence the adoption of compost application by providing farmers with knowledge and confidence in using compost.

The adoption decision of mulching in avocado farming is positively influenced by the frequency of contact with development agents, annual income, and participation in training. Farmers who have more contact with development agents are more likely to adopt mulching due to the technical support and agricultural information provided by these agents. Plot distance from home negatively affects the adoption of mulching, as it increases production costs and makes it difficult for farmers to manage and supervise their avocado plots. Higher annual income enables farmers to overcome financial constraints associated with purchasing and transporting mulching materials. Participation in training enhances farmers' technical knowledge and insight, increasing the likelihood of adopting mulching practices.

The adoption decision of pruning in avocado farming is positively influenced by the sex of the household head, education status, labor availability, non/off-farm participation, and participation in agricultural training. Male household heads are more likely to adopt pruning compared to female household heads, possibly due to better access to training, information sharing, and field day events. Education status, specifically the ability to read and write, enhances decision-making and understanding of pruning practices. Availability of labor, especially family labor, contributes to the adoption of pruning as avocado production requires significant labor input. Plot distance from home negatively affects the adoption of pruning, as it hinders households from managing and applying improved practices. Non/off-farm participation provides additional income to purchase farm materials and technologies, increasing the likelihood of adopting pruning practices. Participation in agricultural training enhances farmers' understanding and adoption of pruning practices.

In conclusion, factors such as the sex of the household head, radio ownership, farming experience, training participation, social capital, livestock ownership, and contact with development agents, plot distance, annual income, education status, labor availability, and non/off-farm participation play significant roles in the adoption of improved avocado technology packages.

5.2. Recommendations

Based on the results of this inquiry the following recommendations are drown:

- Given the low level of education among farmers, there is a need to provide targeted education and training programs to improve their literacy and understanding of technological information.
- Efforts should be made to increase access to credit services for farmers, particularly in areas where cultural and religious beliefs may discourage credit and saving habits.
- In this study , four main avocado practices were selected among all improved Avocado technologies were used to assess the status and determinants of adoption of avocado production technologies , thus, further research should be conducted on the rest of improved Avocado technologies.
- Efforts should be made to increase access to credit services for farmers, particularly in areas where cultural and religious beliefs may discourage credit and saving habits.
- Farmer field school as one of the participatory approaches have shown that it reduces the gap of gender participation in agricultural activities. Therefore, FFS should be chosen as a capacity-building tool for mainstreaming gender in agricultural activities.
- The government needs to strengthen the extension delivery system, which will ultimately elevate technology adoption rates via farmers’ field schools.
- The study’s results strongly encourage the design and implementation of a farmers’ field school to hasten the technology adoption process. Thus, policymakers should prioritize the inclusion FFS training sessions.

References

Abadie, A., Athey, S., Imbens, G.W. and Wooldridge, J.M., (2020). Sampling-based versus design-based uncertainty in regression analysis. Econometrica, 88(1)265-296.

Abate, T.W., Getahun, B., Birhan, M.M., Aknaw, G.M., Belay, S.A., Demeke, D., Abie, D.D., Alemu, A.M. and Mengiste, Y., (2021). The urban–rural differential in the association between household wealth index and anemia among women in reproductive age in Ethiopia, 2016. BMC Women's Health, 21,1-8

Abdullah, F. and Ward, R., (2016). Developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by analyzing commonly used external factors. *Computers in human behavior*, *56*,.238-256.

Abebe, G. and Debebe, S., (2019). Factors Influencing Adoption of Improved Seed Among Wheat Producing Smallholder Farmersâ€™ In West GojjamÂ Zone of Amahara Region, Ethiopia. Journal of Agriculture and Crops, 5(4),.48-56.

Ahmed, M.H. and Melesse, K.A., (2018). Impact of off-farm activities on technical efficiency: evidence from maize producers of eastern Ethiopia. Agricultural and Food Economics, 6(1),1-15.

Alexandratos, N. ed., (1995). World agriculture: towards 2010: an FAO study.

Almaz Giziew Adugna, A.G.A. and Mekuria Yimer Gessesse, M.Y.G., (2019). Analysis of rural women's participation in rice production using ordinal logistic regression model.

Al-Swidi, A., Mohammed Rafiul Huque, S., Haroon Hafeez, M. and Noor Mohd Shariff, M., 2014. The role of subjective norms in theory of planned behavior in the context of organic food consumption. British food journal, 116(10),.1561-1580.

Anderson, D.L., 2007. New theory of the Earth. Cambridge University Press.

Anteneh Mihretie et al., (2021) on Adoption Status and Perception of Farmers on Improved Tef Technology Packages: Evidence from East Gojjam Zone, Ethiopia.

Asfaw, A.M., Argaw, M.D. and Bayissa, L., (2015). The impact of training and development on employee performance and effectiveness: A case study of District Five Administration Office, Bole Sub-City, Addis Ababa, Ethiopia. Journal of Human Resource and Sustainability Studies, 3(04), .188.

Asfaw, S., Shiferaw, B., Simtowe, F. and Lipper, L., (2012). Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. Food policy, 37(3), .283-295.

Ayala-Zavala, J.F.N., Vega-Vega, V., Rosas-Domínguez, C., Palafox-Carlos, H., Villa-Rodriguez, J.A., Siddiqui, M.W., Dávila-Aviña, J.E. and González-Aguilar, G.A., (2011). Agro-industrial potential of exotic fruit byproducts as a source of food additives. Food Research International, 44(7), .1866-1874.

Ayenew, W., Lakew, T. and Kristos, E.H. (2020) Agricultural Technology Adoption and Its Impact on Smallholder Farmer's Welfare in Ethiopia. African Journal of Agricultural Research, https://doi.org/10.5897/AJAR2019.14302

Beke, T.E., (2011). Institutional constraints and adoption of improved rice varieties: Econometric evidence from Ivory Coast. Review of Agricultural and Environmental Studies-Revue d'Etudes en Agriculture et Environnement (RAEStud), 92(2), .117-141.

Belay, M. and Mengiste, M., (2023). The ex-post impact of agricultural technology adoption on poverty: Evidence from north Shewa zone of Amhara region, Ethiopia. International Journal of Finance & Economics, 28(2).1327-1337.

Bentley, T., (1994). Facilitation: Providing opportunities for learning. Journal of European Industrial Training, 18(5), .8-22.

Beyene, A.M., Gashu, A.T., Tegegne, M.A. and Anteneh Mihertie, A., 2022. Is the longstanding local rice cultivar "X-Jigna" being replaced by the improved variety "Shaga" in fogera plain, Northwest Ethiopia. Cogent Economics & Finance, 10(1), .2145748.

Boliko, M.C., (2019). FAO and the situation of food security and nutrition in the world. Journal of nutritional science and vitaminology, 65(Supplement),.S4-S8.

Bonabana-Wabbi, J. .(2002). Assessing factors affecting adoption of agricultural technologies: The case of Integrated Pest Management in Kumi District, Eastern Uganda (Doctoral dissertation, Virginia Technology

Borrell, J.S., Goodwin, M., Blomme, G., Jacobsen, K., Wendawek, A.M., Gashu, D., Lulekal, E., Asfaw, Z., Demissew, S. and Wilkin, P., (2020). Enset-based agricultural systems in Ethiopia: A systematic review of production trends, agronomy, processing, and the wider food security applications of a neglected banana relative. Plants, People, Planet, 2(3),.212-228.

Brüntrup, M., (2011). The Comprehensive Africa Agriculture Development Programme (CAADP)–An Assessment of a Pan-African Attempt to Revitalise Agriculture–. *Quarterly Journal of International Agriculture*, *50*(1), .79-106.

Cappellari, L. and Jenkins, S.P., (2003). Multivariate probit regression using simulated maximum likelihood. The STATA journal, 3(3), .278-294.

Ching, T., Himmelstein, D.S., Beaulieu-Jones, B.K., Kalinin, A.A., Do, B.T., Way, G.P., Ferrero, E., Agapow, P.M., Zietz, M., Hoffman, M.M. and Xie, W., (2018). Opportunities and obstacles for deep learning in biology and medicine. Journal of the royal society interface, 15(141), .20170387.

Debelo, A.R. and Jirata, T.J., (2018). "Peace is not a free gift": Indigenous conceptions of peace among the Guji-Oromo in Southern Ethiopia. Northeast African Studies, 18(1-2),.201-230.

Diiro, G.M., (2013). Impact of off-farm income on agricultural technology adoption intensity and productivity. Agric. Econ, 11.1-15.

Feder, G., Just, R.E. and Zilberman, D., (1985). Adoption of agricultural innovations in developing countries: A survey. Economic development and cultural change, 33(2),.255-298.

Feleke, S. and Zegeye, T., (2006). Adoption of improved maize varieties in Southern Ethiopia: Factors and strategy options. Food policy, 31(5), pp.442-457.

Gallagher, H.L. and Frith, C.D., (2003). Functional imaging of 'theory of mind'. Trends in cognitive sciences, 7(2),.77-83.

Gallagher, S.,(2000). Philosophical conceptions of the self: implications for cognitive science. Trends in cognitive sciences, 4(1),.14-21.

Gebre, G.G., Isoda, H., Amekawa, Y. and Nomura, H., (2019), September. Gender differences in the adoption of agricultural technology: The case of improved maize varieties in southern Ethiopia. In Women's studies international forum (Vol. 76, 102264). Pergamon.

Gedefa, B., (2016). Adoption and cost benefit analysis of sesame technology in drought prone areas of Ethiopia: Implication for sustainable commercialization. International Journal of African and Asian Studies, 23,.11-35.

Gedefa, S.D. and Kibret, K., (2014). Spatial Variability of Selected Physico-chemical Properties of Soils of Gelesha Sub-watershed in Mejengir Zone of Gambella Regional State, Southwestern Ethiopia (Doctoral dissertation, Haramaya University).

Gedefaw, E., (2019). Determinants Of Adoption of Improved Maize Bh540 Variety Among Smallholder Farmer: The Case of Dera Woreda, South Gondar Zone Amhara National Regional State, Ethiopia.

Gitz, V., Meybeck, A., Lipper, L., Young, C.D. and Braatz, S., (2016). Climate change and food security: risks and responses. Food and Agriculture Organization of the United Nations (FAO) Report,

Hailu, H., Mamo, T., Keskinen, R., Karltun, E., Gebrekidan, H. and Bekele, T., (2015). Soil fertility status and wheat nutrient content in Vertisol cropping systems of central highlands of Ethiopia. Agriculture & Food Security, 4,.1-10.

Headey, D., Dereje, M. and Taffesse, A.S., (2014). Land constraints and agricultural intensification in Ethiopia: A village-level analysis of high-potential areas. Food Policy, 48,.129-141.

Jaleta, M., Yirga, C., Kassie, M., De Groote, H. and Shiferaw, B., (2013). Knowledge, adoption and use intensity of improved maize technologies in Ethiopia.

Jamal, E., (2006). Adoption of diary innovation: Its income and gender implication in Adami Tulu District, Ethiopia. An MSc (Doctoral dissertation, Thesis presented to the School of Graduate Studies of Haramaya University). Journal of Trends in Horticultural Research.

Kilale, A.M., Mushi, A.K., Lema, L.A., Kunda, J., Mukasi, C.E., Mwaseba, D., Range, N.S. and Mfinanga, G.S., (2008). Perceptions of tuberculosis and treatment seeking behaviour in Ilala and Kinondoni Municipalities in Tanzania. Tanzania Journal of Health Research, 10(2),.89-94.

Korgaonkar, D.S., Bharamal, D.L. and Koli, Y.J., (2014). Determination of water quality index in Annapurna River in Devgad Taluka, district Sindhudurg, Maharashtra.

Law, S. and Braun, K.A., (2000). I'll have what she's having: Gauging the impact of product placements on viewers. Psychology & Marketing, 17(12),.1059-1075.

Legesse, D. and Ayenew, T., (2006). Effect of improper water and land resource utilization on the central Main Ethiopian Rift lakes. Quaternary international, 148(1),.8-18.

Loiseau, J., Assefa, Y., Ayenachew, D., Berhe, F., Berhe, H., Chekroun, A., Dorso, S., Gebresellassié, Y., Gleize, Y., Hirsch, B. and Ollivier, D., (2019). Preliminary Report Excavations and Surveys: Bilet (Tigray, Ethiopia), 1-20 December 2018 (Doctoral dissertation, Authority of Research and Conservation of Cultural Heritage (Addis Ababa)).

Ludemann, C.I., Wanner, N., Chivenge, P., Dobermann, A., Einarsson, R., Grassini, P., Gruere, A., Jackson, K., Lassaletta, L., Maggi, F. and Obli-Laryea, G.,(2023). A global reference database in FAOSTAT of cropland nutrient budgets and nutrient use efficiency: nitrogen, phosphorus, and potassium, 1961–2020. Earth System Science Data Discussions, 2023, pp.1-24.Dorosh,

P.A. and Rashid, S., (2012). Introduction [In Food and agriculture in Ethiopia: Progress and policy challenges]. IFPRI book chapters.

Mana Woreda, Jimma Zone: A Potential Crop for Coffee Diversification. Journal of Trends in Management: Farmer Field Schools. FAO, Rome.

Marangunić, N. and Granić, A., (2015). Technology acceptance model: a literature review from 1986 to 2013. Universal access in the information society, 14,.81-95.

Marangunić, N. and Granić, A., (2015). Technology acceptance model: a literature review from 1986 to 2013. Universal access in the information society, 14.81-95.

Matata, J.B.W. and Okech, A.G.O., (1998). Promising and New Methods, Draft Report on New and Adapted Field Methods in Kenya. FARMESA, Nairobi.

Melesse, T.M., (2015). Agricultural technology adoption and market participation under learning externality: Impact evaluation on small-scale agriculture from rural Ethiopia (No. 2015/06).

Mesele Belay Zegeye, Abebaw Hailu Fikire & Getamesay Bekele Meshesha | (2022) Determinants of multiple agricultural technology adoption: evidence from rural Amhara region, Ethiopia, Cogent Economics & Finance, 10:1, 2058189, DOI: 10.1080/23322039.2022.2058189

Mesfin, A. (2006). Analysis of factors Influencing Adoption of Triticale and its Impact. The Case Farta Wereda. Dissertation for Award of MSc Degree at School of Graduate Studies of Alemaya, Ethiopia.

Mihretie, A.A., Misganaw, G.S. and Siyum Muluneh, N., (2022). Adoption status and perception of farmers on improved tef technology packages: evidence from east gojjam zone, Ethiopia. Advances in Agriculture.

Mikias, D. and Beri, G., (2020). Assessing farmer's perception towards improved Quncho teff varity in gindeberet district, west shoawa zone, oromia region Ethiopia. Journal of Plant Sciences,

Milkias, D. and Getahun, A., (2023). Determinants of Participation Decision of Smallholder Farmers on Cluster Farming: The Case of Teff in West Shewa Zone of Oromia Region, Ethiopia. Management,

Ministry of Agriculture Food Security and Cooperatives (2012) Crop Production Country Statistics, Tanzania: Dar-es-Salaam University Press.

Mohamed, S.F., Mutua, M.K., Wamai, R., Wekesah, F., Haregu, T., Juma, P., Nyanjau, L., Kyobutungi, C. and Ogola, E., (2018). Prevalence, awareness, treatment and control of hypertension and their determinants: results from a national survey in Kenya. BMC public health, 18,.1-10.

Morkunas, V.J., Paschen, J. and Boon, E., (2019). How blockchain technologies impact your business model. Business Horizons, 62(3), .295-306.

Mwangi, M. and Kariuki, S., (2015). Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. Journal of Economics and sustainable development, 6(5).

Nawi, M.N.M., Lee, A., Kamar, K.A.M. and Hamid, Z.A., (2011). A critical literature review on the concept of team integration in industrialised building System (IBS) project. Malaysian Construction Research Journal, 9(2),.1-17.

Oduori, R.W., (2002). Language and politics in Kenya: Restricted and elaborated codes. Journal of Language and Linguistics, 1(4).434-441.

Ogada, M.J., Mwabu, G. and Muchai, D., (2014). Farm technology adoption in Kenya: a simultaneous estimation of inorganic fertilizer and improved maize variety adoption decisions. Agricultural and food economics, 2.1-18.

Orr, G., 2003. Diffusion of innovations, by Everett Rogers (1995). Retrieved January 21, p.2005.

Perrons, D., (2005). Gender mainstreaming and gender equality in the new (market) economy: An analysis of contradictions. Social Politics: International Studies in Gender, State & Society, 12(3), pp.389-411.

Schusler, T.M., (2001). Exploring social learning in the development of collaborative natural resource management.

Seka Chokorsa District Agricultural Office (MDAO) (2022). Annual report, Seka Chokorsa district, Oromia, Ethiopia.

Shiferaw, B.A., Okello, J. and Reddy, R.V., (2009). Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. Environment, development, and sustainability, 11, pp.601-619.

Sila, I., (2015). The state of empirical research on the adoption and diffusion of business-to-business e-commerce. International Journal of Electronic Business, 12(3),.258-301.

SNV Ethiopia, HortiLIFE II in (2019) Farmers' Field Schools in manual on learning and linking for smallholders.

Stringer, M.D., (1999). On the perception of worship. A&C Black.

Taherdoost, H., (2019). Importance of technology acceptance assessment for successful implementation and development of new technologies. Global Journal of Engineering Sciences, 1(3).

Taherdoost, H., Sahibuddin, S. and Jalaliyoon, N., (2011). Smart card security; Technology and adoption. International Journal of Security, 5(2),74-84.

Taherdoost, H., Sahibuddin, S., Namayandeh, M., Jalaliyoon, N., Kalantari, A. and Chaeikar, S.S., 2012. Smart card adoption model: Social and ethical perspectives. Science, 3(4).1792-1796.

Tamirat, N., & Abafita, J. (2021). Adoption of row planting technology and household welfare in southern Ethiopia, in case of wheat grower farmers in Duna district, Ethiopia. Asia-Pacific Journal of Science and Technology, 26(02), APST–26. https://doi.org/10.14456/apst.2021.13

Teame Hailemariam. (2011). Factors determining fertilizer adoption of the peasant farm sector in northern Ethiopia, Tigray region. Journal of Life Sciences, 1(3), 338–395.

Tedla, T.H., (2011). Factors determining fertilizer adoption of the peasant farm sector in northern Ethiopia, Tigray region (master's thesis).

Tefera, T., Tesfay, G., Elias, E., Diro, M.U.L.U.G.E.T.A. and Koomen, I., (2016). Drivers for

Teklewold, H., Kassie, M. and Shiferaw, B., (2013). Adoption of multiple sustainable agricultural practices in rural Ethiopia. Journal of agricultural economics, 64(3).597-623.

Tesfaye S, Bedada B, Mesay Y. 2016. Impact of improved wheat technology adoption on productivity and income In Ethiopia African Crop Sci J 24 (Issue Supplementt s1)

Tidwell, J.H. and Allan, G.L., (2001). Fish as food: aquaculture's contribution. EMBO reports.

Tillmanns, and Krafft, (2021). Logistic regression and discriminant analysis In Handbook of market research (pp.329-367) Cham: Springer International

Uaiene, R.N. and Arndt, C.,(2009). Farm household efficiency in Mozambique.

URT (2011). Tanzania Agriculture and Food Security Investment Plan (TAFSIP); 2011/12 to 2020/21. Working Paper No. 3. TAFSIP Policy and Institutional Framework.

Weyessa, G., Tsegaye, B. (2011). Trends of Avocado (Persea americana) Production and its Constraints in Mana Woreda, Jimma Zone: A Potential Crop for Coffee Diversification.

Wiggins, S.,(2009), June. Can the smallholder model deliver poverty reduction and food security for a rapidly growing population in Africa. (Vol. 2050. 24-26).

Wolde Kentayiso, T., Alto, A.A., Abebaw, Z., Misker, D. and Godana Boynito, W.,(2023). Cataract prevalence and its associated factors among adult people aged 40 years and above in South Ari District, Southern Ethiopia. Advances in Public Health.

Worku, A.A. (2019) 'Factors Affecting Diffusion and Adoption of Agricultural Innovations among Farmers in Ethiopia Case Study of Oromia Regional State Western Sewa' International Journal of Agricultural Extension, https://doi.org/10.33687/ijae.007.02.2864

Woyessa G, Berhanu T (2010) Trends of avocado (Perseaamericana M.) production and its constraints in Mana Woreda, Jimma zone: a potential crop for coffee diversification.

Yamane, I. and Sato, K., (1967). Effect of temperature on the decomposition of organic substances in flooded soil. Soil Science and Plant Nutrition, 13(4).94-100.

Yokamo, (2020). Adoption of improved agricultural technologies in developing countries: Literature review. Int. J. Food Sci.Agric,

Zecharias, S. (2010). Avocado production and marketing in Southwestern Ethiopia. Trend in Agricultural Economics.

Zegeye, M. B., Fikire, A. H., & Meshesha, G. B. (2022). Determinants of multiple agricultural technology adoption: evidence from rural Amhara region, Ethiopia. Cogent Economics & Finance, 10(1). https://doi.org/10.1080/23322039.2022.2058189

Appendix

Appendix Table 1. Variance inflation factor

Variables	VIF	1/VIF
log Income	2.065	.484
Income	2.058	.486
Age	1.513	.661
Social capital	1.41	.709
primary cooperative	1.373	.728
total plot distance	1.373	.728
labour	1.298	.771
Training participation	1.226	.815
Frequency DA cont	1.205	.83
Total Land	1.2	.833
Sex	1.153	.867
non-farm	1.133	.882
Experience	1.12	.893
Radio ownership	1.109	.901
Credit Utilization	1.098	.911
Educ	1.074	.931
TLU	1.057	.946
Mean VIF	1.321	.

Appendix Table 2. Heteroskedasticity test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of

$chi^2(1)$ = 7.50

Prob > chi^2= 0.0062

Appendix Table 3. Correlation

Variables	(1)	(2)	(3)	(4)
(1) Compost	1.000			
(2) Grafted seedling	0.104	1.000		
(3) Mulching	0.185	0.407	1.000	
(4) Pruning	0.181	0.117	0.202	1.000

Appendix 4. Interview Questionnaire.

Title: Farmers Adoption of improved avocado technologies introduced by Farmer's Field school (FFS) in case of Seka Chokorsa and Mana districts of Jimma zone, Oromia, Ethiopia.

General Instructions to Enumerators

Make brief introduction to each farmer before starting any question, get introduced to the farmers (greet them in the local way) get his / her name; tell them yours, the institutions you are working for, and make clear purpose and objective of study.

Please fill up the interview questionnaire according to the farmers reply (do not put your own reply/ feeling).

Please ask each question so clearly and patiently until the farmer understands clearly (get your points).

Please do not try to use technical terms while discussing with the farmers and do not forget the local unit. (Use local language for better communication).

General information

Date of interview --------------------------------------

Number (code) --

District--

Kebele ----------------------------------

Demographic Characteristics

Age of the respondents---------------------years

Sex of the respondent: 1 Male 2 female

Education level _______________ [Put 0 if no formal education]

Total Farming experience of the household head in years --------------

Avocado Farming experience of the household head in years----------

Total family labor of the respondents______________

SN	Age Category (Years)	Sex	
		Male	Female
	< 10 Years		
	10 – 13		
	14 – 16		
	17 – 50		
	> 50		

Economic Characteristics

Land size.

Land allocation	Land size (in timad.)
Coverage of land for total Avocado / plants in number/	
Coverage of land for improved Avocado Technologies / plants in number/	
Land covered by other pulses	
Land covered by cereals	
Fruits	
Coffee	
Enset	
Homestead + others	
Total	

Livestock ownership by the end of 2021/2002 EC production season 2022EC

Types of animals	No	Types of animals	No
Cows		Sheep	
Oxen		Donkey	
Heifers		Poultry	
Bulls		Horse	
Calves		Others	
Goats		Total	

Income from participation in off-farm and non-farm activities.

Do you have off farm and non -farm activities? 1/ Yes 0/ No

Operation involved	1=Yes, 0 = No	Total income received ETB	Operation involved	1=Yes, 0 = No	Total income received ETB
Daily laborers			Firewood/ Charcoal		
Petty trading			Homemade drinks & foods		
Handicrafts			Remittances		
Land rent			Cash transfer/ aids		
Others, specify					

Access to farm/Orchard tools

SN	Type of Orchard tool	Availability				
		Very scarce (1)	Scarce (2)	Not as required (3)	Available (4)	Very much available (5)
1	Pruning shear					
2	Pruning Lopper					
3	Pruning Sow					
4	Ladder					
5	Fruit picker					

Access to grafted Avocado seedling.

Can you purchase the required number of grafted seedling as you need (Availability) 1) Yes? 2) No

Which of the following problems do you think are there with inputs purchased from market? 1 Not available, 2 Not timely available, 3 Quality problem 4 Expensive

Institutional factors

4.1. Credit accessible to you.

4.1.1. Have you obtained credit for Avocado production in the last three years?

1) Yes 2) No

4.2. DA contact (Extension participation)

4.1.1 Do you get advisory service from extension agents on coffee? Yes=1 N0=0

4, 1, 2 Do you get advisory service from research extension experts? Yes=1 No=0

4.1.3 How frequently do the extension agents visit you?

0) never 1) annually 2) monthly 3) weekly 4) daily

4.1.4 Do you visit extension agent? Yes=1 No=0

4.1.5. Do you visit research experts? Yes=1 No=0

4.1.6. If yes, when do you visit?

4.2. What are sources of information about FFS management practices?

1) Friends and relatives 2) neighbours 3) PA leaders 4) research center experts 5) District MOA 6) radio 7) Leaflets and printed materials 8) all the above.

4.3. Do you have Radio? Yes=1 No=0

4.4. If you have radio, do you listen, yes=1 no=o

4.. Social participation

In which of the following social gatherings you member?

Organization	Nonparticipant (0)	Member (1)	Committee member (2)	Leader (3)
Idir				
Iqub				
Religious club				
Avocado marketing				
Kebele leader				
Saving & credit group				
School council				
Cooperatives				

4.4. Distance to market.

4.4.1. How long the household travelled to reach the nearby market-----------------(in km)

5. The status of improved avocado technologies adoption by Farmer Field School (FFS).

4.5. Distance to plots.

How long the household travelled to reach farm plots-----------------(in km)

5.3. Do you participate in any training, yes=1, No=0

In the last three years production season what kind of improved Avocado technologies did you use?

1) Local 2) improved 3) both

Which type of cropping system do you used for Avocado production? 1) mono/sole /cropping 2) intercropping with other crops 3) both

If you are intercropping, with which crop do you intercrop? 1) Maize 2) Enset 3) chat 4) coffee 5) other crop/specify

Which method of Planting layout you used in Avocado cultivation? 1)Recommended (Rectangular, Triangular...) 2) Non or scattered

If your answer is spacing, to which variety you used this method? 1) Local 2) improved 3) Both

Did you apply fertilizer in Avocado production? 1) Yes 2) No

If your answer is yes, to which variety you applied fertilizer?

1) Local 2) improved 3) both

If your answer is yes, which kind of fertilizer you used? 1) NPS 2) Urea 3) both

If you apply NPS fertilizer in Avocado production, what amount of /kg/ Fertilizer do you apply per one seedling per year? 1) 100g 2) 50-80g 3, less than 50 g ,4 other

If you did not apply fertilizer in Avocado production, what is your reason, Reason for not applying

____

Did you encounter disease problem in Avocado cultivation in 2021/2022? Production season? 1) Yes 0) No

If yes, what kind of measure did you take?

1) Local 2) improved 3) Nothing

Did you come across weed problem in 2021/2022 Avocado cultivation?

1) Yes 0) No

Which of the following recommended Improved Avocado technologies do you practice in your own field? Tick the appropriate one and give reasons.

No	Improved Avocado technologies	Adopt (1)	Not Adopt (0)
1	Proper Site selection		
2	Land preparation /Deep ploughing, removing wood brush, stones and leveling /		
3	Plant Pit or hole preparation /60cm*6cm*60cm/ or more than		
4	Access to Grafted improved varieties		
5	Spacing 8m*8m*8m, b/n rows and crops 6m*6m*6m b/n rows and crops		
6	Mulching with decomposable materials and have 10-15cm thickness		
7	Irrigation method, frequency, and amount		
8	Fertilizer application and usage Commercial Fertilizers/NPS, Urea, etc. Composting Organic fertilizers		
9	Canopy management /Pruning /		
10	Pit backfilling (media proportionalities)		
11	Intercropping		
12	Wind break		
13	Stacking		
14	Hoeing		
15	pest Management		
16	Post-harvest handling		

How many other people have learnt about the recommended Avocado production practices from you?............... people.

Which recommended Avocado production practices have other people learnt from you?

____

For improved Avocado technologies, /or practices that you have not utilized effectively for the past two years kindly give can did reasons for failure to do so by writing the appropriate number in the space provided below.---

You are being provided an opportunity to attend a tour for familiarizing you with the new techniques of Improved Avocado technologies / practices. Will you spend some money to attend? the tour? Yes= 1 No= 0

Do you feel satisfied with your present method of Avocado management? Yes=1 No=0

If you do not have sufficient finance, would you like to borrow to make permanent improvement on your Avocado Orchard? Yes=1 No= 0

Better yield can be obtained from improved Avocado technologies. Suppose Grafted seedlings has been provided to you at some higher rate than the local seedling, will you purchase it?

Yes= 1 No=0

Improved Avocado technologies require high labor, and it becomes difficult to get labor at peak season, will you properly manage your Avocado orchard by paying high wage to laborers?

Yes= 1 No=0

Do you give priority of your Avocado Orchard more than other crops for different Avocado management practices? Yes=1 No=0

Checklist to Guide key Informants to Interviews Key informant farmers from Farmers Field School (FFS**) participants**

1. How did the FFS get start?

---

1. How was the curriculum development of FFS started?
2. Who was participating for the development of FFS curriculum?
3. How was the process of FOS implementation conducted?

---

4. What was the FFS participant members' opinion about Adoption of improved Avocado practices?
5. Did the FFS participants benefit from Improved Avocado technologies training program?

   At personal level-

   At village level
6. Participant farmers' role/ practice during FFS?
7. Participant farmers' role/ practice after FFS?

8. Are the uses of practices such as knowledge and attitude on Adoption of Improved?
9. Avocado technologies now a day's expanding, declining or maintained among FFS members?
10. Did they form or organize anything together after the school stopped?

    12. If your answer is yes/no explain your reason?

    ____

13. What are the benefits, major strengths, and weakness/ limitations of FFS practices as? realized by participant farmers and expert

---

Checklist to guide focus group discussions with farmers from FFS participants:

- Opinion regarding FFS in improved Avocado technology practices in reference to Group learning process and discussions.
  - What was the motivation to join FFS?
  - What benefit you got from it?
  - In addition to improved technologies, what new ideas you introduced as a group?
  - What benefits you got in working as a group?
  - What are the agreements, rules, or norms you have for this group functioning?
  - After FFS is completed, will you continue to work as a group?
  - How this group helps in gathering better information sharing in improved avocado technologies?
  - Do you share the knowledge and skills to other farmers who are not members of FFS?
  - What are the major problems encountered in FFS? Prioritize/ rank the major problems.

Anex

SNV is a not-for-profit international development organization that makes a lasting difference in the lives of people living in poverty by helping them raise incomes and access basic services. SNV is a mission-driven global development partner, rooted in the contexts and societies where we work. It contributes to the Sustainable Development Goals (SDGs) through effective programme delivery and influencing, with a central focus on transforming agri-food, energy, and water systems to enable sustainable and more equitable lives for all.We are one team of over 1,600 people, the vast majority coming from the more than 20 countries in Africa and Asia where we work.

The vision of SNV is world where across every society, all people live with dignity and have equitable opportunities to thrive sustainably. The mission is to strengthen capacities and catalyze partnerships that transform the agri-food, energy, and water systems which enable sustainable and more equitable lives for all. And are committed to collaboration and partnerships as key elements to enabling the accelerating and scaling of impact, as we contribute to the global transformation envisaged by the 2030 Agenda for Sustainable Development.

Our three sectors of focus are agri-food, energy, and water. We apply our strong foundations and technical expertise within and across these three inter-related sectors that are critical to enabling people to lead dignified lives and thrive. Within and across these sectors of focus are three core themes: gender equality and social inclusion (GESI), climate we pursue innovations which enable us and other partners to extend our reach to more marginalized and excluded groups – particularly women and young people. We endeavor to do this with a range of innovative financing instruments and partnership modalities, and increased emphasis on digitalization.

Th organization embrace the requirement to be increasingly agile in an uncertain world. We seek to reflect our strategic approach in the way we work, ensuring that the principles we apply in our programmes are equally reflected in our culture, values, behaviors, and practices, including by setting and implementing ambitious targets. adaptation and mitigation, and strong institutions and effective governance. Integral to the amplification of our core themes, we will explicitly focus on power dynamics, inequalities, and a rights-based approach. Across these sectors and themes, we align our efforts with the relevant SDGs and measurably contribute to specific elements of nine SDGs.

In line with our commitment to reducing inequity, we focus our work in least developed and lower middle-income countries in Africa and Asia. We strive to strengthen the agency and capacity, and the rights and wellbeing, of those facing the most significant challenges of inequity and poverty, to enable sustainable and more equitable lives for all. Given demographics and persistent inequalities, we have a central focus on generating opportunities and strengthening the agency of young people.

We recognize that those living in extreme poverty are increasingly located within fragile contexts, and we commit to working alongside them wherever we can deliver the long-term commitment required to contribute to meaningful change. The organization will always act in solidarity and partnership with communities, organizations, and institutions seeking to drive systemic, inclusive, and sustainable transformation towards achievement of the SDGs. It aims to deepen partnerships with financial institutions, governments, and the private sector to expand our impact-driven finance portfolio.

As a key pathway to scaling impact, we pursue innovations which enable us and other partners to extend our reach to more marginalized and excluded groups – particularly women and young people. We endeavor to do this with a range of innovative financing instruments and partnership modalities, and increased emphasis on digitalization. We embrace the requirement to be increasingly agile in an uncertain world. We seek to reflect our strategic approach in the way we work, ensuring that the principles we apply in our programmers are equally reflected in our culture, values, behaviors, and practices, including by setting and implementing ambitious targets.