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þÿ Assessment of Seed System, F Use of Certified Seed, and Storage Practices of Bread Wheat (Triticum Aestivum L.) to Enhance Grain Production In Seed-Insecure Area of East Gojjam Zone, North Western Ethiopia

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COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

GRADUATE PROGRAM

ASSESSMENT OF SEED SYSTEM, FARMER'S USE OF CERTIFIED SEED, AND STORAGE PRACTICES OF BREAD WHEAT(*Triticum aestivum* L.) TO ENHANCE GRAIN PRODUCTION IN SEED-INSECURE AREA OF EAST GOJJAM ZONE, NORTH WESTERN ETHIOPIA

M.SC. THESIS

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M.Sc. Thesis

By

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Advisor: Wossen Tarekegne (PhD)

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ADVISOR APPROVAL FORM

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M. Sc. IN SEED SCIENCE AND TECHNOLOGY

Approval of Thesis for Defense

I hereby certify that I have supervised, read, and evaluated this thesis titled "Assessment of Seed System, Farmer's Use of Certified Seed, and Storage Practices of Bread Wheat (*Triticum aestivum* L.) to Enhance Grain Production in Seed-Insecure Area of East Gojjam Zone, North Western Ethiopia.", by Ayehualem Mossaw Mengist prepared under my guidance. I recommend the thesis to be submitted for oral defence.

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M. Sc. IN SEED SCIENCE AND TECHNOLOGY

Approval of Thesis for Defense Result

As members of the Board of Examiners of the Master of Sciences (M.Sc.) thesis open defense examination, we have read and evaluated this thesis prepared by Ayehualem Mossaw entitled: Assessment of Seed System, Farmer's Use of Certified Seed, and Storage Practices of Bread Wheat (*Triticum aestivum* L.) to Enhance Grain Production in Seed-Insecure Area of East Gojjam Zone, North Western Ethiopia. We here by certify that the thesis is accepted as fulfilling the requirements for the award of the degree of Master of Sciences (M.Sc.) in Seed Science and Technology.

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DECLARATION

This is to certify that the thesis entitled: “Assessment of Seed System, Farmer’s Use of Certified Seed, and Storage Practices of Bread Wheat (*Triticum aestivum* L.) to Enhance Grain Production in Seed-Insecure Area of East Gojjam Zone, North Western Ethiopia,” submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in Seed Science and Technology Department of Plant Sciences to the graduate program of the College of Agriculture and Environmental Sciences, Bahir Dar University, by Ayehualem Mossaw Mengist (ID.No. BDU1500171), is a real work carried out by me and has never been submitted to this or any other institution to get any degree or diploma to the best of our knowledge and belief.

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Name of the candidate	Signature	Date	Place

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LIST OF ABBREVIATION AND ACRONYMS

ACSI	Amhara Credit and Saving Institute
AGRA	Alliance for a Green Revolution in Africa
ATA	Agricultural Transformation Agency
ASE	Amhara Seed Enterprise
CSA	Central Statistical Agency
DA	Development Agent
EIAR	Ethiopian Institute of Agricultural Research
ESE	Ethiopia Seed Enterprise
FGD	Focus Group Discussion
HLI	Higher Learning Institutions
ISSD	Integrated Seed System Development
KII	Key Informant Interview
MOA	Ministry of Agriculture
NGO	Non-Governmental Organization
OSE	Oromiya Seed Enterprise
PHS	Pre-Harvest Sprouting
PICS	Purdue Improved Crop Storage
QDS	Quality Declared Seeds
RARI	Regional Agricultural Research Institutes
RBoA	Regional Bureau of Agriculture
RSE	Regional Seed Enterprise
SNNP	South Nation and Nationality of Peoples
SPC	Seed Producer Cooperatives
WAO	Woreda Agriculture Office

Assessment of Seed System, Farmer's Use of Certified Seed, and Storage Practices of Bread Wheat (*Triticum aestivum* L.) to Enhance Grain Production in Seed-Insecure Area of East Gojjam Zone, North Western Ethiopia

By

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ABSTRACT

Bread wheat is a key cereal crop in Ethiopia, playing a crucial role in ensuring food security and generating income for the country. Regarding production volume and area coverage, Ethiopia is the second-largest wheat-producing country in Africa. However, average wheat productivity is low (2.97 t ha^{-1}) compared to international wheat productivity. This may result from different factors, among which seed insecurity is the most remarkable problem. This study was initiated to assess the seed system, farmer's use of certified seed, and storage practices of bread wheat to enhance grain production in seed insecurity districts of the East Gojjam Zone. This study was conducted in the Gozamin and Aneded districts of the East Gojjam Zone. The survey was conducted using 265 sample households based on probability proportion to population size from four kebeles during 2023/2024 cropping season. A structured questionnaire was used to collect data from sample households, while a checklist was used to collect qualitative data from 16 key informants and 4 focus group discussions participants. Descriptive statistics were used to analyze the study findings using SPSS version 27 software. The findings of this study revealed that farmers accessed bread wheat seed from different sources, i.e., informal seed sources such as about (49.3% in Gozamin, 42.7% in Aneded) were farm-saved from the previous cropping seasons, (15.7% in Gozamin, 16.1% in Aneded) from local markets, (17.9% in gozamin, 15.3% in Aneded) from relatives, and (17.1% in Gozamin, 25.9% in Aneded) were from formal seed sources. Therefore, the informal seed source is a major seed source and important in wheat production at study areas. Yield advantage (37.4%), disease tolerance (40.4), market value (20.7%), and food quality(1.5) were found to be the most common criteria in making the decision to use improved bread wheat varieties in the study area. Farmers in the studied areas have good knowledge of certified bread wheat seed use and practiced saving and storing their own seed for up to one year. Therefore, Amhara Agricultural Research Institutes, Amhara Seed Enterprises, and agricultural extension offices at regional, zonal, and district levels should give more attention to establishing a sustainable seed system, increasing farmers awareness of certified seed use and knowledge of how to store bread wheat seeds, and providing affordable access to PICS bags to enhance production and productivity in the study area.

Keywords: *Bread wheat, Certified seed, Descriptive statistics, Household, Seed system, PICS bag*

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Chapter 1. INTRODUCTION

1.1. Background and Justification

Bread wheat (*Triticum aestivum* L.) is an important annual self-pollinating cereal crop that belongs to the grass family of *Poaceae* (Gramineae), genus *Triticum* (Bakry *et al*., 2017). Bread wheat is an important primary food crop in Ethiopia. In Ethiopia, bread wheat is one of the most important strategic cereal crops due to its role in food security, import substitution, and the supply of raw materials for the agro-processing industry (Getinet Belay *et al.*, 2020). Bread wheat (*Triticum aestivum* L.) is the dominant wheat type accounting for 95% of the global wheat production area and covering currently more than 90% of the total wheat production area in Ethiopia (Wuletaw Tadesse *et al*., 2022).

In Ethiopia, wheat is one of the major cereal crops and is largely grown in the southeast, central, and northwest parts with moderate rainfall, humidity, and temperatures (Gedifew Gebrie *et al*., 2020). Production of wheat in Ethiopia is limited in mid- and highland areas of the country, lying between 6–16°N latitude and 35–42°E longitudes at an altitude range from 1500 to 3000 meters above sea level (m.a.s.l). However, the most suitable altitude zones of wheat fall between 1900 and 2700 m.a.s.l. Moderate temperatures are crucial for wheat growth. In the highland area, the mean annual temperatures typically range between 16°C to 25°C (Mengistu Meskele *et al*., 2022).

In Ethiopia, bread wheat is consumed heavily in different forms, which can be prepared in an industrially processed way or via cultural processing techniques. It is used in the preparation of a wide range of products, such as the traditional fermented thin bread (“injera”), regular bread (“dabo”), local beer (“tella”), and several other local food items (Dibaba Regasa, 2019). It is a major source of starch and energy and also provides substantial amounts of several components that are crucial for health, notably protein, vitamins (vitamin B), dietary fiber, and phytochemicals (Saini *et al*., 2020).

Wheat is the major staple food for 40% of the world’s population. World’s average wheat production during the 2023/2024 cropping seasons was 792.1million ton (FAO, 2024). Africa’s average wheat production during the 2017/2018 and 2018/2019 cropping seasons was 74.8 and 75.2 million tons, respectively (Mengistu Meskele *et al*., 2022). Ethiopia is the second largest

wheat producer in Africa with an area coverage of 1,867,47.71 hectares annually with a total production of 58,078,220.52 grain at an average productivity of 31.11 qt/ha during the 2021/22 production year (CSA, 2022).

Wheat is mainly grown in the Oromia, Amhara, SNNP, and Tigray regions of Ethiopia. The Amhara region is the second largest producer, next to the Oromia region. According to the CSA report, Amhara region wheat production covered 689,614.06 ha of land and produced 19,220,289.70 quintals of yield with a productivity of 27.87 qt/ha of yield. From Amhara region administrative zones, East Gojjam Zone ranks first in area coverage, 166,577.99 ha, production 5,303,301.67 qt, and 31.84 qt/ha of productivity (CSA, 2022). These low yields per hectare could be attributed to inappropriate uses of fertilizer, unavailability of quality seed for varieties that are high yielding as well as adapted to a wide range of agro-ecologies of the area and the use of farm-saved poor-quality seeds (Mulugeta Abebe and Yohannes Erkeno, 2022).

Among factors that have contributed to improving bread wheat productivity and production, seed is one of the most effective and efficient inputs to agricultural development for improving crop production and productivity (Tarekegn Kassa and Mogiso Merkine, 2020). Therefore, a fundamental factor for sustainable access to the seed is a well-organized seed system. The seed system in Ethiopia represents the entire complex of organizational, institutional, and individual operations associated with the development, multiplication, processing, storage, distribution, and marketing of seeds in the country (Dejen Bekis, 2021; Tekeste Kifle *et al*., 2022).

Ethiopia's seed distribution system was confronted with several problems, such as a lack of enough amounts of quality seed, problems with pests and diseases, poor infrastructure, a lack of institutional support, inadequate storage facilities, concerns about quality, expensive seed prices, and the required amount of seed not being reached at the right time and place. Hence, these vicious problems forced farmers to use their own saved seed and purchase seed from the local market (Hagos Kidane *et al*., 2018; Temesgen Teressa, 2019). To improve the situation and help farmers access to quality seed at the required time and amount with reasonable cost, there is a need to strengthen the seed systems (Dawit Tsegaye *et al*., 2017).

Using certified seeds is essential for improving the productivity of key food crops like wheat, which is crucial for combating food insecurity and poverty. For that, increasing access to

improved certified seeds is a critical factor for smallholder farmers to improve agricultural production, productivity, and food insecurity. However, farmers access to certified seed from recently released varieties remains very low (Akpo *et al.*, 2020). Moreover, studies have indicated that the utilization of certified seeds in Ethiopia has the potential to result in a significant increase in self-pollinated crops such as wheat. With the wider uptake of certified seeds, this crop can observe a remarkable growth of 30% (Abra Gemechu *et al*., 2023).

Agricultural production depends on the quality of seeds stored under controlled conditions which have direct effects on the quality of stored seed until the next growing season. Under improper storage, loss of germination might be caused by selective feeding of the germ by insects or damages due to storage fungi. To prevent quantitative and qualitative losses due to several biotic and abiotic factors during storage, several methods are being adopted, such as seed treatment with appropriate chemicals and storage in secure containers to the point of sanitation of the storage place (Ali *et al*., 2018).

Seed storage, in particular for wheat, does not affect only seed quality and yield. Particularly, it has a significant effect on flour quality, dough rheological properties, and bread and bakery product characteristics (Saeed *et al*., 2020). Hence, wheat seed stored without care may incur loss resulting in future food shortages (Shaila and Nafeesa Begum, 2021). In this context, accessing farmers' knowledge of seed storage and current storage practices is essential for designing strategies to empower them as competent decision-makers in their farm operations (Khatri *et al*., 2019).

The major bread wheat production constraints in the study districts are inadequate seed distribution, a shortage of certified seed, limited storage capacity, inadequate storage facilities, disease, especially yellow rust, and high seed costs are a significant issues. In relation to these constraints, the production and productivity of bread wheat are not to boost. Moreover, there was no assessment done recently concerning the seed system, farmer's use of certified seed, and storage practices of bread wheat by involving and participating farmers in the study area. Thus, the aim of this study is to assess the seed system, farmers' certified seed use, and the storage practice of bread wheat in the selected districts of East Gojjam zone.

1.2 Statement of the Problem

A sustainable seed system will ensure that high-quality seeds of a wide range of varieties and crops are produced, fully available in time, and affordable to farmers and other stakeholders. But Ethiopia's bread wheat seed system faces significant challenges that hinder agricultural productivity and food security. Among the challenges, seed insecurity remains a very impressive problem. Research findings of Ola *et al*. (2023) reveal that seed insecurity is significantly affecting the agricultural production of smallholder farmers in central Ethiopia. As a consequence, the majority of farmers rely on informal, farmer-to-farmer seed exchange and rely on traditional, low-yielding varieties due to the limited availability of improved seeds.

In connection to, this many farmers in the study area still do not have access to the improved certified seeds from the formal seed suppliers; due to political insecurity, and unavailability of enough improved seeds even at the source, the seeds were not available to farmers in time and at reasonable costs. Hence, the growing demands of the farmers result in decreased satisfaction with improved bread wheat varieties that were supposed to boost production and productivity among the smallholder farmers. This indicates that improved bread wheat seed distribution constraints and seed shortages become a major setback to smallholder farmers not boosting bread wheat production in the area.

Though, an adequate understanding of farmers' preferences for certified seed use and seed management can help establish a successful seed program. However, many farmers may not be fully aware of the benefits of proper seed management practices. Therefore, lack of proper storage facilities and poor storage practices lead to significant bread wheat seed quality loss and germination decline (Singh and Sahoo, 2019). But the reasons why the seed distribution system failed to satisfy the needs of the ever-growing demand of farmers were not analyzed so far in the study areas. Therefore, to get reliable information that can be useful to facilitate and fasten the production of bread wheat, this research was undertaken with the full involvement of farmers

1.3 Objectives of the Study

1.3.1 General objective

To assess the seed system, certified seed use, and storage practices of bread wheat to boost grain production in East Gojjam Zone

1.3.2. Specific objectives

- To identify the roles of formal, informal, and intermediate bread wheat seed systems for effective seed production and supply,
- To assess farmers' preferences for improved bread wheat varieties and related technologies, and
- To identify farmers' seed sources, certified seed use, and storage practices to address seed insecurity and enhance productivity.

Chapter 2. LITERATURE REVIEW

2.1. Origin and Botany of Bread Wheat

All species of wheat, domesticated or wild, belong to the genus *Triticum* and the families *Poaceae* and Gramineae, which are collectively referred to as the "grass family". It is the first domesticated food crop and has been the basic staple food of human beings for 8000 years (Arzani and Ashraf, 2017). From its birthplace, wheat was farmed throughout its original lands, extending eastward to China, India, and Pakistan, westward to the Mediterranean region, and northward to other European nations. It is believed that Western agriculture began in the Near East's Fertile Crescent, approximately 10,000 BC. Wheat was domesticated nearly 10,000 years ago in the Middle East region known as the Fertile Crescent by an ancestor called wild emmer (Feldman and Levy, 2022).

Most wheat that is grown now is hexaploid; however, evidence indicates that diploid and tetraploid wheat first developed (appeared) in the "Fertile Crescent," an area that is located in the basins of the Euphrates and Tigris rivers in modern-day Syria and Iraq, before 8000 BC (Bethlehem Melese *et al*., 2022). Bread wheat (*Triticum aestivum* L.), which contains 2n = 6x = 42 chromosomes and AABBDD genome code, accounts 95% of the global wheat production area and it is the dominant wheat type covering currently more than 90% of the total wheat production area in Ethiopia (Wuletaw Tadesse *et al*., 2022).

2.2. Environmental Requirement of Bread Wheat

Wheat is a widely adapted crop. It is grown from temperate, irrigated to dry and high-rainfall areas and from warm, humid to dry, cold environments (Wuletaw Tadesse *et al*., 2017). Wheat can be produced in xerophytic to littoral moisture regions with an average annual rainfall of 250 to 1750 mm, while the ideal rainfall range for wheat is between 900 and 1100 mm throughout the growing season (Alemu Tolesa *et al*., 2019). Bread wheat is grown mainly in the highland, midland, and lowland agro-ecologies of Ethiopia. However, the most suitable altitude zones of wheat fall between 1900 and 2700 m.a.s.l (Mengistu Meskele *et al.*, 2022) .

Even though the optimal growing temperature is 25 °C, it can be grown at temperatures ranging from 15 °C to 30 °C (Dibaba Regasa, 2019). The best daily temperature ranges for germination, good tillering, and appropriate plant development in wheat are 20–25°C, 16–20°C, and 20–26°C,

respectively. It can be grown in a variety of soils with reasonable drainage and good water-retentive capacity, although it is best adapted to the well-drained, fertile clay loam soils having moderate water-holding capacity that are ideal for irrigated wheat (Israni and Joshi, 2023).

2.3. The Production and Importance of Bread Wheat

Bread wheat (*Triticum aestivum* L.) accounts for 15% of the world's total sowing area and is one of the most widely produced and marketed cereal crops. Ethiopia is one of the principal producers of wheat in East, Central and Southern Africa. It is produced mainly in the southeast, northwest and central parts of Ethiopia. Increasing wheat production and productivity is crucial for meeting global wheat food demand, and thereby mitigate the impacts of food shortage and rising food prices. The area covered, productivity, and production of wheat do periodically increase, but these increases are variable and steady because of shifting preferences for food, a strong urbanization tendency, and population growth. This leads to an increasing shortage of food, which is mostly met by imports across all regions (CSA, 2022).

Among all cereal crops worldwide, it is ranked second in significance, behind rice, and is a major industrial and food grain that can be purchased internationally (Minwagaw Gizachew and Ejigu Wubalem, 2021). Bread wheat is not only the most important cereal crop in the world but also the major source of staple food for the peoples. Wheat is used in the manufacture of flour for different purposes. Pasta, bread, biscuits, and macaroni are a few commercial products manufactured using wheat. In addition to this wheat is used to produce carbohydrates and gluten. Moreover, wheat is used for brewing local drinks such as *tela* (fermented local beer) and *areke* (distilled local spirit) (Dibaba Regasa, 2019). Among all the staple cereals, it has the highest protein level and contains essential minerals, vitamins, and lipids (Gadisa Alemu, 2019).

2.4. Production Constaints of Bread Wheat

The average productivity of bread wheat (2.97 t ha^{-1}) in Ethiopia is very low as compared to the world average (3.55 t ha^{-1}) and even much below that of Egypt by 30% (CSA, 2022). The major causes for the low productivity of the crop are continued use of unimproved varieties, access to varieties and variety selection systems, little use of modern agricultural inputs such as improved seeds, chemical fertilizers, and herbicides, lack of improved management practices, declining soil fertility, and abiotic stresses (Adugnaw Anteneh and Dagninet Asrat, 2020). Wheat production in

Sub-Saharan Africa, predominantly in Ethiopia, is constrained by a number of abiotic and biotic stresses at different levels of intensity across rain-fed and irrigated environments (Wuletaw Tadesse *et al*., 2022).

2.5. Seed System in Ethiopia

Seed is a key input for improving crop production and productivity. Increasing the quality of seeds can increase the yield potential of the crop by significant folds and thus is one of the most essential components and valuable commodities in agricultural development (Girma Abebe and Amanuel Alemu, 2017). Seed systems are the systems that make seed available to farmers. The seed system will ensure seed security for all farmers, i.e., that "men and women within the household have sufficient access to adequate quantities of good quality seed and planting materials of preferred crop varieties at all times in both good and bad cropping seasons"(Ola *et al*., 2023).

Seed systems are made up of a variety of dynamic interactions between the supply and demand for seeds, which lead to the use of plant genetic resources at the farm level. A seed system refers to physical, organizational, and institutional components, their actions, and interactions that determine seed conservation, improvement, supply, and use (Teshome Hunduma, 2021). The establishment of the national seed system has been recognized as one of the key components of the nation's agricultural reform objective (Abebe Atilaw *et al*., 2017). Strong national seed systems must be established and maintained in order to produce and distribute high-quality seeds. A functional seed supply system that multiplies and distributes produced or saved seeds is the only way to provide easy access to high-quality seed (Ayalew Merkebu, 2020).

Ethiopia's seed system has been developing an effort to ensure seed availability in the required quantity at affordable prices and in a timely manner. Ethiopia's seed system has been the subject of extensive research, but due to inefficient seed production, distribution, and quality assurance systems, as well as bottlenecks brought by a lack of effective seed policy on crucial issues like credit availability for inputs, farmers have not yet been able to fully access the benefits of using quality seed (Alemu Kumulachew, 2015).

Different authors classify seed systems into different types: Dawit Alemu (2010) explains that seed systems are classified as formal and informal, while others classify them as local and formal. Later, ATA classified the country's seed system into three categories, namely: formal, informal,

and intermediary (ATA, 2015). However, informal, formal, and intermediate seed systems coexist in Ethiopia with low quality, low quantity, and medium contribution to crop production, respectively (Teshome Hunduma, 2021).

2.5.1. Formal seed system

The formal seed system is the development, distribution, and sale of certified seeds of improved varieties in registered outlets (Ola *et al*., 2023). The formal seed source is called formal because it is mainly a government-supported system, and several public institutions are also involved in it. The formal seed system is highly regulated and involves a chain of activities leading to clear products that are certified seeds of verified varieties. The chain usually starts with plant breeding and selection, resulting in different types of varieties, including hybrids, and promotes advanced fixed germplasm materials leading to formal variety release and maintenance (Ayalew Merkebu, 2020).

Regulations exist in this system to maintain variety identity and purity as well as to produce seeds of optimal physical, physiological, and sanitary quality (Girma Abebe and Amanuel Alemu, 2017). This system aims to supply adequate amounts of seeds at the right time and place and at reasonable prices. The formal seed system is guided by plant breeding and multiplication methodologies mainly used by the public or private sector and formal regulation, certification, and laws (Nabuuma *et al*., 2022).

The major actors of the formal systems in Ethiopia are the National Agricultural Research System (NARS), which comprises the Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs), and higher learning institutions (HLIs); the Ministry of Agriculture (MoA), which includes the Regional Bureau of Agriculture (BoAs), the Ethiopian Seed Enterprise (ESE), and Regional Seed Enterprises (RSEs) in Amhara, Oromia, Southern Nations Nationalities and Peoples Region (SNNPR), and Somali; and private seed companies specializing in specific crops like Pioneer (Dawit Alemu *et al*., 2017).

Formal sources like the Amhara Seed Enterprise and farmer cooperatives offer seed to a significant number of farmers (Gizachew Wosene and Wubalem Gobie, 2021). Formal seed sources are expected to introduce new varieties or certified seeds into a farming system for seed replacement or for specific characteristics of interest such as high yield, drought tolerance, early

maturity, and disease resistance (Louwaars and De Jonge, 2021). Improved variety seeds are supplied to farmers through farmer cooperatives, input suppliers, and other channels in the "formal" or "commercial" seed sector. Currently, less than 5% of the farmed area is covered by improved seed, and the formal seed system is believed to account for about 10–20% of the nation's actual demand (Dejen Bekis, 2021).

Key challenges of formal seed systems that affect bread wheat production and productivitys are fluctuations in seed prices, particularly for farmers who rely on formal sources and lack of timely seed supply is a persistent challenge in both the formal and informal systems. In Ethiopia the formal seed sector has not developed as expected due to multiple reasons. Lack of proper organizational set up, inadequacy in trained manpower, and limited private participation are some of the main drawbacks. All of the components and segments of activities are seriously affected with the overall weakness (Dawit Alemu *et al*., 2017).

2.5.2 Informal seed system

The informal seed system involves farmers' seed selection, multiplication, storage, use, and distribution through social seed networks and local markets (Teshome Hunduma, 2021). The informal seed system, also known as the local system or sometimes as the "farmers" system, is called informal because it operates under non-law-regulated conditions and is characterized by farmer-to-farmer seed exchange. Informal seed systems (traditional seed system) are playing an important role in improving seed access and variety choice of farmers, although they do come with a challenge to seed quality and timely seed availability (ATA, 2015).

According to Abebe Atilaw (2010), five key features distinguish the informal from the formal seed system. The informal seed system is traditional, semi-structured, operates at the individual community level, uses a wide range of exchange mechanisms, and usually deals with small quantities of seeds often demanded by farmers. The informal system provides the majority of the seed supply and is crucial for national seed security in Ethiopia. Informal systems work best in remote areas where farmers cannot readily access seed and output markets and where seed wholesalers have limited access, as well as in small agro-ecological zones where it is challenging to adopt a particular seed variety (Alemu Kumulachew, 2015).

In Ethiopia, the majority of farmers show a tendency to depend on the informal system because it is relatively cheaper and readily available in the farmer's villages at the required time, it is more reliable, its sustainability is more guaranteed than the formal system, and it allows the use of seeds after testing on primary adopter farmers. It also consists of programs and development organizations that assist community seed production without being subject to regulations. Flexibility and access to local varieties can be crucial for seed security in the face of challenges in the formal system. The seed production-distribution chain in the informal seed system is short and simple, without any regulation (Abdi Beshir and Nishikawa, 2022).

Farm-saved and community-based systems fall under the informal system. An informal agreement between a group of farmers that has created a system for producing, trading, or selling high-quality seed is known as a community-based system. Farm-saved seed refers to the practice of saving seeds for use from year to year. The farmer's saved seeds serve as an important source of seed because farmers are familiar with their crop's performance and future growing techniques (Tekeste Kifle *et al*., 2022). The informal seed system is the predominant system for food crops in subsistence agriculture. It is very resilient system, which is very active even without the support of public or private institutions (Girma Abebe and Amanuel Alemu, 2017). Seed sourced from the informal sector covers more than 90% of Ethiopia's total cultivated area (Dejen Bekis, 2021).

2.5.3 Intermediate seed system

In Ethiopia, both the formal and informal seed systems operate simultaneously and sometimes overlap. The intermediate seed system has emerged during the past decade in Ethiopia as a way to increase farmers' access to seed and build local economies through decentralized community-based seed production and distribution from market-oriented farmer groups that produce and market non-certified seeds of improved varieties and farmer-preferred local varieties (Teshome Hunduma, 2021). This category should not be limited to the informal sector; rather, it presents a special chance to address seed needs. It involves community seed production by farmer groups with higher-quality seeds than the ones produced by the informal sector (Dawit Alemu *et al*., 2017).

Intermediate seed systems imply coordinated actions between the formal and informal seed sectors (ATA, 2015). It is characterized by enterprising farmers and farmer collectives that cultivate and

sell crops not included in the formal seed system (Ayalew Merkebu, 2020). Integrating the formal and informal systems is important to exploit the synergetic impacts of integration on addressing seed security and sustainability in the country. Therefore, it is very crucial to implement and follow all the marketing functions and marketing principles to reduce the high-risk business nature of the seed sector (Dejen Bekis, 2021).

They play a key role in meeting seed demand and contribute greatly to seed supply improvement through high-volume production of seed, crop and variety diversification, and seed delivery to farmers. They produce and market the seed through various market channels, including direct sales to farmers, sales through contractual agreements, and sales directly to institutional buyers. Their contribution to improving the seed supply and seed security has received considerable recognition from policymakers and development practitioners (Kuhlmann and Dey, 2021).

Intermediate seed system made by the government and NGOs to promote quality seed production and distribution through market channels for landrace varieties, although until now the volume they represent is quite small (Tekeste Kifle *et al*., 2022). Farmers' associations involved in community-based seed production and marketing are the main actors in this system (ATA, 2015). These are community-based seed producer groups, including community seed banks that produce good quality uncertified seeds and seed producer cooperatives (SPCs), which produce quality-declared seeds of improved varieties. Cooperatives may be granted licenses under this system to grow and market seeds (Dawit Tsegaye *et al*., 2017).

The SPCs are classified as intermediary seed systems because they combine elements of both formal and informal seed systems. Seed producer cooperatives (SPCs) are enterprises started by associations or teams of individual farmers. The SPCs have the comparative advantage of delivering seed to farming communities at affordable prices (Dawit Tsegaye *et al*., 2017). Seed producer cooperatives (SPCs) are specialized cooperatives for seed businesses and aim to accomplish together a common goal that would be impossible for members individually. Therefore, government and development partners should support and strengthen SPCs to maximize their success in the seed business and their contribution to improving the seed supply in Ethiopia (Dawit Tsegaye *et al*., 2017).

The other form of the intermediate seed system is the Quality Declared Seed (QDS) which involves seed production by farmers or farmer cooperatives and marketing of seeds that meet at least a minimum standard of quality while the government plays a monitoring role (Teshome Hunduma, 2021). To strengthen formal and informal seed systems and reduce the gap in seed access, it is essential to connect unofficial seed production systems with them. This will help to boost food production and trade in Africa. This is due to the fact that doing so will help alleviate the supply-side bottleneck (Rajendrana *et al.*, 2016).

2.7. Farmer's Practice to Use Bread Wheat Certified Seed

Certified seed is a seed that fulfill the minimum seeds certification standards. Certified seed refers to improved seed newly purchased or received by farmers, which was not retained from their own harvest or exchanged with neighboring farmers. Certified seed is produced to ensure physical quality and genetic integrity, and from the farmer perspective it may either be a new variety or just fresh seed of a previously grown variety (Gashaw Tadesse *et al*., 2018). Certified seed is a pure seed that has been grown and processed in accordance with rigid production standards, with rigorous restrictions on weeds and other crop types; maximizes the purity of varieties; provides quality assurance; access to new possibilities; allows for capitalization on traceability measures; improves traits such as better yield, pest resistance, and drought and herbicide tolerance; maximize other inputs; access to premium markets (Tekeste Kifle *et al*., 2023).

Certified seeds are produced following seed grower association standards and undergo inspections. High-quality certified seed raises crop yields, which in turn contributes to food security, product value in the marketplace, and econome. However, access to certified seed of improved varieties has remained a major constraint in many countries. Limited access to seed of improved bread wheat varieties is an obstacle to agricultural productivity in sub-Saharan Africa (Obayelu *et al*., 2016). Therefore, increasing smallholders' access to high-quality inputs is frequently preferable to reducing yield gaps and boosting productivity because most farmers would otherwise turn to framer-preserved seed (Adu-Gyamfi *et al*., 2018).

Some studies have suggested that national seed regulatory bodies should move from directly supervising seed production to providing technical and policy support for the establishment of a wider range of seed production choices to increase the accessibility of certified seed from formal

seed markets. Access to certified seed through formal channels like seed companies or cooperatives is essential for achieving high wheat yields and reducing risks associated with poor seed quality. Improving the quality of seeds has the potential to significantly multiply crop yields in Ethiopia, making it one of the most cost-effective and productive inputs for agricultural development (Abebe Atilaw and Lijalem Korbu, 2012).

Kalsa *et al.* (2020) indicated that field emergence, freedom from mixing other variety seed, and seed from a different crop were the primary factors considered by farmers when evaluating seed quality. A crucial first step towards obtaining quality plant stands is guaranteeing the field planting value of seed supplies. Varied farmers have varied opinions about figuring out the wheat seed's field planting value. It is advantageous for farmers to be aware of the qualities of high-quality seed in order to protect themselves from inferior seed that could be incorporated into the seed supply chain (Bekele Abeyo *et al*., 2020).

Certified seed production settings in the formal systems provide ways of enhancing the genetic purity of the varieties, while such practices are rarely applied by farmers. Seed quality can be affected by several factors, including repeated planting. In contrast to hybrids, self- and open-pollinated crop varieties potentially allow for seed recycling (Habte Endeshaw *et al.*, 2023). Adoption of all recommended production technologies is crucial for increasing wheat productivity and production, which directly affects Ethiopia's food security and farmer welfare (Aklilu Atinafu *et al*., 2022).

When utilizing certified seed, farmers typically apply the suggested agronomic packages; however, farmer-saved seed usually receives such packages. The improved genetic purity of certified seed may not be the only factor contributing to the yield advantages of certified seed; farmers may also use better agronomic practices when purchasing certified seed. Farmers may be more likely to buy certified seed if they are well-informed on the yield and other characteristics of different wheat types (Dawit Alemu and Zewdie Bishaw, 2015).

One of the crucial requirements for determining whether there is sufficient demand is the frequency of using certified seed (Bekele Gemechu *et al.*, 2019). Knowledge of the trend of certified seed use by farmers is vital to setting effective demands and implementing corrective measures in the extension system (Kalsa, 2019). Furthermore, the amount of certified wheat seed

purchased may be determined or directed by the landholding and the area designated for wheat production. Chauhan *et al.* (2020) also noted that farmers' demand for new seeds could be triggered by emergencies, poverty (lack of planting materials), seed quality, or variety change.

2.8. Factors affecting farmers use of Certified bread wheat seed

Enhanced seed availability through formal, informal, or both systems will improve smallholder farmers' access to seed and enhance certified seed utilization (P.R. Kumar and Kumar, 2018). However, accessing and utilizing certified seed is constrained by its high price, the unavailability of the needed type in time and amount, and a lack of credit to access it. Thus, other possibilities include extending credit to encourage the use of the certified seed and making it more affordable and available before the cropping season (Tarekegn Kassa and Mogiso Merkine, 2020).

The factors that affect farmer's use of certified wheat seed are listed below:

2.8.1. Extension service

Extension is an informal educational process directed toward the rural population. This process provides guidance and knowledge to assist people in resolving their issues. Extension also aims to improve the general standard of living for farming families as well as the productivity and efficiency of family farms. The availability of agricultural information to farmers has a significant impact on their understanding of certified varieties that are currently in use or have recently been released (Kuma, 2022).

Extension is a valuable information source. When farmers have enough access to extension agents, they are more likely to accept new technology, like certified wheat seed. In comparison to areas with better access to extension services, a higher proportion of farmers in zones with lower agent coverage reported being unaware of certified seed options. There seems to be a relationship between farmers' use of productivity-boosting technologies like certified wheat seeds and extension services (Begum *et al*., 2021).

2.8.2. Distance to market

Farmers must have access to efficient input markets to make an informed choice about the adoption of agricultural technologies. The distance of the seed market from the farmer's home

increases also related transaction costs increase, hence they prefer alternatively available seed sources at short distances. Gizachew Wosene and Wubalem Gobie (2021) pointed out that distance from the seed distribution area negatively influences the selection of households on formal seed sources. The adoption of improved varieties is significantly impacted by the ability to communicate with agro-dealers. Farmers are less likely to adopt a wheat technology package as market distance increases. A possible reason for this could be that farmers who live closer to the market center have easier access to the market, where they can sell their produce, than those who live farther away. Farmers in far-off markets are compelled to go farther, spend more time, and exert more effort. Consequently, farmers would be less likely to use the new bread wheat technology package (Aklilu Atinafu *et al*., 2022).

2.8.3. Seed price

Seed price is expressed as how wheat producer farmers perceive the price of improved wheat seed sourced from formal seed sources. High seed price is hindering farmers from sourcing improved wheat seed from formal seed supply sources in the study area. Farmers sometimes mention the high cost of certified seed as a barrier to adoption. The high cost of transportation and the high cost of developing and producing hybrid seeds are factors in the high price of seeds. Farmers are less motivated to utilize new varieties when seed prices are higher because they are less profitable. Especially for resource-constrained farmers, certified seed is not economically advantageous when the seed-to-grain price ratio is low (Morris, 2022).

2.8.4. Access to credit

Access to credit plays an important role in farmers' decisions to adopt new seed technologies. Credit can ease farm-level liquidity restrictions, which prevent smallholders from investing in productivity-boosting technologies like improved varieties and fertilizer (Jama and Pizarro, 2018). Access to credit is crucial to adopting wheat production technology. A successful input credit system in the smallholder sector could be important for poverty reduction. Most descriptions of the present agricultural supply problem in Africa point to market failure brought on by incomplete knowledge and risk. Market failures result from the high expense of vetting candidates for input credits, the inadequacy of contract enforcement organizations, the lack of insurance (due to related causes), and the dearth of collateral among farmers for financing (Jama and Pizarro, 2018).

Access to money is necessary for many wheat production practices, including weeding, clearing land, purchasing and applying fertilizer, and employing personnel. Financial accessibility is one element affecting the pace and scope of adoption of wheat production methods (Aklilu Atinafu *et al*., 2022). Therefore, the choice to apply for credit promotes smallholder farmers to choose more profitable and riskier agricultural technology like planting certified seed instead of more conventional, low-risk, low-return farming methods, like employing local varieties. However, smallholders' access to formal banking services, such as those provided by commercial banks, is sometimes limited by the lending practices of those entities (Daniel Domeher *et al*., 2016).

The Ethiopian government is trying to promote "adequate credit packages suitable for small-scale producers will be made available to enable producers to access key inputs such as fertilizer, agrochemicals, and seed" according to the current Agricultural Sector Development Strategy 2010–2030 plans (Deresse Mersha and Zerihun Ayenew, 2018). Many Asian and Latin American countries have used various price support and stability policies to boost crop production and productivity while also improving social welfare since the 1960s. In Ethiopia, the lack of price support policies resulted in low crop productivity as well as social welfare for producers (Zewdie Habte, 2022).

2.8.5. Level of education

The level of education influences farmers' decision-making and, consequently, their adoption of new technology for producing wheat. Farmers with higher levels of education typically have easier access to information about emerging technology and are better equipped to absorb, process, and use it. The necessity of extension and training for smallholder farmers in the adoption process is emphasized by the value of education in adoption (Suvedi *et al*., 2017). Farmers with a higher educational background would have a better opportunity to access information and could easily understand the benefits of improved wheat technology packages (Aklilu Atinafu *et al*., 2022).

2.9. Farmers' Seed Storage Practices of Bread Wheat

Storage plays a crucial role in seed programs, which are generally focused on preserving the high standards of the seed from harvest until the crop is ready to be sown in the next or subsequent seasons (Dadlani and Yadava, 2023). To avoid deterioration, the conditions under which seeds are stored are crucial. Especially for wheat, seed storage has an impact on more than just seed output

and quality. It particularly affects the rheological qualities of dough, the quality of flour, and the features of bread and bakery products. In terms of wheat flour production, milling contaminated wheat could exacerbate the milling process, which is an essential step in the creation of flour and bakery goods, as well as cause serious health issues for customers (Saeed *et al*., 2020).

In sub-Saharan Africa, where seed saving is the predominant seed system, appropriate storage practices are crucial to preserving seed quality from planting season to planting season. Farmers' storage structures and handling techniques during the storage period may cause reductions in seed quality (Singh and Sahoo, 2019). The most crucial phase in the management of wheat seed is pre- and post-storage handling. Proper seed storage (temperature, humidity control, etc.) is crucial to maintain seed viability and vigor, which directly impacts germination and yield potential. The most significant element affecting a seed's viability during storage is its level of moisture (Singh *et al*., 2021).

Farmers can meet the necessary conditions to maintain the quality and quantity of stored grain and seed by having a basic understanding of the important components of a good storage environment, such as a suitable storage facility and the execution of prestorage activities like harvesting, drying, threshing, or cleaning. Simple, effective post-harvest and storage techniques can help minimize post-harvest losses, which can account for up to 30% of agricultural output. This can enhance the food and nutrition security of small-scale farmers and have a positive economic impact (Chegere, 2018).

The ability to store seed is one potential solution to the problem of seasonal variations-induced imbalances in supply and demand. Insufficient storage conditions may cause fungal damage or insect feeding on the germ, which can lead to germination failure. Consequently, wheat seed that is not stored correctly may lose its quality and result in future food shortages (Stathers *et al*., 2020). Wheat growers store their seeds in a variety of ways and with different kinds of facilities. According to Berhe *et al.* (2022), traditional Ethiopian seed stores include gotera (grain pits), gota, bags made of polyethylene, sisal, or goat leather, and a few more items.

The length of time that seeds must be kept in storage determines the ideal conditions for seed storage. Farmers keep storing their own seed until they are ready to change back to a different kind of seed; poor storage causes the quality of the seed to be lost (Vitis *et al*., 2020). The yield of

crops and seed quality could improve with effective control of diseases that infect seeds. But, poor seed storage facilities can promote these issues. Traditional on-farm storage methods (gotas) are common in Ethiopia, but improvements in storage facilities can reduce post-harvest losses and ensure seed availability over longer periods (Belay Habtegebriel, 2016).

Improved storage can also facilitate the maintenance of improved seed varieties, including those from formal sources. Then, the use of hermetically sealed bags including Super Grain bags (SGB) and Purdue Improved Crop Storage (PICS) bags, is an alternate method of storing grain and seeds that will preserve quality for a variety of crops. Hermetic bags can be more effective in agricultural settings than polypropylene bags, which are primarily used by wheat growers (Kalsa *et al*., 2020).

Chapter 3. MATERIAL AND METHODS

3.1. Description of the Study Area

The study was conducted in Gozamin and Aneded districts, located in the East Gojjam Zone of the Amhara Regional State, Ethiopia during 2023/2024 main cropping seasons (Figure 3.1). These districts are situated in the northern part of the country, approximately 300 km in Gozamin and 280 Km in Aneded district, northwest of Addis Ababa. The districts are classified into three distinct agro-ecological zones: lowland, highland, and midlland. These zones are characterized by different climatic conditions and agricultural suitability. The average altitude of the study area ranges between 2175 and 2200 meters above sea level (Table 3.1).

According to the district report, the amount of land covered by certified bread wheat seed in Gozamin district was 505 hectares from the total of 25,344 hectares of land covered by bread wheat, and in Aneded district, 388 hectares of land were covered by certified bread wheat seed from a total of 10,180 hectares of land covered by bread wheat in the 2023/2024 cropping season (WAO, 2024).

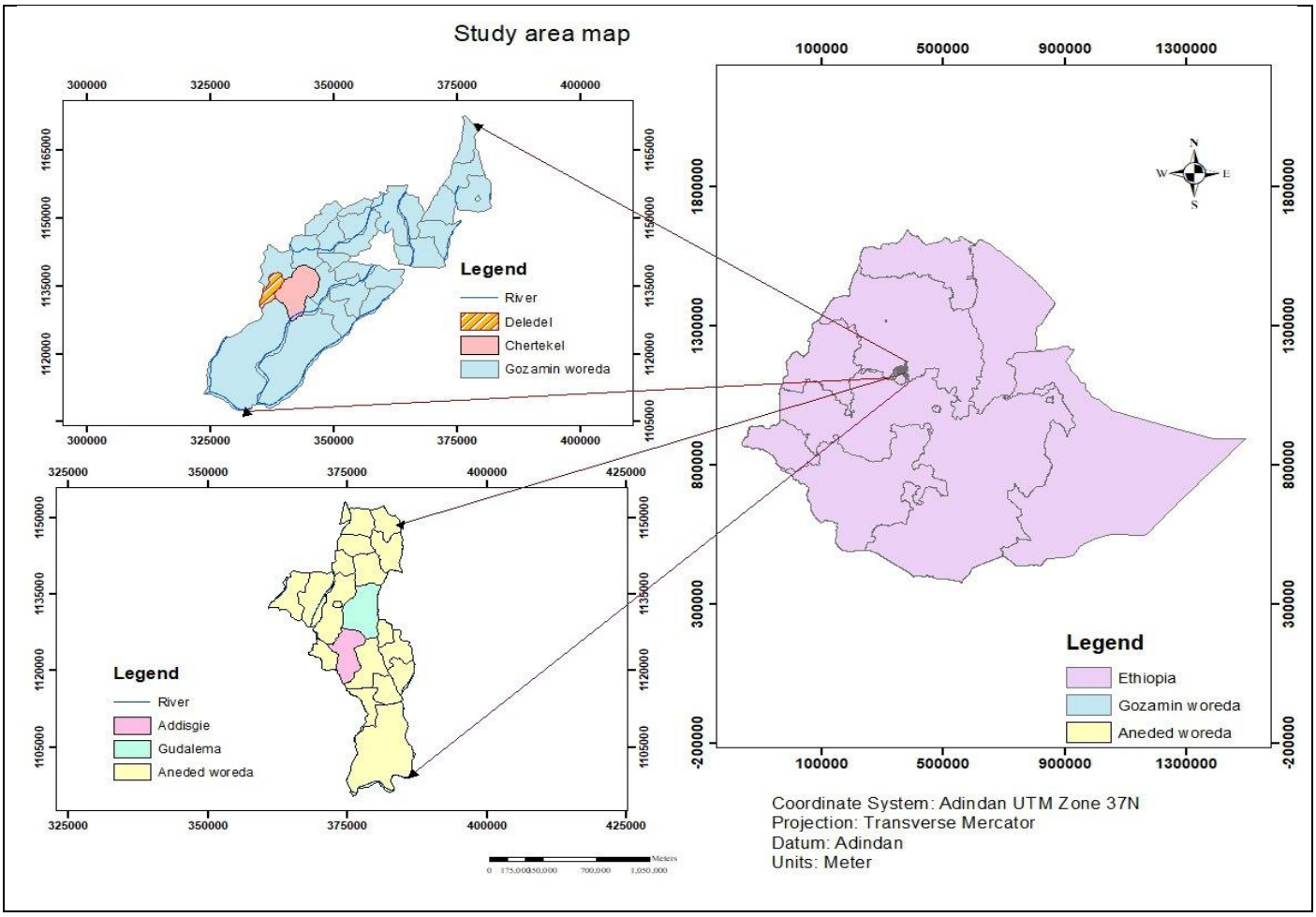

Figure 3.1. Lcation Map of study Area

Table 3.1 Geographical description and climatic characteristics of study areas

Items	Study areas	
	Gozamin district	Aneded district
Annal rainfall range	1148-1808mm	1200-1600mm
Longitudes	38° 00 ' 0.00"East	37° 52' 11" East
Latitudes	10° 19 ' 60.00"North	10° 14' 22"North
Altitude	2200 m.a.s.l	2175m.a.s.l
Soil type	Red soil 80%, Black soil 5% and Brown soil 15%	Red soil 36%, Black soil 25.1% and brownsoil38.9%
Temperature range	11^0c - 25^0c	10^0c-27^0c

Source: Gozamin and Aneded Woreda Office of Agriculture, 2024 basic socio-economy data

3.2. Sampling Procedure, Sample Size, and Participants

The study used a multi-stage sampling technique to select respondents from Gozamin and Aneded districts. The East Gojjam Zone was chosen purposely due to its significant wheat production in the Amhara region at the first stage. Gozamin and Aneded districts were also selected purposely based on their seed insecurity and potential for bread wheat production at the second stage. Four *kebeles* (local administrative units) were randomly selected within the districts at the third stage and finally 265 bread-wheat-growing households were randomly chosen from the total population of 5719 bread-wheat producer farmers in the study area.

The sample size for each *kebele* was determined based on its population and the desired level of precision based on the formula (Yamane Taro, 1967). This ensured that the sample was representative of the population while maintaining a reasonable margin of error. The sample size was determined by considering a 94% confidence level with a level of precision equal to 6% (e = 0.06) used to obtain the sample size required.

Yamane's formula for calculating sample size;

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

Where N=Number of total bread wheat producer house holds in the district

n=Sample size

e= The desired level of precision or sample error

$$\text{n} = \frac{5719}{1+5719(0.06)^2} = 265$$

Table 3.2: Number of Sample size and sampling location

District	Sample Kebele	Population size	Sample size
Gozamin	Chertekel	2196	**102**

>>	Deledel	687	**32**
Aneded	Addisgie	1316	**61**
>>	Gudalma	1520	**70**
Total		**5719**	**265**

Source: District Office of Agriculture, 2023 farmers list of wheat production document

3.3. Source of Data and Data Collection Methods

Primary data sources were used to collect adequate information for the intended purpose. The study primarily used face-to-face interviews with household heads using semi-structured questionnaires to collect the primary data. This method allowed for efficient information gathering from a large number of respondents. The questionnaires were prepared for households, development agents, WAO (Woreda Agricultural Office), and cooperative unions workers. These questionnaires were pre-tested to ensure clarity and relevance after translated into Amharic, the local language.

Focus Group Discussion (FGD) and Key Informant Interviews (KII)

The combination of FGDs and KIIs appears to be a sound approach for gathering qualitative data on the issue of interest. Then, 4 focus group discussions and individual interviews were conducted using 16 key informants. The use of a checklist and the selection of key informants was based on their expertise strengthens the methodology. Combining FGDs and KIIs provides a well-rounded approach, allowing for both broader perspectives and in-depth insights. Focus group discussions participants were selected based on their knowledge and experience in the study area, including: both female and male sexes, old and young people and individuals with in-depth knowledge about the areas, farms, crops, and local conditions.

The data collection process started from a sample checklist which was developed to guide the FGD interviews and it was pre-tested to ensure its effectiveness and clarity. The checklist was updated based on the pre-testing results. The reflections of the farmers were recorded through note-taking. Key informants were selected based on their subject-matter expertise in agricultural development and represented various organizations, including: Agricultural development agents,

District agricultural offices, District cooperative offices, and Multi-purpose cooperative unions. In-depth interviews were conducted with the key informants to support the concept of individuals and gather additional information on the issue of interest.

3.4. Data Analysis

Qualitative data was analyzed through explanation and interpretation of the issue, whereas quantitative data was analyzed by using simple descriptive statistical tools like percentage, mean, and frequency. The Statistical Package for Social Science (SPSS) was analyse the data collected from the field survey (SPSS version 27).

Chapter 4. RESULTS AND DISCUSSION

4.1.Demographic Characteristics of the Respondents

4.1.1. Gender, age, marital status, and education background the respondent's

Out of the total households included in Gozamin district (n = 134) and Aneded district (n = 131); about 123 (91.8%) and 122 (93.1%) were headed by males, respectively (Table 4.1). Female-headed households constitute 8.2% in Gozamin and 6.9% in Aneded district. This pattern is consistent with the broader national trend, where male-headed households are more common. This implication within households may be limited women's decision-making power, impacting their ability to influence agricultural practices and household well-being. This finding aligns with the observations made by Abera Gemechu *et al*. (2023).

Age is another demographic characteristics that influenced the decision to adopt new technologies. About 73.1% of respondents in Gozamin and 77.1% in Aneded districts fall within the economically active age group of 36–60 years (Table 4.1). This has significant implications for agricultural productivity and innovation adoption. Likewise, about 17.35% of respondents in Gozamin and 9.2% of respondent in Aneded districts are in the age of 17-35 range, indicating potential for future agricultural leadership and innovation.

The provided data reveals that about 88.8% of respondents in Gozamin and 89.3 in Aneded districts are married, with 2.3% of respondents in Aneded districts being single (Table 4.1). The marital status of household heads can influence access to resources, labor, and social support networks, which may impact bread wheat productivity and household well-being. This finding aligns with the broader trend observed by Girma Mulugeta (2022), showing that similar result to the present study.

In terms of the educational status of the respondents, a significant proportion of household heads in both Gozamin and Aneded districts have limited formal education, with a high percentage being illiterate (43.3% and 45.0%) or only able to read and write (40.3% and 39.7%), respectively (Table 4.1). However, others has attained primary, secondary, or even higher levels of education. This implies that low literacy levels can limit farmers' access to information and training, hindering

their ability to adopt improved agricultural technologies. While educated farmers may be more likely to adopt new technologies and practices, leading to increased productivity and efficiency. This study is contradict from the study of Tekeste Kifle *et al*. (2023) .

Table 4.1: Gender, age, marital status, and education background of the respondent

	Goamin district		**Aneded district**	
Gender of respondent	Frequency	Percent	Frequency	Percent
Male	123	91.8	122	93.1
Female	11	8.2	9	6.9
Total	134	100	131	100
Age of respondent				
17-35	20	14.9	12	9.2
36-60	98	73.1	101	77.1
above 60	16	11.9	18	13.7
Total	134	100	131	100
The marital status of the respondent				
Married	119	88.8	117	89.3
Single	0		3	2.3
Divorced	9	6.7	6	4.6
Widowed	6	4.5	5	3.8
Total	134	100	131	100
Education background of the respondent				

Illitrate	58	43.3	59	45.0
Read and write	54	40.3	52	39.7
Primary school	14	10.4	14	10.7
Secondary school	6	4.5	4	3.1
College and above	2	1.5	2	1.5
Total	134	100	131	100

4.1.2. Family Size and Bread Wheat Production Experience of the Respondent

The survey data suggests a strong correlation between family size and experience of bread wheat production with wheat production behavior among farmers, and as shown, the average family size of the respondents was 5.12 (SD = 1.622) and 4.81 (SD = 1.515) in Gozamin and Aneded districts, respectively (Table 4.2). This implies that the larger families often have more available labor for various farm tasks, including planting, weeding, and harvesting. This finding was similar to Smale *et al*. (2018), as the size of the household increases, the use of improved sorghum seed also increases.

The average experience of the respondents was 26.45 (SD = 11.374) and 26.59 (SD = 10.593) in both Gozamin and Aneded districts, respectively, in (Table 4.2), this indicate that the presence of a substantial amount of experience in bread wheat production. This long-standing experience is likely to have a positive impact on their farming practices, which allow farmers to accumulate valuable knowledge and skills in crop production, management, and input utilization. This finding is aligns with Girma Mulugeta (2022).

Table 4.2:Family size and experiance of bread wheat production of the respondent

Family size of respondent	**Gozamin**	**Aneded**
Minimum family size	2	1
Maximum family sizee	9	8

Mean	5.12	4.81
Sd	1.622	1.515

Experiance of bread wheat production of the respondent	**Gozamin**	**Aneded**
Minimum Experience of bread wheat production	3	2
Maximum Experience of bread wheat production	52	49
Mean	26.45	26.59
Sd	11.374	10.593

Sd: Standard devation

4.2. Access to Credit for Purchasing Bread Wheat Technology

From the total of (134) respondents in Gozamin district, about 38.1% (n = 51) and (131) respondents in Aneded district about 42.0% (n=55) of the respondents received credit for buying bread wheat seeds (Table 4.3). Credit is an important element in agricultural production systems. Credit empowered poor farmers to buy the type of agricultural input that they wanted to use and adopt new technologies. Hence, a substantial portion of farmers in both districts rely on credit to purchase bread wheat technologies. The primary sources of credit were microfinance institutions used by 54.9% of respondent in Gozamin, 36.3% in Aneded and cooperatives used by 27.5% in Gozamin, 47.3% of respondent in Aneded district.

Whereas, about 61.9% of respondent in Gozamin and 58% of respondent in Aneded district prefer cash purchases due to availability of other alternative, perceived complexities, and costs associated with credit. This result is different from the study by Girma Mulugeta (2022). Earlier studies also confirmed that access to credit plays an important role in farmers' decisions to adopt new seed technologies (Aklilu Atinafu *et al* ., 2022).

Table 4.3:Credit accesses, source of credit, and reason for not using credit

	Gozamin	**Aneded**

Have you use credit to purchase seed	Frequency	Percent	Frequency	Percent
Yes	51	38.1	55	42
No	83	61.9	76	58
Total	134	100	131	100
Source of credit				
Informal creaditor	9	17.6	9	16.4
Microfinance (ACSI)	28	54.9	20	36.3
Cooperative	14	27.5	26	47.3
Total	51	100	55	100
Reason for not using credit				
Lack of access	2	2.4	3	4.0
High interest	34	41	32	42.1
Availability of other alternative	47	56.6	41	53.9
Total	83	100	76	100

4.3. Information about Improved Bread Wheat Technology

Out of the total bread wheat grower sample households in Gozamin and Aneded districts, 94.0% (n = 126) and 89.3% (n = 117), respectively, had access to information about improved bread wheat technology (Table 4.4). This result is similar to the study of Gizachew Wosene and Wubalem Gobie (2021). Among the sources, agricultural extension services are the primary source of information reported by 63.5% of respondent in Gozamin and 63.3% of respondent in Aneded district. Neighbors and other farmers appeared to be the second important source information of about improved bread wheat technology, as compared to radio and television, and the Amhara

Research Center. The experience gathering information from research center is limited, as reported by a few respondents in Aneded district.

This finding is in line with the study of Kalsa (2019), who reported that respondents had access to information with multiple sources, while, among them, extension services play amajor role in information dissemination. Other authors, Altalb *et al*. (2016) and Mulu Nigus *et al*. (2022) agreed that agricultural extension services are the main source of information for new technologies, and farmers are also using multiple sources of information about improved bread wheat technology, respectively.

Table 4.4: Information about improved bread wheat technology and source of information

	Gozamin		**Aneded**	
Information about improved bread wheat technology	Frequency	Percent	Frequency	Percent
Yes	126	94	117	89.3
No	8	6	14	10.7
Total	134	100	131	100
Source of information				
Radio and Tv	17	13.5	17	14.5
Extension service	80	63.5	74	63.3
Neighbor/relative	29	23	24	20.5
Research center			2	1.7
Total	126	100	117	100

4.4. Sources of Bread Wheat Seed and Challenges with Current Seed Supply

4.4.1.Source of seed for improved bread wheat varieties

The informal sector was the major initial source of bread wheat seed for 95.5% and 94.7% of the farmers, whereas the formal sector was the initial source of wheat seed for about 4.5% and 5.3% of farmers in Gozamin and Aneded districts, respectively (Table 4.5). This finding is contradit to the study of Zewdie Bishaw *et al*. (2014).

The farmers rely on informal sources like their own saved seed, neighbors/relatives, and local markets to acquire wheat seed; numerically, it indicated that 82.9% and 81.6% of the farmers obtain bread wheat seed in Gozamin and Aneded districts, respectively in 2023/24 cropping season. While formal seed sources like cooperative unions exist, their contribution to seed supply is relatively low as reported by 17.9% respondet in Gozamin and 25.9% of respondent in Aneded district. Though, for the next planting season, a significant proportion of farmers rely on their own saved seed rather than other means of sources. This indicates that informal seed sources were a major source of seed in the study area.

This finding is similar to the study of Lakew Aschalew *et al*. (2018), the informal seed system is still the major source of seed, showing the involvement of the formal seed system is far away from the diversified demand of the rural communities in Ethiopia. Previous studies also indicated that farmers' seed demand has been significantly addressed through informal mechanisms (Mcguire *al*., 2016). This finding is also contradict to the study of Mulu Nigus *et al*. (2022).

In general, this study identified that farmers are accessing bread wheat seed through two seed systems, i.e., formal and informal seed sources. This is in line with the explanation made by farmers and experts during KIIs. This study did not identify the presence of an intermediate seed system in the area, which is characterized as an alternative seed system having both the features of formal and informal seed systems (Dawit Tsegaye *et al*., 2017). The study could not identify the presence of private seed companies that are involved in the production and distribution of improved seed directly to the farmers.

Table 4.5:Intial and source of bread wheat seed in 2023/24 cropping season

	Gozamin		Aneded	
Source of seed in 2023/24 cropping season	Frequency	Percent	Frequency	percent
Own saved seed	66	49.3	56	42.7
Local market	21	15.7	21	16.1
Relative	24	17.9	20	15.3
Cooperative	23	17.1	34	25.9
Source of seed in 2023/24 cropping season				
Own saved seed	66	49.3	56	42.7
Local market	21	15.7	21	16.1
Relative	24	17.9	20	15.3
Cooperative	23	17.1	34	25.9
Total	134	100	131	100

ASE-Amhara Seed Enterprise

4.4.2. The challenges of the current seed system

Among the challenges of the current seed system, high prices of improved seed, which were unaffordable for low-income farmers, seed shortages, and time of supply were the major problems. As a result, about 32.1% and 29.8% of respondents said that the high price of seed was followed by a seed shortage of 32.1% and 21.4%, and 16.4% and 16% of respondent said that time of supply in Gozamin and Aneded districts, respectively (Table 4.6).This challenge affect the farmers use of certified seed, production and productivity of bread wheat. This finding is in line with Tarekegn Kassa and Mogiso Merkine (2020), who confirmed that unaffordable seed prices and the unavailability of the required quantity of seeds at the right place and time are the key factors affecting improved seed utilization.

Moreover, the farmers during the FGD session confirmed that improved seed supply and distribution in the study areas are not based on farmers demand. Discussion made with agricultural experts and cooperative workers indicated that in addition to high prices of seed, there is also a late delivery of seed, resulting in the seed being left over in the store, which were the frequent challenges faced by formal seed distribution channels. The reasons for seed being left over in the storage area were demand-driven seed not being supplied for smallholder farmers, lack of on-time seed supply, and unfair price of improved wheat seed.

Table 4.6: The challenges of the current seed system

	Gozamin		**Aneded**	
Challenge of the current seed system	Frequency	Percent	Frequency	Percent
Poor quality	5	3.7	14	10.7
High price	43	32.1	39	29.8
Seed shortage	43	32.1	28	21.4
Time of supply	22	16.4	21	16
Type of demanded variety	9	6.7	13	9.9
Limited on few crop	12	9	16	12.2
Total	134	100	131	100

4.4.3. Problem of buying seed from local market and reason of using their own saved seed

Farmers in the study area believed that the major problems of purchasing seed from the local market were poor quality of crops, as reported by 27.6% and 30.5% of respondents; a high price, as reported by 43.3% and 43.5% of respondents; and it was difficult to get seed needed in type and amount, reported by 29.1% and 26.0% of respondents in the Gozamin and Aneded districts, respectively (Table 4.7). Among the problems, high price was the major problem of buying seed from the local market. There was also a clear market price difference between the local seed market and the local grain market. Most farmers who used seed from other farmers or from the market did carry out cleaning and checked germination informally before they planted the seed. This finding is similar to the study of Gizachew Wosene and Wubalem Gobie (2021)

Their own saved seed is the most prominent source of seed in this study area to raise crops year after year. Because farmers are familiar with the seed they themselves grow and know that the variety is adapted to local conditions and preferences. Farmers use their own saved seed for many reasons, namely: seed is available on time, there is no extra cost, seed quality is good, certified seed is not available, and there is no new or better variety (Table 4.7). According to the survey result, the timely availability of seed as reported by (34.3%, 30.5%) and have no extra costs as reported by (30.6%, 36.6%) of respondents were considered the most important reasons for farmers use of their own saved seed in Gozamin and Aneded districts, respectively. This study is contradict to the study of Zewdie Bishaw and Dawit Alemu (2017).

Table 0.: Problem of buying seed from the local markets and Farmers' perception of own saved seed

	Gozamin		**Aneded**	
Problem of buying seed from local market	Frequency	Percent	Frequency	percent
Poor quality of crops	37	27.6	40	30.5
High price	58	43.3	57	43.5
Difficult to get seed neded in type and amount	39	29.1	34	26
Total	134	100	131	100
Reason of using their own saved seed				
Seed available on time	46	34.3	40	30.5
No extra cost	41	30.6	48	36.6
Seed quality is good	14	10.4	25	19.1
Certified seed is not available	12	9	6	4.6
No new /better variety	21	15.7	12	9.2

Total	134	100	131	100

4.5. Farmers' Use of Wheat Varieties, Selection Criteria, and Experience with Certified Seeds

4.5.1.Improved bread wheat varieties use and selection criteria by farmers

The most widely used varieties at the time of this survey were Kakaba, which was used by 82.1% and 76.3% of the farmers, followed by Ogolcho, which was used by 9.7% and 11.5% in Gozamin and Aneded districts, respectively (Table 4.8). Variety Danphe and Hidasie were the least frequently used bread wheat varieties in the studied districts due to loss of yield. The high frequency of the Kakaba variety was attributed to its resistance to yellow rust and adaptability compared to other varieties. The most common improved bread wheat varieties grown in the study area were Kakaba, Ogolcho, Danphe, and Hidasie, as mentioned by farmers during the Focus Group Discussion (FGD) and experts during the Key Informants Interview (KII). This result is different from the study of Mulu Nigus *et al*. (2022).

Farmers use bread wheat varieties following their preferences criteria. Variety preferences by bread wheat farmers followed criteria such as grain yield, disease resistance, food or bread quality, and market demands. However, high yielding potential and disease tolerance are the most commonly selected criteria that farmers consider during varietal selection, as mentioned by (39.6%, 40.0%) and (40.3%, 38.9%) of the respondents in Gozamin and Aneded districts, respectively. Likewise, the criteria of market value of the variety were mentioned by 18.6% and 17.6% of the respondents of Gozamin and Aneded districts, respectively, whereas only 1.5% of the respondents considered the food or bread quality of the variety (Table 4.8). The development of new varieties, therefore, should consider those criteria that farmers believe are essential.

FGDs with farmers and key informant interviews with experts also revealed that yield potential and disease tolerance attributes are the most important factors for the selection of improved bread varieties in the area. This study is similar to earlier studies by Yekoye Abebaw *et al*. (2022).

Table 4.8: Grown improved bread wheat varieties and its selection criteria during 2023/24 cropping season

	Gozamin	**Aneded**

Improved variety used by farmers	Frequency	Percent	Frequency	Percent
Danphe	6	4.5	8	6.1
Kakaba	110	82.1	100	76.3
Hidasie	5	3.7	8	6.1
Ogolcho	13	9.7	15	11.5
Total	134	100	131	100
Selection criteria of improved variety				
High yield	53	39.6	55	42
Disease resistance	54	40.3	51	38.9
High market demand	25	18.6	23	17.6
Bread quality	2	1.5	2	1.5
Total	134	100	131	100

4.5.2. Farmers' experience of certified seed purchase and use

Farmers in the study areas about 100% of respondents in both Gozamin and Aneded district demonstrated good experience of using certified seed of wheat varieties, and they believed that certified seed would give better yield as compared to local seed. This finding is similar to a report by Kalsa (2019). This finding is also contradicted by the report of Ali *et al*. (2018), who indicated that in Pakistan, the majority of farmers do not have access to certified seed of bread wheat.

The reason farmers purchase certified seed is to replace old varieties, replace old seed, and have no saved seed. According to this result, to replace old seed by 44.8% and 48.9% of respondents and to replace old varieties by 36.6% and 38.9% of farmers were the major reasons for certified seed purchases in Gozamin and Aneded districts, respectively (Table 4.9). The decision to replace seed or varieties may be because of a perceived reduction in productivity arising probably from genetic change of a variety and deterioration in quality through continuous use of the same variety

or seed. Whereas, their have no own saved seed was the reason raised by a few farmers in the study area. This finding is in agreement with the study of Kalsa (2019).

According to the survey result, high seed prices reported by 37.3% and 38.2% of respondents and a shortage of certified seed reported by 35.8% and 31.3% of respondents were the major constraints for farmers not using certified seed from the formal sector in Gozamin and Aneded districts, respectively. Likewise, disease and pest damage, poor seed quality, and shortage of capital were the reasons raised by a few farmers for the constraint of using certified seeds in the study area (Table 4.9). This result is contradictory to the study of Zekarias Bassa *et al*. (2018).

Table 4.9: Farmers' perception and constraints of certified seed use from formal sector

	Gozamin		**Aneded**	
Reason of purchasing certified seed	Frequency	Percent	Frequency	Percent
Replace old variety	49	36.6	51	38.9
Replace old seed	60	44.8	64	48.9
No own saved seed	25	18.6	16	12.2
Total	134	100	131	100
Constraints of certified seed use from the formal sector				
Shortage of capital /absence of credit	11	8.2	5	3.8
Shortage of improved seed	48	35.8	41	31.3
High seed price	50	37.3	50	38.2
Disease and pest damage	11	8.2	18	13.7
Poor seed quality	14	10.4	17	13
Total	134	100	131	100

4.5.3. Cost and accessibility of certified seeds

This text summarizes findings from a survey of wheat farmers in Gozamin and Aneded districts regarding the cost and accessibility of certified seeds. About (84.3% in Gozamin and 85.5% in Aneded) of respondents considered certified seeds are expensive (Table 4.10). The high perceived cost of certified seeds could be a significant barrier to their adoption by farmers. This aligns with previous research by Kalsa (2019), who found a similar perception among farmers.

The distance traveled to buy certified wheat seed was in the range of 0–15 km. About (85.1% and 82.4%) of farmers traveled less than 10 km to acquire certified seed, although about 14.9% and 17.6% of farmers traveled over 10 km in Gozamin and Aneded districts, respectively (Table 4.10). This indicates a willingness to invest time despite potential travel challenges due to poor rural infrastructure. While travel distances are generally short, poor infrastructure can still pose challenges, particularly for farmers in more remote areas. This result is similar to the study of Zewdie Bishaw *et al*. (2014).

Farmers could obtain the required amount of seed in terms of cash and credit, credit, and cash. About (53.0% and 48.1%) of farmers acquire certified bread wheat seeds through a combination of cash and credit; a substantial portion (32.1% and 29.0%) purchase wheat seeds solely with cash, and a smaller but significant number of farmers (14.9% and 22.9%) obtain them through credit arrangements with cooperatives, respectively, in Gozamin and Aneded districts (Table 4.10). Cooperatives play a crucial role in facilitating seed acquisition, both through cash sales and credit arrangements. Hence, the availability of credit options is crucial for farmers to access certified seeds, especially those with limited financial resources. These findings align with Kalsa (2019), which found that cash payment was the most common method, followed by credit, exchange, and gifts.

Table 4.10: Evaluation of seed price, distance traveled to buy seed, and method of certified bread wheat seed purchase

	Gozamin		**Aneded**	
How do you evaluate seed price	Frequency	Percent	Frequency	Percent

Affordable	21	15.7	19	14.5
Expensive	113	84.3	112	85.5
Total	134	100	131	100
Distance travelled to buy certified seed				
1 to 4km	67	50.0	53	40.4
5 to 10 km	47	35.1	55	42
11 to 15 km	20	14.9	23	17.6
Total	134	100	131	100
Method of certified seed purchase				
Cash	43	32.1	38	29
Cash and credit	71	53	63	48.1
Credit	20	14.9	30	22.9
Total	134	100	131	100

4.6. Seed Insecurity Assesment

Seed security has access to seed of adequate quantity, acceptable quality, and in time for planting. However, the survey result indicated that about 83.6% and 82.4% of respondents said that there is a certified bread wheat seed shortage, whereas the remaining 16.4% and 17.6% of respondents said that there is no shortage of certified bread wheat seed in Gozamin and Aneded districts, respectively (Table 4.11).

The survey result also indicated that, all respondents in the study area cultivate bread wheat, but a significant majority of them do not use certified bread wheat seed in the 2023/24 cropping season. Therefore, the average land allocated to bread wheat production in the sample household was 0.60541 ha (SD=0.263210) and 0.56966 ha (SD=0.273053), whereas the average land covered by certified bread wheat seed in the sample household was 0.20427 ha (SD=0.091669) and 0.20161 ha (SD=0.114916) in Gozamin and Aneded districts, respectively **(**Table 4.11). This indicated that

there is a shortage of certified seed that affects the production and productivity of bread wheat among farmers.

The key informant interview result also revealed that the demanded and supplied bread wheat seeds have a huge gap. This indicated that a certified seed shortage or insecurity in both study areas. Therefore, seed insecurity is significantly affecting the agricultural production of smallholder farmers. As a result, due to a lack of improved certified bread wheat seed, the production and productivity of bread wheat are not bost. To fill this gap, the Amhara Agricultural Research Institute (AARI) assigned additional duty from the regional government to multiply improved bread wheat seeds based on specific crop excellence.

Table 4.11: Assesment of Seed Insecurity and land covered by certified bread wheat seed

	Gozamin		**Aneded**	
Is there seed insecurity in your area	Frequency	Percent	Frequency	Percent
Yes	112	83.6	108	82.4
No	22	16.4	23	17.6
Total	134	100	131	100

Land covered by bread wheat (ha)			**Land covered by certified bread wheat seed** (ha)		
	Gozamin	**Aneded**		**Gozamin**	**Aneded**
Minimum	0.25	0.125	Minimum	0.125	0.125
Maximum	1.25	1.125	Maximum	0.5	0.5
Mean	0.60541	0.56966	Mean	0.20427	0.20161
Sd	0.263210	0.273053	Sd	0.091669	0.114916

Sd (Standard devation)

4.7. Farmers' Seed Saving and Storages Practices

The study showed that about 84.3% respondents in Gozamin and 85.5% of respondent in Aneded district practiced bread wheat seed saving, and stored from one month up to more than six months (Table 4.12). This result in line with that of Kalsa (2019), who reported that about 89.9% (n=487)

of respondents said that they save their own seed for planting in bread wheat growing areas of Ethiopia.

Farmers in the study area said that they selected grain of bread wheat for seed, usually during threshing, during storage, or just before planting time. Therefore, the selection criteria of bread wheat for seed were consistent and again reflected farmers' knowledge, which was based on easily observable characteristics, such as being free from weed seed, having no disease/insect damage, and having big grain size. Free from weed seed was the major selection criteria, as reported by 46.0% and 48.2% of respondents, respectively, in Gozamin and Aneded districts (Table 4.12). This study contradicts the study of Zewdie Bishaw *et al*. (2014)

About 46.9% in Gozamin and 39.3% in Aneded districts of them stored wheat seed for a period of five up to six months, and 37.2% in Gozamin and 49.1% in Aneded districts of them said that they stored wheat seed for a period of more than six months. Therefore, a large number of respondents in Gozamin districts store their bread wheat seed for a period of five up to six months, and in Aneded district, store their bread wheat seed for a period of more than six months (Table 4.12). This finding is a line with that of Kalsa (2019).

Table 4.12: Bread wheat seed storage practice by farmers

	Gozamin		**Aneded**	
Have you save bread wheat for seed	Frequency	Percent	Frequency	Percent
Yes	113	84.3	112	85.5
No	21	15.7	19	14.5
Total	134	100	131	100
Selection criteria of bread wheat for seed				
Free from weed seed	52	46	54	48.2
Grain size	31	27.4	27	24.1
No disease/insect damage	30	26.5	31	27.7
Total	113	100	112	100

How long do you store bread wheat seed				
1-2 months	13	11.5	9	8
3-4 months	5	4.4	4	3.6
5-6 months	53	46.9	44	39.3
More than 6 months	43	37.2	55	49.1
Total	113	100	112	100

4.7.1. Source of stored seed and storage material used

The result of this study describes the sources of stored seeds used by farmers and storage material used in the Gozamin and Aneded districts. The most common source of seeds saved is from the farmer's own harvest (62.8% in Gozamin and 66.1% in Aneded). The other informal stored seed sources are neighbors or relatives (19.5% and 20.5%) and local markets (12.4% and 8.9%), which are also significant sources, respectively, in Gozamin and Aneded districts. While a notable proportion of farmers (5.3% in Gozamin and 4.5% in Aneded) stored seeds purchased from the formal seed sector (Table 4.13).

These findings suggest that while the formal seed system is gaining traction, informal seed systems remain crucial for many farmers. Then, Addressing the challenges of timely seed availability and promoting the benefits of certified seeds will be essential for enhancing seed quality and agricultural productivity in these areas. These findings align with Kalsa (2019), with a strong emphasis on self-sourced seeds and seeds obtained from informal networks.

The result of this study describes how wheat farmers in the study area store their seeds. In the study districts, farmers stored their seeds in different types of storage material. Like, PICS bags are the most popular, used by nearly 40% of farmers in Gozamin and 43% of farmers in Aneded; likewise, traditional methods Gotta is also widely used, with 35.4% and 33% of farmers; additionally, a significant portion of farmers (24.8% and 19.6%) use reused fertilizer bags for seed storage, respectively, in the Gozamin and Aneded districts. However, gotera is used as storage material for a few farmers in the Aneded district (Table 4.13). Accordingly, the specific usage of each method varies slightly between Gozamin and Aneded districts. PICS bags represent a shift towards modern storage methods, while "gotta" signifies the continued reliance on traditional

practices. This implies that awareness and knowledge of modern storage techniques and their benefits can encourage the adoption of methods like PICS bags. This result contradicts the study of Abamecha and Tolera (2020).

Farmers in this study, about 68.1% in Gozamin and 73.2% in Aneded districts, stored seed separately from grain during storage and about 31.9% in Gozamin and 26.8% in Aneded districts, stored seed together with grain during storage. This result is similar to Zewdie Bishaw *et al*. (2014).

Table 4.13: Source of stored seed and storage material used

	Gozamin		**Aneded**	
Seed from which source you store	Frequency	Percent	Frequency	Percent
ASE/cooperative	6	5.3	5	4.5
Neighbors /relative	22	19.5	23	20.5
Own grown seed	71	62.8	74	66.1
Local market	14	12.4	10	8.9
Total	113	100	112	100
Storage material used for storing seed				
Reused fertilizer bag	28	24.8	22	19.6
Gota	40	35.4	37	33
PICS bag	45	39.8	48	42.9
Gotera			5	4.5
Total	113	100	112	100
Do you separate seed and grain				
Yes	78	68.1	82	73.2

No	35	31.9	30	26.8
Total	113	100	112	100

ASE (Amhara Seed Enterprise), PICS (Purdue Improved Crop Storage)

4.7.2. Cleaning of your seed storage, storage pest control method, and the role of gender

Farmers in this study clean their storage every month, every three months, every six months, per year, and they clean their storage whenever necessary. About of (46.9% and 42.9%) respondents of them in Gozamin and Aneded districts, respectively, revealed that they clean their storage whenever necessary (Table 4.14). This result contradicts the study of Abamecha and Tolera(2020).

Cleaning with ruminant waste, mud and smoking, sundrying, chemical spraying, and changing other crop storage are common traditional and modern seed management practices. According to the survey result, the majority of respondents, about 54.9% and 54.5%, use chemicals, followed by cleaning storage material revealed by 23.9% and 27.7% of respondents were storage pest control methods in Gozamin and Aneded districts, respectively (Table 4.14). This result is different from the study of Zewdie Bishaw *et al*. (2014).

This result highlights the shared responsibility of men and women in managing seed storage in agricultural communities. Hence, a significant portion of households (61.1% in Gozamin and 50.0% in Aneded) involved both men and women in seed storage management. Also, a considerable number of households (27.4% in Gozamin and 31.3% in Aneded) had women solely responsible for seed storage. While less common, male-only responsibility for seed storage was observed in 11.5% of households in Gozamin and 18.7% in Aneded.

However, the proportion of households with male-only responsibility about 11.5% in Gozamin and 18.7% of respondent in Aneded district is slightly higher in the previous study. These findings emphasize the importance of recognizing and valuing the contributions of both men and women in agricultural practices. Promoting gender-equitable approaches in seed storage management can enhance agricultural productivity and food security. In comparison with Zewdie Bishaw *et al*.

(2014), the findings are generally consistent with the earlier study. Both studies indicate that shared responsibility between men and women is a common practice in seed storage management

Table 4.14: Cleaning of your seed storage, storage pest control method, and responsibility of onfarm storage practice

	Gozamin		Aneded	
Cleaning of your seed storage	Frequency	Percent	Frequency	Percent
Every three months	6	5.4	10	9
Every six month	15	13.2	11	9.7
Per year	39	34.5	43	38.4
Whenever necessary	53	46.9	48	42.9
Total	113	100	112	100
Storage pest control method				
Sun dry	20	17.7	17	15.1
Cleaning storage material	27	23.9	31	27.7
Change other crop storage	4	3.5	3	2.7
Chemical spraying	62	54.9	61	54.5
Total	113	100	112	100
Responsibility of onfarm storage practice				
Female	31	27.4	35	31.3
Male	13	11.5	21	18.7
Both	69	61.1	56	50
Total	113	100	112	100

Chapter 5. CONCLUSIONS AND RECOMMENDATIONS

The study reveals that wheat farmers in the study area use both formal and informal seed sourcing channels, with formal sources coming from certified suppliers and informal sources from farm-saved seeds, neighbors, and local markets. Informal sources are more prevalent, offering better accessibility due to their greater spatial and temporal availability compared to formal sources, but formal seed sources face challenges like high prices, untimely availability, shortage of certified seed, and poor quality that significantly impact farmer adoption.

The most commonly grown improved bread wheat variety in this study is Kakaba, followed by Ogolcho, Danphe, and Hidasie. Among them, Kakaba is dominant and favored by farmers due to its adaptability and desirable traits for local environments. The traits influencing farmers' variety choices are grain yield, disease tolerance, and market value. Therefore, Most farmers store wheat seeds for three to more than six months using PICS bags, traditional bins (gota or gotera), and reused fertilizer bags. Then, improving seed storage practices, such as promoting the use of improved storage containers and techniques, can reduce seed losses and enhance seed quality.

Therefore, Agricultural research institutes, seed enterprises and agricultural extension offices at regional, zonal, and woreda levels ensure seed supply with farmer needs and understanding farmer preferences for developing and promoting improved wheat varieties that meet their specific needs and to enhance bread wheat production. Encouraging farmers to understand the advantages of improved seed varieties is a critical step in promoting their adoption. Despite increased regional seed enterprise production, robust seed multiplication and distribution systems are crucial for ensuring timely and sufficient seed availability for all farmers. Support initiatives that provide affordable access to PICS bags and other modern storage solutions. In essence, the study calls/advocates for a multifaceted approach that combines market-driven seed production, efficient seed distribution, strengthening cooperatives, promoting PICS bags, subsidies, credit access, and farmer education and awareness about improved seed varieties and their benefits, which enhance agricultural productivity in the region. This study was conducted on two district of East Gojjam zone. Then, replicate this research at many location of potential bread wheat growing district of East Gojjam zone for further study.

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7. APPENDIX

Appendix 1: Survey Questionnaire

Part I: General Information for household survey questioners

Identification Number (code) ----------

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

Woreda: ----------

Kebeles: ----------

Name of the Interviewer: ----------

Sign ----------

Instruction

Introduce myself to the respondent and ask his or her permission politely.

Tell the respondent about the purpose of the study.

Check that all questions are asked and responses are filled accordingly.

Please fill in the answer by encircling it in the appropriate choice for a closed-ended question and writing your opinion in the space provided for an open-ended question.

If you need further explanation, please mention

Questions related to personal background

1. What is the sex of the household head? 1. Male 2. Female

2. What is your age_____years?

3. What is the age household head? 1. 17-35 2.36-60 3. Above 60

4.What is your educational background ?

1. None (illiterate) 2. Read and write 3. primary (1-8)

4. Secondary (9-10) 5. Preparatory (11- 12) 6. level based graduate

7. Higher education graduate 8. other (specify)_____

5. What is the religion of the household?

1. Muslim 2. Orthodox Christian 3. Protestants 4. Other

6. What is the marital status? 1. Married 2. Single 3. Divorce 4. Widowed

Questions related to household income

7. What is your annual income ----------?

8. How much is your annual income?

Questions related to access to credit

9. Is there credit access in your area? 1. Yes 2. No

10. If you say no to the above question, do you think that you cannot buy seed because of a lack of credit access? 1. Yes 2. No

Questions related to farm experience

11. For how many years have you participated in farming activities?

Questions related to input cost

12. Do you think that the input cost (you pay for seed) is high? 1. Yes 2. No

Question related to Transport Access

13. Is there transport access in your area? 1. Yes 2. No

14. If you say no, do you believe that lack of transport access is an obstacle to you and that you can't come to the seed source and distribution center easily?

1. Yes 2. No

Question related to extension service

15. Do you get advisory services from extension agents on bred wheat production?

1. Yes 2. No

16. If you say yes, how frequently do you have contact with the extension agents during the production season? 1. Once a week 2. Fortnightly 3. Monthly 4. Yearly 5. Never

17. Have you ever attended any training or seminar on improved bread wheat varieties last year?

1. Yes 2. No

18. If you say yes, which topics were discussed? 1. Wheat variety selection 2. Production of wheat 3. Wheat management practices 4. marketing of wheat

19. Do you believe that your inability to get extension service causes you not use quality seed?

1. Yes 2. No

Question related to Land Size

20. How many hectares of farmland do you have? ----------

21. How many hectares of farmland were covered by improved seed?

22. How many hectares of farmland were covered by bread wheat?

23. How many hectares of farmland were covered by certified bread wheat seed?

Question related to Distance

24. How long are the seed distribution sectors far from your home?

1. 1 to 4 km 2. 5 to 10 km 3. 11 to 15 km 4. More than 15 km

25. Do you think that the distance between your home and seed distribution sectors affects your ability to come easily? 1. Yes 2. No

Part II: Question related to seed sources or Seed systems of bread wheat for farmers

1. Do you grow bread wheat every year? 1. Yes 2. No

2. How many years have you been producing bread wheat?

3. What was your initial source for the seed of bread wheat?

1. Ministry of Agriculture 5. Loan or credit from farmers

2. University or research center 6. Exchange with other crop seeds

3. NGOs 7. Exchange for labor

4. Purchase from farmer 8. Gift from other farmers 9. Own saved seed

4. Where did you get bread wheat seed in this cropping season?

1. Own saved seed 2. from Relatives 3. from local markets

4. from Research center 5. NGO 6. Cooperative 7 . Seed enterprises (ASE, ESE)

5. What are the challenges of the current seed source?

1. Poor quality 2. Time of supply 3. Type of demanded variety

4. Higher price 5. Seed shortage 6. Limited on a few crops

6. Why do farmers use their own saved seed?

1. Seed is available on time 2. No extra cost 3. Seed quality is good or better

4. Certified seed is not available 5. Keep own variety 6. No new or better variety

7. What are the major problems when you buy seed from a local market?

1. Poor quality and mixed with other crop seed

2. High price 3. Difficult to get the seed needed in type and amount

8. Did you have information about bread wheat technology, such as improved varieties of bread wheat seed, agronomy, fertilizer, herbicides, and pesticides? 1. Yes 2. No

9. If your answer above is no, why? ----------

10. If you have information, what is the source of information most of the time?

1. Radio / Television 2. Relatives & neighbors 3. From farmer's association
4. From extension agents 5. From research

11. Do you have seed distribution sectors in your area? 1. Yes 2. No

12. Do you think that these seed distribution sectors are well enough for you?

1. Yes 2. No

13. Are the seed suppliers supplies timely? 1. Yes 2. No

14. Are farmers getting the required type and amount of bread wheat variety at the right time?

1. Yes 2. No

15. Is the seed supply process based on the demand assessment of farmers? 1. Yes 2. No

16. If your answer above is no, what are the reasons?

17. What are the bread wheat seed suppliers in the area?

1. Public companies 2. Private Companies

3. Farmers to farmer's exchange 4. Others please specify

18. Why do you choose the seed supplier from which you are buying?

1. Lower price 2. Higher quality 3. Near your home

4. Supply in time 5. Absence of other suppliers 6. Services

19. Have you used credit or loan services for purchasing bread wheat seed? 1.Yes 2. No

20. If your answer to the above is no, what was the main reason?

1. Lack of access 2. High interest 3. Availability of other alternatives

21. If your answer to the above is yes, what is your major source and how much do you get from it? 1. Savings and credit institutions 2. Informal creditors

3. Commercial banks 4. Cooperative

22. Are you satisfied with the current seed source of bread wheat? 1. Yes 2. No

23. If your answer above is yes, what are the main values?

24. If your answer above is no, describe the reasons?

1. Limited varieties 2. Late delivery 3. Availability/long chine
4. High price 5. Inadequate supply of seed 6. Poor quality

Part III: Question related to farmers certified seed use

1. Have you used improved varieties of bread wheat? 1. Yes 2. No

2. If the answer to the above is no, which of the following are the reasons for not using it?

1. Shortage of capital 2. lack of improved seed 3. High cost of production

4. Lack of experience 5. lack of extension advice

3. If your answer to the above is yes, when do you start to use improved bread wheat varieties?

4. Which improved bread wheat varieties did you grow?

1. Danphe 2. Kekeba 3. Hidasie 4. Ogolcho

5. Which improved bread wheat variety do you prefer?

6. What are your preference criteria? 1. Better yield advantage 1. Disease resistance
3. Early mature 4. Higher market demand 5. Better price 6. Bread making quality 7. Seed size 8. Seed color 9. Straw yield 10. Drought tolerance

7. Which local bread wheat varieties did you grow? Mention them? What is your selection criteria for each?

8. Do you believe that your annual income is not sufficient to buy a new bread wheat seed variety?

1. Yes 2. No

9. Why do farmers prefer certified bread wheat seed?

1. Better seed quality 2. Better grain yield 3. Disease resistance

4. High yielder 5. Bread making quality 6. Marketability/ high prices

10. What is the reason for purchasing certified bread wheat seed?

1. Replace old seed 2. Replace old variety 3. No own saved seed

11. How do you evaluate price of certified bread wheat seed?

1. Cheap 2. Affordable 3. Expensive

12. What are the constraints on using improved bread wheat variety?

1. Improved variety is not available 2. Improved variety is expensive 3. Lack of credit Service 4. Poor seed quality and productivity 5. Disease and insect pest damage

13. What is the method of certified bread wheat seed purchase?

1. Cash 2. Cash + credit 3. Credit

14. Is there seed insecurity in your area? 1. Yes 2. No

Part IV: Question related to farmers seed storage practice and structure

1. Are you save bread wheat seed by farmers?

1. Save own seed 2. Do not save own seed

2. What are the selection criteria for producing bread wheat for seed?

1. free from weed seed 2. grain size 3. no disease/insect damage

3. Seed from which source do you store? 1. own grown seed 2. neighbors/ relative

3. Local market 4. ASE 5. Research center

4. What type of storage do you use?

1. Reused fertilizer bag 2. Gota 3. PICS bag 4. Gotera

4.1 If sack storage is used, what type of storage bag?

1. Polypropylene 2. Sisal-woven bag 3. Plastic bag 4. Purdue improved crop storage (PICS)

5. Did you separately manage seed and grain during storage? 1. Yes 2. No

5.1 For how long are the bread wheat seeds stored?

1. 1-2 month 2. 3-4 months 3. 5-6 months 5. more than 6 months

6. How often do you do cleanliness of your storage structure?

1. Once a month 2. Once every 3 months 3.Once every 6 months

4. Once per year 5. whenever necessary 6. Never done

7. Do you have a record of the seed quality when the seed was delivered from a different seed source? 1. Yes 2. No

7.1 If you say yes, what is the quality parameter chalked? 1. physical quality 2. physiological quality 3. pathological quality 4. genetically quality 5. other

8. What control of storage pests is applied at on-farm bread wheat seed storage?

1. No infestation 2. Sun drying 3. Cleaning 4. Change or dispose seed

5. Chemical spraying 6. Fumigation 7. Others

9. Who is responsible for storage practices at on-farm bread wheat seed storage?

1. Men 2. Women 3. Both (Men and Women)

Check list for Key Informant and Focus Group Discussion (FGD)

Check list for Focus Group Discussion (FGD)

1. Which types of improved wheat varieties and local seeds are available and accessible to farmers in your area?

2. What type of improved wheat seed variety do you grow in this area?

3. Individually, for how long have you been continuing to grow improved wheat seed varieties?

4. Give examples of improved wheat seed you grow in this area?

5. Among the varieties you are continuing to grow, which one do you think is the most preferred variety among the others? Rank them in order of preference

6. What is your preference criteria the varieties?

7. Do you easily access improved wheat varieties?

8. What are the differences between improved wheat varieties and local varieties in terms of production?

9. What factors have contributed to the adoption of these wheat varieties?

10. Which factors affect the adoption of improved wheat varieties in the area?

11. Is the seed supply process based on the demand assessment of farmers? 1. Yes 2. No

12. If your answer above is no, what are the reasons?

Check list for cooperative unions

1. Are farmers growing improved wheat seed varieties?

2. What types of improved wheat varieties are grown by farmers in this area?

3. What are the sources of seed in this area?

4. Are the union knows the seed source of taken seed?

5. Where was the union obtained seed?

6. How does the union seed distribute to cooperatives?

7. What are the challenges of the seed distribution system?

8. What do you suggest to solve the challenges?

Check list for *Woreda* Agricultural Office, Multi-purpose Cooperatives, and Development Agents

1.When and how you started seed distributed by cooperatives?

2. What improved bread wheat varieties do farmers grow in the district now, and why do they grow them?

3. What characteristics of improved bread wheat seed varieties do you think are more liked by farmers?

4. How do you evaluate the seed supply system?

5. What are the challenges of implementing a seed system?

6. What are the factors determining the price of bread wheat seed?

7. Is there a price difference comparing the seed system with the traditional one?

8. Are the seed suppliers supply timely? A. Yes B. No

9. If your answer to the above is yes, do farmers' requests for seed match how much is supplied?

10. If the above is no true, what about the reasons?

11. Does the farmers' demand match the availability of seeds? A.Yes B. No

12. If the above is no true, what about the reasons?

13. What are the impacts of seed insecurity on the production of bread wheat in this area?

14. Are seed left over in the storage area? A. Yes B.No

15. If your answer to the above is yes, what about the reasons?

16. Dose the supplied seed appears to have quality problems? A. Yes B. No

17. If your answer to the above is yes, what are the quality problems occurs?

18. Who are the accountability organization to the above problem appears?

19. What are the amounts of bread wheat seed distributed by multipurpose cooperatives (formal distribution system) in the past 5 years?

20. What are the amounts of bread wheat seed distribution by the informal distribution system in the past 5 years?

21. What is the total hectare of land allocated to farms in your woreda in the 2015/2016 production season? _____hectare

22. From it, how much hectare of land is covered by bread wheat seed? _____ha, among them how much land is covered by certified wheat seed _____ha

23. Which seed system is practice in this area?

A. Formal seed system B.Informal seed system C. Intermidate seed system

24. What do you suggest to make seed supply efficient and effective in the future?

AUTHOR BIOGRAPHY

The author was born in Gozamin District (Chertekel kebele), East Gojjam Zone, and Amhara region on April 21, 1997. She attended her primary school and Secondary school at Chertekel primary and Secondary school respectively. She attended her preparatory school at Debre markos preparatory school. After completion of her preparatory education, she joined Debre markos University College of Natural and computational science, Department of Biotechnology in 2016 and she earned her BSc. degree in June 2019. After graduation she was employed in Dejen quarantine post as seed laboratory expert in June 2020. After these she got an opportunity to join Bahir Dar University college of Agriculture and Environmental Science to attend her M.Sc. program in Seed Science and technology in October 2022.