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Adoption Dynamics of Wheat Technologies among Agro-Pastoral Systems in Somali Region, Ethiopia: A Comprehensive Review and Analysis

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ABSTRACT

This review examines the adoption dynamics of wheat technologies among agro-pastoral systems in the Somali Region, Ethiopia. Drawing upon a systematic review of existing literature, the study highlights key factors influencing adoption, including household characteristics, socioeconomic variables, and institutional support systems. The findings reveal that age, education level, and gender significantly impact technology adoption decisions at the household level. Socioeconomic factors such as farm size, livestock ownership, and off-farm income play a pivotal role in shaping farmers' ability to adopt new technologies. Institutional variables, including extension services, market proximity, and credit availability, emerge as critical enablers for fostering adoption. Despite significant barriers, opportunities exist to enhance adoption through targeted interventions and policy support. The insights from this study provide valuable implications for policymakers, researchers, and practitioners in promoting sustainable wheat production systems and improving livelihoods in agro-pastoral communities.

Key Words: Adoption, Agro-pastoral Systems, Ethiopia, Wheat

1. Introduction

Wheat is cultivated on 10 million hectares in Africa, making it a major staple crop for several countries, though it is an imported commodity across the continent. Over the past 20 years, wheat consumption in Africa has steadily increased due to factors such as population growth, changing food preferences, and socioeconomic shifts related to urbanization. African countries are the world's largest wheat importers, with over 45 million metric tons imported in 2013, valued at around 15 billion US dollars. Wheat imports account for 60% of Africa's total wheat consumption (FAOSTAT, 2015).

The average wheat productivity in Sub-Saharan Africa (SSA) is 1.7 tons per hectare, nearly 50% below the global average. National average wheat productivity in SSA varies by country, and yield data from experimental stations and crop models suggest there is significant yield potential, among the highest reported for spring wheat. As a result, the yield gap could be closed through the use of improved technologies, such as better varieties, fertilizers, and pesticides, along with improved institutional and market frameworks that incentivize wheat producers and other actors involved in wheat marketing and processing in SSA. From 2010 to 2013, the average annual wheat import was approximately 17.5 million metric tons, which accounted for nearly 80% of the total domestic wheat consumption in these countries (FAOSTAT, 2015).

Ethiopia ranks second in Africa, after South Africa, in terms of total wheat area and production. Wheat is the fourth most widely cultivated crop in the country, following Teff, Maize, and Sorghum, in terms of area coverage and the third in total production (CSA, 2012). Wheat is primarily grown in the highland regions of Ethiopia, located between 6° and 16° N latitude and 35° and 42° E longitude. These areas have altitudes ranging from 1,500 to 2,800 meters above sea level, with mean minimum temperatures between 6°C and 11°C. In the 2012/13 cropping season, approximately 4.8 million farmers grew wheat, with more than 1.6 million hectares dedicated to wheat cultivation, accounting for 13.5% of the national grain area. Wheat production during this period reached 3.4 million metric tons, representing 15% of the country's total grain output (CSA, 2013b).

The wheat varieties grown in Ethiopia include durum wheat, which accounts for 60% of production, and bread

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wheat *(Triticum aestivum)*, which makes up the remaining 40% (Bekele and Shiberu, 2014). Wheat produced in Ethiopia is mainly used for domestic food consumption, seed, and industrial purposes. On average, households in Ethiopia allocate 9% of their total per capita food expenditure to wheat, making it the second most important crop after maize. Wheat consumption in the country has been steadily increasing, with annual consumption reaching 4.2 million metric tons in 2012/13, up from 2 million metric tons in 1995/96. Wheat is a major staple crop in Ethiopia, both in terms of production and consumption, and ranks second in importance, after maize, in terms of caloric intake (Berhane et al., 2011). Wheat consumption growth is particularly pronounced in urban areas due to higher population growth, lifestyle changes, and rising tea prices (Abu, 2013).

Despite significant growth in wheat production over the past 15 years, domestic production continues to fall short of meeting consumption demands, making Ethiopia a net importer of wheat. Wheat is by far the most important staple imported into the country, with most commercial imports and humanitarian food aid consisting of wheat. Although the ratio of imported wheat to domestic production has decreased in recent years, Ethiopia's wheat self-sufficiency stands at only about 78%. Wheat imports account for approximately 22% of domestic consumption and 33% of the wheat market (CSA, 2013a).

Wheat production among agro-pastoral households in the Somali Region began before 1970. However, the introduction and dissemination of improved bread wheat varieties at the farmer level began in 1999 Farmers' adoption decisions are influenced by a variety of factors, including personal, demographic, socio-economic, institutional, and psychological characteristics (Kebede et al., 1990). In a study by (Giziew, 2008) in ADA'A and Akaki Districts in Eastern Shewa, it was found that factors such as gender, landholding size, social participation, extension contact, and attitude toward chickpea technology had a positive and significant impact on the adoption and intensity of improved chickpea production. Similarly, research in Alaba Special District, Southern Nations, Nationalities, and Peoples' Region by (Bedasso, 2008) revealed that farm experience, family size, number of Tropical Livestock Units (TLU), participation in non-farm activities, mass media exposure, and extension contact significantly affected farmers' innovativeness.

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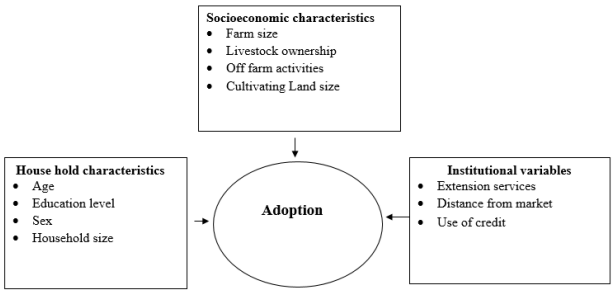

Figure 1: Conceptual framework of the study

2. Materials and Methods

This study adopts a systematic review approach to examine the adoption dynamics of wheat technologies among agro-pastoral systems in the Somali Region, Ethiopia. The review methodology involved the following steps to ensure a comprehensive and rigorous analysis:

2.1. Literature Search and Data Sources

A comprehensive literature search was conducted using multiple academic databases, including Scopus, PubMed, Web of Science, and Google Scholar. Keywords such as "wheat adoption," "agro-pastoral systems in Ethiopia," "wheat technologies," "Somali Region agriculture," and "adoption challenges" were employed to retrieve relevant studies. Additionally, gray literature from institutional reports, government publications, and regional development agencies, such as the Central Statistical Agency (CSA) and the Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI), was included to capture region-specific insights.

2.2. Inclusion and Exclusion Criteria

To maintain the relevance and quality of the reviewed materials, the following inclusion criteria were applied: Studies published in peer-reviewed journals or credible institutional reports from 2000 onward,research focusing on wheat adoption in Ethiopia, with emphasis on agro-pastoral systems., articles examining socioeconomic, institutional, or technological factors influencing adoption. At the same time the exclusion criteria included studies with limited methodological transparency, those unrelated to wheat technology adoption, and publications not available in English.

2.3. Data Extraction and Synthesis

The selected studies were reviewed systematically to extract relevant data on key themes like Socioeconomic determinants of wheat technology adoption (e.g., income, education, gender),institutional support factors, such as extension services, credit access, and market linkages. Barriers and opportunities for adopting improved wheat varieties and practices.Trends in wheat production and policy frameworks in Ethiopia.Data synthesis was conducted qualitatively to identify recurring patterns, contradictions, and knowledge

gaps. A thematic analysis was used to group findings into major themes, which are presented and discussed in the results section.

2.4. Conceptual Framework Integration

The conceptual framework for this study guided the organization and interpretation of findings. This framework categorizes influencing factors into household characteristics, socioeconomic variables, and institutional variables, all of which converge to affect the adoption of wheat technologies.

2.5. Validation and Peer Review

To enhance the robustness of the review, initial findings were cross-referenced with recent reports from local institutions and validated through informal consultations with regional agricultural experts.

3. Results and Discussion

3.1. Introduction

The adoption of improved wheat technologies in agro-pastoral systems is influenced by a complex interplay of household characteristics, socioeconomic factors, and institutional variables. This section provides an in-depth analysis of these factors, highlighting how they shape farmers' decisions and behaviors regarding technology adoption. The results are organized into three main categories: household characteristics, socioeconomic characteristics, and institutional variables. Each subsection explores the specific role of these factors, supported by relevant literature and examples from Ethiopian agro-pastoral systems. By identifying key barriers and opportunities, this section aims to provide insights that can inform strategies to enhance the adoption of wheat technologies and promote sustainable agricultural development.

3.2. Household Characteristics

3.2.1. Age

While older farmers often possess a wealth of experience gained over many years in the field, they may exhibit a hesitancy to embrace new technologies that could enhance their practices. In contrast, younger farmers tend to be more receptive to innovation and are more willing to explore cutting-edge techniques and tools that could revolutionize their approaches to agriculture (Ayenew et al., 2020; Kebede et al., 2017).

3.2.2. Education level

Research consistently shows that higher education levels significantly enhance the likelihood of farmers adopting advanced wheat technologies. Educated farmers possess the knowledge and skills necessary to effectively understand and implement innovative practices, leading to improved agricultural outcomes (Zeleke et al., 2022; Abda, 2022; Deboche et al., 2020; Mentire, 2017).

3.2.3. Sex

Studies reveal a pronounced tendency among male-headed households to embrace new technologies, a phenomenon largely attributed to their superior access to essential resources and their greater authority in decision-making processes. In contrast, female-headed households often face significant barriers, which limits their technological adoption. This disparity underscores the broader implications of gender dynamics in innovation and resource allocation (Abda, 2022; Mentire, 2017; Tesfaye et al., 2016).

3.2.4. Household size

Larger household sizes can positively influence adoption by providing more labor for implementing new technologies. However, the dependency ratio within the household can also affect adoption, as higher dependency may limit available resources for investment in new technologies (Kebede et al., 2017; Mentire, 2017).

3.3. Socioeconomic Characteristics

3.3.1. Farm size

Extensive research reveals a compelling link between larger farm sizes and the successful adoption of superior wheat varieties. Farmers managing vast expanses of land are notably more inclined to allocate segments of their fields to the exploration and integration of cutting-edge agricultural technologies. This trend highlights not only the strategic advantage of land ownership but also emphasizes how expansive farming operations drive innovation and enhance productivity within the agricultural sector (Abda, 2022; Kebede, 2020; Gebresilassie and Bekele, 2015).

3.3.2. Livestock ownership

Farmers who own a larger number of livestock often experience enhanced financial stability, which in turn fosters their willingness and ability to adopt innovative agricultural practices. Research indicates that this correlation is significant, suggesting that the greater the livestock holdings, the more resources and security these farmers possess to invest in new techniques and technologies that can improve productivity and sustainability (Abda, 2022; Kebede, 2020; Gebresilassie and Bekele, 2015).

3.3.3. Off-farm activities

Off-farm income serves as a vital financial resource, enabling farmers to access additional capital. This supplemental income can be strategically allocated toward investing in advanced agricultural technologies, thereby enhancing productivity and sustainability in their farming practices (Ayenew et al., 2020).

3.3.4. Cultivated land size

Farmers who cultivate extensive plots of land are generally more inclined to experiment with and embrace innovative technologies. This readiness to adopt new methods stems from their ability to allocate a portion of their acreage for trials, allowing them to explore fresh techniques without jeopardizing their entire harvest. Such a strategic approach

not only fosters agricultural advancement but also mitigates the risks associated with adopting untested practices (Kebede, 2020; Gebresilassie and Bekele, 2015).

3.4. Institutional Variables

3.4.1. Extension services

Enhanced extension services play a crucial role in shaping farmers' choices to embrace new wheat varieties. These services not only facilitate the adoption of innovative agricultural practices but also contribute to a more effective utilization of fertilizers and pesticides. However, it's worth noting that while the influence on fertilizer application is consistently positive, the impact on pesticide use may not always reach statistical significance, as highlighted by (Yitayew et al., 2021).

3.4.2. Distance from market

Farmers situated at greater distances from markets often face significant barriers to adopting advanced wheat technologies. These challenges primarily stem from elevated transportation costs, which can erode potential profits, as well as diminished access to essential inputs and vital information. The combination of these factors creates a daunting environment that stifles innovation and progress in agricultural practices (Kebede, 2020; Kebede et al., 2017; Gebresilassie and Bekele, 2015).

3.4.3. Use of credit

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4. Conclusion and Recommendations

This review highlights the complex factors influencing the adoption of wheat technologies among agro-pastoral systems in Ethiopia. Household characteristics such as age, education, and gender play a pivotal role in adoption decisions, with younger, educated, and male-headed households often more likely to embrace innovations. Socioeconomic factors, including farm size, livestock ownership, and off-farm income, significantly shape farmers' ability to adopt new technologies by providing resources and financial stability. Institutional barriers, such as inadequate extension services, limited access to credit, and distance from markets, hinder widespread adoption despite the potential benefits. Addressing these challenges requires a multi-faceted approach that combines policy support, institutional strengthening, and farmer-focused interventions. To enhance adoption rates, tailored extension programs are essential to raise awareness and provide continuous support. Improving infrastructure and market access can reduce transportation costs and facilitate the flow of inputs and outputs. Affordable credit schemes should be made accessible to empower farmers to invest in improved seeds, fertilizers, and tools. Gender-inclusive policies are vital to address the unique challenges faced by female-headed households and ensure equitable access to resources. Additionally, research and development efforts should focus on developing resilient wheat varieties suited to the agro-climatic conditions of the Somali Region. Finally, aligning agricultural policies with local needs through stakeholder collaboration can foster an enabling environment for sustainable agricultural growth. By addressing these barriers and leveraging available opportunities, policymakers and practitioners can unlock the full potential of wheat technologies, contributing to improved food security, livelihoods, and sustainable development in Ethiopia's agro-pastoral communities.

Conflict of Interest

Authors declare that there is no conflict of interests involve in publishing this research paper.

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