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FACTORS INFLUENCING THE ADOPTION OF WHEAT TECHNOLOGIES IN GEDEO ZONE, SOUTH ETHIOPIA: TOBIT MODEL APPLICATION

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ABSTRACT

Boosting wheat productivity through the adoption of improved varieties and modern agronomic practices is vital for securing food and livelihoods in smallholder farming communities. While previous research often examines wheat technologies in isolation, this study bridges the gap by analyzing farmers' adoption of multiple practices together, offering a clearer picture of what drives effective technology use. Thus, primary data were collected from 150 randomly selected farm households using a structured questionnaire for this study. A probit regression model was employed to identify factors influencing the adoption decision, while a Tobit model was used to examine the intensity of adoption. The results reveal that total livestock unit (TLU), frequency of extension contact, and area allocated for wheat positively and significantly affect the adoption decision, whereas access to credit negatively influences the likelihood of adoption. Similarly, the intensity of adoption is positively influenced by TLU, wheat market price, and extension contact, while it is negatively affected by the sex of household head and distance to the nearest market center. The findings underscore there need to improving extension services, market access, and institutional support to enhance wheat technology uptake and economic productivity in the study area.

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INTRODUCTION

Ethiopia's economy is mainly depending on the agriculture sector where 34% of the gross domestic product (GDP) and 71% of the employment derived from this sector (Ayele et al., 2021; Kebede et al. 2017). Grains (such as Wheat, Corn, Teff, Sorghum, and Millet) make up the bulk of crop production as the main staple food in the country (ATA, 2018). Wheat is the one of the most significant cereal crops produced in wide range of agro-ecologies in Eastern Africa. However, its productivity has remained low (Anteneh and Asrat, 2020). The technology adoption by the farmers is an essential pre-requisite for economic prosperity in developing countries like Ethiopia. Increasing population pressures, traditional farming systems and small farm holding are not enough to support growing number of people in the household. Hence, adoption is a gradual process that involves learning about new technologies boosting production and productivity. Most of the time adoption decisions depend on farmers' attitude toward risk (risk aversion or risk neutrality) and riskiness of the new technology (Abate, 2024).

In recent years, several studies have explored the adoption of agricultural technologies in developing countries, including Ethiopia. Most of these studies, however, focused on identifying factors influencing the adoption of a single technology component such as improved crop varieties or inorganic fertilizers rather than examining the combined use of multiple technologies (Gebremariam et al., 2021; Katengeza et al., 2022; Nigatu et al., 2023). For instance, Gebremariam et al. (2021) analyzed smallholders' adoption of improved wheat varieties in Ethiopia's highlands, while Katengeza et al. (2022) assessed fertilizer adoption patterns among maize farmers in Malawi using household survey data. Similarly, Nigatu et al. (2023) investigated the drivers of improved teff and fertilizer adoption in Ethiopia but did not consider the joint adoption of complementary technologies.

Moreover, various statistical and econometric models such as logit/probit, multivariate probit, and seemingly unrelated regression have been employed across these studies to analyze adoption decisions, resulting in methodological inconsistencies that make comparison difficult (Asfaw et al., 2020; Ullah et al., 2022). If these conceptual and methodological gaps remain unaddressed, policy recommendations and extension interventions will continue to be narrowly focused, targeting single technologies rather than integrated adoption packages. This can lead to inefficient resource allocation, slower productivity growth, and limited progress toward climate resilience among smallholder farmers. Moreover, overlooking the complementarities among technologies such as the joint benefits of improved varieties, fertilizers, and soil conservation practices could result in underestimating their synergistic impacts on farm efficiency and sustainability.

Thus, the present study has bridged these gaps by examining the *simultaneous adoption* of multiple agricultural technologies and their intensity of utilization. Consequently, methodological inconsistencies across studies have limited the generalizability of findings and their practical use in guiding integrated agricultural development strategies. If such conceptual and methodological gaps remain unaddressed, policy interventions would continue to promote technologies in isolation such as improved seeds without adequate fertilizer or soil management practices, leading to suboptimal productivity gains and lower returns on investment. This fragmented approach can further constrain farmers' capacity to build climate resilience and achieve sustainable efficiency gains, particularly under increasing climatic and market uncertainties.

To address these challenges, the present study integrated the Probit model to identify factors influencing the adoption of individual technologies and the Tobit model to estimate the intensity of technology use. This dual-model approach enabled a clear understanding of both the decision to adopt and the extent of utilization thereby bridging the methodological gap found in much of the previous research. Conceptually, the study moves beyond the conventional "single-technology focus" by analyzing the complementary role of multiple technologies in improving farm efficiency and climate resilience.

Theoretically, this research builds upon the Innovation Diffusion Theory (Rogers, 2003) and the Utility Maximization Framework, while integrating insights from the Sustainable Livelihoods Approach. It contributes to these theories by emphasizing that technology adoption decisions are not isolated events but interdependent, risk-adjusted choices shaped by farmers' resource constraints, perceptions, and climate-related risks. The findings, therefore, pinpointed to refine the diffusion and efficiency theories by incorporating the dimension of *complementarity* and *resilience*, offering a more realistic representation of smallholder behavior in developing economies.

According to the Southern Nations, Nationalities, and Peoples' Region (SNNPR) Bureau of Agriculture 2022/23 report (SNNPR, 2023), wheat is cultivated in highland woredas of Gedeo for household consumption rather than as a commercial crop. (e.g., Bule, Gedeb, and Kochere), but the total share of wheat in the zone's crop production is less than 5% of the cultivated area. Average wheat yield in Gedeo is reported at around 2.3 to 2.6 tons/ha, slightly below the national average of approximately 2.9 tons/ha (CSA, 2022; Bule and Tsegaye, 2020). In Gedeo Zone, the area under wheat production has shown steady expansion due to the government's wheat self-sufficiency initiative and increasing adoption of improved varieties and fertilizers. At the zonal and district levels, recent reports from the Gedeo Zone Agriculture Office (2023) indicate that wheat is becoming an increasingly important crop in the Gedeb and Choriso districts, largely due to improved rainfall patterns and promotion of cluster-based farming. According the report, in the 2022/23 production year, the average yield of wheat in Gedeb district was estimated at approximately 3.4 to 3.6 tons/ha, while in Choriso district, average productivity reached around 3.2 to 35 tons/ha. These figures are slightly above the regional average (around 3 to 3.2 tons/ha), reflecting successful technology dissemination efforts and farmers' growing engagement in improved wheat production practices.

In terms of total volume, despite national efforts to scale up wheat production through improved seed, fertilizer, and agronomic packages, the adoption of improved wheat technologies in Gedeb and Choriso districts of Gedeo Zone remains low and varies with farmer to farmer and across locations. This limits productivity gains and food security in these highland areas, where population pressure and land scarcity demand more efficient use of resources. Based on these, this study had attained the following objectives. First, study identified the major wheat technologies practiced by farmers in the study area; it also determined the core factors affecting farmers' decision to adopt wheat technologies in the study area, and finally, it also estimated the level/ extent of adoption of improved wheat technologies by smallholder farmers in the study area.

METHODOLOGY

Study Area Description

The study was conducted in Gedeb and chorizo districts, Gedeo zone. South Ethiopia. Gedeo Zone, located in southern Ethiopia, is traditionally known for its coffee-enset-based mixed farming system, but in recent years, it has increasingly expanded into wheat cultivation through the government's national wheat self-sufficiency and irrigation expansion initiatives (MoA, 2024; CSA, 2023). Districts such as Gedeb and Choriso have shown notable engagement in the adoption of improved wheat varieties, inorganic fertilizers, and cluster-based farming approaches promoted by the Ministry of Agriculture (Gedeo Zone Agriculture Office, 2023). The area's mid- to high-altitude agro-ecological conditions, with reliable rainfall and fertile soils, provide favorable environments for wheat, maize, barley, and other cereals, alongside traditional perennial crops like coffee and enset (Tadesse et al., 2022; Birhanu et al., 2021). Nevertheless, technology adoption remains uneven due to differences in input access, extension support, and resource endowment across farming households (Nigatu et al., 2023).

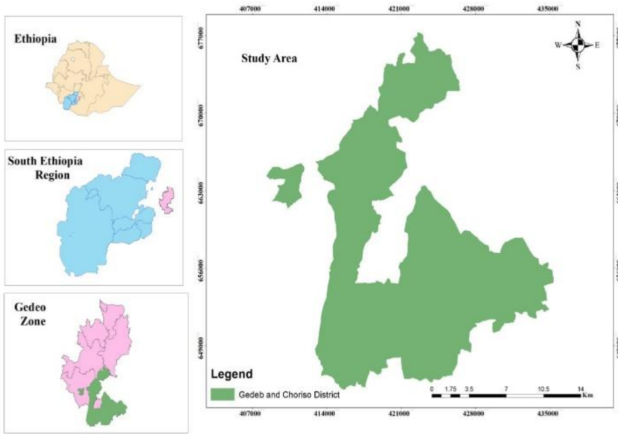

Figure 1. Study area map

Data type, Data sources and Data Collection Methods

Both qualitative and quantitative data were collected from primary and secondary data sources. Primary data on seed type, sowing method, type of fertilizer used and/or rate of application were collected from smallholder wheat producers through household survey. Moreover, the major challenges related to the technology and farmers feedback were collected through Key-Informant interview and Focus Group Discussion. In addition, the secondary data was also collected from various sources such as, past published papers, reports, agriculture offices in order to support and strengthen the results.

Sampling Technique and Sample size determination

Multistage sampling procedure was used to select the representative sample from the study Zone. In the first stage, two districts (Gedeb and Choriso) were purposively selected based on their wheat production potential and being FSRP project sites from the Gedeo zone. In second stage, a total of four (4) kebeles, two kebeles from each district was selected according to simple random sampling. Finally, 150 HHs (78 non-adopters and 72 adopters) were randomly selected from four kebeles through simple random sampling with sample proportional to the size of population in the kebele. The sample size was determined using sample design developed by Yemane (1967);

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

Where; n is the number of sample household selected which 150 households; N is the total number of wheat producers in the study districts (568), e is the margin of errors usually from 5 to 10%. During the sampling, the study area has similar, agro ecology, farming characteristics and also almost similar kind of adoption behavior in intra households.

Data Analysis

Both descriptive and econometric analyses were used for this study. The descriptive data analysis used include, mean, standard deviation, percentage and frequency. The test-statistics like t-test, chi2 were also used. In addition, the other qualitative data were further analyzed using five stage likert-scale analysis. The Econometric analysis was carried out to analyze the adoption and intensity of adoption scenario. To quantify the extent to which farmers have adopted the improved wheat technologies, including variety, sowing method, recommended fertilizer rate, the technology adoption index was calculated (Siyum et al., 2022). Thus two limits Tobit model was employed to handle the adoption decision and intensity of utilization (technology).

$$AI = \sum \frac{\left[\frac{LIw}{TLW}+\frac{NFA}{RNF}+\frac{URA}{RUF}+\frac{ARW}{TAW}\right]}{NP} \quad (2)$$

Where, AI is an Adoption Index, for technology utilized by the ith household.

LIw =is the actual land where improved wheat is sowed/planted by ith farmer.

TLW= is the total land allocated for wheat production by the ith farmer.

NFA = the amount of NPS fertilizer applied by the ith farmer for wheat crop during the survey season (100 kg/ha).

RNF=recommended rate of NPS fertilizer for wheat (100 kg/ha)

URA= Actual amount of urea fertilizer applied on wheat crop in the study area by ith farmer.

RUF= recommended rate of urea fertilizer to be applied for wheat (100kg/ha).

ARW= the land area under row planting of wheat in hectare.

TAW= Total area of land under row planting and broadcasting for wheat in hectare.

NP = Total number of technology practices used by ith farmer.

RESULTS AND DISCUSSIONS

Table 1 shows that there is no variation across districts regardless of adopting improved wheat varieties indicated by chi-square (chi2=0.234) test of association. Table 1 shows, the relationship between improved variety adoption with respect to sowing method, showed that the existence of positive association between sowing method and wheat seed/variety adoption (chi2=55.76).

Table 1. Characteristics of Wheat variety adoption across districts

Districts	Kebeles	Non-adopter (local variety)	Adopter (Improved)	Overall	chi2
Gedeb	Gubeta	5	23	28	0.234
	Galcha	32	14	46	
Choriso	Gora dibadibe	13	22	35	
	Kedida Gubeta	28	13	41	
	Total	78	72	150	

Table 2. Association of wheat seed adoption with (sowing method).

Sowing Methods	Seed adoption category			chi2
	Non-adopter (N=78)	Adopter (N=72)	Overall (N=150)	
Row	(32.05) 25	(91.67) 66	(60.67) 91	55.76***
broadcasting	(67.95) 53	(8.33) 6	(39.33) 59	

NB: numbers inside the brackets are %, and outside the bracket are frequency distributions.

Table 3. The proportion of different inorganic fertilizers and chemicals based on adoption of wheat technology.

Technologies	User HH		Non-user HH		Rate of application (kgha-1)	
	Freq.	%	Freq.	%	User (N=112)	Total Average N=150
NPS fertilizer	112	74.67	38	25.33	54.29	40.53
Urea fertilizer	99	66	51	34	49.54	32.7
Chemicals	60	40	90	60		

Own result (2025).

Table 4. Distribution of HH by wheat Technology adoption intensity.

Category	Frequency	%	Adoption index (AI)	Overall Mean	SD
Non-adopter	30	20	0.00	0.407	0.308
Low	52	34.67	0.01-0.33		
Medium	20	13.3	0.034-0.66		
High	48	32	0.67-1.00		
Total	150	100	0.00-1.00		

Out of the total lands allocated for wheat, 20% had an adoption index (AI) of zero (0) implying that non-adopters of the technology (improved seed, fertilizer, sowing method, and agro chemicals), whereas low adoption rate (34.67%), medium (13.3%) and high (32%) rate of adoption according to their distributions. Wheat farming households in the study area on average has an adoption rate (AI) of 0.407 with the standard deviation of 0.0308 respectively.

The mean age of household head in sample HH in the study districts; Gedeb and Choriso were (43.12); similarly. The sample HH accounted an average Education level of household head is (7.06), Family size in the household head in the adult equivalent is (6.45), Total Livestock Unit of household head (TLU**)** (3.05), Total land holding of household head in (ha) (1.47), and the land accompanied by wheat crop alone (ha) 0.42, respectively with the mean production experiences of over ten years.

Factors affecting adoption decision: Two limit Tobit

There are different variables that were hypothesized and would affect the adoption decision of wheat technologies (Table 6) among smallholder farmers.

Interpretation of Model Results

The adoption of improved wheat technology was affected TLU, the frequency of extension contact, credit access and land allocated for wheat. Farmers with more livestock assets are more likely to adopt wheat technologies. Livestock may serve as a proxy for wealth or risk-buffering capacity, enabling farmers to invest in new technologies. Thus, one unit increase in the livestock holding in (TLU), the probability of decision to utilize wheat technology increase by a factor of 16.59% at 5% significant level citrus-paribus. Moreover, farmers with larger livestock holdings not only adopt but also adopt more intensively. Livestock holdings likely strengthen capital availability and reduce risk perception, allowing broader application of technologies. Extension contact (frequency) is another variable affecting the adoption decision positively. This shows the importance of access to information, guidance, and demonstrations in reducing uncertainty and encouraging adoption. Thus, as the frequency of extension contact of household increase by 1 unit, there is a probability of adopting wheat technology by the factor of 37.63% holding other variables constant. Similar to the decision stage, extension services enhance not only the probability but also the depth/intensity of adoption. Farmers with frequent extension interaction tend to apply technologies more comprehensively.

Land allocated for wheat positively affected adoption decision: Farmers with larger wheat plots are more likely to adopt wheat technologies. This suggests that farmers who are more commercially oriented or specialized in wheat production have stronger incentives to adopt improved practices. Furthermore, larger wheat plot size enables farmers to adopt wheat 9 technologies more intensively. Scale of production and expected returns motivate further adoption. Accesses to credit affect the adoption negatively: This might be due to that credit taken has been diverted to non-agricultural purposes (e.g., consumption, social obligations, or other investments), or that credit access was associated with risk-averse households who prioritize security over experimentation with new technologies. In line with this, credit service and its affordability to farmers are also not available on time. The result is consistent with that of Lemecha, (2023) Distance to all weather roads has negatively affected the level of wheat technology adoption in the study area. Farmers living farther from reliable roads adopt less intensively. Poor infrastructure increases transaction costs, reduces market access, and creates input/output delivery challenges, discouraging intensive adoption.

Table 5. Socioeconomic, demographic and institutional characteristics of sample households.

Household characteristics	Mean	SD
Age of household head	44	11.455
Education level of HH in Years	7.1	3.91
Family size of HH	6.85	2.47
Total land holding in ha	.67	.575
Years of experience in input use	19.58	9.56
Average annual income (ETB)	14825.9	14008.57
Distance to FTC	15.51	11.71
Distance to market center (Min)	38.09	29.14
Distance to All weather road(Min)	14.22	12.36
Distance to health center (Min)	27.545	26.05

Table 6. Model result for probit and two limit Tobit.

Variables	Coef.	Std.err	Dy/dx/Coef.	Std. Err.	t	P>t
Sex of household head	.47556	.32849	-.1356455***	.0273	-4.97	0.000
Age of household head	-.02136	.01766	- .0030359	. 00269	-1.128	0.177
Education level (years of school)	.0483765	.041935	.007541	.0055	1.367	0.123
Family size (adult equivalent)	.07898	.0700434	.0058895	.0104	1.057	0.571
Total livestock Unit (TLU)	.1659221**	.0759792	.0224506**	.0109	2.07	0.040
Wheat farming experience (yrs)	.0297281	.0232613	.0035211	. 00332	1.06	0.291
Wheat marketing price (ETB)	.000213	.000147	.0000813***	.0000226	3.60	0.000
Extension contact (Freq contact)	.37632***	.131614	.0672369***	.01697	3.96	0.000
Membership in cooperative	.406299	.35869	.0430883	.0365	1.18	0.154
Credit received (yes= received)	-1.0870*	.58520	-.0843431	.1069	-0.79	0.432
Distance wheat market (walk minute)	-.0088523	.00814	-.0000789	.001476	-0.05	0.957
Distance to weather road (minute)	-.00385	.002143	-.0029279**	.00136	-2.15	0.033
Log annual income (ETB)	-.053519	.073149	.0296767	.0221	0.74	0.459
Wheat plot/land (ha)	2.3343**	.99515	.41108***	.08355	4.92	0.000
Constant	-1.3727	1.2778	-.3739	.22848	-1.64	0.104

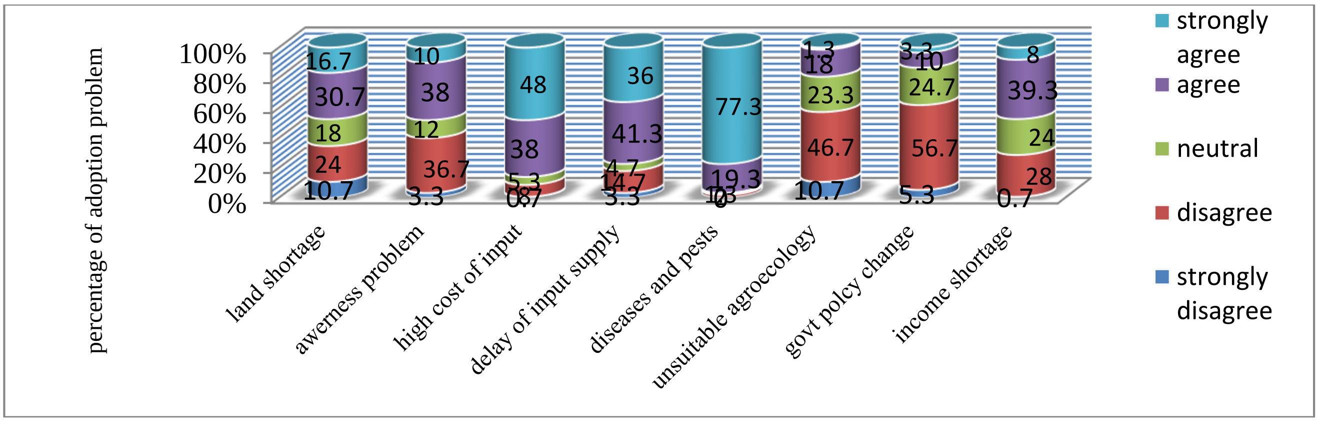

Figure 2. Perceptions on constraints hindering wheat technology adoption.

Test of reliability (Cronbach alpha =0.74) indicating the data have consistency and validity checked eight(8) characteristics were gone through evaluation whether they are bitterly hindering adoption of wheat technology or not; thus, diseases & pests(77.3%), high cost of input (48%), delay of input supply (36%) perceived the most serious challenges

CONCLUSIONS AND RECOMMENDATIONS

This study was conducted in Gedeb and Choriso districts of Gedeo Zone South Ethiopia region, where the Food System Resilience Program (FSRP) was implementing. The districts have a potential in producing wheat crop based on the baseline need assessments; However, the influential factors of adopting the production boosting technologies and the intensity of utilization of wheat technologies in area was not addressed well. Thus, this study was primarily designed to meet three objectives. First, to identify, major factors of adoption decision at household level, second, to estimate the level of adoption of wheat technology, and third to collect the perceptions of farmers on problems related to major wheat production technologies. Both primary and secondary data were utilized to address the objectives. The primary data was collected from a total of 150 sample households (78 non-adopters and 72 adopters) using structured and pre-tested questionnaire. The multistage purposive sampling was employed to select the representative sample households. Secondary data were collected from district agriculture offices, peer reviewed journal articles, reports and other data sources. A probit model was used to identify factors influencing the adoption decision, while a Tobit model was used to examine the level of adoption. The results reveal that Total Livestock Unit (TLU), frequency of extension contact, and area allocated for wheat positively and significantly affect the adoption decision, whereas access to credit negatively influences the likelihood of adoption. Similarly, the intensity of adoption is positively influenced by TLU, wheat market price, and extension contact, while it is negatively affected by the sex of household head and distance to the nearest market center. The findings underscore there need to improving extension services, market access, and institutional support to enhance wheat technology uptake and productivity in the study area.

REFERENCES

Abate, T.W., 2024. Analysis of agricultural technology adoption: the use of improved maize seeds and its determinants in Ethiopia, evidence from Eastern Amhara. J. Innov. Entrep. 13, 61.

Anteneh, A., Asrat, D., 2020. Wheat production and marketing in Ethiopia: Review study. Cogent Food Agric. 6, 1778893.

Asfaw, S., Di Falco, S., Lipper, L., 2020. Climate variability, adaptation, and agricultural technology adoption: Evidence from Ethiopia. Environ. Dev. 33, 100523.

ATA, 2018. Annual Report. Agricultural Transformation of Ethiopia. https://staging.afchub.org/public/data/annual-report-2018-19.

Ayele, A., Erchafo, T., Bashe, A., Tesfayohannes, S., 2021. Value chain analysis of wheat in Duna district, Hadiya zone, Southern Ethiopia. Heliyon 7, 7.

Birhanu, A., Tadesse, M., Worku, T., 2021. Characterization of mixed farming systems and crop diversification in southern Ethiopia. J. Agric. Environ. Int. Dev. 13, 223–232.

Bule, H., Tsegaye, D., 2020. Farming systems and land use in Gedeo Zone, Southern Ethiopia. J. Agric. Environ. Int. Dev. 114, 5–22.

CSA, 2022. Agricultural Sample Survey 2021/22: Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Central Statistical Agency (CSA) Addis Ababa: CSA.

CSA, 2023. Population Projection of Ethiopia for All Regions at Zonal and Woreda Level. Central Statistical Agency (CSA) of Ethiopia. Addis Ababa: CSA.

Gebremariam, G., Teklewold, H., Abebe, G.K., 2021. Adoption and impacts of improved wheat varieties in the Ethiopian highlands. Agric. Syst. 190, 103126.

Gedeo Zone Agriculture Office, 2023. Annual Agricultural Performance Report, 2022/23 Production Year. Dilla, Ethiopia.

Katengeza, S. P., Holden, S., Lunduka, R., 2022. Adoption of inorganic fertilizer among smallholder maize farmers in Malawi: Insights from panel data. Food Policy 108, 102233

Kebede, D., Ketema, M., Dechassa, N., Hundessa, F., 2017. Determinants of adoption of wheat production technology package by smallholder farmers: Evidences from eastern Ethiopia. Turkish J. Agric. Sci. Technol. 5, 267–274.

Lemecha, M.E., 2023. Credit constraint and agricultural technology adoptions: evidence from Ethiopia. Agric. Financ. Rev. 83, 395–415.

MoA, 2024. National Wheat Development and Expansion Strategy (2024–2030). Ministry of Agriculture, Addis Ababa, Ethiopia.

Nigatu, L., Tessema, Y., Belay, A., 2023. Drivers and constraints of improved teff variety and fertilizer adoption among Ethiopian smallholders. Heliyon 9, e15587.

Rogers, E. M., 2003. Diffusion of Innovations (5th ed.). Free Press.

Siyum, N., Giziew, A., Abebe, A., 2022. Factors influencing adoption of improved bread wheat technologies in Ethiopia: empirical evidence from Meket district. Heliyon 8, 2.

SNNPR, 2023. Southern Nations, Nationalities and Peoples' Region (SNNPR) Bureau of Agriculture (2023), Annual Agricultural Performance Report 2022/23 Hawassa: SNNPR BoA.

Tadesse, B., Abate, T., Gebremedhin, H., 2022. Agro-ecological characteristics and crop production trends in southern Ethiopia. African J. Agric. Res. 18, 45–56.

Ullah, R., Shivakoti, G. P., Ali, G., 2022. Determinants of multiple agricultural technology adoption in South Asia: Evidence from Pakistan and Nepal. Technol. Soc. 70, 102032.