THE IRRIGATION WHEAT INITIATIVE FOR WHEAT POLICY AND SUSTAINABLE DEVELOPMENT IN ETHIOPIA

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Summary

Wheat remains an essential food crop globally, including Ethiopia, although production has to face many challenges. Where domestic production lags demand, wheat farming guarantees food security and promotes economic development in Ethiopia. Due to limited precipitation, irrigation is an essential component of wheat production in the country. The Ethiopian government started structural, economic, and sectoral changes in 2019, designating wheat as a strategic commodity to promote agro-industry, lower imports, turn toward exports, and create jobs across the value chain. Ethiopia's wheat production in 2022/23 exceeded 7.2 million metric tons, a 23%–27% (1.3–1.5 million) increase in the area cultivated over more than 2.3 million hectares, 15%–18% (0.3–0.4 million) increase in productivity, and estimated 3.0 metric tons per hectare. Even with these advances, the full potential has not yet been realized since irrigation development has not been applied to its best advantage. This study explores the current situation regarding irrigated wheat production, based on a thorough survey of the relevant literature and on secondary data evaluated by descriptive statistical methods. Results suggest, that improving smallholder farmers' output through irrigation, increased technical knowledge, changes in governmental frameworks, and investments in irrigation infrastructure can contribute to self-sufficiency of the country under current and future climate change conditions.

Keywords: *wheat self-sufficiency, irrigation, Ethiopia*

JEL: *Q15, Q18, Q01*

Introduction

Wheat serves as a crucial staple food crop, consumed by more than 2.5 billion individuals globally (Bentley et al., 2022). It constitutes 35% of the global food supply and contributes 20% of the total caloric intake (Reynolds et al., 2012). Wheat is cultivated at around 217 million hectares, making it the most extensively grown crop, with an annual production of 752 million tons, with China, India, and Russia accounting for 41% of the output. Wheat is ranked 49th in global commerce at $73.3 billion, with the exports rising 13.6% to $73.3billion between 2021 and 2022, which accounts for 0.31% of global trade (OEC, 2022). Wheat accounts for more than 40% of the global cereals trade by value or weight, but it does not account for 25% of total production globally (USDA, 2025). Global wheat production must rise to accommodate the expanding global population, estimated to reach 9.8 billion by 2050, necessitating a 50–60% increase in food supply to satisfy the additional demand (Falcon et al., 2022). Many African countries produce wheat for both consumption and commercialization, though production and market levels vary significantly across regions with an estimated 25 million tons of wheat annually on 10 million hectares, accounting for 8% of the continent's cereal-growing area (FAO, 2022b; Grote et al., 2021). In Sub-Saharan Africa, wheat is a strategic commodity that contributes to farm income and enhances food security (Tidiane Sall et al., 2019). The major initiative of the Sustainable Development Goals (SDGs), with the foremost two global goals of ending poverty in all its forms and achieving zero hunger, poses significant challenges for developing nations, particularly in Sub-Saharan Africa (SSA) including Ethiopia, one signatory of SDGs, challenging the major bottlenecks that have put the population at risk, leading

to unending dependency on foreign food aid for survival. An estimated 24% of the Ethiopian population lives below the poverty line, while 12.8 to 15 million individuals experience chronic hunger and require urgent aid with food yearly (National Disaster Risk Management Commission and UNOCHA, 2020). Furthermore, the prevalence of stunting among children under five reaches as high as 37% (WB, 2020).

Ethiopia is the largest wheat producer with about 65% share of the total wheat production in Sub-Saharan Africa, but still fails to meet domestic demands, with the annual production of approximately 7.5 million metric tons accounting for about 75% of domestic wheat consumption. It produces 21.7% of Africa's wheat output and contains 18.3% of the continent's harvested wheat area (FAOSTAT, 2024). The area under wheat increased from about 1.5 million hectares in 2010 to 2.5 million hectares, and it ranks fourth after teff, maize, and sorghum, with maize being the most widely cultivated cereal crop in terms of grain area coverage and grain production (USDA, 2024). Wheat comprises about 12.2% of the harvested area, 20.2% of overall production, and productivity increased from 1.8 tons per hectare to about 3 tons per hectare from 2010 to 2023, implying an increase of about 5% per annum in productivity, and provides employment for 4.9 million subsistence smallholder farmers. Regionally, the largest volume of wheat originates from Oromia, contributing around 53% of the wheat area and 57–58% of national output of the country (see Figure 1), followed by Amhara, accounting for 34% of the wheat area and 28–32% of production, followed by the SNNP region with 8% of the wheat area and 8% of production, and Tigray representing 5% of the wheat area and 3–6% of production (CSA, 2022). As a result, this region serves as a model for learning areas to improve the best practices of cluster farming priority areas and ten high-value commodities, with the goal of commercializing smallholder-dominated agricultural production in Ethiopia. The government has implemented a number of development interventions aimed at increasing productivity and fostering agricultural commercialization through vertical and horizontal linkages with value chain actors (Louhichi et al., 2019).

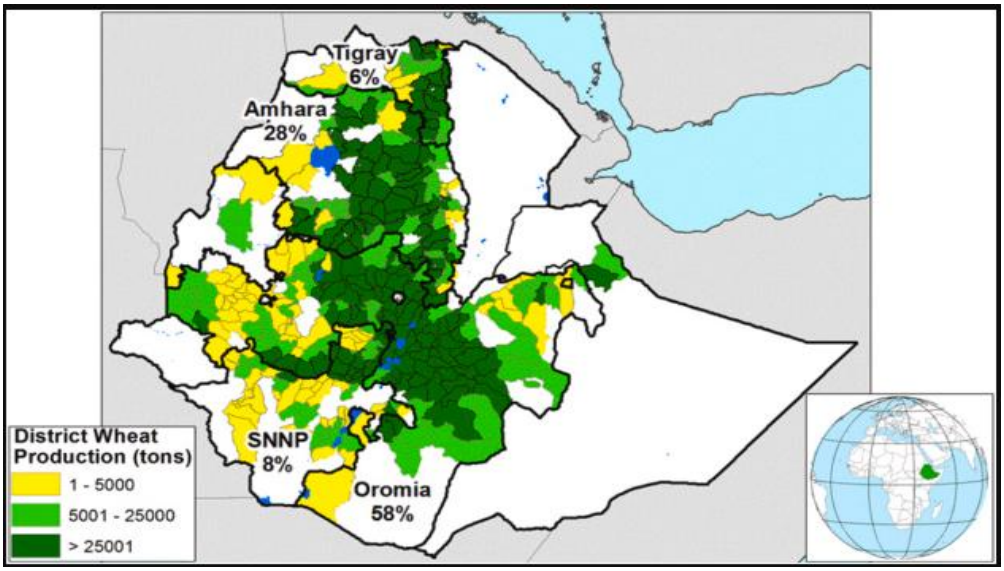

Figure 1. Average wheat produced in major wheat producing regions and districts of Ethiopia

Source: Adapted from Effa et al. (2023)

This cluster-based approach enhances productivity by transforming subsistence farming into a market-oriented system, and improving agricultural productivity is a key strategy for alleviating chronic poverty (Otsuka & Ali, 2020). Then, both irrigated and rain-fed agriculture are vital to Ethiopia's economy, while expanding irrigation is essential for poverty reduction, food security, and sustainable development. Given Ethiopia's reliance on wheat imports, increasing irrigated wheat production, particularly in arid and semi-arid regions, is crucial. This paper examines wheat production trends, and irrigation wheat initiatives for the sustainable development of Ethiopia.

Even though, it has a lot of potential, switching to irrigated wheat is hard, because of multiple shocks of varying magnitude and nature, including internal conflicts, the COVID-19 pandemic, climate shocks , overexploiting of foreign currency, and the impact of the Russia-Ukraine crisis (de Siqueira et al., 2022). Adverse natural conditions, such as harsh weather and extreme temperatures, soil salinity in the lowland part of irrigation, water quality, and bird damage are worse in irrigated systems, which creates even more problems, making farming less sustainable and creating social and economic problems. At the same time, the rise in pests and diseases, driven by global trade and climate change, has led to significant yield losses, emphasizing the need for resilient agricultural practices (Bebber et al., 2014). Land degradation affects 33% of the world's agricultural land, reducing its capacity for wheat cultivation (FAO, 2022a). Climate change further complicates wheat production, with rising temperatures, shifting precipitation patterns, and more frequent extreme weather events posing major threats (Asseng et al., 2015). Hence, a 2°C global temperature increase could reduce wheat yields by up to 25% in some regions, with a projected 6% decline in global wheat production for every additional degree of warming. The frequent occurrence of droughts, particularly in arid and semi-arid regions, presents a severe challenge to crop development (Lobell et al., 2011). This study synthesizes existing research, FAOSTAT data, policy frameworks, and practical experiences to provide actionable recommendations for researchers, policymakers, and development practitioners engaged in agricultural transformation, and ultimately, it also seeks to investigate ways how Ethiopia can achieve food security and self-sufficiency through innovative agricultural practices relying on the irrigation wheat initiative.

Material and method

The dataset used in this study was generated from two sources. A comprehensive desk review of available literature on relevant policies, resource assessment reports, and other relevant sources generated the first dataset.

The second dataset was generated from the wheat field data recorded by the Central Statistics Authority (CSA), FAOSTAT, World Bank, United States Department of Agriculture (USDA), Ethiopian Institute of Agricultural Research (EIAR), the Regional Bureau of Agriculture, the Ministry of Agriculture (MOA), and the Ethiopian Agricultural Transformation Institute/Agency (ATI).

The analysis of the surveyed literature and the collected data was done using the MS-EXCEL program, presenting time trends and simple statistical averages.

Results

Trends in Wheat Production and Initiatives for Irrigated Wheat Farming

Modern irrigation in Ethiopia began in the 1950s in the Awash River Basin, part of the Rift Valley, courtesy to a collaboration with a Dutch company, primarily for commercial crops like sugarcane and cotton. As it is presented in Figure 2, in the production and marketing year of 2022/23, Ethiopia's wheat production went over 7.2 million metric tons, which is an increase of 23%–27% (1.3–1.5 million metric tons), in the area cultivated over more than 2.3 million hectares, 15%-18% (0.3-0.4 million) increase, and productivity (6%-8%) with an estimated 3.0 metric tons per hectare (Ababa, 2023; ATA, 2022), on consumption rate rising by 9% annually, while local production grows at only 7.8%, leading to a supply-demand gap (Muchie, 2022), these gains are attributed to favorable rainfall distribution in the highlands and the expanded use of irrigation in wheat-producing regions.

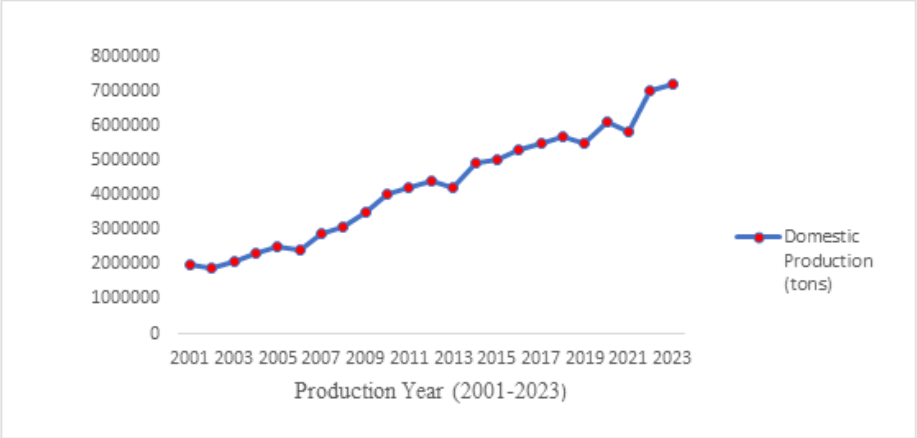

Figure 2. Trend of Ethiopia Wheat Production (2001-2023)

Source: Author's own construction

Expanding irrigable land for wheat farming could greatly increase production, so positioning Ethiopia as a strong competitor among African wheat-producing countries (Anteneh & Asrat, 2020), along with initiatives by regional states and nongovernmental organizations, the development policies of the country are emphasizing promoting small-scale irrigation schemes to enhance and stabilize food production (Abdissa et al., 2017).

Wheat varieties used in the irrigated wheat system

Ethiopia's irrigated wheat system utilizes various wheat types suited to distinct agro-ecological zones, and these arise from the hybridization of introduced exotic material and from regional landraces. The indigenous and local wheat varieties have primarily been created through hybridization of invasive exotic material obtained from the Consultative Group for International Agricultural Research (CGIAR) and were utilized in the current irrigated wheat program (CIMMYT & EIAR, 2023). The wheat breeding program within the National Agricultural Research System prioritizes essential qualities, while also considering supplementary features for selecting, developing, and dis-

seminating stable, high-yielding advanced lines characterized by robust pest resistance, stress tolerance, and superior-quality early-generation seeds through various strategies and breeding techniques.

According to (CIMMYT & EIAR, 2023) Ethiopia's irrigated wheat system based on their suitability for specific agro-ecological zones and their ability to withstand biotic and abiotic stresses wheat varieties like; Kingbird: piloted testing variety in Ethiopia's lowlands has produced encouraging outcomes, including as enhanced yield, greater farmer income, and rust resistance, and generates increased yields. Danda'a: contemporary variety developed by the Ethiopian Institute of Agricultural Research (EIAR) and CIMMYT, it has strong adaptability to high temperatures and stressful situations. Wane, Bulala, Daka, and Fetan are traditional drum and bread wheat types cultivated by farmers in the Amhara Region, affiliated with the Africa RISING project, while Abay, Hidase, Boru, and Dursa are modern varieties developed by EIAR and CIMMYT, recognized for their high yield and stress resilience.

Governance Structure and Institutional Arrangements of the Irrigated Wheat Initiative in Ethiopia

The Ethiopian irrigated wheat initiative was initially developed by the Ethiopian Institute of Agricultural Research (EIAR) and subsequently came under the purview of the Ministry of Agriculture (MoA) and on the behalf of Office of the Prime Minister. The MoA designated the EIAR as the coordinating body for the project, tasked with providing comprehensive oversight and technical support to ensure effective execution, and delegated responsibilities for the initiative to the regional states, which play vital roles in its implementation. To facilitate coordination across various regions, the Regional Bureau of Agriculture established and managed several institutions, including universities, regional seed enterprises, cooperatives and unions, zonal agricultural development offices, and regional research institutes (Figure 3).

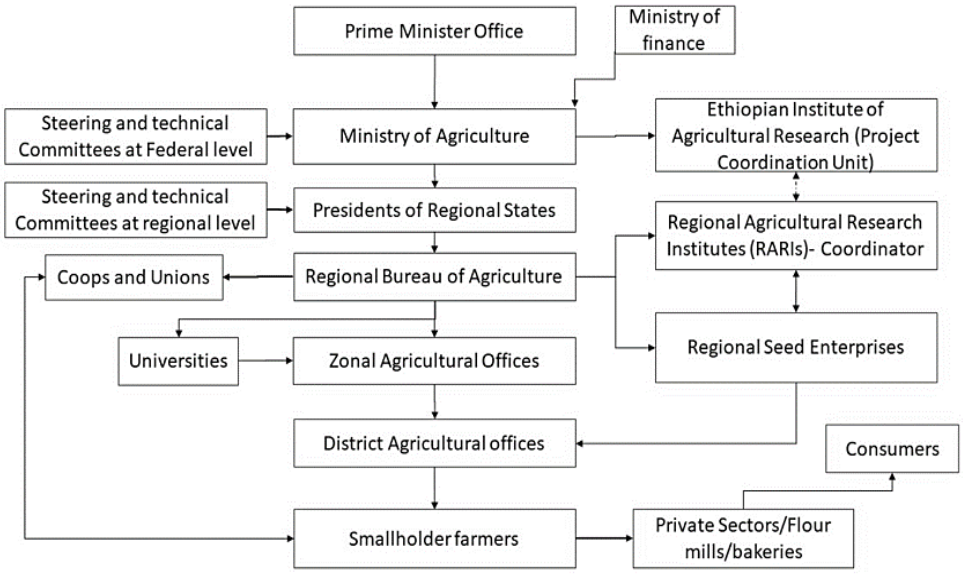

Figure 3. Institutional roles in the irrigated wheat irrigated wheat initiative of Ethiopia
Source: Adapted from Effa et al. (2023)

Every sector assigned specific responsibilities within the initiative, for pursuit of green legacy of economic, social, developmental and environmentally sustainable development, homegrown economy, and indicating that the country is achieving not only wheat security but also championing the possibility of replicating the new paradigm of Asia's Green Revolution in Africa for local solutions, and its irrigated wheat initiative has become a key national priority.

Irrigation potential used in the irrigated wheat system of Ethiopia

According to Rena-Ramos et al. (2022) freshwater is a crucial global resource especially in Sub-Saharan Africa, sometimes giving rise to disputes between nations instead of cooperative development. A key transboundary water conflict involves Ethiopia, Egypt, and Sudan over the Grand Ethiopian Renaissance Dam (GERD) on the Nile River, and after failed hydro diplomacy negotiations, the United Nations Security Council (UNSC) addressed GERD for the first time. This dispute results from ancient agreements between Egypt, Sudan, and the British colonial government, excluding Ethiopia, even though Ethiopia provides around 86% of the Nile's water. The Sustainable Development Goal (SDG) 6 supports sustainable water management, cross-border cooperation, and mitigating water scarcity, therefore global attention is today on fair water utilization in irrigation, as this greatly increases crop yields by reducing soil moisture limitations (Van Ittersum et al., 2016). Even if, irrigation is vital in Ethiopia, where smallholder farming prevails and droughts endanger food security, in spite of the investments and policy support, only 5% of cultivated land is irrigated and largely rainfed, with only 0.3% of meher (the main season in Ethiopia, from May to September) and 10% of belg (the shorter season from February to April) wheat was cultivated using irrigation in 2021/2022 (CSA, 2021/22). From rivers to groundwater to rainfall collecting, Ethiopia boasts around 5 million irrigable hectares, 4 million from rivers, 1 million from groundwater, and 0.5 million from rainwater harvesting (Awulachew, 2019), and even though only 4–5% of its potential has been used, small-scale irrigation accounts for 46% of expected increase (UNEC, 2020). If fully completed, irrigation may generate ETB 140 billion ($2.8 billion) value yearly, therefore ensuring food for six million homes and benefiting thirty million people (Awulachew, 2019).

Ethiopia spans 112 million hectares, with 34% of its land cultivable (Awulachew et al., 2010). Currently, 15.08 million hectares are under cultivation, but irrigated land remains limited at 4–5%, with 640,000 hectares equipped for irrigation (Awulachew et al., 2010; CSA, 2020). Irrigation coverage doubled over the last ten years to reach 1.3 million hectares, therefore increasing the irrigated land share to 8%. Ethiopia set aside 1.79 million hectares for wheat output in 2019–2020, although just 3,773 hectares were irrigated (CSA, 2020). However, with the new irrigated wheat initiative, this figure has surged around 2.4 million hectares covered by wheat production, significantly expanding irrigated wheat cultivation, even if the estimated size of land under cultivation varies in the relevant literature (CSA, 2022).

Despite Ethiopia's abundant water resources and significant rainfall, irrigation use remains low due to inadequate storage facilities and uneven rainfall distribution. Most rivers are seasonal, with 70% of total flow occurring between June and September, while only 30% flows during the dry months, largely from springs (Awulachew et al., 2010), therefore, without enhanced water storage and irrigation infrastructure, Ethiopia remains vulnerable to drought, limiting agricultural productivity and increasing food insecurity (FAO, 2016).

Hence, Ethiopia's water resources are distributed across four major basins: the first basin, the northern and central Nile Basin (33%), drains westward into Sudan, Egypt, and the Mediterranean Sea via the Abay (Blue Nile), Baro-Akobo, Setit-Tekeze (Atbara), and Mereb rivers; secondly, the

Rift Valley Basin (28%) Awash, Denakil, Omo-Gibe, and Central Lakes create a succession of interior basins from Djibouti to Tanzania, with about half in Ethiopia; thirdly, Wabi-Shebelle and Genale-Dawa rivers drain the southeastern mountains into Somalia and the Indian Ocean in the Shebelli-Juba Basin (33%); finally the North-East Coast Basin (6%) includes the Ogaden and Gulf of Aden, so these basins demonstrate Ethiopia's complex hydrological geography and the necessity for efficient water management and irrigation (Table1).

Table 1. Irrigation potential of Ethiopia by river basins

River basins	Catchment area (km^2)	Irrigation potentials (ha)			
		Small scale	Medium scale	Large scale	Total
Abbay	199,890.7	45,856	130,395	639,330	815,581
Awash	112,696	198,632	–	139,627	338,259
Baro-Akobo	75,912				
Denakil/Afar	74,002	2309	45,656	110,811	158,776
Genale-Dawa	171,042	1805	28,415	1,044,500	1,074,720
Mereb Gash	5900				
Omo-Gibe	79,000		10,028	57,900	67,928
Rift Valley	52,739		4000	45,700	49,700
Tekeze	82,350			83,368	83,368
Wabishebele	202,697	10,755.00	55,950	171,200	237,905
Ayisha (Gulf of Aden)	2223	*			
Ogaden	77,121	*			
Total	1,135,572.7	259,357	274,444	2,292,436	2,826,237.00

Source: Author's construction based on Awulachew et al. (2007) and Berhanu et al. (2014)

Irrigated Wheat Initiative in Ethiopia and Sustainable Development

The Ministry of Agriculture (MoA) conducted lowland irrigated wheat trials along the Awash River Basin in Afar, Ethiopia, to assess the feasibility of wheat cultivation in pastoral and agro-pastoral systems; previously, wheat was never grown in Ethiopia's lowlands, despite vast arable land. At the same time, the Ethiopian Institute of Agricultural Research (EIAR) conducted tests to see if growing wheat with irrigation is practical, find the best wheat types for lowland areas, and gather basic information for future growth. The main results of these tests are summarized in Table 2. Therefore, between 2012/13 and 2019/20, the trial expanded from 1 hectare to 12,500 hectares, with productivity ranging from 2.9 to 4.128 tons per hectare, resulting in a total wheat production increase from 2.9 to 51,600 tons (EIAR, 2020).

The trials indicated that irrigated wheat cultivation was feasible and 33–50% more productive than rain-fed systems (EIAR, 2020). In 2019/20, the project refocused on its natural niche mid-

and highland ecologies, with Oromia region as its nearby for the project, and future extensions will exploit Tigray region, Amhara region, Afar, and Somali Regional States eastern and southwestern lowland surplus water. Hence reliance on wheat imports, ensuring greater self-sufficiency and stabilizing food supply chains, and expanding irrigated wheat farming in mid and highland ecologies, with each corner of the countries, contributes to climate resilience by reducing dependency on erratic rainfall, and simultaneously enhancing food security by rural livelihoods which is particularly SDG 2 (Zero Hunger) and SDG 1 (No Poverty) (MoA, 2020). Furthermore, it creates employment opportunities in rural areas and promotes sustainable agricultural practices. Despite initial challenges in lowland pastoral areas, the program's expansion into water-surplus regions aims to optimize water use and enhance agricultural efficiency (FAO, 2022a) with continued investment in irrigation infrastructure and technology, Ethiopia can further strengthen food security, reduce poverty, and drive economic growth, making significant progress toward achieving the SDGs by 2030.

One of the irrigated wheat initiative's disadvantages is a lack of uniformity and/or unavailability of trustworthy data, which is ascribed to the absence of a well-organized data gathering system and a centralized database platform (EIAR, 2022). The success of the initiative can be attributed to several key factors: sustained input supply, cluster farming, and intensive farmer training conducted by experts and variety trials have identified suitable wheat varieties for various agro-ecological zones, to satisfy national wheat demand and attain surplus production for export purposes, while strong policy support and government commitment have reinforced the initiative, ensuring its long-term impact on food security and economic growth.

Table 2. National irrigated wheat field trial results of Ethiopia

Year	Area cultivated (ha)	Area harvested (ha)	Production (ton)	Productivity (ton/ha)
2019/20	18,498	17,398	40,836.71	41.28
2020/21	187,525	172,387.4	704,422.14	41.18
2021/22	709,735.5	674,626.5	2,525,110.9	37.43
Overall average	39.96			

Source: EIAR (2020)

Implications and recommendations

Driven by population growth, changing dietary requirements, and increasing incomes, meeting the growing demand for wheat requires a significant increase in production. Ethiopia has shown remarkable improvement in input acquisition, land expansion, and wheat output during the last two decades; to realize this review, the government's initiative to bridge the wheat gap by area expansion, providing input of production, and irrigation development is a crucial step toward increasing production and achieving self-sufficiency on behalf of achieving the two utmost SDGs of zero hunger and ending poverty with well-implemented strategies and interventions.

Addressing multiple challenges is essential for ensuring long-term success. The timely availability of high-quality inputs, such as enhanced seeds and fertilizers at reasonable prices, remains a significant challenge. Promoting cluster farming, private investment in irrigation systems, and adopting high-yield, drought-tolerant wheat varieties contribute to resource enhancement, technological ad-

vancement, and the empowerment of inclusive, participatory methods while generating employment opportunities. Due to the long-term nature of agricultural investments, the government must implement policies that attract and protect private entrepreneurs involved in wheat production and seed development while ensuring accountability through appropriate regulatory measures.

While the endeavor's "campaign" strategy can bring about temporary success, a change in emphasis could cause the loss of development without unchanged efforts. To ensure long-term livelihood sustainability, governmental and non-governmental organizations and even research institutes should combine the initiative with a slow, step-by-step execution, learning from past events. Mechanization technologies must be prioritized in rainfed and irrigated wheat farming to attain notable production increases and agronomical management packages customized to different production systems and agroecological zones.

This review was based on a review of the amount that exists in research; further ground-based study is required to evaluate the prospects and difficulties of the initiative at the local level. A deeper investigation of how climate change affects irrigated wheat output and possible adaptation techniques is necessary. Local attention should also be given special consideration since Africa's varied climates, methods of agriculture, and socioeconomic systems call for context-specific solutions.

Ethiopia's irrigation wheat task has become a top national priority as its homegrown economic reform seeks to solve local problems with local solutions. Through irrigation and agricultural cluster commercializing, the country's fast moves toward wheat self-sufficiency point to the possibility of recreating Asia's Green Revolution in Africa. Policymakers should thus also take long-term sustainability risks connected with extensive irrigated wheat growing under account. Addressing socioeconomic, political, and cultural dynamics, strategic policy frameworks, climate-smart technologies, loss of crop biodiversity in highland regions, and possible irrigation infrastructure maintenance between upstream and downstream communities, concerns about capacity building and knowledge transfer have been expressed. The government must establish fair irrigation systems, develop guidelines for equitable water distribution, and apply sustainable farming techniques to ensure the irrigated wheat endeavor's resilience to reduce these hazards.

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