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The Ethiopian large scale irrigation wheat, policy and productivity: A case study

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ABSTRACT
Wheat has played a fundamental role in human civilization and has contributed to improving food security at global and regional levels. The launch of irrigation wheat production in Ethiopia is for food security, self sufficiency and exporting goals. The average wheat yield per hectare is lowest in Ethiopia as compared to world country and a productive policy reform will be required. The country's policy efforts were insufficient to increase wheat productivity to further level up with some African and world country averages. The significant differences between the area of wheat production and productivity per hectare have to be minimized. Wheat production and productivity are constrained by pests, diseases, climate variation, and limited access to new information, technical knowledge and agricultural technologies. Therefore, sustainability with surplus production and modernization of farming system with access to new information and recent technologies supported by continued investment is an important consideration.

Keywords: Ethiopia, irrigation, policy, productivity, wheat yield

1. Introduction
Bread wheat (*Triticum aestivum* L.) is an economically important crop due to the high demand for food resources as well as production of the crop in a large-scale including use of irrigation to satisfy the demand has become critical in Ethiopia (Kedir, 2022). Meeting this demand is very challenging and is complicated by factors including climate change, increasing drought/water shortages, soil degradation, reduced fertilizer supply and increasing costs, the emergence of new virulent diseases and pests that attack crops (Tadesse *et al.,* 2016). Among cereal crops, wheat has played a fundamental role in human civilization and has contributed to improving food security at global and regional levels (Kedir and Ahemad, 2017). More than 79 million people in Ethiopia rely on agriculture for their livelihoods (World Bank, 2018), many people in the country are still poor and food insecure. The launch of irrigation wheat production in Ethiopia is for food security, self sufficiency and exporting goals. Such successful transformation is driven by agricultural productivity growth which enables the peoples to shift from agriculture towards manufacturing, and industry, increase per capita income and reduction in poverty and hunger (FAO, 2017). Wheat yield is measured in output per unit of a hectare whereas wheat productivity is defined as output per unit of inputs. Adequate production is the main goal of any government to be able to feed its population (Xu *et al.,* 2014). The average production/yield quantity of wheat in Ethiopia and Egypt was 5.47 and 9 million tonnes in 2020 respectively (FAO, 2021). The average wheat yield potential per hectare is lowest in Ethiopia as compared to world country and a productive policy reform will be required. Therefore, the purpose of this paper was to provide a general overview of wheat policy for wheat yield per hectare, productivity and production.

2. The policy of irrigation Wheat in Ethiopia
Policy making has influenced development in many countries and without proper policies it is rare to achieve intended goals (Chidoko and Makochekanwa, (2018). To intensify production under irrigation cluster based policy on large scale demonstration of irrigated wheat production technologies projected by Ethiopian government. Agricultural policies play a key role in the process of agricultural

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economic growth (Shikur, 2020). Among them, technological change has been acknowledged as the principal driver of productivity growth (OECD, 2012; Michael *et al.,* 2007). The Ethiopian policy efforts were insufficient to increase wheat productivity to further level up with some African and world averages (Shikur, 2022). Agricultural policies of the country heavily reliant on area of irrigated wheat production and it also should have to consider on wheat yield per hectare productivity. The significant differences between the area of wheat production and productivity per hectare have to be minimized. Because of the production impacts are mainly driven by productivity increases. The largest amount of area cultivated is allocated for wheat production which is not a guarantee to reduce the wheat yield gap in Ethiopia (Shikur, 2022). Policy reform in terms of using high-yielding seeds, new production techniques, exposure to new information on technological changes, modern irrigation techniques, environmental protection schemes, crop insurance support, sustainable rural finance system, increased expenditure on rural infrastructures targeting irrigation, storage, and marketing facilities etc. is supposed as the quite consideration.

3. The Era of Ethiopian wheat production under irrigation

In Ethiopia there is five types of evolution era still are there i.e. the hunter gathering era (arrow and bow), Agrarian era (Oxen plow), worker era (Industry), ICT era (Computer), knowledge working era (wisdom). Among those majority of irrigated wheat is cultivated under traditional sector of oxen plow which is difficult to plow the land at dry season and modernization of farming system using different type farm machinery is not well considered. The first large scale irrigated wheat production in Ethiopia started nationally at the low land of east Shawa zone of three districts Fantalle, Boset, and Lume and Arsi zone of three districts Sire/Tibila, Marti and Jeju in October 2019/20 on the total of 3000 hectare land. With the jointly working of two research center i.e. Adami Tulu and Werer Agricultural research center. The two pioneer researchers (Usman Kedir, Urgaya Balcha from Adami Tulu and Adem Kedir, Hailu Mengistu from Werer) participates with responsibility to put down of their research center job and stay on field efforts up to five month follow up, monitoring and management of crop from land preparation to the final harvesting of irrigated wheat crops at each locations. All encouragement of basic seed, two type of fertilizer i.e. NPS and Urea, different type of chemicals, transportation cost of (seed, fertilizer and chemicals) up to farm site, tractor for land preparation at some areas and final harvesting of the crop by combiner at some areas were done freely by direct support of government for farmers. The government of Ethiopia has done a dedicated significant effort and invested significantly in irrigated wheat. The irrigated wheat of those areas is observed by higher governments' official persons and Shimalis Abdisa of Oromia regional presidents. After observation of good performance of those areas Adama declarations was announced at "*Galma Abba Gada*" as the whole Oromia regional zone should produce irrigated wheat technologies for wider adoption that was planned on 300,000 hectare of land.

Currently, the Ethiopian government is pushing the wheat crop production to the lowland areas of the country (the areas where the rain fed wheat production was not yet practiced) and high land areas during the off season to be cultivated under irrigation. Production and productivity are the function of all the recommended packages, not only variety. Adoptions of all scientifically recommended production technologies play a significant role in wheat production and productivity (Atinafu *et al.,* 2022). The current policy, research and development projects should be well aligned against priorities of sustainability with surplus production. Sustained surplus productivity with a modernization of farming system supported by continued investment will lead the country to wheat export.

4. Irrigation wheat constraints in Ethiopia

Wherever they grow, irrigated wheat may subject to stresses that tend to restrict their growth and development which finaly negatively impact the yield. Irrigated wheat production constraints are biotic (disease, broad leaf weeds, grass weeds, soil borne pathogens, insect pests, wildlife animals etc.) and abiotic (soil alkalinity, faster nutrient depletion, defficiecy of nutrient, soil levelling, hard pan formation, drainage etc.) stresses. Wheat production and productivity are constrained by diseases, pests and climate variation (Tadesse *et al.,* 2018), limited access to new information, technical knowledge and agricultural technologies (Anteneh and Asrat, 2020). Stress at stem elongation stage had the highest sensitivity than other growth stages (Amir *et al.,* 2011). Water stress at flowering and grain filling

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should be avoided as they are the most critical growth stages in yield determination in wheat, because plants cannot recover, while delay in sowing resulted in reduction in yield and yield components (Sokoto and Singh, 2013). These growth restrictions limit the number of kernels that produced causing an irreversible reduction in yield potential. Farmers apply urea nitrogen fertilizer at different growth stage of the crop which does not meet their demand. The first 26-28 magic days for low land areas and the first 40 magic days for high land areas of urea nitrogen fertilizer application is for yield production and after these days application is for protein/quality improvement of the crop. Plants cannot absorb urea nitrogen. In order for the plant to absorb nitrogen applied as urea, nitrogen must be converted into ammonium (NH_4^+) and nitrate (NO_3^-), which are the nitrogen available forms that plants can use. Urea takes time process to become an available form of nitrogen (i.e. approximate time to complete Urea to ammonium is 2 to 4 days and approximate time until Nitrate is 1.25 to 2.5 weeks) under optimum condition depending on soil type. However, if the entire urea nitrogen is applied in the beginning, plants roots are not well developed and cannot absorb all the applied urea nitrogen and the second split application may be avoided if the soil moisture is not adequate for top dressing in time (Kedir, 2020). Urea fertilizers should be applied carefully and correctly, if not nitrogen losses due to volatilization may occur and in some cases, urea might cause damage to germinating seeds. Application of urea fertilizers to the soil surface without incorporating them into the soil results in greater losses of nitrogen. Urea Losses are greater in soils of high pH. Urea fertilizers should be applied when temperature is not too low or too high. Soil temperatures of 15- 20°C (70°F) are considered adequate.

The ridge and water feeding furrow should be done properly with the main consideration once it was done it is used up to final maturity of the crop. Sometimes ridge and furrow made by oxen may not be done properly at needed depth and straight which finally results over flooding of water. The water feeding system should be from back to front to minimize the over flooding of water and when planting furrow fully saturated simply to divert into another furrow. The other dominant constraint of irrigation wheat was lack of market and low market price for grain at harvesting time, recommended cultivar based on their agro ecological choice, inadequate irrigation water in some area, basic or certified wheat seeds in the country and the presence of quelea birds in some areas. Improving the above and other areas which need low rates of agronomic technical knowledge is important to minimize irrigation wheat constraints except to natural factor.

5. The production potential of Wheat under irrigation

In Ethiopia, it has been estimated that 3.8 million hectares land is the potential of irrigable area (Bekele *et al.,* 2007; CSA, 2015). The potential benefits of irrigation are great but the actual achievement in many irrigated areas of the country is less than its potential. Wheat production under irrigation provides higher yields than rain fed condition in some areas. In order that, wheat productions under irrigation is expected to contribute to the national economy in several ways. Agricultural growth serves as an "engine" of economic growth, and irrigation-led technological changes are the key drivers behind productivity growth in the agricultural sector (Hussain and Hanjra, 2004). Irrigation enables smallholders' farmers to adopt more diversified cropping pattern, and change them from low value subsistence production to high-value market-oriented production (Fitsum *et al.,* 2008). However, the low level of modern agricultural mechanization, expenditure on rural infrastructures targeting irrigation, access to new information on technological changes, high-yielding seeds and fertilizer in Ethiopian agriculture has continued as a huge obstacle towards advancing sustainable productivity as well as production potential of wheat and other crops.

6. Conclusions and Recommendation

As conclusions, irrigated wheat is produced politically and actually but not known in which year Ethiopia become championship of irrigated wheat and turn into wheat exporter. However, it could be suggested that for such successful transformation of irrigated wheat the government should consider on its sustainability with surplus production, access to new information and modernization of farming system with recent technologies supported by continued investment as the main focus.

The modern irrigation techniques ,with good follows up of irrigation scheme and maintenance, resolving conflict of interest on water in some areas, supply of functional water pump for small scale farmers, supply of basic or certified seed based on their agro ecological condition, supply of inputs like different type of fertilizer at right time with right amount, solving logistic problem at district level, training from zone to farmer's levels to increase farmers knowledge should be continued.

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