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# Pilot Review Study on Current Research Status and Economic Value Limitations of Bread Wheat (*Triticum aestivum* L.) Production in Ethiopia

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**Abstract:** The primary goal of this review study is to convey an impression of the existing research status and economic value limitations of bread wheat (*Triticum aestivum* L.) production in Ethiopia. Bread wheat is a widespread crop in temperate countries and is being used as human food and livestock nourishments. It produces on wide farm lands than any other food crop and is one of the most significant sources of nutrients for humans in several countries of the world. The intent look of the plant is classic of the grass family, however the head or a spike is thickly overflowing with ounces. The utmost cultivars have awns, which are the attachments close to each spikelet, giving the spikes a hairy appearance. The good achievement of bread wheat production depends relatively on its adaptableness and great yield capacity, and also on the gluten protein parts, which weigh up the viscous-elastic things that permit its bread to be handled into bread, pasta, noodles, and other food produces. In terms of the human diet, it donates nutritive elements, useful phytochemicals, and nutritional fiber components. The existing minor review study relates with recent and the upcoming worries that comprise bread wheat production and quality with minimized inputs of agrochemicals and developing lines with improved quality for precise end-uses, notably for biofuels and human nourishment. The Economic value limitations analysis by means of a partial budgeting method was done on purposely designated bread wheat cultivars grain yields in order to decide the preeminent treatment by the utmost cost-effective earnings. The valuable marginal rate of return (8.50) and valuable benefit-cost ratio (8.07) was attained from the variety Hidassie/large seed size at a plant population of 300 seeds $m^{-2}$ followed by a marginal rate of return (9.55) and benefit-cost ratio (8.05) were also gained once more from the variety Hidassie/large seed size at a plant population of 250 plants $m^{-2}$. So the most profitable cultivar and plant population level for farmers with low cost of production and higher profits were recognized to be the variety Hidassie/large seed size at the plant population level of 300 plants $m^{-2}$ in the rain-fed cropping time is recognized as minimized cost of production with the maximum profit and can be validated for the farmers of bread wheat producers.

**Keywords:** Ethiopia, Economic Benefit, Marketing Opportunity, Soil Nutrients, Wheat Production and Productivity

## 1. Introduction

Bread wheat (*Triticum Aestivum L.*) is one of the numerous cereal crops mostly grown in the hilltops of Ethiopia. It is produced mostly in southeast central and northwest areas of the country. Small quantity of bread wheat is similarly produced in the rest of the south and north provinces of the country. Its production is greatly focused among the latitudes of 30° and 60°N, and 27° to 40°S and within 60 the temperature range of 3°C to 32°C [5]. Bread wheat is a significant crucial food crop in Ethiopia, mostly in urban areas. It is an essential food in the foods of several Ethiopian, in case around 15% of the caloric consumption for the country's above 90 million populaces [37, 41, 42], engaging it afterwards of maize and somewhat ahead of teff, sorghum, and enset, which provide about 10-12% each [78]. Bread wheat is also the fourth widespread cereal crop produced by near to 5 million small-scale farmers, which makes about 35% of all smallholder farmers in the country. It accounts near to 17% of arable land and a fifth of all cereal food crops produced in the country in 2013/14 [24, 25]. Next to South Africa, Ethiopia is the 2nd dominant bread wheat producer in sub Saharan Africa [38, 39, 40]. Until now, various cultivars of bread wheat and durum wheat have been technologically advanced to gratify the rising production demands and accordingly, around 76 bread wheat and 34 durum wheat cultivars have been released [80].

Bread wheat production has developed promisingly over the past 20 year next to numerous government programs and initiatives executed to motivate agricultural development and food security in the country. Production raised from about 1.1 million tons in 1995/96 to 3.9 million tons in 2013/14, which is a typical yearly progress of 7.5%. Even if bread wheat production has grown-up progressively, feeding of bread wheat has also extended promisingly. Bread wheat feeding raised from 2.1 million tons to 4.2 million tons, instead of an annual increase of about 4.2% amongst 1996 and 2014. Bread wheat importation has also grown up dramatically over the past periods.

Bread wheat is actually the only most significant main food crop trade in from overseas. Bread wheat importation raised by an average of about 6.6% over the past importing periods. In 2008 Ethiopia, for instance, trade in more than a million tons of bread wheat, which was comparable to around 40% of the entire local production and almost 250% of the promoted capacity (Rashid and Solomon, 2014). In 2013/14 the country trade in about 1.39 million metric tons, which is around 34% of the internal production and above about 160% of the promoted bread wheat in the country [78].

In similar with the accumulation in bread wheat importation, the country was enforced to employ a considerable quantity of overseas currency exchange that mainly arises from exportation of other predominantly agricultural produces. The considerable rise in internal production and importation of bread wheat, on the other hand, has not help out to converse the accumulative tendency in bread wheat value.

Ratified statistical indicators on consumer prices point out that prices of bread wheat and bread wheat produces relatively raised considerably. Above the eight-year stage of development, between 2005 and 2012, the price of bread wheat has raised nearly 300%. The comprehensive price of tone bread wheat at Addis Ababa open market has raised beginning from 1975 to 7045 Ethiopian Birr 257% and the farm entrance price from 1713 ETB to 6709 ETB 292% [15, 36].

Then again, between 2000/01 and 2012/13 actual prices of bread wheat, bread wheat flour and bread in Addis Ababa raised by 176, 131 and 116%, in that order. The existing tendency appears to persist also in the upcoming as well. Samuel G. [91], pointed out the increasing the bread wheat supply insufficiency in the upcoming years.

In relation to this study, supply is predictable to raise by 73% from 2.6 million in 2010 to 4.5 million tons in 2030, while demand is predictable to rise by 90% from 3 million to close to 5.7 million tons for the period of the same duration. A collection of factors that comprise population progression, increase of agro processors, urbanization, and growing household revenue donate for bread wheat demand progression in the upcoming periods. As a whole, the rising price tendency appears to persist in the near imminent.

The increasing basic shortage in bread wheat supply and the government's energetic role, mutually in terms of making bulky investments in extension lead plans and accepting protective programs to guarantee government control of entirely profitable bread wheat importations, requirements studies on the arrangement and performance of bread wheat production. The current study intents to contribute to this on condition that an impression of the existing eminence and significant challenges of the Ethiopian bread wheat production.

A well thoughtful about the present status of bread wheat sector and its value chain, the formal marketing preparations, and microeconomic dealer behaviors of bread wheat market members contributes to origination of rules that are market-enhancing as well as that might improve native bread wheat production [91].

Bread wheat establishes the main source of human food worldwide and needs a most important research work to rise their production efficiency and sustainability in the expression of great food prices, climatic fluctuations and natural resource reduction. Countries have a crucial necessity to rise bread wheat production to come across the increasing demands under the limitations of reducing natural resources and ecological instabilities.

Year after year difficulties are gratifying more influential and thus emphasizing the basic requirement to focus leaning research on the extent areas like drought tolerance, disease resistance and quality seed production. Composite of inventive methodologies and breeding approaches can improve the floating situations in the future [93].

It is evident that bread wheat is one of the greatly significant food crops grown above 200 million ha in diverse range of environs all over the world. Green revolution set an amazing growth in boosting bread wheat production and the praise drives to Dr N. E. Borlaug who advanced some top yielding dwarf cultivars.

So as to meet the overwhelming task of rising yield potential in a sustainable method, Ethiopia desires to advance the general breeding productivity [12]. The present review study is concentrated on the continuing research areas in Ethiopia, challenging encounters in the future and a conceivable technique which ready to deal with the critical issues advantageously in order to balance the demand and supply proportions.

The imprint of this review study is prearranged as follows. The first section presents an overview of the existing research limitations and economic benefit status of bread wheat production in Ethiopia, as well as the plentiful facts and prominence of bread wheat crop in the world. The next sections begin with a brief description of the earlier and existing institutional arrangements of bread wheat production situations and proceeds by extensive discussions on the structure of bread wheat small farms, production and productivity as well as nutritional components and grain quality resistance features of bread wheat crop.

This information is used to highlight important proofs on bread wheat research status and production comprising the economic value limitations in the country as well as the behavior and challenges of dealers in the bread wheat markets. The last section provides concluding assumptions and policy endorsements.

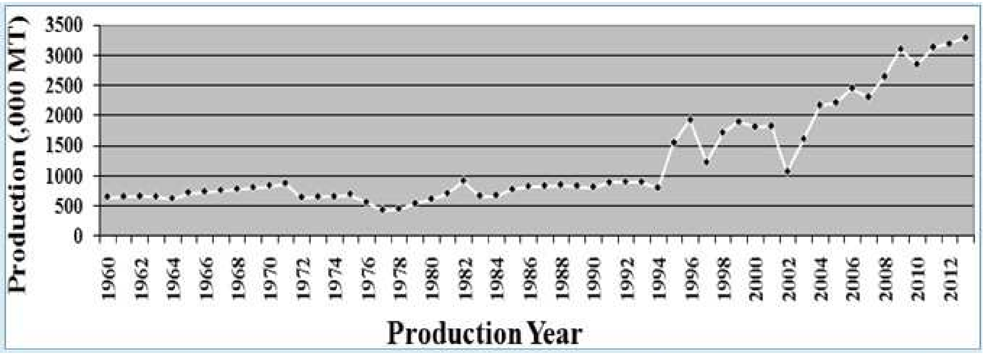
## 2. Body of Discussion

### *2.1. Current Bread Wheat Research Status and Economic Value Limitations in Ethiopia*

Ethiopia is one of the primary producers of bread wheat in East, Central and Southern Africa. It is produced mostly in the southeast, northwest and central parts of Ethiopia. Slight quantity is similarly produced in the rest of the south and northern regions. Bread wheat is one of the most important cereal crops in the Ethiopian highlands, which range among 6° and 16°N, 35° and 42°E, and from 1500 to 2800m. At present, bread wheat is produced merely under rain fed environments [80].

The two economically significant wheat species grown in Ethiopia are hexaploid bread wheat (Triticum Aestivum) and tetraploid durum (Triticum Durum). At the national level presently, 1,664,564.62 million ha of land is covered by bread wheat & durum wheat and over 42,192.57 metric tons' coverage produced from this land annually and recently-released bread wheat cultivars are highly responsive to improved management systems relative to older bread wheat lines [80].

The Economic value limitation analysis by means of a partial budget method was done on deliberately nominated bread wheat cultivars grain yields to decide the outstanding treatment by the maximum cost-effective earnings. The valuable marginal rate of return (8.50) and valuable benefit-cost ratio (8.07) was attained from the variety.




Source: USDA, http://www.indexmundi.com/

***Figure 1.*** *The national average yield Status of wheat production in Ethiopia from the year 1962-2012 GC.*

Altitude plays an important role in the distribution of bread wheat production through its influence on rainfall, temperature, and diseases. In Arsi, Bale and Shewa regions, the soil, moisture and disease conditions in the 1900-2300 m altitude zone are favorable for the production of early and intermediate maturing varieties of bread wheat. This is estimated to comprise 25% of the total bread wheat area, while the remaining 75% falls in the 2300-2700 m altitude zone. There, early, intermediate and late varieties are grown. Soil types used for bread wheat production vary from well-drained fertile soils to waterlogged heavy Vertisols.

Hidassie/large seed size at a plant population of 300 seeds $m^{-2}$ followed by a valuable marginal rate of return (9.55) and benefit-cost ratio (8.05) were also gained once more from the variety Hidassie/large seed size at the plant population level of 250 plants $m^{-2}$ [5]. Its production is boosting quickly owing to both a great native demand, and the accessibility of top-yielding, input-receptive cultivars improved to heterogeneous ecological conditions [27]. So far, plenty of varieties and adaptable collections of bread wheat and durum wheat have been advanced to fulfil the rising production requirements and as a result, about 76 bread wheat and 34 durum wheat cultivars have been released [80]. Production area handling of bread wheat has considerably extended mostly by substituting unimproved, contribution non-receptive outdated cereal crops such as teff (Eragrostis Teff), durum bread wheat (T. Durum) and barley (Hordeumvulgare).

### *2.2. Earlier Bread Wheat Research Status and Grain Yield Statistics in Ethiopia*

Ethiopia is the principal bread wheat producer in sub-Saharan Africa with around 0.75 million ha of durum wheat and bread wheat. Bread wheat is one of the most important cereal crops in the Ethiopian moorlands, which range among 6 and 16°N, 35 and 42°E, and from 1500 to 2800 m. currently, bread wheat is produced exclusively underneath rain fed environments. About 60% of the bread wheat producing region is covered by durum wheat and 40% by bread wheat crops. Of the existing entire bread wheat production region, 75.5% is situated in Arsi, Bale and Shewa regions. 46% of the 13 million ha categorized as extremely appropriate for bread wheat production is situated in Arsi and Shewa.

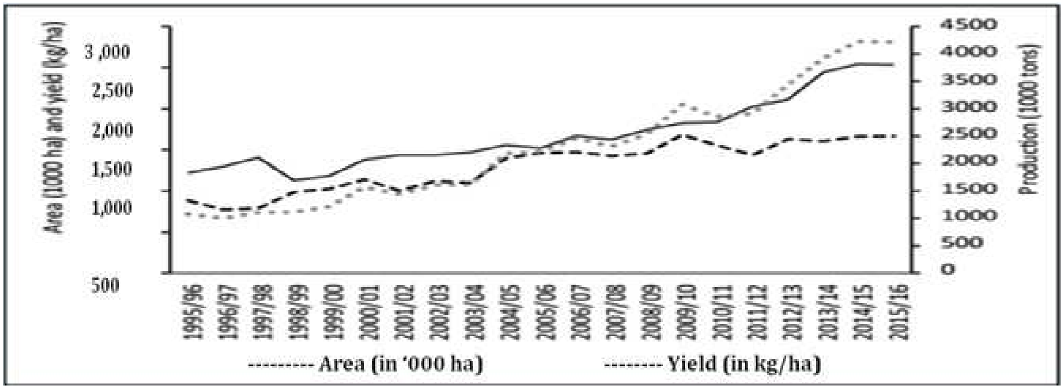
Bread wheat improvement research in Ethiopia could be alienated into 4 epochs, Earlier to 1930, crop research deal out mostly with germplasm gathering, documentation, and classification. From 1930-52, introduction, hybridization and selection originated, ending in the release of Kenya 1 and 5. This research effort sustained at Debre Zeit and more additional stations throughout the period 1953-66 when 6 durum wheat varieties were released. Bread wheat improvement research is coordinated countrywide by a multidisciplinary team of researchers from diverse agricultural research establishments prearranged into 2 mechanisms, one dealing with bread wheat and the other with durum wheat.

Intentionally, the nation-wide bread wheat improvement research parallel aspect of the package discourses the moorlands of about 6 major bread wheat producing regions all served by a research center. Precise breeding and assessment programs have been planned for environments with superior production difficulties.

Based on the production zone, both minor and extensive producers were in the open-minded groups. Upright, the program has the following technology creating and transmission elements: breeding and genetics research, bread wheat pathology and entomology, bread wheat agronomy and weed control, soil fertility and fertilizer use, agricultural economics, and research and extension. The nation-wide bread wheat improvement program was organized most efficiently from 1967 1991.

Throughout the past more than 24 years, complete research program was advanced and about 30 upgraded bread wheat cultivars were released. Bread wheat research was held countrywide by a multidisciplinary team of researcher from unlike organizations systematized into two mechanisms, one relating with bread wheat and the other dealing with durum wheat.

Persistently, the nation-wide bread wheat improvement research horizontal dimension of the program discourses the moorlands of 6 most important bread wheat producing areas all with functioned by a research center. The precise breeding and yield assessment series were intended for regions with superior production problems. Contingent on the production areas, both small and large-scale farmers were in the target entities. The upright, research program has the following technology generation and transmission.




Source: Central statistical Agency (1995/1996- 2015/2016).

***Figure 2.*** *Wheat production, area cultivated, and yields in Ethiopia from the years (1995/1996-2015/2016).*

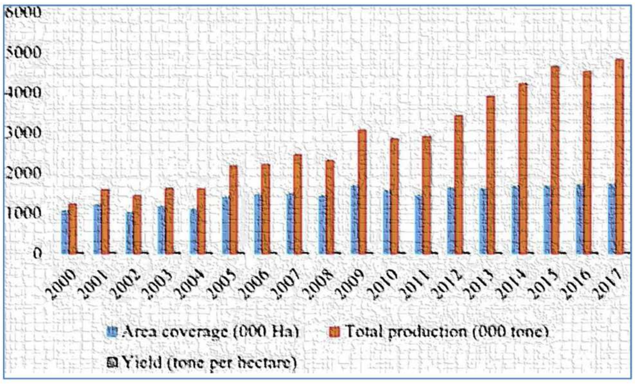
In terms of area, bread wheat is the fourth most extensively grown crop in Ethiopia, next to teff, maize, and sorghum. Currently, nearly 1.7 million hectares of land are dedicated to bread wheat crops a substantial rise from fewer than 1 million hectares sowed bread wheat in 1996, on behalf of a yearly growth rate of 3.2% (Figure 2). Furthermore, the country has improved its bread wheat yield by nearly 3.7% per year over the last two decades: Twenty years ahead, signifying that more than half of the progress in production ever since 1996 can be qualified to top yield improvement. The proportion of yield increment has been particularly somewhat great in current years. Since 2005, yield has raised more than 5.2% per year mechanisms: breeding and genetics research, bread wheat pathology and entomology, bread wheat agronomy and weed control, soil fertility and fertilizer use, agricultural economics, and research and extension. According to the land use statistics of the 1960s, the bread wheat area was predictable at about 364 000 ha, producing 255000 tones.

At present at the countrywide level about 1,664,564.62 ha of land is covered by bread wheat and durum wheat and over 4,219,257.23 tones are produced from this land yearly [80]. In the 1960s, the bread wheat region was estimated at about 364 000 ha, producing 255000 tones.

### *2.3. Existing Bread Wheat Production Status in Ethiopia*

Bread wheat is one of the Ethiopia's the mainly essential crops in terms of both in production and consumption. Based on its leading role in the population's caloric consumption, bread wheat is the next most significant food in the country, after maize (FAO 2016). Bread wheat is grown largely in the moorlands of Ethiopia, and the two main bread wheat producing regions (Oromia and Amhara) account for approximately 85% of national bread wheat production [25].

Even if bread wheat is certainly grown by small-scale farmers in Ethiopia, the country is the major bread wheat producer in Africa south of the Sahara by a substantial boundary. Bread wheat production during the 2015/2016 Meher season was 4.1 mmt and has been rising meaningfully over time increasing by an average yearly progress of 7.1% over the previous 20 years due to both area extension and yield enhancements (Figure 2).




(Source: FAOSTAT, 2018 online report)

***Figure 3.*** *Status of wheat production, area coverage and productivity of Ethiopia from 2000 to 2017.*

However, related to the yields achieved by other major producers in Africa, for instance, Egypt, South Africa, and Kenya. Ethiopian bread wheat yields are less, signifying significant prospective for improvement. The existing bread wheat yields are unevenly paired the average bread wheat. Report of FAOSTAT shows that on average bread wheat production and the entire area coverage raised from 2000 to 2017. Exactly so, there was a cumulative rate of production and area coverage from 2000 to 2001, but it also indicates a declining rate throughout the 2002 and 2004 years (Figure 3). As specified in Figure 3, production productive efficiency and area coverage vary among years.

As showed in the figure, the yield of all wheat, teff, and maize shows a raising tendency as of the year 1994 to 2016 (Figure 4). On the other hand, even if their yield tendency is raising over time, their raising rate is unalike among them. Over again with respect to the predictable yield, the report by CSA [28] also stated that wheat, maize and teff within the arrangement of cereals have shown raising range from 22.8 to 296.7 metric tons per hectare for wheat; 73.2 to 289.3 metric tons per hectare for maize; and from 50.5 to 267.6 metric tons per hectare for teff; from over the last 5 years (2012/2013–2017/2018) post-harvest assessments. This reveals that wheat indicates the maximum raising rate which is 223.9 metric tons than teff 216.1 metric tons and maize 217.1 metric tons. Such raising rate of wheat production is in the cause of the application of numerous government programs and ingenuities which drive agricultural development and food security in the country [47]. Report of FAOSTAT specifies that on average wheat production and the whole area handling improved from 2000 to 2017. Bread Wheat exhibit limited genetic diversity, raising concerns about the ability to rise the crop yield & quality of dynamic ecological and biotic threats [43, 60].

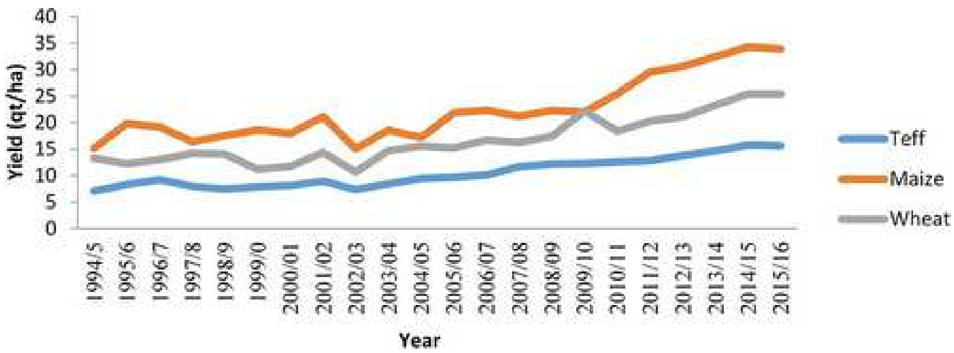
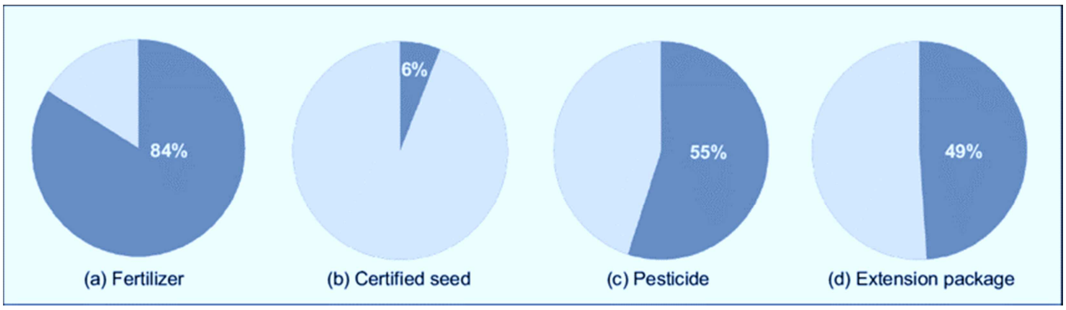



***Figure 4.*** *Yield status of wheat, as compared to maize and teff from 1994 to 2016 (Source: PARI, 2015).*

As stated by Gebreselassie [47], the core cause for this substantial annual distinction is mostly due to variance in precipitation which means that if the precipitation is worthy and the production is also praiseworthy, while if the precipitation is not adequate, the significance of the production is also inadequate. Crop receipts the maximum part in the entire production and area coverage, and they fixed on average 68% of the Ethiopian agricultural GDP.

Cereals are the best significant crop which delivers food calories in the day-to-day food intakes of the people. Bread wheat is comprised under the group of cereal crops which creates its production a major supplier to the agricultural sector development of at large and to the farmhouse family food security status in specific. Numerous limitations combine to clarify the bread wheat yield gaps in Ethiopia. Proper usage of contemporary production-ornamental inputs, such as fertilizers and improved seeds, among bread wheat farmers in Ethiopia is apparently a bit less than of its potential.

Nation-wide statistics on fertilizer RVVNHMY usage show that a significant portion of the bread wheat producing environment is enhanced with fertilizer (Figure 3), and the application of fertilizer on bread wheat plots is relatively demanding 0.15 metric tons per hectare, which is still lesser amount of than the suggested rate, related to the current usage of fertilizer with the extra cereal crops. On the other hand, merely 6% of the bread wheat-growing environment is concealed by new improved seed, well-defined as seed bought from the Ministry of Agriculture, a cooperative, a seed company, or alternative source of varietal clean seed.




Source: Central Statistical Agency (2015/201)

***Figure 5.*** *Share of bread wheat area covered by modern inputs and practices (2015/2016).*

Accordingly, on average, bread wheat farmers buying better-quality seed approximately each 17 years. Furthermore, the country has extended way of going to close the yield gaps that have originated from farmers' imperfect use of new chemicals such as, pesticides, herbicides and use of the best agronomic practices that are encouraged by the extension system (Figure 5).

In spite of the speedy growing in bread wheat production Ethiopia. The 2015/2016 Agricultural Sample Survey reports over the past decade, portions of promoted excess supplies of bread that merely 20.8% of Ethiopia's bread wheat production was traded, wheat are constantly less in country is not sold; as an alternative, it is signifying that maximum bread wheat in the country. In spite of the by farmers and used for personal consumption, seed, and maybe an extra reserved uses. A diverse study by Minot [78] found significant difference in the share of bread wheat traded through farmers' households. The extensively held of bread wheat farmers do not provide the impress to trade any of their bread wheat production, and merely 10% of bread wheat farmers sell more than half of their bread wheat. Regardless of the inadequate growth or deficiency of growing in marketed surplus, bread wheat handing out is prosperous in Ethiopia, next to the tendency established by the well local demand for bread wheat products, a request that is forecasted to produce in the future. Extensive flour mills and pasta producers are developing in raising numbers. Although their milling dimensions is predictable to be half the volume of the present limited hammer mills [11, 78].

These extensive bread wheat processors depend severely on new introduced bread wheat varieties. The share of bread wheat they source nearby is insignificant. This certainty reproduces difficult features of the Ethiopian bread wheat marketplace that preclude smallholders from negligence processors' growing demand for bread wheat, with bread wheat subsidizations being one of the major limitations. Ethiopia depend on enormously imports to come across its growing bread wheat handling and consumption needs; certainly, the country's bread wheat importations have improved by more than 5% per year, on average, over the past twenty two years. In recent years, the total level of bread wheat importations has begun to be as a key apprehension for the country.

All-out of these importations are marketable in natural environments, providing subsidized bread wheat to carefully chosen mills. The providing, which is apparently relatively costly, has a destructive effect on local producers by dropping the price of bread wheat and thus unfavorable investment in quality-attractive inputs.

Latest estimations show that the price of the bread wheat importation support to the Ethiopian government and farmers is eight times greater than the profits that accumulate to Ethiopian customers [78]. The country's poor rural structure such as inadequate transport system, nonexistence of marketplace info, and so on are broadly mentioned as a cause that has forced farmers' readiness to take part in Ethiopia's bread wheat market.

As, a current study on the bread wheat value chain in Ethiopia by Minot [78] showed that transportation signifies the key marketing cost and that transportation dues are not comparative to distance, because of the Ethiopian roads' poor status of repair, a shortage of all-season feeder roads, and nonexistence of transportation in rural areas. The nonexistence of market establishments is another issue that adversely affects farmers' encouragements to play a part in the bread wheat market.

Productivity and equity paybacks, it would deliver, a structure of ranks & criterions has not been established for local-level bread wheat marketplaces in Ethiopia. Small-scale bread wheat farmers and their trade-off allies depend on deeply on physical check-up of grain when negotiating over prices, even if the major excellence limitations are often unobservable such as for protein, moisture, and hectoliter mass. Eventually, the nonexistence of the extensively known quality grades and standard units of measurement significantly rises the prices of market trades. Such cavities make the necessity at numerous stages for negotiators, whose tasks comprise testing the grain quality by means of factors known only to the mselves and defining the market-clearing value on behalf of either the purchaser or the wholesaler and effect in a long and the amalgamated of bread wheat marketing chain.

Likewise, the lack of grades and supplementary motivations disappoints farmers from spending in quality-enhancing technologies. The existing study aims to address some indications and technical limitations concerning grade sand criterions, which signify a valuable encouragement to the production of superior agricultural products. Now at the nation-wide level about 1,664,564.62 ha of land is covered by bread & durum bread wheat crops and over 4,219,257.23 tones are produced from this land annually. Up to now, numerous cultivars of bread and durum bread wheat have been advanced to fulfil the increasing production demands and accordingly, about 76 bread wheat and 34 durum bread wheat varieties have been released [80].

In spite of the great area cultivated for bread wheat, the nation-wide average yield of bread wheat in Ethiopia is about 2675 kg/ha [27]. This is without doubt lesser than the world's normal yield which is about 3320 kg/ha in 2017. The entire physical area of the country is 1,104,300 sq. km of which the maximum concentration is built in the moorlands of the north and middle areas of the country, mostly nearby the centrally situated principal city of Addis Ababa; the far-east and southeast are lightly peopled. From the whole topographical area of the country, the arable land is almost about 15.2%; constant crops: 1.1% eternal pasture: 20%; irrigated land is almost nearly 2,900 sq. km and 1,664,564.62 ha is covered by bread & durum bread wheat [16, 17].

### 2.4. Importance of Bread Wheat Crop

Bread wheat is not only the extreme significant cereal crop in the world but then again also the most important source of most pertinent food for the peoples. In spite of being grownup on greater area, normal yield at farmers' fields is quiet far less than the prospective. Outdated technique of seedbed preparation for previous crop late planting, high weeds infestation, lack of water at critical growth times and non-sensible usage of fertilizers diminish the bread wheat production efficiency.

The most important role of inorganic fertilizers is to recover crop yields but then again the peak limitation in attaining demonstrated crop prospective is little usage of fertilizers mostly that of P and S as compared to N [8]. Bread wheat is broadly used up, in the countries to come across the consumers demand for bread and other food produces. This point out that world widely there are quite a lot of people who depend on bread wheat for a considerable portion of their food amounts to numerous billions. Statistics for the entire capacity of bread wheat which is consumed directly by people as divergent to feeding livestock, for the United Kingdom point out about one-third of the entire production, just about 5.7 m tones per annum are pulverized with home production.

All over the world there is no hesitation that the number of people who depend on bread wheat for a major part of their food quantities to quite billions. The great content of starch, nearly 60-70% of the entire grain and 65-75% of white flour, means that bread wheat is usually measured to be slight more than a cause of calories, and this is undoubtedly real for animal feed production, with great yielding, less protein feed varieties being accompanied by other protein rich crops, notably soybeans and oilseed residues [3].

Regardless of its fairly slight protein content, usually 8 15% bread wheat however delivers as much protein for human beings. As a result, the nutritious significance of bread wheat proteins should not be undervalued, mostly in less advanced countries wherever bread and other products (e.g. burger, cookies, baby biscuit etc.) may deliver a considerable amount of the food [3]. The future of mankind depends on ever-increasing agricultural production to provide food, fiber, fuel and other essential commodities [72]. In general, bread wheat is the most extensively used cereal for bread and bakery production process through the entire world.

It is grown in almost every region of the world and signifies a dominant source of food and revenue for millions of small-scale farmers. Bread wheat-based foods are opponent for food security and nutritious security wide-reaching of the world. The world-wide bread wheat researchers appeal consideration to the projected imminent food disaster, as populations in unindustrialized countries develop speedily, particularly in Africa and South Asia. They remind that population progression is expected to overtake yield increases in bread wheat and call for greater investments in bread wheat and other cereal crops to preserve pace with the forthcoming demand.

### 2.5. Wheat Improvement Research in Ethiopia

Wheat upgrading research in Ethiopia can be categorized into four epochs: The time earlier to 1930, wheat research owed mostly with scientific works, germplasm collection, proof of identity and classification. Early in the 16th century, the portuguese run their upgrading way to Africa and established trade missions and an embassy in Ethiopia attempted to discuss wheat seed source in Arsi, Bale and West Shewa administrative zones of Ethiopia.

From the earlier produce, and 8.9% and 7.4% of them used seed from other farmers and local market, in that order. Though, only 15.5% of the farmers used seed from proper wheat sector, where 12.2% of them acquire it from agrarian offices, 1.1% from research centers and the rest is from other farmer cooperatives. Therefore, breeding programs and proper seed foundations in the country have to provide further stress on increasing the frequency with which releases new varieties that yield well.

Of course, farmers with low educational level has also a undesirable impact on their willingness to take the new wheat improved varieties. Their discovery shows that informal wheat seed producer sectors were the source of 84.4% of the farmer. Out of this, 68.1% of them used seed which is reserved.

Well ahead, numerous European scientific excursions to Ethiopia were noted by several plant pioneers. Koernicke and Werner in 1885 complete the first report of some Ethiopian wheat's and identified 5 species and 9 cultivars. Chiovenda inscribed, in 1912, about Ethiopian wheat's and conveyed T. Dicoccum, T. Durum, T. polonicum and T. vulgare varieties [102]. Later, Percival in 1927, Vavilov in 1929 and 1932 and Ciferri and Giglioli in 1939 assumed excursions and described on Ethiopian wheat germplasm.

### 2.6. Wheat Production Challenges and Potential Marketing Limitations in Ethiopia

Agriculture in broad and cereals in specific are the means of living for millions of families in Ethiopia [32]. Cereal production is the only major sub-sector within Ethiopian agriculture far beyond all others in relations of its part in rural engagement, agricultural land use, calorie consumption and involvement to nation-wide revenue [18, 19].

Wheat is one of the most imperative essential crops of the country in terms of production and consumption [88]. On the other hand, still, the Ethiopian government bring in approximately 180 million quintals of wheat per year [108]. There are two core causes for the importation of wheat in the country.

The main thing is to become stable national price and the second is to come across the overgrowing wheat demand of the customer in the country. Wheat production is typically farm to fork which means the farmers produce more of it for their feasting at home and fewer of it for the market [47, 76].

However the key question is why those farmers produce wheat for only eating? The motive behind this is owing to the being of numerous production limitations. These directly lead to fewer production and production efficiency, incompetency and underdevelopment of the wheat market [46].

Production and marketing difficulties of wheat start from entree to cultivars and variety selection systems [2]. There are various aspects that are directly or indirectly distressing the level of acceptance of better-quality and improved wheat varieties. Farmers' low buying ability with that of scarcity of the essential credit outcomes lack of resistance to the rising price of better-quality seed from time to time. Seed quality inconsistency, difficulties of obtainability and appropriate distribution of better-quality seed and inadequate amount of distribution were the main difficulties of the rate of acceptance of better wheat varieties [9, 78]. As the scholastic level of the farmers is low, their keenness to receive the newly coming wheat seed varieties also come to be low. This figure discovers the theoretical outline of the production chances and production limitations adopted from the gone through literatures. This theoretical structure (Figure 6) which guides the assessment study is constructed on the affiliation among wheat production and marketing and chances and limitations of the wheat sector.

As shown in the figure, there are many of chances which inspire the farmers and traders to come in into production and marketing. Such prospect can be a means of raising production, productive efficiency and marketing of wheat.

On the other hand, these prospects are affected by diverse production and marketing limitations which are the key motives for the low progression of the wheat sector. Even with the great development in wheat production, the market excess of wheat farmers, yet, leftovers very low, signifying the survival environment of wheat production in the country.

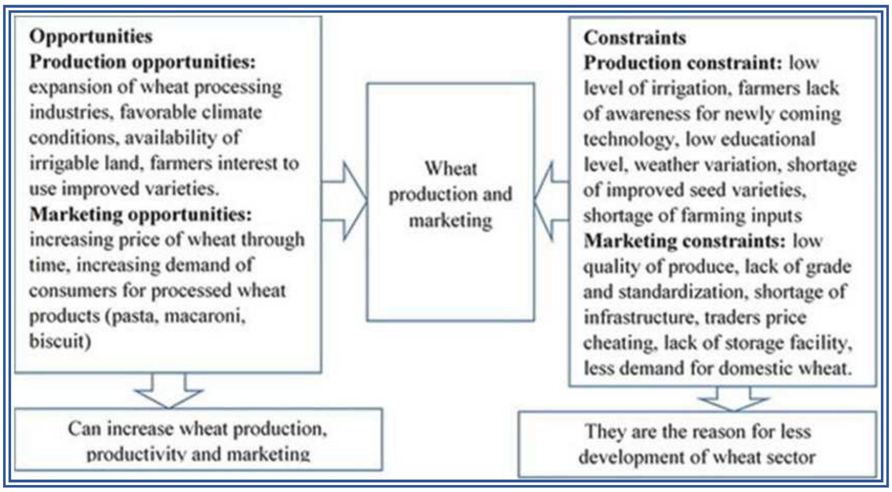
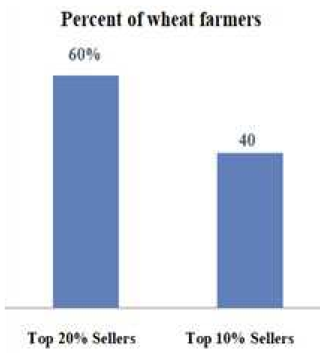
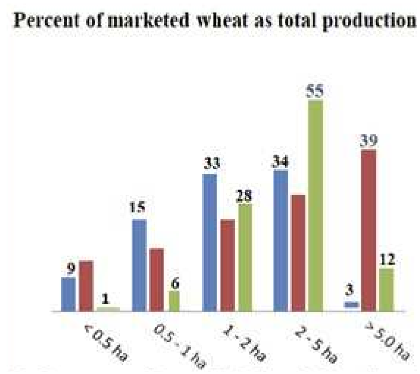



***Figure 6.*** *Conceptual framework of the wheat production opportunities and production constraints.*




Source: Minot, et al., 2015

***Figure 7.*** *Market Share of the Best Bread Wheat Among Farmers Operate Different.*




Source: Minot, et al., 2015

***Figure 8.*** *Patterns of Bread Marketed Surplus of Sellers Percent of All Wheat Marketed.*

Extreme wheat production in Ethiopia is not sold; as a substitute it is reserved by the farmer and used for their own feasting, seed, and conceivably other uses. Pursuant to the 2013/14 Agricultural Sample Survey, just 19% of wheat output was marketed. The amount of about 25% was somewhat greater in the 2012 IFPRI-ATA Baseline Survey of Minot 78]. Authorized statistics also specify that in 2014/15 production year, the normal wheat producer produce 7.51 metric tons of wheat and sell 1.89 metric tons [23], so that the normal profitable surplus was 25%. The portion of wheat production that is marketed, still, differs extensively across households.

Over half of the assessed 4.7 million wheat growers, for instance, produced merely for own national consumption. Depending on a national distinctive data, a study by Minot 78], point out that about 54% of wheat makers do not trade any of their wheat production, which shows that insufficient producers supply the wide-ranging of wheat sold in the country.

In other words, the nation-wide wheat market is controlled by a few and comparatively bulky producers. The top 20% of wheat wholesalers account for 60% of wheat trades.

Just 10% of them trades more than 40% of the wheat supplied to the internal market. The gathering and assessment of original wheat and the overview of exotic germplasm for testing under local situations initiated primary in the 1930s.

### *2.7. The Epoch Among 1930 to 1952*

Throughout this period, some wheat varieties were bring in from Europe and produced acceptably awaiting they surrendered to diseases. Alternatively, the local cultivars formed consistent and reasonable yields for their good modification. Accordingly, good quality native wheat's were grown at Ambo, Dese, Gonder, Holetta, Addis Ababa, Sishoftu and Debre Berhan areas during this period. The cultivars recognised in the early 1940s comprised Aless, Badeghe, Eloboni, Hanzat, Kodo, Manna, Ruso, Shecona Adghi and numerous emmer wheat varieties [86].

A proper wheat improvement research program started in 1949 at the Paradiso Government Research Station near Asmara with the testing of enormous amounts of native and exotic cultivars. Accordingly, certain prospective inherent variety selections, including A10, R18, P20 and H23, and 3 bread wheat varieties of Kenyan origin, namely Kenya 1, 5 and 6, were out in the early 1950s.

### *2.8. The Epoch Among 1953 to 1966*

Wheat research continued at Paradiso, Debre Zeit, Alemaya and Kulumsa during the period 1953-66. In the north, as the Kenyan cultivars multiplied in hectares, but they were became susceptible to stem and leaf rust. Therefore, the program at Paradiso looked for other international sources of germplasm and released two cultivars of Mexican source in 1960.

Alongside, the research center started hybridization among native and exotic durum wheat's. The basic purpose of these crosses was to combine stem rust and leaf rust resistance in the great quality with the disease vulnerable diversities by bring together durum wheat varieties.

The College of Agriculture, with the Debre Zeit Experiment Station, Jima Agricultural and Technical School and the Extension Service of the Ministry of Agriculture, bound its wheat improvement activities by gaining nursery resources from local land races and also exterior origins.

The main research activities comprised germplasm screening, variety testing, and crop management studies and seed multiplication. This effort give rises in the release of six bread wheat cultivars including the multiplication and dissemination of seed of the varieties Kenya 1 and Kenya 5 in the Shewa and Arsi highlands [102].

### *2.9. The Epoch Among 1967 to 1990*

The establishment of the Institute of Agricultural Research (IAR) in 1966 was charted by the formation of numerous other research and development organizations, ensuing in an efficiently structured nation-wide wheat research program. Besides a sequence of research locations and substations under IAR and the Debre Zeit Agricultural Research Center, other important agricultural research and development organizations which originated into being since 1967 have contributed directly or indirectly to wheat improvement research in the country.

These institutions include the National Crop Improvement Conference (NCIC), Chilalo Agricultural Development Unit (CADU), Wolaita Agricultural Development Unit (WADU), Awasa Experiment Station, Ada Agricultural Development Project, Extension Project Implementation Department (EPID), Southern Region Agricultural Development Project (SORADEP), Plant Genetic Resources Center/Ethiopia (PGRCIE), Arsi Agricultural Development Unit (ARDU), Scientific Phytopathology Laboratory (SPL), Ministry of State Farms Development (MSFD), Ethiopian Seed Corporation (ESC), and the National Variety Release Committee (NVRC).

The significances given by the IAR for wheat improvement research give emphasis to increased wheat production by focused on better-quality varieties with a set of cultural practices. IAR's wheat improvement research activities, in nearby teamwork with other research institutions, have involved.

1) The use of international and nationwide nurseries to classify required genotypes;
2) The mistreatment of the Ethiopian tetraploid wheat germplasm;
3) The implementation of an extensive countrywide and district variety testing program;
4) The improvement of varieties through breeding and adaptation;
5) The co-ordination and carrying out of agronomic and crop management studies; and
6) The seed increasing and dissemination of breeder and basic seed.

### *2.10. Potential Wheat Producing Regions in Ethiopia*

Wheat is produced in higher moorlands of the northern, middle and south-eastern parts of Ethiopia [27]. In this sense it can be produced in nearly at all areas of the country comprising pastoral and agro-pastoral areas such as Somali, Afar and Gambela regions. On the other hand, the mainstream (85%) of local production of wheat is grown in Amhara and Oromia regions of Ethiopia [10]. In relations of regional involvement, the production of wheat creates from Oromia (57%), Amhara (28%), SNNP (8.7%) and Tigray (6.2%) [25].

There are about 4.7 million wheat-producing peasants in Ethiopia. From all of these farmers, more than three-quarters (78%) living in Amhara and Oromia regions. Southern Nations, Nationalities, and Peoples' of Ethiopia (SNNP) are about 13% and the Tigray region are only about 8%. A lesser amount of about 1% are the wheat farmers living in other regions of the country [78].

The normal wheat area of each farm is also prevalent in Oromia regional state of the country where peasants plant an average of 0.43 ha per farm. This is the outcome of the presence of bulky farms in Bale and Arsi areas which are the highest wheat-producing areas of the country. That is why the two zones of the country are recognized as the *binding* of wheat production areas in Ethiopia [10, 78]). In divergence, the minimum area cultivated for wheat is available in SNNP with an average of 0.19 ha of each farm. The average wheat area in Amhara, Tigray and other regions is among 0.28 and 0.39 ha of each farm.

We can comprehend that in Ethiopia wheat is typically produced from Oromia, Amhara and SNNP regions in relations to both entire production and area coverage. However, as specified in relations to production efficiency, so far the Oromia region receives the first rank, and SNNP and Amhara region receives the second and the third ranks, correspondingly. In relation to CSA [26, 27, 28] report as specified in the listed conceivable wheat-producing regions, Amhara region indicates the maximum increasing tendency of wheat yield (0.153 metric tons per hectare) in 2017/2018 production period as equated to 2016/2017 production period.

Yet again regarding the assessed yield, the report by CSA [28] also stated that maize, teff and wheat within the classification of cereals have shown increasing range from 0.732 to 2.893 metric tons per hectare for maize; from 0.505 to 2.676 metric tons per hectare for teff; and from 0.228 to 2.967 metric tons per hectare for wheat all over the past 5 years (2012/2013–2017/2018) post-harvest approximations.

This shows that wheat indicates the maximum raising rate which is 2.239 metric tons than teff 216.1 metric tons and maize 217.1 metric tons. Such raising rate of wheat production is because of the application of numerous government programs and creativities which drive Agricultural growth and food security in the country [47].

Report of FAOSTAT indicates that on average wheat production and total area coverage increased from 2000 to 2017. Up to 1974, the Debre Zeit Agricultural Research Center was responsible for organizing the nation-wide wheat improvement research program. Subsequently in 1975, the co-ordination of the nation-wide wheat improvement research program was reviewed and prearranged into bread wheat and durum wheat constituents.

The Holetta Agricultural Research Center was made responsible for the co-ordination of bread wheat improvement research while the durum wheat program was assigned to Debre Zeit. Throughout the past 50 years, the extensive nation-wide wheat improvement program has been developed and more than 83 improved bread and durum wheat varieties have been released. At present-day, wheat is recognized as one of the important nation-wide commodity crops by the government with research headquarters at Kulumsa for bread wheat and at Debre Zeit for durum wheat.

# 3. The Current National Wheat Research Program in Ethiopia

The National Wheat Research Program (NWRP) has a multipurpose objective of creating rudimentary scientific information and practical technology to intensification and endure wheat production in Ethiopia. The program has two elements, one dealing with bread wheat and the other with durum wheat. Every activity is corresponding by a research program leader. Intentionally, the NWRP has four scopes. These are the zonal, disciplinary, client and resource operational features.

### *3.1. The Zonal Structural Aspects*

The parallel working structures of the program address the moorlands of six main wheat producing areas, namely Arsi, Bale, Gojam, Gonder, Shewa, and Tigray-Welo. Every one of these areas are helped by at least one main research center, namely Kulumsa, Sinana, Holetta and Debre Zeit, Adet, and Mekele, respectively. Within these regions, Awrajas with vastly favorable agro-ecological potential are established the pre-eminent importance. Functional research programs in the areas of germplasm development, varietal selection, crop protection and agronomy crop management are developed for all the zones.

Precise breeding, selection, collection and crop, as well as natural resource management research programs have been considered for environments with distinct production difficulties. These areas of research comprise the development of varieties and crop management practices for drought and frost-prone regions, waterlogged Vertisols, and the environments with low soil fertility or certain disease or pest problems.

### *3.2. The Disciplinary Structural Aspects*

Vertically, the National Wheat Research Program has the following discipline-focused on technology generation and transferal constituents: breeding and genetics research, wheat pathology and entomology, wheat agronomy and weed control, soil fertility research program under natural research management research pro soil fertility programs and fertilizer use, agricultural economics, and research extension.

Project development and implementation contain specialists in the diverse disciplines to resolve the multidimensional difficulties of wheat production.

### *3.3. The Client Structural Aspects*

The major assemblies of the NWRP are the producers and consumers. The producers comprise smallholder, private, survival, and lowly-resource farmers, average to great-measure marketable private farmers, and the great-measure state-owned farms. The users comprise grain dealers, the powdering and food manufacturing, and customers. Wheat research projects are directed to supply, as far as possible, the precise requirements of the various producer and user groups.

### *3.4. The Resource Structural Aspects*

The resource structural features of the NWRP deals with team establishment, specialists and proficiency expansion, the program evaluation and assessment system, and collaboration. Wheat research is controlled by a multidisciplinary group of specialists from various research and development organisations. The increasing of a least acute quantity of workforce, substructure and research niceties at Holetta, Kulumsa, Debre Zeit, and other main cooperating centers has been a central effort of the NWRP.

In general, the development and efficient proficient team scattering of the researchers has been essential. Project review and assessment by the national team has been developed efficiently. Wide-ranging national, regional and international cooperation in the altercation of information, germplasm, know-how, data, information and workforce development have suggestively contributed to the achievement of the NWRP.

On farmers' fields have improved to the range of 1500 to 2000 kg/ha.

Planting date trials showed that the optimal planting date for wheat differs from site to site, and based up on site-explicit periodic precipitation and the maturity time of certain wheat varieties. From seed rate trials, it was detected that the outdated technique of seeding (i.e. broadcasting seed and covering by ox-plow) needed about 20-30% more seed than drilling. Cultivars with whichever ineffective appearance or reduced tillering capacity also needed greater seed rates.

Greater seed rates were an operative means of overwhelming weed populaces. The rotation of wheat with non-cereals, mainly pulses, was greatly helpful for the yield of wheat. At Holetta, Kulumsa and Arsi Robe, faba bean was well-known to be the greater opportunity crop, while at Ginchi vetch attained best. Dual cropping was not helpful at Holetta because of the irregularity of the second cotton was verified.

### *3.5. Wheat Agronomy Research in Ethiopia*

Earlier to the founding of agricultural research in Arsi Zone, bread wheat yields of farmers' were as low as 0.6 metric tons. Establishing in the late 1960s, agronomic trials were run at the various research centers and state farms situated in bread wheat producing regions. In view of that the distribution of research improvements, bread wheat yield intensities period's precipitation. Under planting of fodder legumes in wheat seemed to have conceivable in Bale region. Concerning cultivation practices, in greatest trials zero and lowest cultivation bring about in reduced wheat yields compared to the traditional usage. On Vertisols, the drainage of surplus water by means of camber beds reduced variances in planting dates and improved fertilizer response.

The usage of the extensive bedstead and gulley system raised the grain yield of wheat by up to 131%, and also enhanced fertilizer response. The assortment of better-quality production performs in one cultural package resulted in highest wheat yields, mainly with an input receptive semi dwarf varieties. On-farm verification of bread wheat new cultivars in the Sinana area verified that farmers desire larger varieties which can contest with weeds, and which are great yielding, are adequate when prepared into numerous local dish wares.

In the Awash Gorge, dual cropping of irrigated wheat with possible with an early November planting. The maximum grain yields were produced by drilling wheat, by a seed rate of 1.25 metric tons, in whichever 2 or 3 rows on rims set apart 60 cm separately; the whole of 7 irrigations were essential by 10 day breaks with 75 mm of water for each application [63, 79].

### *3.6. Regional Distribution of Bread Wheat Production in Ethiopia*

The then country sides of Begemdir, Gojam, Harar, Shewa, Tigray, and Welo were main bread wheat producing regions. Right now, 75.5% of the total bread wheat production comes from Arsi, Bale, and Shewa areas. The 46% of 1.3 million ha categorised as exceptionally appropriate for bread wheat production is sustain in Arsi and Shewa.

The areas well-known as greatly appropriate for bread wheat production comprise Arsi, N. Gonder, Bale, N. Shewa, Ilubabor, W. Harerge and, W. Shewa, S. Shewa, Sidamo, Tigray, and Gojam (Table 1). The majority of the bread wheat crop is grown throughout the meher season. Previously, merely 4% of the whole bread wheat area was sowing in the belg season. On the other hand, in the private sector, the maximum normal yield was gained throughout belg: 1.6 vs. 1.2 t/ha in the belg and meher seasons, correspondingly.

### *3.7. Agro Ecological Environment of Wheat Production in Ethiopia*

The Ethiopian tetraploid bread wheat's, which are conventionally grown-up as blends of various cultivars and even species, are improved to the diverse climatic environments of the country, while bread wheat germplasms were familiarized during the 1930s and 1940s by the Italians either disappeared entirely or come to be a negligible constituent of the current blends [15, 21].

***Table 1.*** *Land suitability for bread wheat production by region.*

| Regions | Highly suitable land area (‘000) | Presently under bread wheat (‘000) | % |
|---|---|---|---|
| Arsi-Bale | 312 | 237 | 76 |
| Gojam-Gonder | 320 | 218 | 68 |
| Harerge | 76 | 102 | 134 |
| Welega-Kefa | 140 | 14 | 10 |
| Ilubabor | 192 | 25 | 13 |
| Gamo Gofa-Sidamo | 136 | 14 | 10 |
| Tigray | 132 | - | - |
| Wello | - | 49 | - |

Source: Adopted from Land Use and Regulatory Dept. Report, MOA

Elevation plays an imperative role in the dissemination of bread wheat production through its impression on precipitation, temperature, diseases and pests. Furthermore to general production efficiency, altitude has inspirations on plant characters such as caryopsis arrangement and coloration of glumes and awns.

It has been stated that bread wheat grown at higher elevations (2200-2700 m) has glasslike seeds and deeper coloration of the spikes, which may bemelanic or anthocyanic, whereas bread wheat grown at lesser elevations (1800-2000 m) shows yellow-berry seed indications and a whole nonappearance of coloration of the glumes and awns. Altitudes among 2000 and 2200 m appear to be provisional zones, where mixed indications of mutually coloration and yellow-berry can be witnessed.

Soil types and dampness rules of the bread wheat producing areas differ from area to area. In Arsi, Bale, and Shewa areas, where nearby 85% of the bread wheat is currently grown, the soil dampness and disease circumstances in the 1900-2300 m elevation zone are favorable for the production of early and middle maturing cultivars of bread wheat area whereas the left over 75% falls in the 2300-2700 m elevation zone. The soil types used for bread wheat production differ from well-drained rich soils to water-soaked extensive Vertisols. An estimated 75% of durum bread wheat is grown in Gojam, Gonder, Shewa and Tigray areas. In these durum bread wheat producing areas, there are also 2 main elevation zones. These are the 1500-1900 m zone which is appropriate for small and middle season cultivars and the 1900-2300 m zone where intermediary season cultivars are grown.

The prevalence of the various bread wheat diseases differs with elevation and other climatic features. Yellow rust, for instance, used to be inadequate mostly to high elevation, calmer areas but has now lengthy its adaptation to lesser and warmer elevations.

### *3.8. Bread Wheat Contributions to the Entire Crop Production*

Bread wheat contributes more than 50% of calories to the people on nation-wide level. Bread wheat contributes about 95% to the total bread wheat production, while another 4% comes from durum bread wheat and 1% from dicoccum bread wheat.

***Table 2.*** *Nutritional Components and Characteristics of Bread Wheat Crop.*

| | |
|---|---|
| Nutrition realities | Manganese, phosphorus, magnesium and selenium are existing in very large quantities. Also rich in zinc, copper, iron & potassium. Calcium present in small amounts. |
| Vitamins | Rich in vitamin $B_6$, niacin, thiamine, folate, riboflavin and pantothenic acid. Small amount of vitamins E and K are also present. |
| Calorie gratified | Calorific value: 339.0 calories per 100 g |
| Health welfares | Avoids breast cancer, gallstones, and childhood asthma and heart risks. Reduces risk of high blood pressure, diabetes and high cholesterol. |

Source: Sapna Grewal and Sonia Goel., (2015)

World bread wheat production for 2013-14 was projected at N record 708.89 Mt, up 53.69 Mt or 8% from 655.2 Mt in 2012-13, whereas global bread wheat consumption was predictable at a best ever Mt by USDA. In the former 40 years in Ethiopia, more than about 200 bread wheat cultivars are released for tilling in the 6 extra-large bread wheat rising atmospheres. Furthermost of these cultivars are released for tilling underneath water flooded, high-fertility and timely-planted situations [13]. Bread wheat consumption in Ethiopia mainly takes place in the form of home-based bread, chapattis, rotis, or flat bread and traditional pulverized porridge which is complete meal gruel, whereas wide-reaching it is used up mostly as bread. Bread wheat acceptance and attainment can mostly be qualified to the next features:

1) Extensive adaptation of bread wheat to various ecological situations and occurrence of a robust visco-elastic loading protein complex called gluten are the important issues making bread wheat the greatest imperative food crop in the world.
2) High protein content of bread wheat creates it a significant cause of human food and, furthermore, bread wheat grain is also used for the creation of alcoholic drinks.
3) Flour powdering gives fiber, which is used in cattle feed, and the germ is a valuable addition to fodder focus.
4) Grains are nourished to cattle all-inclusive or indelicately ground. The bread wheat plant is also used

as a grassland feed prior to stem elongation, a practice that permits plant renewal.

5) Bread wheat straw is also used as a source of fiber.
6) There are numerous additional produces of bread wheat from the food manufacturing such as bread wheat germ oil, bread wheat gluten and bread wheat starch, which have industrial applications [14].

# 4. Nutritional Improvement Required in Bread Wheat

Lacks of micronutrients, like, iron, zinc, and vitamin A, trouble above 3 billion people. Presently, there is an accumulative partiality among users for food that comprises not merely out-dated nutrients, however also deliver further combinations that are helpful to health and welfare. Food systems that feed the world must need to be altered in methods that assures a well-adjusted nutrient quantity in reasonable manner.

By nutritious level, the primary goals of enhancement are to improve the grain quality by:

a. Raising the protein content,
b. Raising the necessary amino acids, such as, lysine,
c. Raising great molecular weight glutenins to increase bread making material goods of bread wheat flour,
d. Amending starch arrangement.

### *4.1. Bread Wheat Pathology Research in Ethiopia*

As of the historical perceptive reports on the incidence of bread wheat diseases in Ethiopia were first reported as early as 1930. Since then, around 30 fungal, three bacterial, one viral, and four nematode diseases have been identified. Among them, merely a rare, exactly the rusts, Septoria tritici, Fusarium spp., and the smuts have been challenging. Episodic disease surveys have been conducted subsequently in the establishment of IAR, the Alemaya College of Agriculture, and the Scientific Phyto-pathological Laboratory. Occurrence, greatness, and development of the common diseases have been observed occasionally. Comprehensive biological and virulence studies have been carried out for some of the pathogens, predominantly the rusts and septoria. Identification of physiological races has been attempted; race dynamics have been observed ever since 1960 for black rust, brown rust and yellow rust [57].

Inconsistency in virulence of the races on monogenic lines was assessed using bread wheat rust trap nurseries in fields at stated sites in the country and in green house at Ambo. Despite a wide range of races for certain of the resistance genes for the three rust fungi have not yet been come across. Assortment of disease resistant lines has been conducted for numerous years in mutually bread and durum wheat, native resources. Research on disease controlling body measures other than genetic resistance has been endeavored.

Research studies were carried out on the influence of sowing date on rust expansion, the intensity, the effect of sowing method, and the rate, type and technique of fertilizer use on disease severity. Fungicide screening experiments have been carried out to assess biochemical control of septoria, rusts, smuts and bunts diseases. Research studies on bread wheat seed pathology were negligible. Reserved studies comprised the effect of ecological factors on rust and septoria expansion, immunization techniques, development stages for greatest infection, pathogenicity examinations, feasibility and existence of spores, histological alterations in diseased hosts, and the resolution of basics of the inoculums [58].

The following main points ought to justify a distinct courtesy in the future:

1) Studies on other conceivably significant diseases;
2) An epidemiological methodology to disease controlling;
3) Breeding for partial resistance;
4) Inheritance studies to deliver rudimentary facts required for resistance breeding.

When the Debre Zeit Agricultural Experiment Station was established in 1953, a great number of economically significant diseases on bread wheat and other crops were known. In 1967, Stewart [99] issued an "Index of Plant Diseases in Ethiopia", classifying the entire plant diseases arising in the 13 outlying areas of the country.

In 1967 Dagnatchew Yirgu compiled a bulletin entitled “Plant Diseases of Economic Importance in Ethiopia” [29]. Later the founding of the Institute of Agricultural Research (IAR) in 1966, coordinated research programs on bread wheat and other field crops were inaugurated at Holetta Agricultural Research Station, and research on crop bread wheat plants to Alternaria triticina [85]. Protection was officially started with the nomination of an FAO proficient.

Eminence was assumed primarily to surveying, detecting and recording bread wheat, diseases. Studies on bread wheat rusts, septoria leaf and glume blotch on bread wheat, other diseases were began. Research studies on bread wheat diseases were more maintained after the founding of CADU (Chilalo Awraja Development Unit) in 1967/68. Yield loss assessment studies were also initiated for a few economically significant bread wheat diseases. An additional imperative advance in the promotion of crop protection research was the founding of the Ambo Phytopathological Laboratory (SPL) in 1977. The SPL has been caring out research experiments on fungal, bacterial and viral diseases of cereals, pulses and vegetable crops.

In specific, wide-ranging effort on bread wheat rusts has been conducted over several years. Presently, underneath the supervision of the National Bread Wheat Research Improvement Program, bread wheat pathology research is being coordinated at Holetta Research Center, Kulumsa Agricultural Research Center, Debre Zeit Agricultural Research Center, and at Ambo Plant Protection Research Center.

### *4.2. The Main Potential Challenges in Improving Bread Wheat Production*

Apart from the massive area cultivated for bread wheat, the nation-wide normal yield of bread wheat in Ethiopia is about 2.675 metric tons [27]. This is certainly not as good as than the world’s average yield which is nearly 3.320 metric tons. According to Jamal [61], the quantity of productive cultivators is dependent on varieties, environment and is strongly inclined by planting density. On the other hand, tillering is improved with raising light and suitable nutrient obtainability throughout the vegetative stage and be contingent greatly upon the varieties potentiality.

With the intention of tackling our economic value limitations of bread wheat production optimal seed rate is one of the most essential agronomic factor which need abundant prominence for great yield of crops as to the nation-wide yearly bread wheat production can be improved. High seed rate rises the competition amongst crops for communal resource mostly nutrients, water, and sunlight which result in minor economic value and less yield. Furthermore, Hameed [56] stated usage of less seed rate leads to less yield because of minor number of plants per unit area.

On the other hand, lesser seed rates suggestively raised the number of fertile tillers created per plant which do have distinct result on yield of varieties. Along with its yield outcome, planting at a seed rate that result in best plant population concentration might also decrease the key limitations such as seed costs, lodging, disease and pastes difficulties and also the quick population progressions which add together some additional worth magnitudes in crop production process.

As in the other country like China, if it is expected that nutritional tendencies in China sustain and that the Chinese population will become stable at about 1.6 billion after additional 20 years, the demand for grain can only be happened and the population fed on the outstanding arable land if once a year bread wheat production can be raised to about 580 metric tons. To attain this, bread wheat grain yield in China must need to raise by 2% yearly over the subsequent 20 years of the rest 40% [35].

Nonetheless, more rises in bread wheat production will be further challenging than has been the instance for the earlier about 50 years. The obtainability of water and good soil are primary limiting factors for China Agricultural contributions must need to be reduced, particularly phosphorus and nitrogen fertilizers, overdoing of which have directed to ecological difficulties such as raised greenhouse gas releases and severe water contamination in parts of China. Moreover, weather change will also worsen crop strains such as drought, salinity, heat, & submergence in water.

### *4.3. The Abundant Truth of Bread Wheat Crop*

Bread wheat (Triticum aestivum L) is the most broadly grown cereal crop in the world, covering around 237 million hectares per annum, and accounting for a combined of 420 million tons [59]. Bread wheat is an annual grass emergent to amongst ½ to 1 ¼ meters in tallness, with an elongated stalk that terminates in a firmly molded band of plump seeds surrounded by a beard of thick spikes. It is grown all over the world for its extremely nutritive and valuable grain, as one of the highest three greatly produced crops, together with maize and rice. It is used in the production of bread, biscuits, feeds, sweets, among many, consumption [98]. The crop, which has been cultivated for over 10,000 years perhaps, originates in the Fertile Crescent, together with other essential crops.

On the other hand, inherited bread wheat may have seen much altered from what we currently have today, with much lesser kernels. Timely domesticators of bread wheat clearly required to select for plants with mainly large seeds, ever since further nutrient might be leaked out from each stalk. Bread wheat has been cultivated in Ethiopia for so many decades and particularly in Nigeria for centuries. For instance, abundant indication occurs to indicate that bread wheat has been cultivated in Nigeria as early as 200BC, while the presently cultivated varieties are relatively new introduction. Nevertheless, Ethiopia's nation-wide bread wheat production has persevered at a very small level irrespective of the continuously increasing demand for the crop. The restrictions to the bread wheat cultivation in most bread wheat growing regions in Ethiopia comprise appropriate agronomic activities, climatic requirements, and preconception for the farming of vegetables. Development of value-added agronomic performs regarding land preparation, planting, nutrition, water management, crop protection, harvest and post-harvest technology have been the main areas where researchers have focused their efforts.

The good profits of bread wheat be contingent totally on the form in which it is used up. Therefore to obtain highest profit from the good condition of bread wheat, it is imperative to select bread wheat products made from whole bread wheat flour rather than those that are sophisticated and exposed off their standard healthiness. These profits are insufficient when bread wheat has been handled into 60% extraction-bleached white flour. The normal process for preparation of the furthermost bread wheat products comprises only 60% of the original bread wheat grain and elimination. Unsuitably, the 40% that becomes removed comprises the fiber and the germ of the bread wheat grain, which is the best nutrient-rich part of bread wheat. In the procedure of making 60% elimination flour, over half of the vitamin $B_1$, $B_2$, $B_3$ and E, folic acid, calcium, phosphorus, zinc, copper, iron and fiber are misplaced (Annual Report 2013-2014).

Even if certain processing is necessary for sweetness, wellbeing and even nutrient bioavailability, there has been attention in the likely health benefits of great bran food products for numerous years [43]. Accompanied by bread wheat fiber, the bread wheat germ also be worthy of its health-food status. The germ is the vitamin and mineral rich embryo of the bread wheat seed that is packed with vital B-vitamins, great oil contented and consequently great quantity of vitamin E, an influential antioxidant that is essential for resistant structure purposes, cancer avoidance and blood glucose control in mutual healthy and diabetic developed persons. Collective facts are accumulating to indicate that fiber may actually reduce the danger of definite enduring diseases in persons like diabetes, cardiac diseases and definite kinds of cancers too [51, 52].

### *4.4. Quality Control Activities Required in Bread Wheat Research*

Quality control is an essential device to guarantee that the application procedure of field trialing that comprise data gathering, analysis and interpretation of effects to come across the standards. Monitoring and valuation (M & V), which will be preserved in a distinct guide, can be taken as one of the managing systems used to guarantee quality of field trials. It can be used to assure quality in agricultural system from the planning phase to application and reportage. However, this review paper goes elsewhere the subject areas of M & E [30].

### *4.5. Seed Quality Control Program*

Seed quality control actions like, detection monitoring and action, happen throughout the cropping years and then of data gathering and the details should be wisely documented in the manual, whereas seed quality is the proprietorship of seed with essential hereditary and physical clarity that is go with biological reliability and health importance. Decent quality seed organizes the foundation for refining agricultural production efficiency and guaranteeing food security. Seed quality program contains several stages, comprising production, harvesting, drying, processing, treating, and storage. The apparently well-defined communication arrangement is a basic pre-condition for inaugurating monitoring systems. There have to not be any doubt about the movement of information among principal agents and other researchers following the finding of errors in data assortment. Quality control concentrations not merely on the field works, but also on the laboratory analysis; since, the quality of data created from soil and water or agronomy laboratories is essential for guaranteeing reliable interpretation of field trial data and generation of technologies.

### *4.6. Properties of Bread Wheat Grain Quality*

Bread wheat is the world's important agricultural source of energy, protein and fiber; it belongs to a family Graminaea and genus Triticum and can be characterized into three main classes like hard, soft and durum. Bread wheat quality can be defined in relations of end-user, nutritious excellence, milling, and baking and rheology value. As a whole, bread wheat desires to be sound, clean, well mature, and free from foreign material and injured [22].

The entire area underneath bread wheat farming is approximately 1.7 m ha, of which nearly 4.2 m ha is sown with bread wheat (Triticum aestivum) and durum (Triticum durum). Therefore the emphasis of Ethiopian breeders essential to shift from "Quantity" to "Quality" currently as quality is far-off from being adequate. Breeders produce seeds for bread wheat cultivars per annum, of which merely fifteen varieties accounts for 80% of the crop [80]. Bread wheat varieties can be considered into four classes and their quality types are listed in Table 3.

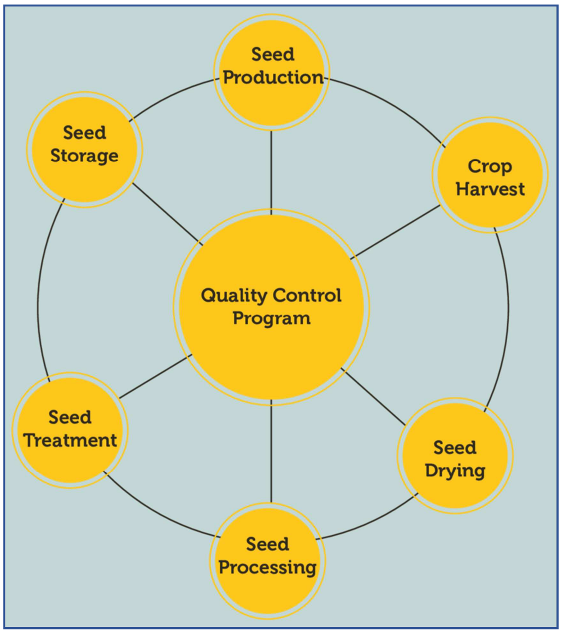



***Figure 9.*** *Seed quality control laboratory is a midpoint of seed quality inspecting program.*

***Table 3.*** *Quality Characters of Five Major Classes of Bread Wheat.*

| No | Bread wheat class | Protein (%) | Moisture (%) | Grain Quality | End use |
|---|---|---|---|---|---|
| 1 | Medium hard bread wheat | >10 | 11 | Hard, good milling qualities | Non-fermented |
| 2 | Hard bread wheat | >12 | 11 | Hard, good dough properties | Fermented & non-fermented |
| 3 | Soft bread wheat | <9.5 | 12 | Soft kernel | Biscuit bread wheat |
| 4 | Hard white bread wheat | >13 | 10 | Hard, best for high protein | Semolina & high proteins |
| 5 | Durum bread wheat | >12 | 11 | Large and hard kernel | Semolina, pasta and pizza |

Source: CIA. 2019. World Fact Book of the United States. Central Intelligence Agency, USA.

### *4.7. Bread Wheat Grain Quality*

Generally bread wheat quality can be spaced out into three major groups.

Botanical such as species and varieties,

(ii) Physical

(iii) Chemical characteristics.

Botanical Criteria of quality in botanical terms, bread wheat quality can be described as falling into the following two principal criteria.

(i) Species

(ii) Varieties.

#### *4.7.1. Physical Criteria*

Physical features of bread wheat quality comprises, grain weight, hardness, grain size and shape, goodness and color. Physical possessions of grain such as bread wheat play a very significant role in the quality of the grain, and in ultimate products such as flour. Major physical properties that impact quality of bread wheat are test weight, hardness, grain size and shape, goodness and color.

#### *4.7.2. Test Weight*

Test weight of bread wheat is well thought-out the most communal and quietest method to measure bread wheat seeds. It is a significant excellence factor in bread wheat classifying as it stretches uneven estimations of flour yields. The basic elements that disturb the test weight of bread wheat are seed size and shape, seed density, maturity of bread wheat, a wellbeing and real bread wheat variety [64, 65].

#### *4.7.3. Hardness*

The inflexibility of bread wheat endosperm is precarious in conclusive the appropriateness of bread wheat for numerous finale products and effects the handing out and milling of bread wheat. It is the communal characteristic used by millers and dealer to categorise bread wheat. In relations of firmness bread wheat can be categorised as either solid or lax [64].

#### *4.7.4. Color*

In relations of color, bread wheat is classified into two classes of red bread wheat and white bread wheat, dense red winter bread wheat is considered higher and typically used for bread flour production, while white bread wheat is usually used for cake, chapattis, and pasta or macaroni, each types of bread wheat has dissimilar properties such as taste, baking quality and milling yields.

#### *4.7.5. Vitreousness*

Bread wheat vitreousness is a visual possessions used by several countries to rating or enumerate durum bread wheat. Based on vitreouness, bread wheat can be categorised into three main classes: vitreous, mealy and piebald Samson. Glassy bread wheat varies from nonvitreous by seed appearance starchy and opaque; glassy bread wheat are well thought-out improved quality than nonvitreous seeds, because of higher quality semolina protein, nice color and uniform coarser granulation [33].

#### *4.7.6. Chemical-Quality Properties of Bread Wheat*

A chemical property of bread wheat comprises moisture contents, protein or gluten contents, amylase contents and fiber contents. After baking, bread generally offerings certain enjoyable features like a brownish and crispy coating, an enjoyable smell, a lenient and flexible scrap surface, and a wet opening texture. Bread also offers basic nutritious minerals, typically calcium, magnesium, sodium, iron and potassium.

#### *4.7.7. Moisture Contents*

Bread wheat grain as a standard rule harvested at 10-12% moisture fillings. In most countries moisture contents is not measure of categorizing system, but is the most significant factors distressing excellence value of bread wheat grain, as a result it is in reverse associated to dry substance damage [64].

Moisture contents has two significances in bread wheat excellence.

(i) Too low and also dry affects bread wheat to break during storage and handling operation and
(ii) Too excessive moisture contents will enable molds development which lead to weakening and failing.

#### *4.7.8. Protein Content*

Protein is not part of bread wheat a classifying elements, but its amount and quality excellence are the most significant properties in bread wheat commercial situations. The most purchasers and millers want to know the quantity of protein fillings of bread wheat before they purchases it.

Wheat contains five different classes of protein;

(i) Albumin which can resolvable in water,
(ii) Globulin which can resolvable in salt solution,
(iii) Gliadin which can resolvable in 70% of aqueous ethanol,
(iv) Proteose and
(v) Glutenin resolvable in diluted acid or alkali.

Other imperative potentials of bread wheat are milling and baking excellence.

#### *4.7.9. Milling Quality*

Most of bread wheat is commercially wholesaled as pulverized flour or semolina, and hence grinding excellence is a critical issue in bread wheat trade. Milling be contingent on three principal features.

(i) Size and consistency of seeds-there is a nearby relationship with the heaviness of seed, resolute by 1000-seed weight,
(ii) Texture of the endosperm-categorized by glassiness or pearling index and solidity. They impress the usage of energy essential for grinding as well as the quantity of semolina attained,
(iii) Proportion percentage of the seed-coat the greater the seed the lesser the proportion of seed-coat, and if the coatings are not denser, then the proportion of the seed-coat will decline too, and color of endosperm and seed-coat [50].

#### *4.7.10. Baking Quality*

Baking excellence is another standard used to control the quality and appropriateness of bread wheat; baking excellence be contingent on the types of bread wheat usages and processing circumstances, for example the robust or strong bread wheat are considered of the higher excellence and proper for bread creation, where most of cakes made from soft bread wheat flour Baking quality is determined by rheological properties of bread wheat flour [71]. The rheological property of bread wheat flour is important since it control further physical physical characteristics like baking capacity and sensual characteristics.

### *4.8. Grading and Classification of Bread Wheat Quality*

Bread wheat, alike other cereal, is characterized grounded on definite standards such as; test weight, purity, extreme percentage injured and other materials. Bread wheat is classified into classes and sub-classes. In classes, bread wheat is divided into eight various clusters; hard red spring, hard red winter, soft red winter, durum, hard white, soft white, mixed and un-classed bread wheat. These classes are further sub-classed into five grades (US. No. 1-5) [66] with the exclusion of un-classed bread wheat.

#### *4.8.1. Enhancing Protein Content and Improving Amino Acid Profile of Bread Wheat*

Even if the protein content of cereals is less significant (7-14%) compared to that of pulses (20-40%), they account for almost 45% of the everyday per capita protein source in the world and approx. 63% in developing countries, which plainly explains the importance of cereals in our everyday life. Protein amount in addition to quality are significant and are precious by the levels of Sulphur and nitrogen in the plant as it develops concluded the time of year.

Sulphur and Nitrogen are fine recognized to play crucial role in distressing protein profile of bread wheat as they are a part of most amino acids [31, 77]. Bread wheat is create to be missing in certain of the important amino acids like lysine, tryptophan and threonine [110]. Lysine mutants have formerly been made in barley, maize and sorghum but due to polyploidy nature of bread wheat, this work could not get much success in bread wheat.

Singh [96], have done definite wonderful work in this area. They have renowned a seed packing protein in bread wheat and allowed it triticin, which is initiate to be lysine rich. More, work has been completed to improve the appearance of inventive and improved triticin gene using more effective organizer and to rise the gene copy amount for improving bread creating excellence by attractive lysine content [103], [109]. This study area of improving protein & amino acid content can certainly help in improving the nutritive importance of such an imperative cereal crop, which is the main food for a lot of millions.

#### *4.8.2. Genetic Transformation of Protein Subunits*

Bread wheat seed contains a protein collective called gluten, which is greatly hydrated and viscoelastic. It gives the bread wheat dough with its typical properties of dough creation. Great molecular heaviness glutenins subunit (HMW-GS) plays a main part in decisive the viscoelastic properties, so defining bread creating potentials.

HMW glutenins are essential to make robust dough, which traps small foams of carbon dioxide gas made logically by yeast throughout mixing and consequent increasing, thus allowing the dough to increase. Dough robust point and its ability to contain gas foams is well-known as viscoelasticity and is an essential attribute of bread wheat seed with veneration to its end product excellence. Gluten proteins, for instance, gliadin, glutenins, albumin and globulin, provide bread wheat products exclusive extensibility and handling properties.

When handling the protein quality, the important goal is to gain the plant to produce protein that comprises the HMW, extensive chain gluten proteins. A number of HMW-GS and LMW-GS or small molecular heaviness glutenins subunit genes have been familiarized into bread and pasta (Triticum turgidum) bread wheat by hereditary modification [104].

Leon and his workmates were effectively able to improve transgenic bread wheat lines expressing additional copies of HMW-GS genes, 1Ax1, 1Dx5, and 1Dy10 by atom bombing [74]. They further extended this work ahead and altered the rheological and pasting properties of dough by expressing those HMW-GS genes [74, 75].

#### *4.8.3. Bread Wheat Starch*

The quantity of starch contained in a bread wheat seed might differ amongst 60 and 75% of the whole dry weight of the seed. Starch is a combination of two polymers, the nearly linear amylose molecules and the greatly branched amylopectin particles. The ratio of amylose to amylopectin is relatively constant, at about 23. Work has been done in this area to characterize and become well thoughtful of several components of starch biosynthesis so as to create balanced design of novel starches and modification in starch stages in other crop plants [89].

Research study of bread wheat starch biosynthesis has been promising with the finding of bread wheat with insignificant alleles or transformations for the diverse starch biosynthesis enzymes [89, 111]. The generation of better-quality starches prepared with hereditary engineering has also been reported [89]. This has prolonged the difference in bread wheat starch properties and extended the potentials for novel end uses.

Whereas inadequate food calories are one of the main reasons of malnourishment in unindustrialized countries, an excess of absorbed calories leads to fatness and other sicknesses in industrialized countries [100]. Starch with raised amylose contents is of concentration for the reason that they deliver unaffected starch with positive influence on human well-being.

#### *4.8.4. Abiotic Stress and Progress in Research*

Abiotic pressures, such as, extreme temperatures and water obtainability, great salt, and shortages or poisonousness of minerals, harshly affect production efficiency of global cereal crops. Bread wheat is grown in various atmospheres, particularly high temperature and less water obtainability, becomes significantly affected in relations of yield.

There is plenty difference existing in abiotic pressure tolerance in germplasms of bread wheat and its wild relations, which are not entirely exploited because of complication of bread wheat genome and shortage of sympathetic of its molecular foundation of stress reaction. Useful genomics that comprises methods, like, gene appearance profiling and proof of identity of receptive genes, tracked by better analysis or transgenic methods to allocate the function of precise gene or its produce protein is the new implement to make agreement with this matter.

#### *4.8.5. Temperature Stress*

Many parts of the plain zones, which are exposed to high temperature because of dry winds coming from Tharp Desert. Higher mean temperature particularly immediately after and thesis reduces the yield significantly. Development of heat tolerant genotypes is the inexpensive means of contrasting the temperature and high heat strain. Different lines should be established having high yielding characteristic furthermore to their adaptableness to heater weathers.

Temperature tolerance can be combined by improved tissue thermo constancy, important covering heat depression, raised stay-green custom and well stem-reserve utilization rates [109]. Influence of heat strain on grain starch contented in diploid, tetraploid and hexaploid bread wheat species was studied by Chinnusamy [14] and they bring into being that bread wheat had the highest grain starch content and the lowest heat vulnerability index, followed by durum wheat and diploid species.

Depended on their statement, the prospect research work on refining nutritious importance can be precisely beleaguered on the way to bread wheat. Research studies at gene level has also been completed where heat allied strain genes in bread wheat were besieged for sympathetic the device of rule of these genes by Khurana [69]. Influence of unusual temperature was detected on bread wheat plants by exposing them to heat shock at 37°C and 42°C for 2 h, and receptive genetic factor were renowned through PCR-select deduction technology.

Wide-reaching research is going on with the support of next generation sequencing to separate out the sRNA liable for warmness strain in bread wheat. Numerous warmness lenient cultivars like DBW 14, DBW 16, Raj 3765, Lok 1, GW 322, etc. have been promoted on greater measure in Ethiopia and research is going on to progress more such warmness tolerant bread wheat cultivars.

#### *4.8.6. Drought-Tolerance*

Drought resistance is currently an important characteristic for bread wheat for water is a restrictive influence, particularly, as the world appearances the special effects of worldwide weather change. Decreasing water bench is also count to the distress and, hence, distinctly from water preservation know-hows, breeding of selected varieties that can abide low-water circumstances are a progressively higher importance. Artificial bread wheat has been established by crossing tetraploid durum bread wheat with Aegilops tauschii, the inherited benefactor of the D genome in bread wheat, which has revealed good tolerance to drought stress [105].

By means of these artificial bread wheat's, the breeding Program in CIMMYT (International Maize and Bread Wheat Improvement Center), Mexico has prepared an outstanding improvement in developing bread wheat's modified to drier atmospheres. This effective research project can create important involvement in deal with issues of crop loss and food scarcity. A new study on the influence of chloroplast antioxidant system against stress tolerance in bread wheat was conducted by Sairam [92].

They create certain relationship between the tolerance level of the genotype to dampness and heat stress with its antioxidant enzyme structure. Therefore the workforces be able to use this evidence to target their research study in the area of transforming enzymatic passageways, which be able to lead to rise in crop's resistibility hereafter.

Hereditary and genomic implements to advance drought tolerance are adequately defined by Fleury [44] in depth. They analyzed improvements in the heredities and genomics of drought tolerance in bread wheat wherever a definite environment was targeted and suitable germplasm and the atmosphere was carefully chosen, founded on meaning of morpho-physiological and molecular appliances of tolerance of the parentages.

This evidence was used to make intended populaces and advance models for QTL analysis and positional duplicating. Greatest QTLs for drought tolerance in bread wheat and its nearby proportional barley have been identified through yield and yield constituent quantity. Transgenic bread wheat lines for improved biomass yield underneath water scarcity environments were established by Sivamani [97]. By atom offensive of barley gene HVA1 prearranged for late embryogenesis protein (LEA), which collects during seed dehydration. Genomic relations were detected for drought tolerance on the undersized arm of bread wheat genetic material 4B [67, 107]. A steady genomic area related with drought vulnerability guide (qDSI. 4B. 1) was charted on the short arm of genetic material 4B, which also measured grain yield for each plant, harvest directory and foundation biomass below drought.

Indicators strongly related to this genomic section in mixtures with other significant areas on collection 7 genetic material be able to be used in marker-assisted breeding for drought restraint in bread wheat.

#### *4.8.7. Salt-Stress*

Suppression and breeding has tightened the gene mere of contemporary bread wheat, leave-taking it exposed to ecological strain. Salty soils lead to farming difficult from the time when buildup of sodium in leaves sufferings photosynthesis, which is risky to the plant's persistence. The salt-tolerant gene (TmHKT1; 5-A) excludes sodium from the leaves. It produces a protein that removes the sodium from the cells lining xylem.

Many courtesy is focused in the direction of by means of this gene to alter bread wheat genotypes. Researchers from CSIRO Plant Industry have presented a salt-tolerant gene keen on marketable durum bread wheat, viewing remarkable outcomes in field tests [82, 90]. At Waite Research Institute, University of Adelaide, Australia, researchers have performed on the way to sympathetic just how the gene distributes salinity tolerance in the plants [82].

They studied the occupation of the salt-tolerant genes in the laboratory and their result on improved grain yield in the field. This was the initial study to authorize that the salty-tolerant gene can raise the yield in a field with salty soil, whereas further alike studies have merely observed at the enactment of gene underneath meticulous situations in a laboratory or greenhouse.

In Ethiopia, the nation-wide bread wheat and durum wheat improvement research programs has intensive linked, but below par adapted genotypes into bread wheat and durum wheat on doubled over haploid breeding and overviews alteration methods by amalgamation of tolerance from wheat cultivars. Hereditary difference for disease tolerance in some bread and pasta wheat genotypes on bread wheat cultivars has also been studied to discover out diverse indicators, which can be cooperative in assortment of varieties in diverse breeding programs.

### *4.9. Breeding Bread Wheat for Resistance to Biotic Stress*

Bread wheat is also confronted by the amount of pathological, bacterial and fungal pathogens, along with insect and nematode pests. Introgression of genes from uninhabited families has showed resistance to pests and pathogens in bread wheat.

These genes have been magnificently used terminated the years for the generation of impervious cultivars of bread wheat.

Bluntness of advanced transgenes those encrypt for anti-microbial peptides, defense-linked proteins and enzymes for the production of anti-microbial mixtures in crop plants has been a certainty currently. Their usage importantly improves the opportunity of causing crop plants for impervious to pests and pathogens. Growing impervious resistant bread wheat varieties is the best cost-effective and ecologically non-toxic approach to wipe out the usage of fungicides and to decrease crop damages. Exciting of the work in this area has been intensive on evolving safety counter to fungal pathogens.

#### *4.9.1. Developing Resistance to Common Diseases*

The main bread wheat diseases dominant in Ethiopia are rusts, comprising brow rust, stripe rust and black rust, Kernel bunt, foliar blights, powdery mildew and loose smut. Diseases such as head scab, foot rot and flag smut are of inadequate significance. Leaf rust, produced by Puccinia triticina, is one of the greatest harmful diseases of bread wheat wide-reaching in the world. Pyramiding numerous rust- impervious genes into one modified variety is one new plan these times.

Three highly effective alien genes for brown rvious resistance; Lr 24, Lr 28 and Lr 9 were designated for pyramiding in the experience of a vulnerable but satisfactorily improved bread wheat cultivar [13]. When this cultivar was selected against infectious track type 77-5 (121R63-1) of brown rust, a high degree of seedling & adult plant impervious was perceived. The obtainability of the amalgamation of the three main rust impervious genes in required background would enable the planned disposition of bread wheat cultivars to attain strong impervious. These studies have cemented a track to battle the rust problem in bread wheat. Work on RFLP charting of impervious to rust and loose smut has initiated lately. Panjab Agriculture University has developed artificial immunisation method for selection alongside the pathogens.

This method was then used in conducting methodical breeding work on Kernel bunt. Bread wheat was converted with the piece of gene encrypting the barley yellow mosaic virus coat protein and pathogenesis-related (PR) proteins [68]. This hereditary alteration caused in the development of new better-quality disease impervious bread wheat.

Pellegrineschi and his colleagues [85], assessed the PR proteins, such as, the thaumatin-like protein (TLP) from barley, chitinase and 1, 3, β-glucanase. Steady incorporation of these genetic factors in the genome and inheritance in the scions were resolute by phenotypical studies that dared the plants in contrary to a widerange of pathogens.

Their effects showed the improved impervious of transgenic bread wheat plants to Alternaria triticina [85, 106].

#### *4.9.2. Herbicide Tolerance*

Herbicides are pesticides used to kill undesirable weed plants and their use is one of the key causes for green revolution in Ethiopia. Herbicides have a main difficulty of killing the principal plant varieties along with the weeds, which cause into larger damage. Herbicide tolerant varieties deliver different choices for the controller of main weeds, which are limiting agricultural production.

In North-western Ethiopia Phalaris minor is the great severe weed alongside which isoproturon has been castoff. However its constant usage has caused hostility in the weeds. Now broad spectrum herbicide "Basta" is actuality used to regulate P. minor. Herbicide-tolerant transgenic bread wheat was shaped by micro projectile attacking method, which could deliver operative mechanism beside the P. minor through the usage of herbicide Basta [54].

#### *4.9.3. Genetically Modified Bread*

The production of maize and soybean are in advance of bread wheat for the reason that derivative efforts for bread wheat are not custody in advance with the simplified performances used to advance maize and soybean. Several modifications of the bread wheat genome have been done finished homologous recombination with wild bread wheat species, which proved to be helpful to introduce disease resistance in bread wheat cultivars.

#### *4.9.4. Transgenic Bread Wheat*

Transgenic bread wheat can be complete by the technique of transformation, which comprises the method of introduction of foreign DNA containing the gene into the parent plant. Besides a large genome scope, bread wheat has a high number of DNA repeat engagement slight repair capability and difficult alteration structures [12]. All through the past 20 years, a number of in vitro & in planta alteration techniques were described for alteration in bread wheat. In vitro culture and somatic embryogenesis of several different genotypes have been achieved [70].

So far biolistic element and Agrobacterium-mediated bread wheat alteration approaches were in use, however currently further change performances are also subjugated by researchers. Global several effort has been widespread on the enhancement of bread wheat associated to straining tolerance, yield & value then again different other crops, transgenic bread wheat has not been commercialized.

#### *4.9 5. Gene Muzzling Is an Advanced Start Extensive Way to Resolve*

Gene muzzling or gene silencing-related devices were principal well-known as an amazement thought by plant scientists throughout the study of plant alteration experimentations, in which the overview of a transgene into the genome directed to the muzzling of both transgene and homologous endogens [57, 62].

Since then, the biologists have made important developments in manipulating RNA muzzling as an influential instrument for gene roles studies and crop enhancement. RNA-induced gene muzzling or RNA intrusion (RNAi) is a preserved controlling device of gene countenance that has been extensively categorised in eukaryotic entities [34, 48].

The RNAi mechanism has been exploited widely and has come to be important fixed genomics instrument to stillness practically any gene of importance by bring together target gene orders into cells or entities. The subsequent complete analysis of resultant harm of functions and changed phenotypes signify the greatest keenly interpretable technique for experimentally verifying the starring role of particular gene performance. Virus-persuaded gene muzzling (VIGS) is an expertise that activities an RNA-mediated antiviral defense mechanism [94].

It comprises foundation of engineered viruses carrying orders conforming to the multitude gene to be muzzled. Contagion leads to combination of viral dsRNA, an intermediary pace in viral duplication. This stimulates the anti-viral RNA muzzling passage, resultant in down-rule of the bulk gene transcription [84]. VIGS has been castoff extensively in plants for analysis of gene action and has been modified for great-amount practical genomics [54, 55]. Safety of plants from viral contamination has been one of the principal commercial results causing from the application of a gene silencing technique.

For instance, transgenic papaya (Carica papaya) with confrontation to Papaya ring spot virus (PRSV) was among the first commercial releases and saved the papaya industry in Hawaii [45]. Likewise some work has been also conducted in bread wheat too, however a lot further is desired. Regina and [89] had worked on the adjustment of starch conformation in bread wheat. They used hpRNA hypotheses to stillness an isoform of a starch-splitting enzyme to produce a high-amylose transgenic bread wheat line, which can have important health welfares.

Whereas further research is necessary to create precise roles of RNA quietening passages in plant defense counter to non-viral pathogens and pests, it can be expected that gene muzzling-based skills could possibly be advanced to regulate bacterial contamination, fungal diseases and insect penetration of agronomically significant crop species. Potential practices comprise the overexpression or down-regulation of host-encoded gene muzzling features identified to be elaborate in disease confrontation passages or rock-bottom of sRNA types already exposed to be intricate in plant defense alleyways.

The difficulties of multifaceted genome in bread wheat can be reduced by improving techniques for modest incorporation arrangements, use of precise agents and gene orders secluded from other cereals.

#### *4.9.6. Hybrid Bread Wheat*

United States and a pair of other countries commercialized the use of hybrid bread wheat in the 1970s. Seed production cost was awfully great and that is why it was always grownup on a great scale [112]. Therefore, most corporations released their research programms on hybrid bread wheat, however Ethiopia is an exclusion: the Maharashtra Hybrid Seed Company (Mahyco) launched hybrid bread wheat in 2001 and stated acceptance of 60,000 acre lands in 2005. Amazingly, the firm's selling emphasis is not on the irrigated bread wheat conditions of Northern Ethiopia. However on countries like Maharashtra in the semi-arid tropics, where bread wheat is mainly grownup for home-based feeding.

The request for hybrid bread wheat is price sensitive, which shows that if hybrid seed costs might be depressed such as over production efficiency gains, acceptance rates could rise importantly. We can imagine that hybrid bread wheat might be one significant choice to block challenges met by agricultural research in Ethiopia. From the time when hybrid bread wheat has been in the market merely ever since 2001, more research is desirable to evaluate its efficiency in several bread wheat growing areas of Ethiopia and under diverse climatic environments.

### *4.10. Bio Fortified Bread Wheat*

Bio fortified bread wheat is nutritionally better-quality bread wheat, which can rise people's intake of minerals, zinc and iron. International Centre for Bread wheat and Maize (CIMMYT) is leading the research determinations in co-operation with national agricultural research and extension systems in the South and West Asia. Half a billion people in South and West Asia are lacking in iron and iron deficiency anemia rates in India are among the highest in the world with 79% of children and 52% of pregnant women being affected. This is mostly ascribed to low bioavailability of iron in the food [87].

Bio fortification exertions intends to increase the nutrient level of basic cereals crops and are a scheme planned to increase micronutrient consumptions in Ethiopia. Mutual agricultural policies can be used to advance these great nutritious quality bread wheat's similar to using micronutrient fertilizers, but this includes great expense. Instead, crop bio fortification via outdated cross breeding deals a maintainable and low-cost way to deliver important micronutrients [52]. Hereditary bio fortification comprises standard breeding methods to describe and exploit hereditary difference for mineral content, along with new methods involving gene finding and indicator aided breeding [53].

It is anticipated that acceptance of micronutrient dense bread wheat varieties will be determined by their better-quality agronomic possessions, greater yield prospective, confrontation to new straining of rusts, and tolerance to weather change persuaded temperature and drought strains. As a result development of bread wheat seeds with greater micronutrient intensities is a puzzling duty for bread wheat breeders.

#### *4.10.1. The Use of Mineral Fertilizers in Bread Wheat Production*

Fertilizer needs of crops vary with productiveness importance of the soil, convenience of soil moisture, cultivars of the crop, perseverance for which the crop is grown, etc. of numerous causes, fertility standing of the soils importantly distressing crops yield. Different rates and types of segregates of rhizobia and their value have been assumed helpful in respect to soil resource development and rise yield and yield constituents. Nitrogen (N) is an enormously significant fresh material required for the growing of plants, as it is an important constituent of metabolically active mixtures like amino acids, proteins, enzymes, coenzymes and some non-proteinous combinations [6].

Likewise, broad usage of N-based fertilizers all-inclusive has triggered in distinct ecological difficulties associated with high-input agricultural production arrangements. The contamination of natural possessions and collective costs of N fertilizers has also assumed to be more commitment to improve their practise in agriculture and made the development of better N usage for appropriate crop plants [55]. Quite the reverse, small-scale farmers in Ethiopia are prominent to use slight rates of inorganic nitrogen and phosphorus fertilizers, less than 100 kg $ha^{-1}$ of urea and/or DAP for crop production owing to prohibitively high prices [6].

The small use of mineral fertilizers to crops might stalk from reluctance of farmers to use fertilizers due to expected low response of the crop for the reason that of climatic diffidence like particularly erratic rainfall throughout the main growing season [81].

It might also to be expected because of non-existence of consciousness as to which types and rates of fertilizers are suggested for their explicit crops, soils, and agro-climatic circumstances or to presence of problems in entrance to fertilizers or obtaining influence among farmers accordingly of diverse resource endowments [81].

Farmers use also minor quantities of organic fertilizers because of competing needs such as the usage of cow manure as a source of vitality for providing and crop residues as fodder for animals [81].

The entire amount of N essential for crops will vary with the soil type, the previous crop grown, and the amount of organic material existing in the soil and the climatic circumstances during the growing season. Anbessie [6] indicated that N accounts for a greater proportion of the difference in plant height, leaf area, leaf count, and fresh and dry bio mass when it was increased from 50 to 200 kg $ha^{-1.}$ Nitrogen (N) is a very essential raw material essential for the growth of plants, as it is a crucial element of metabolically dynamic combinations like proteins, amino acids, enzymes, coenzymes and some non-proteinous mixtures.

Then again, wide-ranging use of N-based fertilizers globally has caused insignificant ecological difficulties accompanying with high-input agricultural production systems. The contamination of natural resources and increasing prices of N fertilizers has also motivated more consideration to increase their use in agriculture and produced the progress of enhanced N application for effective crop plants [49].

In reverse, small-scale farmers in Ethiopia are prominent to apply small rates of inorganic nitrogen and phosphorus fertilizers merely less than 100 kg $ha^{-1}$ of urea and/or DAP for crop production due to excessively high costs [81, 101]. The minor application of inorganic fertilizers to crops may stem from diffidence of farmers to small reaction of the crop & fertilizers usage due to forecasting of climatic hesitancy during the strategic growing season [81].

It might also be known to lack of information as to which kinds and rates of fertilizers are recommended for their certain crops, soils, and agro-climatic conditions; or to the presence of dissimilarities in entree to fertilizers or buying supremacy among farmers because of diverse resource supports [81].

Farmers use also small quantities of organic fertilizers because of challenging desires like the use of cow manure as a source of energy for cookery and crop remains as fodder for animals [81]. The entire quantity of N necessary for crops will vary with the soil type, the preceding crop grown, and the quantity of organic matter existing in the soil and the climatic circumstances throughout the growing season. Nitrogen and phosphorus (P) are amongst the maximum necessary and frequently useful nutrients as inorganic fertilizers for creating the dominant crops in Ethiopia.

On the other hand, the rates of application of the nutrients are far less than the desires and based on wide-ranging recommendations on various areas and soils. Phosphorus lack is one of the main limitations to crop production in many tropical soils, on account of small natural contents and high P fixation capability of the soil.

Phosphorus is necessary for root growth and when the obtainability is inadequate, the growth of plant can be reduced. It is complex in many physiological and biochemical procedures in plant ripeness, fruit setting and seed production. It's part of plant nucleoprotein and hence fundamental in plant inheritance and also plays a critical role in cell detachment, stimulates root growing, and quick up plant ripeness and physiologically prominent in the storage and transferal bonds of ATP. The requirement for P is severe throughout the initial step of growth when regular meristem growth and quick height development are essential for a great yield.

The moving action of P in soils is very low and its acceptance typically hub on the emphasis slant and distribution in the soil connecting roots. Research work has been done on the base of NP in varied soil classes and in several climatic situations, however very restricted work has been stated on several sources of fertilizers for a definite nutrient. Amongst the dominant macronutrients, potassium (K) and sulphur (S) have been ignored by most of our local farmers to spread on to their crops. However the capacity of K and S in most of the soils is pertinent, there is also a sign of fixation of K and leakage of S in diverse types of soils [83]. Alike to other macronutrients, sulphur (S) is an energetic nutrient for life and necessary for plant growth. It provides great crop yields and quality excellence in three varied ways [1]:

1) It provides a direct nutritive importance;
2) It develops the use competence of other important plant nutrients, mainly N, P and certain micronutrients, like Zn, Fe, Cu, Mn & B.
3) It rises crop product excellence by increasing protein and oil quantity in seeds, cereal quality for milling and baking, nutritive importance and marketability of vegetables and fruits.

In the main, sulphur has the similar tasks in plant growth and nourishment as N and plant necessities for sulphur are similar to P. Greatest crops eliminate 15 to 25 kg S ha$^{-1}$. Crops want additional sulphur than phosphorus for highest yield and quality importance [35].

#### *4.10.2. Combined Use of Organic and Inorganic Fertilizers*

The usage of well-proportioned sources of nutrients to achieve great yield and good quality-grain is the main practice in today's bread wheat production. Organic inputs are so frequently recommended as additional choice to mineral fertilizers. However, the farmers' organic inputs, crop remainders and animal composts cannot meet crop nutrient requirements in excess of a massive area due to the inadequate quantities obtainable, the minor nutrient content of the resources, and the high labor needs for handing out and usage.

Accordingly, many farmers in Africa drop in the double limits of the organic to inorganic fertilizer range and using the amalgamation of organic and inorganic inputs. Harmonizing the usage of chemical fertilizers and organic fertilizers has assumed excessive prominence these days to conserve as well as tolerate a higher level of soil fertility and the crops productive efficiency [95].

Farmyard manure (FYM) is amongst the main soil adaptations to which farmer's right of entry has in expanded farming schemes as it improves both crop productivity, and the physical and chemical conditions of soils through given that numerous nutrients and organic matter. The extensive usage of FYM prominently depends, amongst others, on suitable usage methods, which increase the value or importance, reduced costs, and increases the production efficiency.

Composts and manures rich in potash like wood ash and poultry manure given that an enhanced out-turn. Well decomposed FYM is used at the rate of 25-50 t ha$^{-1}$ later the first cultivating or it might somewhat be useful to the previous crop. Mutually compost and inorganic fertilizers have a potential role on the growth and development of crops [95]. The usage of FYM at the rate of 20 t ha$^{-1}$ improve yield suggestively with augmented acceptance of N, P and K nutrients; the S and FYM usage shown synergistic interaction result on the acceptance of sulphur. Rigorous cropping, biased fertilization and missing of micronutrients applications, fewer or no use of organic manures may possibly resulted in the decline of soil fertility.

Consuming underneath optimum fertilizer rate is one of the main blockages for increasing wheat yields in nearly all highland vertisol parts of Ethiopia. Farmers also contemplate as the best essential input to sustain or increase their production. On the other hand, the usage of the applicable amount of N and P should be the foremost contemplation to rise the production efficiency, diminish poverty and food uncertainty [30].

Three forms of approvals are prepared bearing in mind the numerous elements disturbing policymaking i.e., fertilizer commendations should be malleable. If farmers cannot have enough money to cover the costs of the highest suggested fertilizer rates, they usually recognize that any other lesser rates cannot work. Therefore, they preserve back to their previously modified practices. So, outstanding thought was assumed to the numerous elements that requirement to be considered for applied usages and receiving by various shareholders.

Depended on farmers first choice of fertilizer application rate and their inclination to progressively accept higher rates the 92-46 (N-$P_2O_5$) kg ha$^{-1}$, which is corresponding to 160 kg ha-$^{1}$ Urea + 100 kg ha-$^{1}$ DAP is suggested. This rate was with the maximum marginal rate of return (MRR). It would be superior to guide deprived farmers to twitch with this nethermost level suggestion. With the accumulative profits they practice they can gradually progress to advanced levels. Depend on the requirement to achieve the extensive time great yield objectives set by proposers, the 138-69 kg ha-$^{1}$ N-$P_2O_5$, which is equal to 240 kg ha-$^{1}$ Urea +150 kg ha-$^{1}$ DAP is suggested.

On the other hand, because of the buildup of P nutrient in the soil through sustained usage, farmers with previous times of good P fertilizer usage should be recommended to use 100 in place of 150 kg ha-$^{1}$ DAP. Lemma [73] reported as the application of blended fertilizer has no significant effect on wheat.

For some of the best farmers and for rational use by poor farmers, an intermediary recommendation of 115-46 kg ha-$^{1}$ N-$P_2O_5$, which is compara [30].

Under Ethiopian circumstances, but, price increase disturbs both input and output values, on account of which the whole incomes could correspondingly rise with accumulative benefits. What is more essential is Ethiopian government generally takes some methods to regulate price increases in fertilizers than in wheat.

This detail obviously specifies that the rationality of the approbations made can have little effect over the course of time on the recommendation made across the recommendation dominions. Additional benefits that could be obtained from the production process were straw yields, soil quality improvements, and grain quality improvements.

The supplementary economic returns that could be attained from such an extra benefits were not considered in the economic evaluation due to the problems posed in the assessment of the market values of straw, remainders, and the nonexistence of grain quality standards to establish superior prices uncertainty [30]. In the future, then, holds possibilities to farmers to produce supplementary revenue from grains products with higher value-added grain potentials causing from uses of the suggested practices. Straw yields and soil quality enhancements are supplementary elements that can rise the benefits-cost ratios of the suggested practices.

## 5. Economic Value Analysis on Purposely Selected Bread Wheat Varieties Grain Yield

The Economic value results of the varieties seed size and plant populations have been revealed a reliable gainful effect on grain yield of bread wheat. As to the partial budget analysis outcomes, the highest net benefit value about (46735 ETB $ha^{-1}$) was achieved from the variety Hidassie at a seed rate of 300 seeds $m^{-2}$, followed by the net benefit value (44460 ETB $ha^{-1}$) was obtained from the variety Hidassie at a seed rate of 250 seeds $m^{-2}$ and the lowest grain yield (30117 ETB $ha^{-1}$) was attained from the variety Hidassie at seeding rate of 400 seeds $m^{-2}$ [5]. The outcomes of the partial budget evaluation and the economic data used in the development of the partial budget are illustrated in (Table 4).

### *5.1. Costs hat Vary and the Inputs Price Data Collected*

Data needed for the economic analysis was gathered from the experimental trials field and from the nearby wheat producing farmers were reviewed as well.

All variable costs including land preparation, planting, weed control, and harvesting costs are assessed based on the real field prices at the time of sowing, and at vegetative growth stages as well as instantly after harvest; and consigned over the varieties and plant population levels.

The variables purchasing costs and selling prices used for economic analysis is the 2018 and 2019 marketing costs and local market prices respectively, because of the best managing situations. The costs of NPS and N fertilizer were assessed based on the cost of NPS and Urea, respectively [5]. Dominance analysis, as suggested by CIMMYT, 1988 was used to screen treatments with greater variable costs, however lower net benefits; and dominated treatments removed from additional considerations in Marginal analysis.

The least adequate rate of profit was taken as 100%; and treatments with lowest rates of profit were also illuminated from further analysis. The above given seed prices are calculated with standard seed price of ETB 2288 per 150 kg (400 seeds $m^{-2}$) for one hectare, however it may come to be differ from this interpretation to the varieties seed size. The total cost that vary (TVC) for smaller plant population levels was lesser than the larger plant population levels. Alternatively, lowest net benefit (NBV) was scored due to the highest seed rate of 400 seeds $m^{-2}$ which profited about 30117 ETB $ha^{-1}$ [5]. Pertinent data to conduct preliminary assessment of economic analysis, yield levels were gathered using data collecting formats that were developed to this effect. These were mostly the costs of inputs, wages, fertilizers, chemicals and the prices of outputs.

### *5.2. Partial Budgeting Analysis of Bread Wheat Grain Yields*

With the intention of creating the investigational data and information about the costs and benefits of various alternative treatments, a partial budget analysis was done to regulate the economic impression of various alternative treatments as compared to the farmers' practice for bread wheat production at the study area. Local market (LM) price was used to calculate the product value. The cost of labour for weeding was taken at 35.00 ETB per day. Bearing in mind the costs that varied such as cost of seed, fertilizers, chemicals and labour wage for planting, weeding and harvesting, the farmers' practice had a minor cost than the experimental method.

In the partial budgeting analysis end result of the current study, the costs for the diverse plant population levels varied consistent with their rates needs being other costs were constant for each treatment. So as to recommend the current results for the study area, it is essential to estimate the least rate of profit satisfactory to farmers or producers in the recommendation dominion.

According to the study results of Anbessie [4, 7] the highest net benefit (46735 ETB $ha^{-1}$) was obtained from treatment combination of variety the Hidassie/large seed size with a seed rate of 300 seeds $m^{-1}$, followed by net benefit (44460 ETB $ha^{-1}$) was obtained from the treatment combination of variety Hidassie/large seed size with a seed rate of 250 seeds/$m^{-2}$, while the lowest net benefit (30117 ETB/$ha^{-1}$) was also achieved from the combination of variety Hidassie/large seed size with a seed rate of 400 seeds/$m^{-2}$ only in one growing season as shown on (Table 4).

### *5.3. Benefit to Cost Ratio Analysis (BCR)*

The benefit-cost ratio analysis was used in the cost-benefit analysis so as to summarize the general relationship amongst the comparative costs and benefits of the proposed research project in which the BCR was articulated in economic terms. The replacements are not merely ranked but can be quantitatively measured one against the other.

***Table 4.*** *Partial Budgeting Analysis of Bread Wheat Grain Yields.*

| Treatment No | Variety | Plant population $ha^{-1}$ | Average grain yield (kg/ha) | Adjusted grain Yield (kg/ha) |
|---|---|---|---|---|
| 1 | Shorima | 2500000 seeds | 3930 | 3341 |
| 2 | Shorima | 3000000 seeds | 4346 | 3694 |
| 3 | Shorima | 3500000 seeds | 4322 | 3674 |
| 4 | Shorima | 4000000 seeds | 4059 | 3450 |
| 5 | Dendea | 2500000 seeds | 4134 | 3514 |
| 6 | Dendea | 3000000 seeds | 4045 | 3438 |
| 7 | Dendea | 3500000 seeds | 4485 | 3812 |
| 8 | Dendea | 4000000 seeds | 4865 | 4135 |
| 9 | Hidassie | 2500000 seeds | 4556 | 3873 |
| 10 | Hidassie | 3000000 seeds | 4788 | 4070 |
| 11 | Hidassie | 3500000 seeds | 3643 | 3097 |
| 12 | Hidassie | 4000000 seeds | 3350 | 2848 |

***Table 4.*** *Continued.*

| Treatment No | Total costs that varied (ETB/ha) | Gross farm benefit (ETB/ha) | Net benefit value (ETB/ha) | Benefit to cost ratio (ETB) |
|---|---|---|---|---|
| 1 | 5382 | 43433 | 38051 | 7 07 |
| 2 | 5656 | 48022 | 42366 | 7.49 |
| 3 | 6001 | 47762 | 41761 | 6.96 |
| 4 | 6178 | 44850 | 38672 | 6.26 |
| 5 | 5595 | 45682 | 40087 | 7.16 |
| 6 | 5931 | 44694 | 38763 | 6.54 |
| 7 | 6236 | 49556 | 43320 | 6.95 |
| 8 | 6572 | 53755 | 47183 | 7.18 |
| 9 | 5889 | 50349 | 44460 | 7.55 |
| 10 | 6175 | 52910 | 46735 | 7.57 |
| 11 | 6541 | 40261 | 33720 | 5.16 |
| 12 | 6907 | 37024 | 30117 | 4.36 |

Note: Cost of seed 15.25 ETB/kg; Labor Cost ETB 35/day; Field Sales price ETB 13.00/kg

The highest benefit cost ratio of (7.57) with low marginal cost and more profitable MRR (795%) was attained from the variety Hidassie/large seed size at the use of 300 seeds $m^{-2}$ seeding rate followed by (7.55) benefit cost ratio with the advantageous MRR (899%) was recorded from the variety Hidassie/large seed size at seeding rate of 250 seeds $m^{-2}$ respectively (Tables 5 and 6). As a result, the furthermost cost-effective seed rates for small scale farmers of the study area with minor cost of production and greater profits in this case were 300 and 250 seeds $m^{-2}$ seeding rates of variety Hidassie/large seed size respectively [7].

### *5.4. Adjusted Grain Yield Analysis of Bread Wheat (kg ha$^{-1}$)*

The adjusted yield is the average yield accustomed downward by a certain percentage to reveal the variance between the experimental yield and the yield farmers could anticipate from the treatment. Experimental yields, even from on-farm experiments under descriptive circumstances, are frequently higher than the grain yields that farmers could anticipate by means of the alike treatments CIMMYT, 1988. There are numerous causes for yield adjustment persistence and just to give emphasis to some key points:

*Field Management*

Researchers can often be more specific and sometimes more appropriate than farmers in operations such as plant spacing, fertilizer use, or weed management.

*Plot Size*

Yields predictable from small plots often exaggerate the yield of the whole field due to faults in the measurement of the harvested area and for the reason that the minor plots tend to be more uniform than the farmers bulky fields.

*Harvest Date*

Researchers often harvest a crop at physiological maturity, while farmers may not harvest at the best time. Accordingly even when the yields of both researchers and farmers are adjusted to constant moisture content, the researchers' yield may be greater, due to lesser losses to insects, birds, rodents, ear rots, or shattering.

*Form of Harvest*

In some cases farmers' harvest techniques may lead to substantial losses than result from researchers' harvest techniques. This might happen, for instance, if farmers harvest their fields by machine and researchers carry out a more watchful manual harvest. Except some adjustment change is made for these elements, the experimental yields will overvalue the revenues that farmers are expected to get from a specific treatment [7]. One way to estimate the modification needed is to relate yields achieved in the experimental treatment which signifies farmers' exercise with yields from wisely sampled check plots in the farmers' fields. Wherever this is not conceivable, it is essential to review each of the four factors discussed earlier and assign a percentage modification.

### *5.5. Dominance Analysis of Bread Wheat Grain Yields*

Dominance analysis process was performed to select possibly cost-effective treatments from the range that was tested. It was done first by listing the treatments in order of increasing costs that differ as shown on (Table 2). Any treatment that had net benefits that are less than or equal to those of a treatment with lower costs that vary is dominated. Then the dominated treatments were rejected from further economic analysis. It led to the assortment of treatments, Hidassie/large seed size at seed rate of 250 and 300 seeds $m^{-2}$, which ranked in equal order of the BCR respectively. The marginal rate of return for non-dominated treatments is stated in (Table 3). MRR among treatments of the variety Hidassie at seed rate of 300 seeds $m^{-2}$ were lower than that of the treatments in the variety Hidassie at seed rate of 250 seeds $m^{-2}$. It was lastly to in that order would offer positive MRR of 795% and 899% respectively.

***Table 5.*** *Dominance Analysis of Bread Wheat Grain Yields.*

| Treatment No. | Variety/Seed Size | PPL | TVC (ETB/ha) | NBV (ETB/ha) | Dominance |
|---|---|---|---|---|---|
| 1 | Shorima/Small | 250 seeds $m^{-2}$ | 5382 | 38051 | |
| 5 | Dendea/Medium | 250 seeds $m^{-2}$ | 5595 | 40087 | |
| 2 | Shorima/Small | 300 seeds $m^{-2}$ | 5656 | 42366 | |
| 9 | Hidassie/Large | 250 seeds $m^{-2}$ | 5889 | 44460 | |
| 6 | Dendea/Medium | 300 seeds $m^{-2}$ | 5931 | 38763 | Dominated |

| Treatment No. | Variety/Seed Size | PPL | TVC (ETB/ha) | NBV (ETB/ha) | Dominance |
|---|---|---|---|---|---|
| 3 | Shorima/Small | 350 seeds $m^{-2}$ | 6001 | 41761 | Dominated |
| 10 | Hidassie/Large | 300 seeds $m^{-2}$ | 6175 | 46735 | |
| 4 | Shorima/Small | 400 seeds $m^{-2}$ | 6178 | 38672 | Dominated |
| 7 | Dendea/Medium | 350 seeds $m^{-2}$ | 6236 | 43320 | Dominated |
| 11 | Hidassie/Large | 350 seeds $m^{-2}$ | 6541 | 33720 | Dominated |
| 8 | Dendea/Medium | 400 seeds $m^{-2}$ | 6572 | 47183 | |
| 12 | Hidassie/Large | 400 seeds $m^{-2}$ | 6907 | 30117 | Dominated |

Note: PPL = plant population level; TVC= total variable cost; NBV = net benefit value.

The alterations to the variety Shorima at plant population levels of 250 seed $m^{-2}$ is removed for this reason to keep on with alterations to the variety Hidassie at plant population levels of 250 and 300 seeds $m^{-2}$ which gave more than 100% MRR as capable new practices for farmers under the dominant price structure (Table 3). According to CIMMYT [20], the minimum tolerable marginal rate of return (MRR) should be 100%. As specified by CIMMYT [20], recommendation is not essentially based on the highest yield and even not based on the highest MRR.

Recommendation is just depends on the maximum net benefit cost ratio and thus, the most economically greater variety and seed rate for farmers of the study area with minor cost of production and the maximum net benefits were recognized to be the variety Hidassie/large seed size at seeding rate of 300 seeds $m^{-2}$ (142.00 kg ha-2). The seeding rate of 250 seeds $m^{-2}$ (118 kg ha-2) of this variety was also profitable with the maximum net benefit and recommended as 2nd option.

***Table 6.*** *Marginal Analysis Effects of Bread Wheat Grain Yield.*

| Treatment No | Variety/Seed Size x Plant Population Level | TVC (ETB/ha) | MC (ETB/ha) | NBV (ETB/ha) | MNB (ETB/ha) | MRR (%) |
|---|---|---|---|---|---|---|
| 1 | Shorima/Small x 250 Seeds $m^{-2}$ | 5382 | | 38051₠ | | |
| 5 | Dendea/Medium x 250 Seeds $m^{-2}$ | 5595 | 213 | 40087₠ | 2036 | 956 |
| 2 | Shorima/Small x 300 Seeds $m^{-2}$ | 5656 | 61 | 42366₠ | 2279 | 3736 |
| 9 | Hidassie/Large x 250 Seeds $m^{-2}$ | 5889 | 233 | 44460 | 2094 | 899 |
| 10 | Hidassie/Large x 300 Seeds $m^{-2}$ | 6175 | 286 | 46735 | 2275 | 795 |
| 8 | Dendea/Medium x 400 Seeds $m^{-2}$ | 6572 | 397 | 47183₠ | 448 | 113 |

Note: ₠ = eliminated; TVC=total variable cost; NBV=net benefit value; MNB=marginal net benefit; MRR=marginal rate of return.

Reliable with the partial budgeting analysis effects, it can be determined that the greatest cost-effective treatment was the variety Hidassie/large seed size which provided the maximum benefit cost ratio of (7.57) and MRR (795%) at seed rate of 300 seeds $m^{-2}$ while, then again the MRR of (899%) and benefit cost ratio (7.55) were attained also from the variety Hidassie/large seed size at seeding rate of 250 seeds $m^{-2}$ as shown on (Tables 1 & 3). Accordingly, the variations to the variety Shorima/small seed size at a seed rate of 250 seeds $m^{-2}$; Dendea/Medium seed size at a seed rate of 250 seeds $m^{-2}$, Shorima/Small seed size at a seed rate of 300 seeds $m^{-2}$ and Dendea/medium seed size at a seed rate of 400 seeds $m^{-2}$ are removed for their minor benefit cost ratio and to remain with the changes to the variety Hidassie/large seed size at seed rate of 300 and 250 seeds $m^{-2}$.

The yield of treatment 8 is higher than that of treatment 10, but the dominance analysis shows that the economic value of the rise in yield is not enough to recompense the rise in costs. Farmers would be better off using the lower seed rate with lower costs [5]. Based on the economic analysis of Anbessie [7] the rolling method and seeding rate of 110 kg $ha^{-1}$ had the maximum net revenue and the lowest cost comparing other treatments.

# 6. Conclusion and Recommendation

One of the great challenges facing Ethiopia at current time is the production of adequate food to feed the rapidly swelling general population growth. Receiving more agricultural land-dwelling into farming is not believable in the rationally populated regions. Value-added agricultural production efficiency needs greater yields per unit land area, which rises the demand of improving the production and productivity of bread wheat.

## 6.1. Conclusion

Over the earlier three decades, as good as bread wheat research and production status have revealed growing inclinations in Ethiopia. Bread wheat importation has also grown significantly over the past years. However, this substantial improvement in national production and importation of bread wheat has not inverted the growing tendency in bread wheat production and product prices, showing an even sooner growth of wheat demand.

Even with a huge investment by the Ethiopian government in agricultural extension programs, studies proves that growing wheat supply insufficiency in the coming decades. This recommends the requirement for increased but well-organized investment not only in wheat research and production but also in wheat processing and marketing. Even if Ethiopian bread wheat producers are mostly small, a review of relevant literature indicates that moderately large amount of farmers and large-scale producers supply most of the marketed local bread wheat in the country.

For example, only 10% of bread wheat producers sell more than 40% of their bread wheat harvest while only 5% sell more than half of their bread wheat production. The top 20% of the bread wheat sellers account for 60% of the local wheat sale. Then again, above half of the bread wheat farmers do not sell any of their wheat production. These facts are very necessary in terms of notifying strategic rules and formations on the necessity to rise bread wheat production in general and marketable bread wheat in particular.

In this way, institutional and policy improvements to advance the supply value chain, development of irrigation and mechanized farming in addition to further investment in research and development can be worthwhile policy interferences to improve wheat supply in the country. Bread wheat is broadly imported by the government. However the result of international trade on the national bread wheat market is predictable to be inadequate as the government made supply and market value chain for such trade in bread wheat intelligently.

Until now, trade in bread wheat is anticipated to influence bread wheat request on the national market of those who obtain endowed wheat, which are millers and few organized customers. As a result, flour prices should shows the largest response to worldwide bread wheat market variations, followed by extensive wheat grain prices. Producer and consumer prices along with the bread market are anticipated to react merely minor to international wheat prices. This observation, however, require to be verified by means of more experimental research. These limitations were largely band together into two groups: practical and socio-economic. The two main bread wheat growing environments were covered: highland cool wet areas and low-altitude warm dry areas.

Even if there has been a reasonable measure of research to enumerate the effect of technical limitations on bread wheat production, research on socioeconomic limitations has mostly been qualitative. Therefore, there is a need to shift the importance of socio-economic research to quantitatively determine the impact of socio-economic limitations on bread wheat production.

Certain studies have assessed the government's judgment to emphasis on bread wheat importation for its price balance policy, by evaluating the validations and cost-effectiveness of communal bread wheat imports concerning local procurement. For example, besides in 2008 and 2009, local procurement of bread wheat would have been justified and delivered better motivations for farmers to grow read wheat at a greater price, which is still lower than importation parity. This could motivate bread wheat researchers and producers to adopt new technologies and rises bread wheat production.

### *6.2. Recommendation*

Regarding bread wheat varietal variations, studies shown that selecting varieties which are related to the stated population and use by farmers may be a reasonable choice for improving bread wheat yields. Based on the result of the economic value limitations analysis, among four plant population levels the use of 300 and 250 seeds $m^{-2}$ for the variety Hidassie/large seed size is superior in most of bread wheat agronomic traits. The bread wheat varieties seed size and plant population rates interaction effect showed that most economical and profitable grain yield of 4100 and 4339 kg $ha^{-1}$ was produced at seed rate of 250 and 300 plants $m^{-2}$ for the variety Hidassie/large seed size respectively. According to the partial budgeting analysis, a observable beneficial and more cost-effective dominance with low cost of the variety Hidassie/large seed size at plant population of 300 plants $m^{-2}$ (142 kg $ha^{-1}$) and 250 plants $m^{-2}$ (118 kg $ha^{-1}$) was found to be higher net benefits of the economic value over the other varieties.

This indicate that presently the variety Hidassie is heritably better in grain yield than varieties Dendea and Shorima varieties. All in all, substantial differences in grain yield and most of agronomic parameters of bread wheat were observed because of variety seed size and plant population levels. The existing study recommended that planting bread wheat with large sized seeds such as the variety Hidassie was remarkably advantageous with most encouraging agronomic performance. With the objective to determine the effect of seed rates and plant population rates on the grain yields and economic effects of bread wheat, the field experimentations were conducted in unlike times at Kulumsa Agricultural Research Center from July to November 2012 and from June to November 2018 cropping seasons.

The economic value limitation analysis of the experiment was transported to select the best combination of the variety Hidassie/large seed size at a plant population rate of 300 seeds $m^{-2}$ (142.00 kg $ha^{-1}$) gave the greatest grain yield (4070 kg $ha^{-1}$) with low cost of production and higher net benefits of the economic value and suggested uncertainly as 1st option for the study area.

Alternatively, the variety Hidassie/large seed size at a plant population rate of 250 seeds $m^{-2}$ (118 kg $ha^{-1}$) gave better yield (3873 kg $ha^{-1}$) with a slightly additional cost rather than the primarily recommended seed rate and it was recommended as a 2nd option for the small scale farmers of the study area.

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