International Journal of Environment, Agriculture and Biotechnology, 5(4)
Jul-Aug, 2020 | Available: https://ijeab.com/

Biofortification of wheat: Genetic and agronomic approaches and strategies to combat Iron and Zinc deficiency

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Abstract— *This study delves into the comprehensive overview of different agronomic and genetic approaches of wheat biofortification to combat iron and zinc deficiency. Secondary source of data is used during the study of the subject. Micronutrient deficiencies, particularly those arising from zinc (Zn) and iron (Fe), pose serious human health problems for billions of people worldwide and millions of children, who predominantly depend upon cereals-based diet, suffer from malnutrition.Wheat, being a chief staple food crop for most of the under-developed countries, should be given emphasized to make it enriched with nutrients and minerals as in many cases, it constitutes a low level of nutritional elements. Most of the nutrients are lost during milling. Biofortification acts as the most promising and economic strategic option to effectively increase the micronutrients in the edible portion of the crop. Agronomic and Genetic biofortification are the two approaches; however, genetic engineering is getting more concern for researches. This uses the techniques to enhance the bioavailability of nutrients and reduce the anti-nutrient compounds. Although there are many technologies to increase nutrient contents, biofortification is assumed to be the most sustainable. Different strategies for wheat biofortification are assessed in this paper for overcoming challenges seen during the process. We discuss promising ways to enhance iron and zinc content in wheat, highlight global wheat production scenario and malnutrition status, and also key challenges are accentuated.*

Keywords— ***Agronomic and genetic approaches, Biofortification, Iron, Zinc, Wheat.***

I. INTRODUCTION

Wheat (*Triticum aestivum L*.), a major agronomic crop cultivated worldwide, is a self-pollinated long day plant belonging to family Poaceae that flourishes well under arid and semi-arid regions (Belderok, 2000). It has been a chief staple food, supplying approximately 35% of the total food as consumed by the global population (Mohammadi-joo et al., 2015). Its adaptive attributes to varied climatic conditions and environmental stresses make it a remarkable crop contributing to food security in the world (Muslim et al., 2015). Most (about 95%) of the globally cultivated wheat is hexaploid, which is extensively used for the preparation of varieties of baked products and bread (Debasis and Khurana, 2001). Therefore, the composition and nutritional concentrations of the wheat crop have a substantial impact on human health. Although, being potentially enriched with essential nutrients; especially in calories, most of the wheat varieties grown today are nutrients deficient– notably Iron (Fe) and Zinc (Zn) (Welch and Graham, 2004). The hefty quantity of these minerals is wasted during the milling process resulting in the paucity of these minerals in the human diet, leading to malnutrition. Due to the malnutrition caused by cereal-based diet, nearly about 2 billion population of the world, particularly in Asia and the African region, has suffered (Grew, 2018). As the global population is increasing alarmingly, the condition will be even more serious than expected in the near future if no urgent remedial strategies are implemented. Many scientists, researchers, and field-related experts have been working to find the way and techniques of improving nutrient contents in under-nutritive wheat varieties. Though a number of strategies have been made, they aren't cost-effective and sustainable for combating malnutrition (White and Broadely, 2009; Gomez-Galera et al, 2010; Hurrell et al, 2010). Effective approaches to solving the problem are supplementation, dietary diversification, fortification, agronomic biofortification.

Biofortification is the idea of breeding crops to enhance their nutritional value in an economic and sustainable manner (De Valenca et al, 2017). This can be carried out either through conventional selective breeding or through genetic engineering. Cereal crops like wheat, due to some barriers in potential uptake of soil nutrients, are usually mineral-deficient for which fortification is the must (Fageria and Baligar, 2008). Also, the continuous applications of weak fertilizers that are poor in mineral concentrations have negatively impacted the nutrient availability of wheat (Fageria et al, 2002). Considering this fact, biofortification acts as a feasible way of delivering micronutrients to populations who have inadequate access to diverse diets (Bouis and Saltzman, 2017; Garg et al, 2018). In wheat, it can be done through different approaches; Agronomic approach through direct foliar or soil application of fertilizers and Genomic approach which include genomic section, Marker Assisted Selection (MAS), and Quantitative Trait Loci (QTL) mapping. Owing to a large number of wild wheat relatives still unexploited, the genetic improvement of wheat can highly be achieved in the future focusing on breeding programs (Ahmadi et al, 2018; Dempewolf et al, 2017). Ordinarily, qualitative traits of wheat are governed by a single gene and quantitative by several genes (Breseghello and Coelho, 2013; Cui et al, 2015; Moose and Mumm, 2008). Through conventional breeding, breeding of qualitative trait is easier than that of quantitative trait. Advanced development in the realm of technology provides us new opportunities that can integrate natural variation, genomic achievements, and agronomic applications for improvement of Fe and Zn content in wheat grains.

1.1 Objectives of the study

The general aims of this study are to recommend promising approaches of biofortification to improve iron and zinc concentrations, including other minerals in wheat crops. Therefore, the review focus on how the increase in wheat nutrient concentrations, Fe and Zn, be achieved effectively and efficiently through an integrated agronomic and genomic approaches of biofortification. The specific objectives are to:

a. Describe the status of malnutrition and wheat production throughout the world.
b. Elaborate effective biofortification techniques to increase nutrients in a sustainable manner.
c. Figure out the future challenges in the biofortification of wheat.

II. RESEARCH METHODOLOGY

This review completely uses secondary sources of information. Pieces of Literature were collected from different Journal articles, Agricultural institutes, other sources like FAO, CIMMYT, and relevant reports were studied and the major findings were summarized. Also, suggestions from related professors and officers were considered in the paper.

III. DISCUSSION

1. Global status of wheat production and malnutrition

In 2020, global wheat production is estimated to reach approximately 765.41 million metric tons which will be the highest production to date. Since a few years, production has constantly increased. It might be due to improvement in the agronomical and genetic practices, development of stress-tolerant high yielding varieties, judicious use of bio-fertilizers, increased interests of researchers and scientists to new varietal development, and raise consumer's demand for wheat.

ISSN: 2456-1878
https://dx.doi.org/10.22161/ijeab.54.29

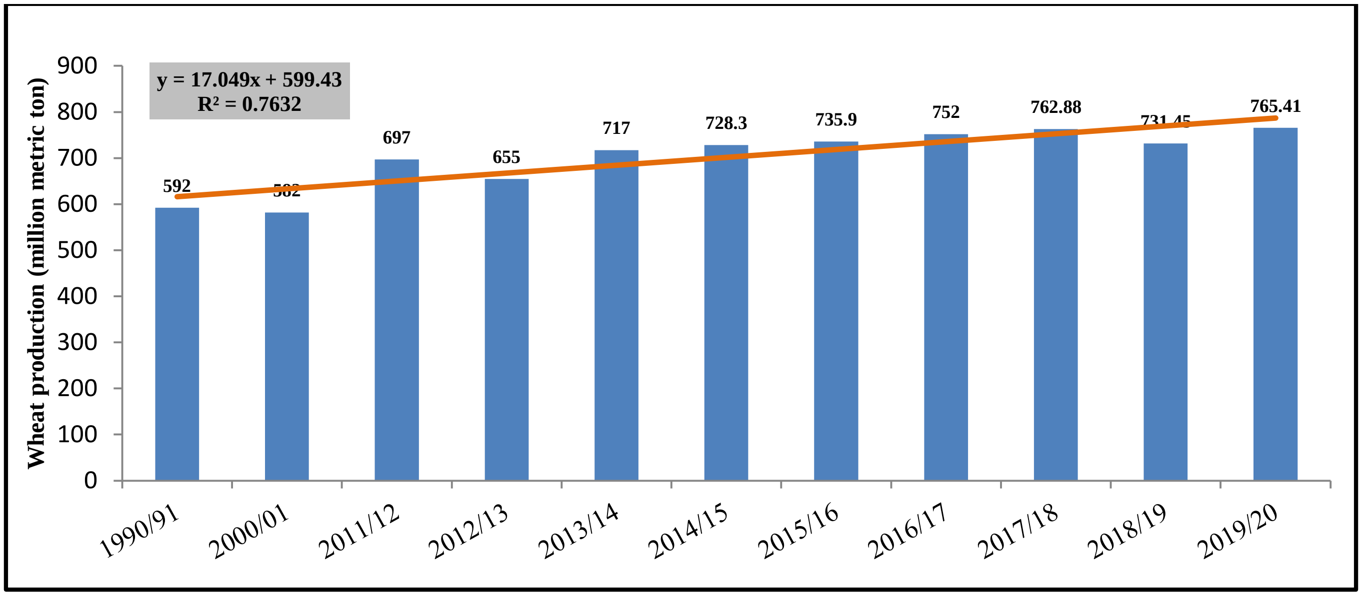

Fig.1: Global status of wheat production from 1900-2019 Source: Statista (2020)

Figure 1 shows that the global wheat production in 1990 was just almost 592 million metric tons which increased and reached 731.45 million metric tons in 2018. There was a decreased in production in 2000, 2012, and 2018 due to several factors such as natural calamities, disease outbreak, lack of interests of growers, and so on. Different organizations like FAO, CIMMYT, etc. have emphasized on quality yield with high production in different parts of the wheat-growing countries.

Within every county in the world, poor people are mostly suffered from malnutrition. Figure 2 shows the rate of malnutrition in different regions and sub-regions in 2018. Oceania is highly affected by very high malnutrition rate (38.1%). The only developed sub-region with overweight data is North America (2.3%). The average global malnutrition rate is found to be 22.2%. African and South Asian countries are still unsuccessful in providing sufficient diets to the suffered people due to a high level of poverty and unemployment. Most of the people have suffered from Fe and Zn deficiency in their diet, especially in cereal-based foods.

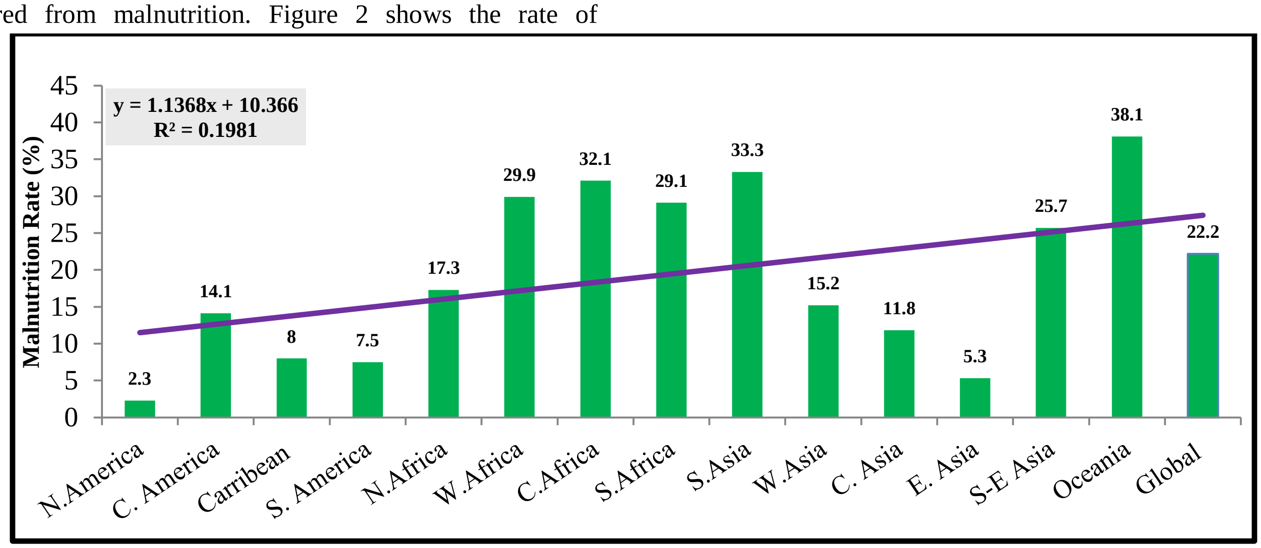

Fig.2: Global status of malnutrition in different regions Source: UNICEF (2018)

2. Biofortification for enhancing Fe & Zn content

Every human being requires essential minerals and micronutrients to enhance metabolism, which humans obtain from their diet. Wheat, like many other staple kinds of cereals, holds suboptimal levels of the essential micronutrients, particularly iron and zinc. Hidden hunger is emerging as a major challenge for the majority of the developing countries as it has become a common public health problem for poor people. Inadequacy of micronutrients results in stunted growth in children, decline in immunity, and work efficiency in adults, in particular women, and impairments in physical development. Iron and zinc have been considered as the most crucial among micronutrients. Its deficiencies causes serious human health hazards such as malnutrition, distorted growth, decreased immunity, increased susceptibility to infections and diseases, and many others (Tulchincky,2010).The potentiality of wheat in reducing micronutrient related malnutrition can be improved through direct (nutrition-specific) interventions, which include nutrient supplementation, dietary diversification, post-harvest food fortification, etc. and indirect (nutrition-sensitive) interventions, which includes biofortification (Ruel and Alderman,2013).Although the wheat crop is usually fortified during processing, an effective and more sustainable solution is biofortification, which needs developing new varieties of wheat with inherently higher iron and zinc concentrations in their grains (Bouis et al; 2011). Genetic biofortification (plant breeding) and agronomic biofortification (application of fertilizer) are two common means of biofortification which were supposed to be cost-effective to the dietary problems (Mara and Petra,2012;White and Broadely,2009;Cakmak,2008). Figure 3 displays a comprehensive overview of different sorts of biofortification for enhancing Fe and Zn content in wheat.

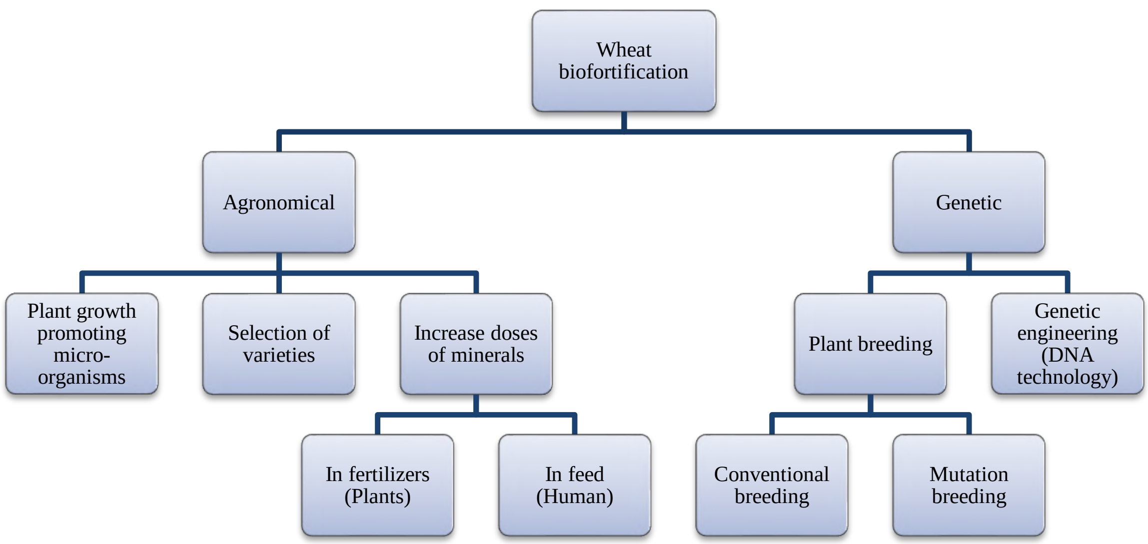

Fig.3: Classification of biofortification in wheat

2.1 Agronomic biofortification:

Most of the cultivated soil, notably which used for wheat and other cereals in the developing countries like Nepal, has a substantial number of chemical and physical constraints that lessen the plant-availability of Fe and Zn. Under such conditions, agronomic biofortification can be adopted either by applying micronutrient fertilizer to the soil or foliar application directly to the leaves of the crop(De Valenca et al,2017). Since antiquity, farmers have used mineral fertilizers to improve the health status of the food crops. A similar way of fertilizer application can also be applied upto a certain extent to enhance mineral accumulation by crop so as to increase nutrient contents (Rengel et al,1999).The various methods of fertilizer application may influence the grain yield and concentrations of Fe and Zn in the crop distinctly. Knowledge of different forms of fertilizers and the timing of soil and foliar application of these minerals is crucial for increasing nutrient content in grain (Velu et al,2013). Micronutrient follows a pathway from soil to crop and then food and finally into the human body. (De Valenca et al, 2017) stated several factors affecting the success of agronomic biofortification, which primarily depends upon;

bioavailability of micronutrients in the soil for plant uptake (soil to crop), translocation of mineral within plant and re-translocation to the harvested food (crop to food), bioavailability of nutrient to human in food and physiological state of human body to absorb and utilize the nutrient (food to human). Soil organic matter content, soil pH, and soil aeration, interaction with other elements, soil moisture content, and the variety of crops determine the extent of bioavailability of soil nutrient to crop (Alloway,2009). Although the application of nutrients through soil is common, the foliar application is considered to be more effective and economical (Cakmak et al, 2010; Zou et al,2010;Peleg et al,2007;Li et al,2016).Soil application of nutrient fertilizer is carried out on based on the soil test whereas; foliar application is done based on the plant tissue test or visual foliar symptom. Agronomic biofortification is popular for the solution to the short term problem as compared to the breeding approach (Cakmak,2008).However, it has several inconveniences in regards to efficiency, sustainability, and economic aspects. The nutrients may be stored in leaves but not in seeds and fruits. Most often, even if crops accumulate nutrients effectively through the soil, the nutrient may not be bioavailable to the crop due to some drawbacks (Frossad et al,2000).Fertilizers must be applied regularly so, this method is unsustainable. The expensive cost of fertilizers is another drawback. As compared to Genetic biofortification, agronomic biofortification is less acceptable on the basis of economics and environmental sustainability (Singh et al,2016). Therefore, agronomic biofortification with Fe and Zn fertilizers, particularly foliar applications, performs well for wheat and provide edible parts of crop plants with sufficient nutrients to combat the global Fe and Zn malnutrition problem. The foliar and soil application of fertilizers in wheat is shown in figure 4.

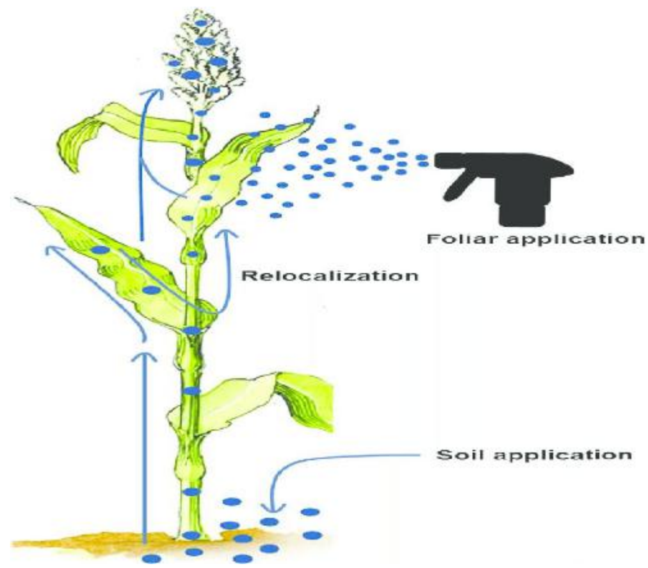

Fig.4: Agronomic biofortification (Foliar and soil application) in wheat Source: De valenca et al. (2017)

2.2 Genetic Biofortification:

Both conventional plant breeding and recombinant DNA technology (genetic engineering) are applied to increase the bioavailability and the concentration of nutrients in crops–known as Genetic biofortification. It can be achieved through marker-assisted breeding, gene discovery, or classical breeding strategy so as to exploit and characterize genetic variation for nutrient content in grain (Grusak,2002). Efficient genetic biofortification enhances the nutrient uptake by plants, increases nutrient translocation to grain, enhances sequestration of nutrients in the endosperm, decreases anti-nutrient compounds, and increases the bioavailability of nutrients(Mulualem,2015). Plant breeders or breeding institutions select and breed nutritious cultivar of wheat crop rich in Fe and Zn concentration and other substances that promote the bioavailability of Fe and Zn. (Velu et al,2013). Variability of the minerals is limited in modern-day cultivar of wheat. Nevertheless, adequate variability has been found to be harbor by the crop of wild relatives for nutrient content improvement (White and Broadely, 2009). To date, a number of researches have been performed in modern and old wheat cultivars, landraces, and wild germ plasma to investigate the variation in the grain zinc and iron amount. (Rawat et al, 2009) carried out similar research in wheat and he concluded that wild relatives were found to harbor 3-4 fold higher grain zinc and iron content than that of modern cultivars. Very close positive correlation was observed in various germplasms of wild, modern, and spelt wheat which indicates that physiological and genetic factors involved in Fe and Zn deposition in the seed are too similar (Cakmak et al,2004; Morgounov et al,2007;Gomez-Becerra et al,2010b). Most of the wheat-growers have been adopting wild relatives to transfer genes for yield and quality improvement as well as biotic and abiotic stress tolerance in cultivated varieties. Besides, conventional and modern breeding approaches can be adopted to transfer useful gene from wild relatives for grain zinc and iron content (Chhuenja et al,2008). Genetic engineering has been practiced to access genes from any desired source and introduces them to the crop directly. It has no taxonomical constraints and even artificially prepared gene can be used.But, limited gene is applicable for plant breeding that can be extracted from sexually compatible plant (Singh et al,2016). In recent years, a remarkable advancement in genetic biofortification has been made to reduce iron and zinc deficiencies that provide a sustainable diet-based solution to complement other interventions (Ludwig and Slamet-Wedin,2019).Investment for mineral improvement is necessary only at the research and development (R & D) stage which is the main advantage of genetic engineering and plant breeding (Singh et al,2016). The genetic biofortification approach is worthwhile and known to have practical values (Saini et al,2020).

2.2.1 Plant breeding approaches

Modern wheat breeding programs, in the last 50 years, have targeted to increase the total yield and productivity by selecting desirable plant height, plant resistance to diseases, and increased harvest index and biomass among all other traits (Ortiz et al,2007).Through plant breeding strategies, substantial genetic variations form the basis for crop improvement (Ortiz-Monasterio et al,2007). Along with focused on crop yield improvement, the nutritional composition in the grain is equally important to feed the world's growing population. Bioavailable Fe and Zn in the seed and grains of the staple food crop are as low as 5% and 25% respectively. Accordingly, micronutrient concentrations and their bioavailability in wheat should be emphasized in the breeding programs. The record of the past shreds of evidence showed that Fe and Zn contents in grain are quantitatively inherited traits (Trethowan et al,2005;Trethowan et al,2007). Quantitative traits aren't easier as qualitative to breed through conventional breeding approaches. An exception to some widely grown cultivars, some genotypes show significantly higher Fe and Zn concentration; e.g.: wild species, landraces, and lines from a pre-breeding program at CIMMYT (Monasterio and Gresham,2000).CIMMYT hasgiven priority on wheat breeding by transferring genes that govern increased nutrient from *Triticum aestivum spp spelta*and *Triticum turgidumspp dicoccon* based synthetics to high yielding wheat varieties(Velu et al,2013). Owing to the fact that colored wheat (black, purple, and blue) has a high concentration of phenolics, it is used in several breeding programs in different countries and many varieties of it have already been released (Garg et al,2018;Shao et al,2011;Sharma et al,2018). In this regard, the breeding programs can be considered as a product pathway driven by the potential effect of research and nutrition at the core of any biofortification (Pleiffer and MC Clafferty, 2007). The targeted regions and population are identified and steps for developing biofortified crops are proceeds which largely based on; bioavailability or bio conservation of ingested nutrient, micronutrient retention after storage, processing and cooking, and requirements of micronutrient in the population (Cakmak et al, 2010; Pleiffer and MC Clafferty, 2007). Identification of high mineral content varieties has been accelerated by breeders utilizing molecular biology techniques like Marker Assisted Selection(MAS) and Quantitative Trait Locus (QTL) maps by accounting differences in properties of soil such as pH, organic composition that may interfere with uptake and accumulation of minerals (Saini et al,2020).

2.2.2 Conventional plant breeding

Grain yields of wheat have increased continually for a few decades. Variety improvement has been responsible for more of the yield increase for a crop. Conventional plant breeding has been adapting on for hundreds of years and is still commonly used today by wheat growers in many parts of the world. It aims to develop plant having genes that help in uptake and accumulation of bioavailable nutrients by changing the genotype of the targeted crop. Once the initial research and development are completed, the benefits from these nutritionally enhanced crops will be sustainable with further little investment (Gomez-Galera et al, 2010), which can be considered as its advantage. It endorses scientists to make a significant improvements in the grain quality, nutritional content, and agronomic attributes of major subsistence wheat crops (Singh et al,2016). Several works have already been performed in conventional breeding to manipulate mineral concentration variability found in different germplasms (Qaim et al,2007).Different methods of selection are applied to develop improved genotypes (Gupta et al,2010). These methods vary not only forvegetative propagated crops but also for self-pollinated and cross-pollinated crops. Mass selection and pure line selection are used to select an improved line for self-pollinated crop from the variability existing in available germplasm. Contrarily, population improvement methods, including recurrent selection are important for cross-pollinated species (Gupta et al,2010).Genetic engineering could be applied to meet sufficient improvement, seeing that all crops don't have such genetic potential so as to meet the desired nutrient level.Conventional breeding can only use the genetic variability that has already observed and available in the improved crop, or occasionally in the wild varieties having the ability to cross with wild relatives. Mostly, by crossing to a distant relatives and thus transferring traits into commercial cultivars nutrient deficiency can be overcome. However, in some cases, breeding for specific traits would be inconvenient using conventional means and the efforts involve and time scale could be quiet unrealistic. Although being used in many cases and many parts, conventional breeding still has many withdraws. It is a slow process, labor-intensive, and often destructive and inaccurate with a high chance of committing errors as they are based either on traditional phenotyping methods or on visual assessment methods (Mwandaingoni et al,2017).

2.2.3 Mutation Breeding Approaches

Mutations have been used successfully in several crops, including wheat for breeding important agronomical traits. It has been used widely to produce grain varieties with improved quality of higher yield and other traits in developed and developing countries (Singh et al, 2016). The enhancement of grain yield and yield components of wheat through the application of mutagens drives towards the improvement of new cultivars with improved traits. The genetic bases of inherited traits can potentially broaden qualitatively and quantitatively by mutation induction through the heritable variation (Mwandaingoni et al, 2017). Mutation breeding, on elite cultivated germplasm of various crops, has previously been applied which creates superior and well-adapted variants (Shu et al, 2012). Mutation breeding develops directly or indirectly thousands of registered crop varieties enlisted in the United Nation's Food and Agriculture Organization (FAO)'s and Mutant Variety Database (MVD) (Mwandaingoni et al, 2017). It makes the perfect use of greater genetic variability by inducing mutation with irradiation or chemical treatments. Both physical and chemical mutagens can be used. Physical mutagens include UV rays, electromagnetic, and corpuscular radiation (Mba, 2013). To detect genomic mutation, such as the targeting induced local lesions in genomes (TILLING), these are coupled with efficient genomics tools (Chen et al, 2014). Thus, among mutant generations, breeder's tasks are to evaluate and screen for desirable phenotypes, and through this approach useful genetic variation is created and could be used for improving adaptability in existing germplasm (Mwandaingoni et al, 2017).

2.2.4 Genetic engineering

To fulfill the nutrient demand of an increasing population, wheat has been genetically engineered by the direct manipulation of its genome using biotechnology. Genetic modification is suggested to be an exquisite approach for obtaining high micronutrient concentrations. Also, a genetically modified organism (GMO) has a high potential for increasing agricultural productivity because of stable expression and fast development of GMO traits. Genetic engineering,compared to conventional plant breeding, needa fewer breeding generation to attain a new variety (Tewodros,2015). Since a single gene can be introduced in the target plant, genetic engineering is more precise. The genes could be extracted from any source, including microbes and animals. It works to improve the mineral mobilization efficiency in soil, reduce the level of anti-nutritional substances, and increases the level of nutrition enhancing useful compounds like inulin (Zhu et al, 2007). Genetic engineering provides a greater approach as it transfers a specific genes of desired traits from a source organism directly into the living DNA of target organisms. Once a useful gene has been identified from the source organism, it is attached to the prompter gene and marker and then inserted into the targeted organism using a carrier. Plants produced as a result of genetic engineering are transgenic orgenetically modified organisms. But GMO'S are unattainable for researchers and unaffordable for farmers as patentable inventions or patented are associated with them (Pardey et al,2000). This method facilitates control of various agronomic and quality traits by direct gene transfer into the targeted wheat crops.

3. Strategies for biofortification

Fe and Zn play a very significant role in plant growth, plant yield, nutrition, and soil fertility. Different institutions and organizations have been involved in increasing the nutrient contents of the produced wheat. Some of the strategies are briefly described below.

Application of fertilizers and foliar spray for raising Fe and Zn concentration:

Application of fertilizers like iron ferrous sulphate (FeSO4) and zinc sulphate (ZnSO4) to the wheat can raise the concentration of Fe and Zn in the growing grain. However, it is not a sustainable solution (Cakmak, 2008). Foliar application of these micronutrients is most reliable strategy (Cakmak et al., 2010a), which increase the concentration of starchy endosperm (Zhang et al., 2010). Use of seeds with high Zn contents, accompanied with foliar application of fertilizers is an effective strategy to enhance Fe and Zn concentration (Velu et al., 2013).

Germ plasm screening for increasing Fe and Zn concentration:

CIMMYT (International Maize and Wheat Improvement Centre) gene bank have been screened for Fe and Zn variation to more than 3000 germplasm accessions, including hexaploid, tetraploid and diploid sources (Monasterio and Graham 2000). Material with the highest Fe and Zn concentrations are progenitors of modern hexaploid wheat like einkorn wheat and wild emmer wheat and landraces (Cakmak et al., 2000; Ortiz-Monasterio et al., 2007).

Transgenic strategy:

Transgenic approach is most reliable and less cost program for increasing Fe and Zn nutritional status as compare to agronomic and breeding approaches (Malik et al., 2016). Researchers used different markers linked to loci to find the gene responsible to determine the variation of micronutrients. Different studies show that ZIP (Zinc transporter protein) family has a role in increasing Zn and Fe concentration (Schachtman and Barker 1999; Eide 2006).

Decreased Phosphorus and increased Nitrogen content in soil:

It is considered that there is a negative correlation between Phosphorus and both Fe and Zn uptake. In wheat grain approximately 75% of the total Phosphorus is stored as phytic acid, particularly in germ and aleurone layers (Lott and Spitzer, 1980). Recent studies show that Nitrogen nutrients status of plant also has positive effects on root uptake and shoot transport, retranslocation from vegetative tissues into seed and seed allocation of Fe and Zn (Aciksoz et al., 2011a; Kutman et al., 2010; Erenoglu et al., 2011). Increasing soil Nitrogen or foliar application was highly effective in improving root uptake and shoots and grain accumulation of Fe and Zn which was shown from wheat experiment (Aciksoz et al., 2011a, Kutman et al., 2011). When plant suffer from Fe and Zn deficiency, they release Zn-Fe mobilizing compounds from roots, which is called phytosiderophores which is promoted by improving N nutritional status (Aciksoz et al., 2011b).

Decreased glutenin content and plant height:

Significant negative correlations have been observed between glutenin content and Zn and Fe concentration (Gomez- Becerra et al., 2010a). Strong negative correlation occurred between Fe and plant height and glutenin content indicating that plant with lower glutenin content and shorter height favor higher grain Fe concentration.

Inoculation of plant growth promoting Rhizobacteria and Cyanobacteria:

Plant Growth Promoting Rhizobacteria (PGPR) comprises useful bacteria that colonizes plant roots and induce plant growth via various mechanisms. Application of PGPRs for Biofortification can be thus, considered as a possible option which along with breeding varieties, can induce increased micronutrient concentration in wheat (White P.J and Broadley M.R.,2009).

Increased in nicotianamine content:

Nicotianamine is an essential to maintainmetals homeostasis in plant. It can bind various metals including ferric and ferrous depending upon pH of soil. Regarding Fe, nicotianamine function is to confirm solubility of Fe in the cell so that, it can be utilize by different part of cell (Riaz et al., 2017). Various studies suggested that positive effect of nicotianamine on Fe uptake and its accumulation in seed (Douchkov et al., 2001; Douchkov et al., 2005).

4. Challenges ahead in biofortification

Up until now, the genotype and environmental interaction with respect to the yield of grain and nutrient concentrations have not been precisely understood. Many research programs for the enhancement of nutrient use efficiency have been restrained by expensive and laborious phenotyping. Moreover, the bioavailability of nutrients is another important factor in determining the grain quality. Changing climate situations may further amplify the problem.

- Biofortication faces challenges with high a cost of development (Bouis et al., 2011 and Nestel et al., 2006). In advance, the achievable breeding level of different nutrients is essential to be determined, which is a complex process and involves the determination of the adoption level by farmers, quantity of food products made from the crop consumed, post-harvest and preparation and cooking losses, the bioavailability of the nutrients and nutrients requirements. Thus, the target breeding level should be sure that there is a useful impact on the nutritional status of the recipient (Taylor and Taylor, 2012).

- For widely available of the released biofortified crop, it would take about a decade (Bouis et al., 2011). When the crops are biofortified through the genetic transformation process, there occur additional political and regulatory issues that have to be addressed (Birner et al., 2007).
- There is a lack of incentives and motivations to the farmers for growing improved crops,and consumers, themselves, are unaware to find quality food products from biofortified crops.
- During the manufacture of the biofortified crop, all the research teams should work together to produce an effective end product with the desired nutritional property. Sometimes, high micronutrient and vitamin has negative impact on color and flavor of end product due to which consumer rejects the product. Thus, there should be a better acceptable and good cooking quality for good adaption of biofortified crops. Also, the more acceptable yield level and persistence to biotic and abiotic stress of these biofortified crop variety. There is no better strategy supporting large-scale prospective studies on the effect of iron biofortified crop and their effective role adopted on decreasing out Anaemia (Iron deficiency diseases) and also improving better health (Hussain et al., 2010).

IV. CONCLUSION

Biofortification is a reliable, most economic, and feasible approach of delivering micronutrient to theunder-nutrient population of crops. Biofortified crop exhibits increased mineral concentration in their edible portion with better uptake of mineral from the soil, improved translocation of minerals to grain from leaves, and enhanced mineral sequestration to endosperm. There is promising and substantial genetic diversity in wild relatives of wheat, having useful and wide genetic variation in grain Fe and Zn content. This genetic variability can be utilized to increase both the concentration and bioavailability of Fe and Zn in modern wheat cultivars through conventional and modern breeding approaches. Compared to genetic approaches, agronomic Biofortification represents a short term solution to the problems, meanwhile, Genetic biofortification of staple crop, like wheat, is potentially sustainable and cost-effective. The agricultural science has been extremely developed by recent advancements in the mutant catalog, genomic resources, and transgenic strategies, and many breeding progresses. However, there are many challenges to carry out Biofortification approaches successfully. Even after the development of Biofortified crop varieties, various socio-economic and socio-political challenges are to be addressed to popularize their cultivation by farmers and their consumption by the end-user. Despite these challenges, scientists and researchers have been working now to make remarkable improvements of nutrient concentration in wheat and produce new wheat varieties. Thus, multi-tire coordination between researchers, farmers, and consumers (end-user) will play a key role in overcoming hidden hunger. The study concludes that biofortification of wheat can predominantly help in reducing malnutrition problems of the world and help in grain yield of higher quality.

ACKNOWLEDGEMENT

We are sincerely thankful to Assistant Prof. Dr. Mukti Ram Poudel, Department of Plant breeding, Paklihawa Campus, Institute of Agriculture and Animal Science for his constructive guidance and valuable advices for the completion of themanuscript.

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