Asian Journal of Research in Social Sciences and Humanities
ISSN: 2249-7315 Vol. 11, Issue 11, November 2021 SJIF 2021 = 8.037
A peer reviewed journal

GENETIC YIELD IMPROVEMENT FORECAST AND WATER-LIMITED PRODUCTIVITY OF SIGNIFICANT AGRICULTURAL CROPS

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DOI: 10.5958/2249-7315.2021.00287.2

ABSTRACT

In the next 4 decades, when growth of this segment, feed, and biofuel feedstock is expected to stabilize, improve crop yields under potential (Yp) as well as water scarcity (Yw) conditions will be important to enhancing food security. To meet predicted demand in 2050, the three main cereal crops (cereals, maize, and rice) will require 1.16–1.31% yearly increase in Yp and Yw. They may fall much more if current absolute yield increase rates continue steady, or if recent indicators of agricultural production halting in certain parts of the world become widespread. There are a variety of methods for increasing Yp and Yw genetic improvement rates, including photosynthetic genetic engineering, above-ground awareness and high design, and boosting root levels of water uptake. Because time is limited, the time scales required to progress potentially advantageous features to field prototype system, farmer-ready cultivars, and widespread farmer adoption are given special attention. The value of molecular breeding methods as tools for improving fundamental and complicated genetic features is highlighted. Only a small percentage of useful features are integrated into the breeding process, and information is not widely shared between research teams. Increasing financing for targeted research, as well as identifying and removing or decreasing roadblocks at different stages of the concept to farmer-ready cultivar chain, might help to accelerate the exploitation of these prospects. Possible genetic advances in Yp or Yw, such as using hybrid vigor in rice or genetically engineering photosynthesis, are unlikely to alter this prognosis. No amount of optimism can hide the reality that without sustained investment in genetic improvement and breeding aids, unfulfilled demand for grains in 2050 will be much higher.

KEYWORDS: *Bio fuel, Breeding, Crop Yield, Cultivar, Genetic Improvement.*

1. INTRODUCTION

By 2050, the world's population is predicted to exceed nine billion people, increasing any need for human and animal nutrition. Over the next 30 years, a variety of additional reasons will boost demand need food and feed grains, including growing livelihoods in many emerging nations, governmental attempts to reduce existing levels of hunger, and government regulations supporting any use of biodiesel generated from cereals. Although estimating the influence of these variables on grain and food consumption in 2050 is a tough and unpredictable task, recent studies have shown that an increase in cereal production on the order of 49 percent above 2006 levels would be needed to satisfy anticipated demand(1).

Estimating the amount of cereal crops needed as biodiesel for first-generation biofuels is even more difficult, but researchers estimate that by 2050, an excess funding of between 163 Mt as well as 363 Mt y1 will be needed, corresponding to an increase in global cereal grain demand with between 9 and 11 % per year. To fulfil these needs for cereals, worldwide cereal yields would have to expand at annual exponential rates of 1.16 % y1 or 1.31 % y1 from now until 2050.Scientists and policymakers are coming to an increasingly wide agreement that expanding cropland would only provide a tiny fraction of the increase in food production that is needed. There is a widespread recognition of the amplitudes of CO2 released from topsoil when grassland or vegetation is decided to convert to cropping, and there is a strong desire to safeguard previously untouched portions of crucial ecosystems including tropical rainforests, which all contribute to increasing environmental concern.

This initiative is also expected to result in the loss of high-quality agricultural soil to urban planning and other non-agricultural purposes. Finally, there really is a growing recognition that irrigation expansion (and it has been a key sign of increased agriculture over the last five decades) is limited, and that water as of now used for irrigation may have to be reduced in at least some systems to make way for other utilizes like industrial or urban consumption (2). The increase in the relative prices of fertilizers, as well as the integration of regulations aimed at reducing write-downs of reactive nitrogen from sectors into the broader environment, are both incalculable but potentially significant factors in the reduction of input variables used by sales in developed countries. As a result, the food manufacturing industry is expected to get an immediate influence from this aspect in the not too distant future. Scholars have reported that modifications of this environment may be at work in establishing a vastly increased yield gap for both farmer and prospects yields for important agricultural rape as in United Kingdom, and they've also proposed that this factor may have been at work in clarifying yield slowdown for wheat in France. According to researchers, shifts of this disposition may be at work in defining an expanding yield gap among both farm worker and potential harvests for rapeseed rape in the Great Britain, but they've also mentioned that this feature may be at work in having to explain yield economic decline for wheat.

According to the findings of the previous research, the bulk of the rise in food consumption over the next quarter century will have to be done via increased crop production on agricultural fields that are now being grossly mistreated by agriculture, which will be difficult to achieve. Growing yields by the implementation of proven methods such as fertilization has the potential to significantly increase crop yields in certain developing nations, notably in Africa, where there is considerable untapped potential. However, successful implementation will involve considerable off-farm changes, such as infrastructure development, generated power of farm production, and efficient markets for agricultural output, in addition to farm-level improvements. The successful implementation of the "Africa option" alone would not be sufficient to meet the necessary growth until 2050, and it would take decades to accomplish due to the long time horizon(3).There has been a considerable deal of debate in the literature over whether current rates of yield potential will be adequate to meet the increased demand forecast for 2050 or if they will not. These discussions have a number of different dimensions, such as the spatial measurement scale, crop species, and reference point used (Agricultural yields provided from global or state averages, historical yield trials data, wing assessments of cultivar released at various periods in history, and crop simulation techniques are all examples of information that may be used in crop numerical simulations).

The findings obtained are greatly reliant on the magnitude of the debate, the crop species involved, and the strategy used in each case. This debate also revolves around whether or not yield advancement is showing any signs of flat lining, and whether or not the defined as the ratio annual rate of growth observed in harvests and regions where produces are increasing are capable to accommodate the projected wheat food requirements, feed, and biofuels through 2050 at the 1.16–1.31 % y1 concoction rates required for meeting projected cereal demand. Several lines of evidence indicate that, at especially in some countries (regions) of the globe, wheat as well as rice yields are holding steady and/or absolute rates of yield development are decreasing below 1.16 %, but these rate may be expected to fall much more if current trends continue. In the case of maize, and especially in the United States, the picture is a little murkier. Some studies indicate that farmer yields will continue to rise in the future.

The statistics presented by researchers who are primarily interested in irrigated high yield settings in Nebraska, on the other hand, show that agricultural yields are reaching or have surpassed their economical upper limit, that is extremely close to forecasted significant yield values. Moreover, academics predicted a proportional rate of development in potential yield of maize in Iowans of 1 percent every year (just slightly higher than the range of 0–0.9 percent per year), moreover, experts expect that irrigated maize yields in the U. S. will reach a plateau in the not too distant future, according to their findings. There is yet another hard truth that rises from each of these various philosophies, scales, and crop yields: the vast amounts of information signifies that comparison rates of crop productivity progress fall short of the necessary increasing rate required to satisfy consumption requirements by 2050, but that there is significant proof of yield peaks in a worrying lot of countries as well as counties, as well as a frightening number of nations and regions. A number of authors have predicted that the current relative rates for yield improvement, as determined from linear functions suited to historical field observations and anticipated for the end point of respective data series, would be preserved in the future. It seems to be unlikely even in the face of prohibitive biophysical restrictions of some kind. Maintaining current linear developments in yield development is almost certainly the most desirable outcome, and this suggests that the relative proportion of yield advances is decreasing rather than expanding at a constant rate (4).

In order to achieve enhanced and sustainable food supply by 2050, a variety of options are being pursued, including genetic modification for grain major crops promise in vowel setting (Yp) and for rain crop productivity in dry land (rainfed) situations, among other things (Yw). Throughout this article, we attempt to assess the current status, prospects, and requirements for advance and its validation across both Yp and Yw, with a particular focus on the likely timeframes for improvement and its verification in each of these systems. Given their major contribution to current and predicted future agriculture, feed and bio fuel requirements, we have centred our efforts on one of the most important cereals (Rice, maize, and wheat).

1.1 Increased Yields Due to Genetic Improvement:

Breeding is at the heart of any process aimed at creating Yp or Yw, and it is now undergoing a rapid growth of the technical options available to progress any given set of aims, including the development of Yp as well as Yw. Yp or Yw improvement processes are fundamentally based on the process of breeding. So we take into account the nature of breeding processes as well as the practical needs of developing cultivars with enhanced Yp or Yw that are suitable for farmers. It is possible that genetic progress will be further accelerated by the introduction of new or better characteristics that have been made accessible either via genetic manipulation or by the mine of existing genetic variation.

In order to evaluate how well these qualities, fit into systems that are ideal for improving either Yp and Yw, it is necessary to first identify them and then assess their relevance. We are making some efforts to solve this challenge. By the 2050 deadline in mind, as well as the timeframes for germplasm creation and breeding, we have utilized some published estimations of the probable time needed to enhance the photosynthetic capacity of crops via genetic engineering to highlight one part of the road ahead(5). The time needed to develop certain concepts or discoveries of characteristics linked to enhanced Yw from the concept stage to the past, stages such as conceptual design or seedling release have been documented in a similar manner to this. Furthermore, it will take time for better rice varieties to be generally accepted by farmers, and that's something we shortly discuss in this section.

Yp and Yw have a wide variety of characteristics that have been proposed as potential contributions to the improvement of either or both of their features, and we make no effort to discuss these characteristics in detail here. Instead, we have chosen two specific processes, which we think have the potential to be extremely significant while also being very substantial hurdles for progress toward better yields, to illustrate the difficulties that must be overcome. Improvements in photosynthetic apparatus in both non-stressed as well as water-limited settings, as well as improvements in the ability of the root system to absorb water in arid climates, are the two primary objectives of this study.

In both Yp and Yw, climate change will have an influence, and this will have an influence on the level of productivity that can be achieved in each of the two locations. This would be mostly owing to changes in the quantities of CO2 and O3 in the atmosphere, as well as changes in mean temperatures and the regularity of episodes of heating and cooling stress. These aspects of climate change will have an impact on sowing dates of crops that are best suited to certain environments, and recent predictions of C3 food crop yields around the world contain some degree of responsiveness to temperature fluctuations and CO2 concentration (6).

Inasmuch as the information base on whose efforts to foresee potential impacts in atmospheric CO2 as well as O3 levels on agriculture are based is limited, so is the knowledge on which trying to forecast potential consequences of temperature fluctuations are based, both of which are limited, whether acute or chronic, are based. The ability to optimize breeding and farming operations across large geographically defined ranges in environmental variables has already been shown by farmers and breeders in the past. Continuing politics as normal in genetical improvement and progressive adaption of agricultural technologies will be adequate to buffer the consequences of climate change due to the fact that the effects will reveal themselves gradually over time. Yp and Yw genetic improvement are not discussed in this study because we do not believe that climate change will have an impact on them.

2. DISCUSSION

This period, which began in 1960, was characterized by the presence of public-funded agricultural research institutions, the open interchange of germplasm and technology amongst research partners, as well as the development of new agricultural technologies. During this time period, intellectual property (IP) did not play a significant role in agricultural innovation. While IP is still important to both public and commercial research organizations, it is becoming more important to protect discoveries that are needed to improve food production as well as to transfer technology and germplasm to partners and across nations. When it comes to conventionally bred germplasm, intellectual property protection has become increasingly important, and this importance is heightened when genetically modified organisms (GMOs) are involved. Consequently, as intellectual property law has gained prominence in cultivar creation, governmental expenditure in plant breeding has declined, while private sector investment is plant breeding has increased, especially among industrialized nations. Therefore, in order to foster the adoption of innovative varieties, peasants in all countries must accept that the retail market now has a greater influence over produce than in the past (7).This is doubtful to be a disadvantage in affluent countries, where it is thought that it would speed up genetic evolution, but that might be a burden in impoverished ones where genetic growth is slower. Because legal and regulatory issues are likely to arise when multiple technologies owned by different organizations are used in cultivar expansion, as is likely for the large percentage of attributes in GM techniques, backlogs in cultivar rollout are likely to occur of issues. A case in point is the intro of Golden Rice, that either makes use of genetically altered technology to manufacture tech test, a precursor to folic acid A, among the rice endosperm, and which is expected to have a wide range of health benefits in rice-dependent impoverished communities (8).

It was in 1992 that the first field experiments of golden rice were conducted, with the first cultivars being released to farmers in 2004 and the anticipated distribution of cultivars in 2013. It is anticipated that resolving the regulatory obstacles associated with genetically modified organisms, as a consequence of the numerous patents and organizations involved, the distribution of the first varieties has been slowed by at least 10 years, according to some estimates. Regulatory processes for the sale of genetically manipulated varieties are very costly, and it is expected it will be a considerable barrier to, and in many cases, a pre-vent, the introduction of genetic modification varieties. It is indeed likely to occur in public agencies ceasing to operate since they are unable to fund the costs on their own (9).It takes a long time for traditional breeders to create and incorporate novel characteristics, such as those for yield or resistance to abiotic stress, into cultivars, as we discussed in Sections 2.3 and 3.4. Most likely, in the overall research and development required for cultivar official launch, insufficient attention or dosh will be allocated to the field and laboratory estimation of characteristics and the beginnings of suitable germplasm for pedigree dogs to be used in the mating process, which will result in inferior cultivars being released. This is a significant barrier to the acceptance of a trait by breeders, and as a result, the distribution of cultivars to farmers is delayed or prevented. Breeders that wish to include another characteristic into their breeding programme will need proof of concept that doing so would result in an increase in yield before making the decision to do so. This typically necessitates demonstrating that the trait exists in germplasm that is suitable for their breeding operations and that the trait confers a competitive advantage. Once a characteristic has been shown, Breeders would want a selection approach that is both rapid and effective in order to choose for it. Depending on the scenario, this might be either genomic flags or a fool-proof data and data collection procedure that is used.

Developing each of them may take time, and they both need specialized knowledge and abilities. Often, in the state services, prototype of the system and lineage development are ignored or never finished, either because the requisite knowledge is not accessible but because there is a view that breeders must be in charge of these tasks, resulting in a lack of adoption of research findings by the general public. Furthermore, funding organizations often fail to recognize the complexity and specialized knowledge that breeders must possess in order to successfully adopt their animals. Breeders may be forced to considerably postpone or even prevent the adoption of new features or technologies as a result of this misalignment between pre-breeding as well as breeding (10).The availability of new cohorts of experts who have obtained instruction in plant breeding, economics, biotechnology, crop physio, and agronomy will be vital in attaining our food production targets, and this is an important but often underestimated factor in achieving those goals. Cutbacks in crop study and a scarcity of trained people in agribusiness, advisory firm, sustainable use of natural resources, and biosecurity, among several other areas, have resulted from reduced government assistance and resources for agricultural education in our universities, among other consequences. Global concerns regarding food security, effective and fair food manufacturing and sales, as well as issues the about preservation of crucial ecosystems and natural mineral wealth are all expected to inspire a new generation scientist in the coming years, as has been expressed both in popular and science media in recent years.

3. CONCLUSION

Plant breeders have effectively recombined genetic diversity in each of our main food crops over the past 100 years, resulting in steady production increases. In the 1960s, bio fortification combined with increased crop management contributed in the Green Revolution, which occurred in massive improvements in yield, — especially under fustigation, in underdeveloped countries, but instead, as a result, in food earnings and lower food prices in both the developed and developing regions, respectively. Global grain supplies have plummeted in recent years, which, combined with poor weather conditions in certain areas, has led in a rise in food costs as well as civil instability in several nations, particularly in the developing world. As a result of this, as well as a sharp price hike of fertilizer and growing consideration about the diminishing water funds allocated to agriculture, society received the wake-up call it required to recognize that we may not even be possible to attain the global growth for feedstuffs corn by the end of this century once we do not act quickly. World harvests must increase at a rate of 5 between 1.16 as well as 1.31 cent every year in order to meet the demand for our staple crops, maize, rye, and rice, without driving up food prices.

After reviewing the results of lengthy studies that evaluated elite eggs and sperm and the strongest released variants of corn, wheat, and rice with well trials of historic configurations of the best cultivars or hybrids in the both water-abundant as well as water-scarce surroundings, we discovered that there are currently no descriptions of current rates in Yp or Yw that are near to the 1.16–1.31 % y1 necessary to keep the current levels of yield either in that environment. It was discovered that an unnerving number of cases with no increase in either the Yp or Yw densities had occurred in a wide assortment of harvest combinations, and this was indicated in the results, which is concerning. However, because of the management element, there is considerable ambiguity about the actual significance of these findings compared to what has been discovered by others using subnational or national statistical data in the past.As a result of the above, even with the finest methods and breeding programmes, it is very difficult to be hopeful about the future compound rates of advancement in Yp and Yw increasing much, if at all, in the near term. While this is clearly hypothetical, the optimistic (naive) option is just as speculative as the first. Another factor contributing to our pessimistic outlook is the uncertainty and doubt about the efficacy of transgenic approaches (apart from perhaps bioengineering photosynthesis), as well as the extremely long gestation period between the development of a new or existing trait and its delivery in the form of new cultivars.

Not only will increased investment in research and development be required to maintain current rates of progress, but it will also be necessary to devote more attention to structural issues in the research, innovation, and cultivar supply chains, as well as to educating a future group of agricultural scientists in the near future. There is still a huge gap between the expertise of leading scientists at the fundamental level of organization and the actuality that breeders, horticulturalists, and farmers are confronted with on a regular basis. According to their results, researchers are passionate about the need to change the way that research is often organized, as well as the crucial need of developing a culture of collaboration between scientists from other fields. Because of this, some research effort is likely to be shifted into more productive directions as a consequence of the process, which is intended to focus attention on the most critical and practical strategies for crop genetic improvement. It should also make it possible to transmit characteristics to breeders more quickly. Private businesses are becoming more involved in crop development and delivery, and as a result, public-private partnerships will become increasingly essential for coordinating efforts and agreeing on conditions of engagement that are acceptable to both parties. If we are to satisfy the anticipated demand for food, we must boost research expenditure as well as make structural and social changes.

REFERENCES

1. Gonzalez VH, Tollenaar M, Bowman A, Good B, Lee EA. Maize yield potential and density tolerance. Crop Sci. 2018;
2. Abeledo LG, Calderini DF, Slafer GA. Genetic improvement of barley yield potential and its physiological determinants in Argentina (1944-1998). Euphytica. 2003;
3. De Souza AP, Massenburg LN, Jaiswal D, Cheng S, Shekar R, Long SP. Rooting for cassava: insights into photosynthesis and associated physiology as a route to improve yield potential. New Phytologist. 2017.
4. Teklu Y, Tefera H. Genetic improvement in grain yield potential and associated agronomic traits of tef (Eragrostis tef). Euphytica. 2005;
5. Foulkes MJ, Reynolds MP, Sylvester-Bradley R. Chapter 15 - Genetic Improvement of Grain Crops: Yield Potential. Crop Physiol. 2009;
6. Prchal M, Bugeon J, Vandeputte M, Kause A, Vergnet A, Zhao J, et al. Potential for genetic improvement of the main slaughter yields in common carp with in vivo morphological predictors. Front Genet. 2018;
7. Zhu G, Li G, Wang D, Yuan S, Wang F. Changes in the lodging-related traits along with rice genetic improvement in China. PLoS One. 2016;
8. Long SP, Marshall-Colon A, Zhu XG. Meeting the global food demand of the future by engineering crop photosynthesis and yield potential. Cell. 2015.
9. Ovaska S, Myyra S, Niemi JK, Peltonen-Sainio P. Optimal renewal interval for malting barley seed. J Agric Sci. 2016;
10. Battenfield SD, Klatt AR, Raun WR. Genetic yield potential improvement of semidwarf winter wheat in the great plains. Crop Sci. 2013;