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Plant breeding as a means to achieve food security

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Abstract
The rise in population has made food insecurity a serious concern. But with limited land resources and threat of environmental degradation, increasing production by planting more crops or over straining the existing situation is not a viable solution. Plant breeding techniques and approaches thus provides a means to food security.

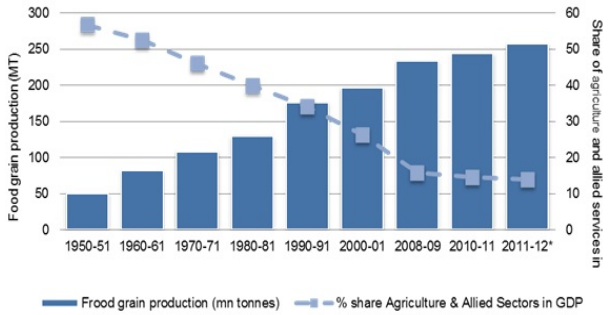
Keywords: Plant breeding; food security; climate change; food production; population explosion; nutritional quality

Introduction
Indian population is increasing at an alarming rate with the prospect of overtaking china in near future. The concern of feeding the million mouths of India has been addressed from different perspectives in the past few years. The total population in India was last recorded at 1238.9 million people in 2014 from 359.0 million in 1950, changing 245 percent during the last 50 years. The population of India when compared with the other countries shows the seriousness of the dearth of available resources to meet the population needs. The need for better productivity in agriculture from the marginal holdings, better varieties suited for different changing climatic imbalances and other threats is the need of the present scenario.
(Population in India as reported by the Ministry of Statistics and Programme Implementation (MOSPI), in million)

Agriculture Scenario in India
Although India has attained self-sufficiency in food staples, the productivity of Indian farms is below that of many developed and developing nations. The wheat productivity of Indian farms is only one third of that of France, while rice productivity accounts to less than half that of China. Several studies suggest India could eradicate hunger and malnutrition, and be a major source of food for the world by achieving productivity comparable with other countries. The growth rate in the food grains production and productivity has decelerated when India entered the era of globalization. Per capita availability of the food grains in India, in the year 1951 was 144.1 kg. After 56 years i.e. in 2006 per capita availability of food grains went up by just 18 kg.

The growth of food grain production during the 1970s and 1980s was largely due to institutional efforts in raising the levels of technology used in agriculture through research and extension, investments in rural infrastructure and human capabilities, credit support, procurement at minimum support prices and the strengthening of supportive institutions like the Food Corporation of India (FCI). From the early 1990s, however, there has been a focus on expenditure reduction, resulting in decline in public investment in and other forms of support to the agricultural sector. As a result of the decline in public investment, expansion in irrigation, growth in input usage and technological improvement, have all slowed down during the 1990s.This has as expected impacted on production.

Chart 2:Growth of food grain production in India



Government Interventions

Government of India has taken several steps to increase productivity of agriculture. These include schemes like; Rashtriya Krishi Vikas Yojana (RKVY), National Food Security Mission (NFSM), Development and Strengthening of Infrastructure facilities for Production and Distribution of Quality Seed, National Horticulture Mission(NHM), Rain fed Area Development Programme (RADP), Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM), Gramin Bhandaran Yojana etc. In addition, Government has also improved the availability of farm credit; implemented debt waiver; introduced better crop insurance schemes; increased Minimum Support Price (MSP), improved marketing infrastructure, etc. Further in order to provide food security to the people by ensuring availability of food at affordable prices, Government has enacted National Food Security Act, recently. National Food Security Act 2013 (NFSA) is a unique step taken by Indian government to fight against hunger and protect right of the people for food. With its peculiarities like the life cycle approach, women empowerment, consideration of vulnerable sections in society and proposed reforms in public distribution system (PDS), NFSA is a promising effort for food security in India (Ajinkya and Jha, 2015) [1]. In spite of these, food security still pose a major threat to the nation with its exploding population, constraints of limited resources and uncertain climatic changes.

Global food security through plant breeding

According to the Organization for Food and Agriculture, (FAO) of the United Nations, food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for active living and healthy life. Food insecurity, is a situation of "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways", according to the United States Department of Agriculture (USDA. The Inter-Governmental Panel on Climate Change released a report that food security may be a big problem in the region post 2030.

International development agencies believe that breeding new crops is important for ensuring food security by developing new varieties that are higher-yielding, resistant to pests and diseases, drought-resistant or regionally adapted to different environments and growing conditions. These global issues are achievable through the process of plant breeding, as it offers the ability to select specific genes allowing the crop to perform at a level which yields the desired results.

Plant breeding is the art and science of changing the traits of plants in order to produce desired characteristics. (Poehlman and Sleper, 1995) [9]. Plant breeding can be accomplished through many different techniques ranging from simply selecting plants with desirable characteristics for propagation, to more complex molecular techniques. Its successful application is essential to provide the major increases in production and nutritional quality. Plant breeding and genetics may also increase the resource use efficiency (Parry and Hawkesford, 2010) [8].

With an increasing population, the production of food needs to increase with it. It is estimated that a 70% increase in food production is needed by 2050 in order to meet the Declaration of the World Summit on Food Security. But with the natural degradation of agricultural land, simply planting more crops is no longer a viable option. Therefore, new varieties of plants need to be developed through plant breeding that generates an increase of yield without relying on an increase in land area. An example of this can be seen in Asia, where food production per capita has increased twofold. This has been achieved through not only the use of fertilizers, but through the use of better crops that have been specifically designed for the area (Guimaraes, Kueneman and Carena, 2006) [5].

Dramatic changes in climatic conditions, with its repercussion as heat waves, water scarcity and heavy rains continue to threaten crop quality and yield. Additionally, the booming plant pathogens are another reflection of climate change creating some potential risks for agricultural production. Most of the abiotic and biotic stresses are under the control of complex traits. Moreover, a wide range of desirable quantitative characters in cultivated crops, such as disease resistance, might degenerate with time. Therefore, buffering crops against the large environmental changes is important for feeding the world's increasing population and requires implementation of effective food security strategies. Crop biodiversity plays a key role in the improvement of stress tolerant species and enables an extensive platform for identification of novel traits by using a range of molecular tools. (Yumurtaci, 2015) [12]; (Chakraborty and Newton, 2011) [2]; (Gregory, Ingram and Brklacich, 2005) [4]

The importance of crop wild relative diversity as a potentially critical resource for future food security is now widely recognized, particularly in the light of climate change and the rapidly increasing human population. The need to conserve crop diversity has been placed firmly on the international conservation agenda. They are an important source of traits that could effectively fight the possible threats to agriculture in future. (Toledo and Burlingame, 2006) [11]; (Maxted, Kell and Brehm, 2014) [7].

Plant breeding can contribute to global food security as it is a

cost-effective tool for increasing nutritional value of forage and crops. The research in plant genetic resources provided insights to improve nutritional quality of staple crops like rice (Kennedy and Burlingame, 2003) [6]. Improvement of crop nutritional quality through breeding, termed biofortification, is a strategy being used to address micronutrient deficiencies worldwide especially in women and children. (Diepenbrock and Gore, 2015) [3].

Poor agricultural management has a huge impact on the degradation of soil worldwide and it is Africa and Asia that are most affected. Through education and development of modified plants, these statistics can be reduced and agricultural land can become more productive. Plant breeding allows for an increase in yield without the extra strain on the land. The genetically modified, Bt white maize, was introduced to South Africa and was surveyed in 33 large commercial farms and 368 small landholders properties and in both cases a higher yield was recorded

Less appreciated is the fact that plant breeding can also be instrumental in easing the distribution problem. The majority of the undernourished people worldwide lives in rural areas, where they directly or indirectly depend on small-scale farming. It is suggested that suitable new crop varieties (both conventional and genetically modified ones) can increase small farm incomes, alleviate poverty, and stimulate economy-wide growth.

Participatory plant breeding can be exploited to accelerate research and adoption simultaneously to achieve the goal of food security. Participatory means that farmers are more involved in the breeding process and breeding goals are defined by farmers instead of international seed companies with their large-scale breeding programmes. Farmers' groups and NGOs, for example, may wish to affirm local people's rights over genetic resources produce seeds themselves, build farmers' technical expertise, or develop new products for niche markets, like organically grown food.

Conclusion

The lack of arable land, limits further expansion of area under cultivation to increase production to meet the growing demands of the exploding population. The trends in population points out the need for doubling of land area to maintain current per capita food consumption by 2050. Moreover the additional fertilizer, pesticide load on farm land to increase productivity is already ringing sirens of environmental degradation and climate change. In this seemingly unalterable scenario of food insecurity, footsteps in plant breeding are a promising solution to roll the wheels of change.

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