

Single cross hybrid maize – A viable solution in the changing climate scenario

Sain Dass, J. Kaul*, Manivannan, Avinash Singode and G. K. Chikkappa

Directorate of Maize Research, Indian Agricultural Research Institute, New Delhi 110012

Abstract

Maize is one of the viable solutions for addressing changing climate. Being C4, maize can fix maximum CO₂ compared to other crop species. The slight rise in temperature would not affect the maize production. Over the years, maize has witnessed a phenomenal growth with respect to area, production and productivity in the country. This is attributed to the cultivation of high yielding stress-free Single Cross hybrids. Single Cross Hybrid technology offers an easy, viable and economical option to the farmers. Maize is a potential crop for diversification of cropping system. In context of peri-urban agriculture, specialty corn viz., baby corn and sweet corn hold great promise for ensuring livelihood security. The single cross hybrids of Quality Protein Maize enriched with tryptophan and lysine provide a nutritious feed to poultry, cattle and for poor people particularly for those who consume maize as staple food thereby providing food and nutritional security. Maize has also great potential for high growth of seed sector and export.

Keywords: Maize, QPM, specialty corn, single cross hybrid technology

Maize (*Zea mays* L.) is the most versatile food crop of global importance. It is being grown widely in tropics, sub-tropics and temperate regions up to 50° N and S from the equator to more than 3000m above sea level under irrigated to semi-arid conditions. In recent years the whole world is witnessing the irregularities in climatic phenomenon viz., rise in temperature, lowering water table, frequent occurrences of drought and flood and the increased CO₂ level in the atmosphere, etc. On the other side maize is an important crop that holds a unique position in world agriculture, providing food (25%), animal feed (12%), and poultry feed (49%), starch (12%), brewery (1%) and seed 1% (Fig. 1). Apart from normal maize it has many other types viz., quality protein maize, sweet corn, baby corn, pop corn, waxy corn, high oil, etc. It has generated employment for many million people in the world. It accounts for 15 to 56% of the total daily calories of people in many of the developing countries. It is In India currently it is cultivated in over 8.26 million ha with a production of 19.30 million tonnes

having an average productivity of 2337 kilogram. In India, maize production has increased >11 times to 19.30 mt (2007-08) from a mere 1.73 mt (1950-51) (Fig. 2). Despite ~80% of 8.26 mha of maize area which is under rainfed condition still maize contribute more than 8% to the national food basket and provide nutritious and risk free green fodder to the livestock. The cultivation of early maturing Single Cross Hybrids (SCHs) has helped in reducing the yield loss on farmers' field in Rajasthan by avoiding the effects of drought. In Andhra Pradesh the decline in the ground water table has made rice cultivation less profitable during winter season, therefore the rice area has shifted to maize cultivation as maize requires less water compared to rice. This indicates that maize single cross hybrids are least affected by the vagaries of the above environmental fluctuations. With the cultivation of single cross hybrid, maize has become more remunerative to the farmer and the area under maize cultivation is continuously increasing in many of the states of India viz., Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Jammu & Kashmir, etc. The area has increased >2.5 times since independence to 8.26 mha at present (Fig. 3).

Apart from uses as food and feed, maize has great demand in the development of various products in different industries viz., pharma, textile, paper, film, tyre and biofuel, etc. The future demand for maize will be 42 mt by the year 2025, out of which around 21% will be used for human food (Fig. 1). This demand will easily be met as research efforts have been focused on the development of high yielding single cross hybrids for different agro-ecological regions of the country because of their high yield and their adoption by the hard working farmers of this country.

In order to mitigate the moisture stress the following traits of single cross hybrid helps to sustain the maize production in future viz., Root systems - profuse and branched root system enables more water

*Corresponding author's e-mail: kaul255@gmail.com

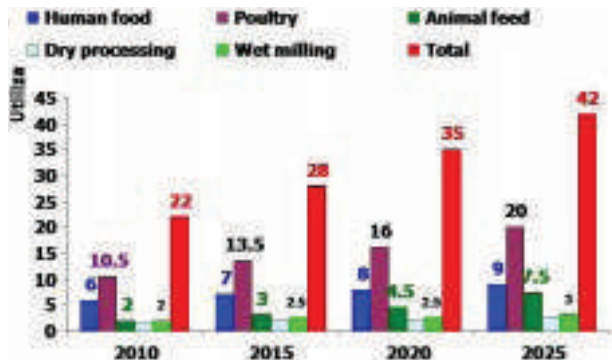


Fig. 1. Projected utilization pattern of Maize in India

to be captured and increases the productivity, erect leaves - erect and narrow leaves reduces the leaf area under direct exposure to sunlight, it reduces the transpirational water loss and erect leaves allow the more sunlight penetration to crop canopy, simultaneously it increases the photosynthetic efficiency of the plants, early vigour – due to high early vigour plants grow quickly and out compete with weeds resulting in more water available for growth, stay green - stay green nature of the plants allows better photosynthetic efficiency, slow leaf senescence, efficient

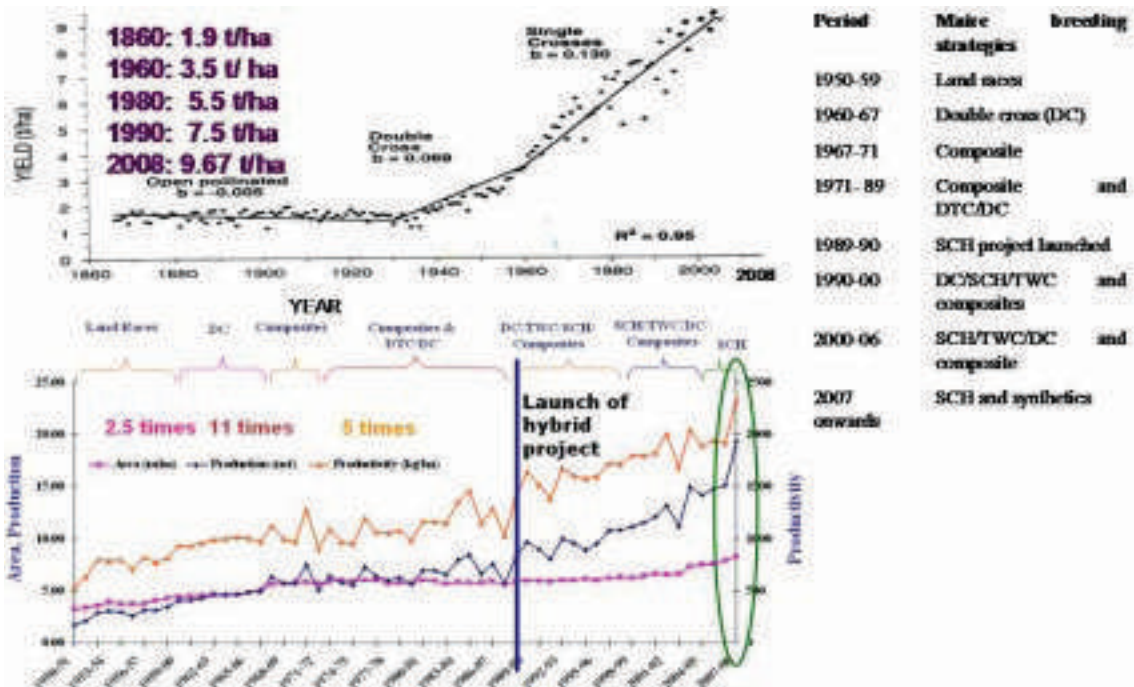


Fig. 2. Area, production and productivity of Maize in India in comparison with USA

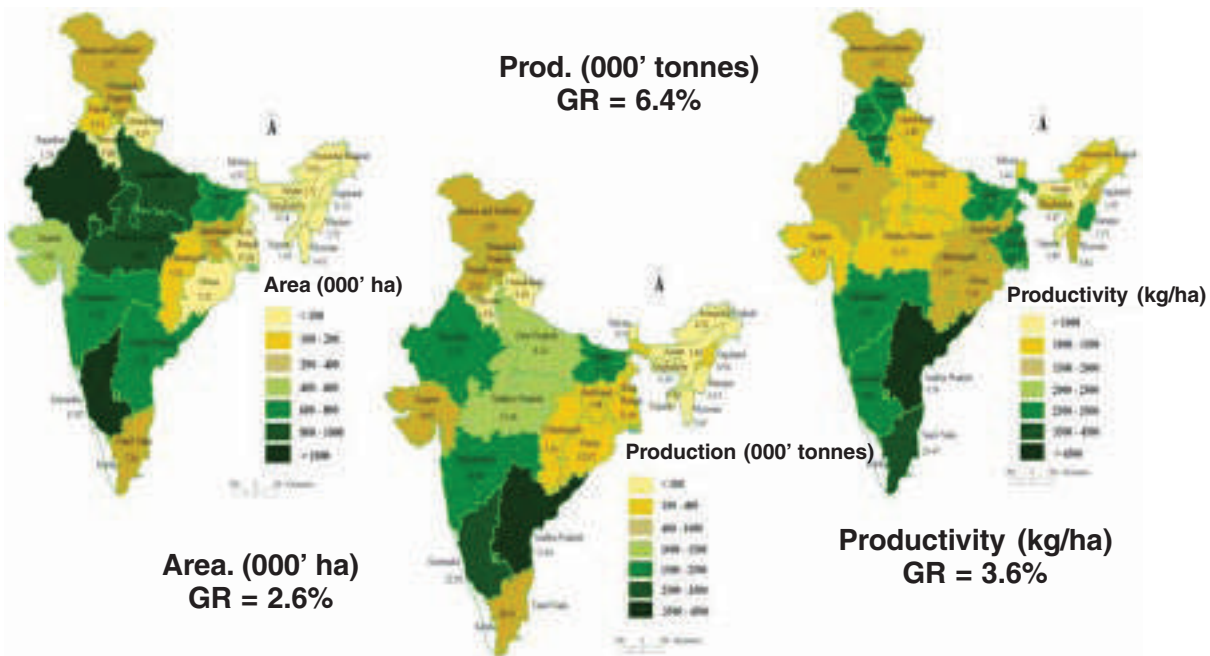


Fig. 3. Growth rate of area, production and productivity of Maize in Indian states

conversion of photosynthate to grains, shorter Anthesis Silking Interval (ASI) - interval between pollen shed and silk emergence, longer duration of pollen shedding with prolonged viability of pollen grains, lax tassel with a few secondary branches, waxyness of leaves there by reducing the transpirational water loss.

Single cross hybrids are most productive among the other types of hybrids and composite varieties. Productive inbred lines are the strength of hybrid development programme. To make the SCH technology viable, the collaborative efforts of SAUs/ICAR institutes have resulted in developing hybrid oriented germplasm from genetically diverse sources, 44 single cross hybrids of different maturity have been developed for different agro-ecological conditions. Because of their uniformity and resistant to various stresses single cross hybrids are most acceptable to the farmers. The adoption of this technology has made maize a global productive crop. The cultivation of high yielding, stress resistant/tolerant single cross hybrids offers viable, sustainable and profitable option for Indian farmers. The impact of single cross hybrid adoption has already been witnessed in USA, China and many other countries of world. Even in India by hardly covering 20% area under single cross hybrids the crop growth rate with respect to area, production and productivity of maize has increased.

This technology is certainly going to provide solution to the climate change that is rising temperature in eastern and some part of central India, lowering water table in rice dominated area and weed menace in wheat belt etc. Therefore it is a potential technology in achieving the nutritional and food security of the nation. With the change in global climatic scenario, maize has emerged as an alternative for diversification of rice-wheat cropping system. Temperate germplasm, being highly productive, has been introgressed for desirable gene(s) into promising tropical/sub-tropical genetic backgrounds to develop productive inbreds suitable for different agro-climatic conditions of the country. Winter maize is gaining popularity in north and eastern India. Hence, late maturing productive hybrids have been developed by using temperate as well as late maturing tropical and sub-tropical inbred lines. With the lowering of water table, rice-area from different states in various seasons has been shifted/likely to be shift more to maize. For these areas productive hybrids have been recommended for sustainability of the agriculture. More than 80% area of maize grown in India is rainfed and is subjected to the vagaries of monsoon. Early maturing single cross hybrids have been developed. Cultivation of early maturing single cross hybrids has helped in

reducing the yield loss on farmer field in the current century's severe drought year.

Adoption of Single Cross Hybrid technology and its Impact

It is expected that the worldwide demand for maize will exceed that of wheat and rice. With the increasing utility of maize the yield and area of maize production will need to be expanded in order to meet the demands of the growing population. The emphasis on development of high yielding single cross hybrids that are resource use efficient under diverse soil and climatic conditions, have lead to development of several single cross hybrids. Single cross hybrids have shown better adaptability to new set of cropping systems and management practices. More than three dozen single cross hybrids for various agro-climatic conditions have been released by various public institutions of the country and dozens of hybrids by the private sector for their cultivation on the farmer field.

High yield potential

In India the adoption of superior single cross hybrids is ~20% of the total maize area. With the adoption of single cross hybrid, protection and production strategies by the farmers of India has registered a spectacular increase of 25.83% and 22.12% maize production and productivity respectively in 2007-08. The growth rate of area, production and productivity is probably highest among the cereal crop in all the major maize growing states of the country as shown in the maps. In Andhra Pradesh the productivity of maize was merely 275 kg/ha during 1950-51 that has increased to 5240 kg/ha during 2007-08. Andhra Pradesh productivity is highest among all states and it is more than double the national average. This major increase was achieved due to adoption of single cross hybrids in the state. The highest productivity of maize has been recorded in Guntur district (7.2-8.8 t/ha), which is higher than the corn productivity of USA on per day basis. This indicates that the average annual increase in yield in single year is much higher than the USA after adoption of single cross hybrids.

Potential crop for crop diversification

Maize is grown round the year in India. The area in non-traditional states in non-traditional season is increasing indicating that maize is emerging as one of the potential driver for crop diversification. In Andhra Pradesh winter maize is more assured crop with higher productivity potential compared to monsoon season. Therefore, in areas where winter rice crop suffers due to water

scarcity, the maize has emerged as potential alternative. Similarly in Karnataka area of cotton and rice and in Maharashtra area of sorghum and cotton has diverted to maize.

Potential crop for better growth of seed industries

The increase in the area under single cross hybrids will increase the profit opportunity and stability for seed industries. More and more seed will be produced by this sector which will create avenues for employment generation and improve the economy of the seed industries.

Potential for export of maize as grain, seed and specialty corn

Maize has great potential for grain and seed export to the neighboring countries because of its low cost of cultivation. In the year 2008-09 India has exported 3mt of grain and >12,000 tones of seed worth rupees 24,000 and 2,000 crores, respectively. Apart from grain and seeds, India can become exporter of specialty corns as well especially the baby corn and sweet corn. One of the baby corn processing industries in India (Fresh Field) has exported about 267 tons of baby corn worth >\$1 million in 2008 and in 2009 it is expecting much more. This will help to earn foreign exchange and generate employment to the rural masses.

The quantum jump in production and the productivity witnessed in recent years across the states, evidently suggests that the research and development in maize in India is in the desired direction and the production will tend to keep pace with the demand trend. The country is poised to give further fillip to the pace of production with new impetus on the expansion of area of maize under single cross hybrids. In future developing maize genotypes which can escape as many vulnerable growth stages as under rainfed conditions is the priority of the researchers.

Specialty corns

With the increase of urbanization, change in food habit and the improved economic status, the specialty corn has gained significant importance in peri-urban areas of the country. To check the migration from rural to urban, to enhancing the profitability and livelihood security of the farmer the suitable hybrids and production technology for baby corn and sweet corn have been developed.

Quality Protein Maize (QPM)

About 86% of the maize produced in the country is directly used as feed (61%) and food (25%). To meet

the requirement of food/feed and nutritional security quality protein maize has better say than the normal maize. Therefore in Indian maize programme greater emphasis is given to promote the quality protein maize research. The development of quality protein maize, their cultivation and availability of QPM grain will provide a nutritious feed to poultry/cattle and for poor people particularly those consuming maize as their staple food. QPM can save the poor people - who cannot afford meat and egg from diseases caused due to malnutrition particularly due to non-availability of rich lysine and tryptophan protein in their diet. India has large number of people with protein malnutrition. On the other hand, price of the meat and meat products has also gone up in recent years and has become unaffordable to meet their nutrition requirement. Thus QPM maize is solution to food and nutritional security. QPM is nutritionally superior with high lysine and tryptophan as compared to normal maize. The biological value of QPM is high (80%) as compared to normal maize (45%), which is near to that of the milk (90%). The biological value of QPM is the highest among all cereals. In India seven single cross QPM maize hybrids viz., HQPM 1, HQPM 5, HQPM 7, Vivek QPM 9, Shaktiman 1, Shaktiman 2, Shaktiman 3 and Shaktiman 4 with different maturity groups have been developed, which suits to different agro-climatic conditions under different cropping systems.

Baby corn

The term baby corn refers to a young finger like unfertilized cob of maize with 2-3cm emerged silk. It can be eaten raw and include in diet in number of ways as *salads, chutney, corn pakoda, soup, raita, vegetables pickles, and kheer*, etc. Peri-urban belt of India is emerging as a one of the potential baby corn producing belt. Because of its low cost of production as compared to many other countries India can become export potential nation in years to come. Because of India's strategic location it will be boon for the export to many Asian, European and Gulf countries. Baby corn has played a significant role in ensuring livelihood security and augmenting income level of farmers in peri-urban areas. Maize single cross hybrid HM 4 possesses all the desirable traits of ideal baby corn. The cultivation of HM 4 is gaining momentum not only in national capital region but also in peri-urban interface of other states in India. The other advantage associated with this hybrid is the low cost of hybrid seed and wider adaptability. HM 4 has proved boon for the farmers of the "Aterna" village in Sonipat district of Haryana, as its cultivation has improved the socio-economic condition of the villagers significantly.