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maize
Vision 2022



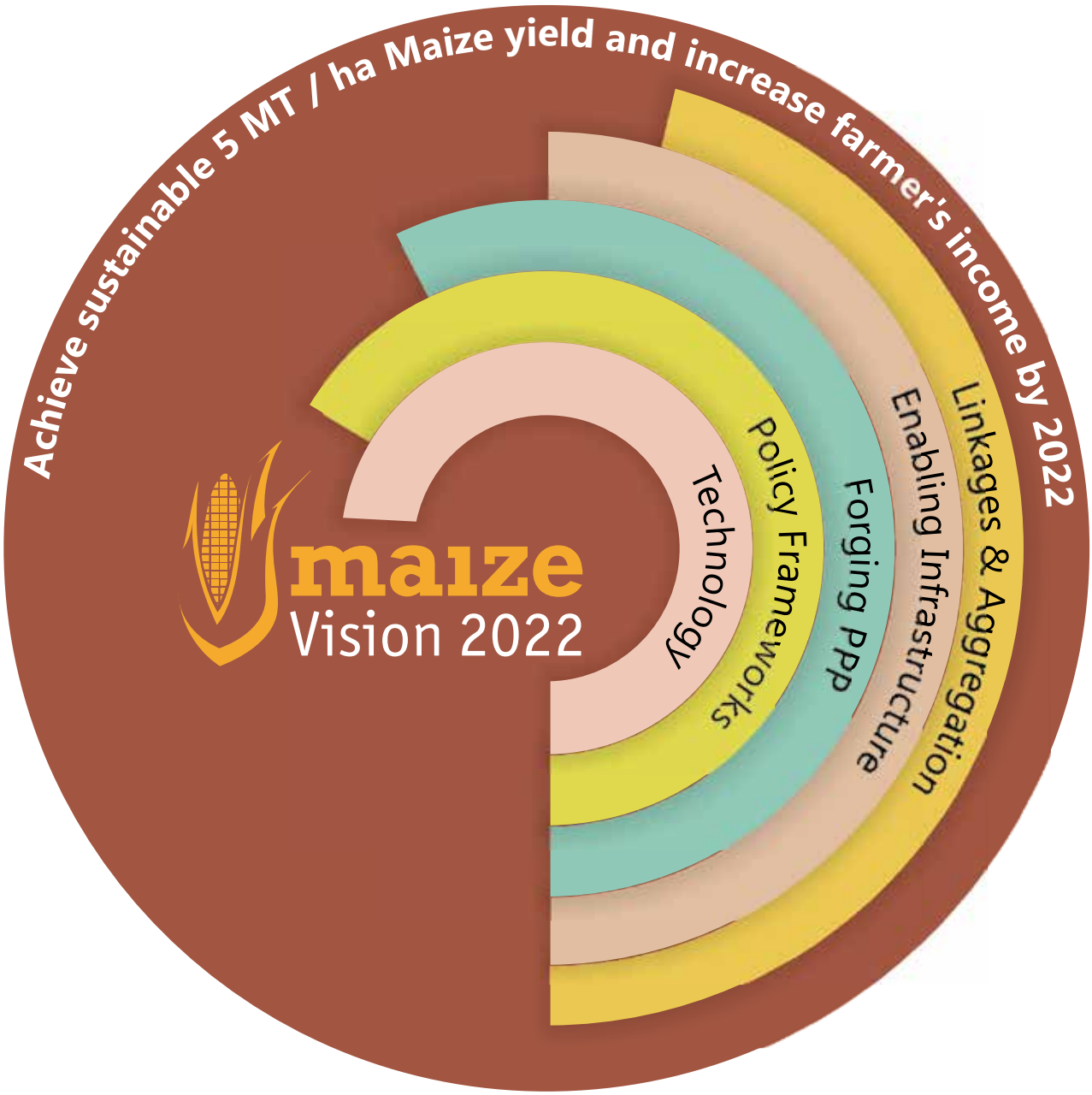






Maize Vision 2022

A Knowledge Report



Time has come for a New Vision for Maize Value Chain.

Achieving sustainable 5 MT/ha Maize yield requires all stake holders to step up their efforts. Innovations along with robust policy support is crucial.

FOREWORD



Mr. Dilip Chenoy
Director General, FICCI

Maize is important to India as 15 million Indian farmers are engaged in Maize cultivation. Having realised the potential of Maize in generating better income to farmers while providing gainful employment, Maize qualifies as a potential crop for doubling farmer's income.

There is a tremendous potential of growth of the Maize value chain in the country. The consumption of Maize has increased at a CAGR of 11% in last five years. Today, Maize is a source of more than 3500 products including specialised Maize like QPM "Quality Protein Maize".

These trends open up vistas of opportunity for India's Maize sector. However, it's time to check if India is ready to capitalize on this opportunity. Although, India has received Maize production level of 26 Mn MT, it would require 45 Mn MT of Maize by the year 2022. The question however is- "Can the Maize supply chain, in its current form, cater to the rapidly increasing demand"? The Government on its part has been providing price support mechanism to push up Maize production; the pressure however, is on the value chain to be streamlined as an immediate measure to enhance the performance of the sector.

FICCI envisions that the existing productivity level of Maize should double from 2.5 MT/ha presently to 5 MT/ha with subsequent increase in farmer's income by 2022.To advance progress toward this vision, the report outlines a value chain based framework.

We hope that this report will encourage more discussions for considering Maize as a potential crop for realising Government's vision of doubling farmer's income and suggest how strengthening each segment of Maize value chain will play a crucial role in achieving same.

अशोक दलवाई, भा.प्र.से.
मुख्य कार्यकारी अधिकारी
भारत सरकार,
कृषि एवं किसान कल्याण मंत्रालय
कृषि, सहकारिता एवं किसान कल्याण विभाग
राष्ट्रीय वर्षा सिंचित क्षेत्र प्राधिकरण

सत्यमेव जयते

ASHOK DALWAI, IAS
Chief Executive Officer
Government of India,
Ministry of Agriculture and Farmers Welfare
Department of Agriculture, Cooperation & Farmers Welfare
National Rainfed Area Authority (NRAA)

Message

Hon'ble Prime Minister has shared his vision of doubling farmers' income and placed the challenge before the nation to realize it by the year 2022. The need for translating this vision into reality in a time bound manner is to enhance the welfare of the farmers, who constitute a large section of our society. The vision has churned the Indian society across various segments, and has engendered debates and deliberations from which appropriate solutions are bound to come forth.

I am happy that the Federation of Indian Chambers and Commerce of Industry (FICCI) has identified 'Maize' as a potential crop that can contribute in its own way to realization of this vision. Not only is maize a globally important cereal, within India too it ranks 3rd with an annual output of 27 million tonnes, next only to rice and wheat. It is amenable to multiple uses including as human food, poultry feed and industrial raw material. The demand for maize as a poultry feed which is already as high as 47 per cent of the total output is bound to increase with higher focus on poultry sector as a part of diversification. Maize also has the potential of creating jobs in the industrial sector, where multiple products are possible.

Another advantage of maize is that it is a hardy crop and, is therefore, well suited to less endowed cropping environments particularly in situations of climate change. There is vast scope for increasing the productivity by adopting new seeds and agronomic practices. In states like Bihar and Tamil Nadu 100 per cent of maize area is already under hybrid maize cultivation. Considering its multiple end uses including in the industrial sector, there exists scope for private sector participation through contract farming, farmer producers organizations and agri-value system platform.

I congratulate FICCI and Pricewaterhouse Coopers (PwC) for coming up with 'Maize Vision, 2022' on the occasion of 5th Edition of India Maize Summit. This will generate awareness among all stakeholders, besides making new knowledge accessible to them thereby contributing to robust growth of maize sector in the country.

My best wishes

A Dalwai

March 20, 2018

(Ashok Dalwai)

MESSAGE



Mr. Vinay Mathur
Deputy Secretary General, FICCI

Maize is a multi-faceted crop used as food, feed and industrial crop globally. Maize has a very prominent role to play in the Indian economy too. Currently this coarse grain is cultivated in about 10.2 Million hectare in India.

The increasing interest of the consumers in nutritionally enriched products and rising demand for poultry feed which accounts 47% of total maize consumption are the driving forces behind increasing consumption of Maize in the country. As per the demand estimates, the Indian Maize production has to grow with CAGR of 15% in next 4-5 years.

It is in response to such increasing demand, India needs to plan production by productivity increase and also reorient value chain if it is to serve the basic goal of remunerative prices for farmers.

India Maize Summit organized since 2013 has gained in stature and popularity over the years on account of its focus on covering very relevant participation from right stakeholders and covering topical issues. This year, India Maize Summit is focused on solutions that will help to increase Maize productivity by building efficiencies in entire chain and thus generating higher value for the farmers .

FICCI would be delighted to play the role of facilitator in realizing the objectives of the set vision for Maize sector.

MESSAGE



Mr. T R Kesavan
Chairman, FICCI National Agriculture Committee and President & COO, TAFE

There is a widespread realization that farm mechanization is indispensable for increasing yield. While we aim to double the yield of Maize by 2022, intervention of mechanization in Maize is crucial.

Shortage of farm labor, need for timely farming operations and the need to increase productivity has seen mechanization expand across different operations such as soil preparation, planting, inter cultivation/ weed management and harvesting. However, we require innovative ideas to meet the projected demand of Maize in our country.

In order to provide significant push to the sector, an effective implementation of Maize vision 2022 would be required. Promotion of Maize based ***Skill development centers*** and ***Maize based farm machinery banks*** for small and marginal farmers can be the big game changers.

I am sure deliberations at 5th edition of India Maize Summit and this report will provide important inputs for Policy interventions in Maize sector.

MESSAGE



Mr. Ashok Varma
Partner, PwC

The Indian Maize sector is now on threshold of a new revolution. This time the driver of change is surge in demand for Maize from Maize based businesses, be it poultry, feed, starch or processed food. Maize consumption has reached to a figure of 24 Mn MT. This cumulative demand comprises of 13.5 Mn MT from poultry feed, 1.8 Mn MT from starch, 1.2 Mn MT from ethanol and balance for food, seed and other usage.

Keen interest has been evinced by private sector players as well as Government in harnessing the potential offered by Maize sector. Their interest has been buoyed by expected increase in consumption of Maize. However, the Indian Maize yields are significantly below the yields in benchmark countries. The difference in Maize yield between India and world is 130%- which is alarming.

This calls for developing an integrated value chain plan for Indian Maize sector, focusing on clear objective of doubling productivity of Indian Maize in selected states. Karnataka, Andhra Pradesh, Maharashtra, Rajasthan and Bihar, together account for about 2/3rd of the total maize production in country. States like Bihar have witnessed Maize revolution in last decade. This signifies that State wise meticulous planning is required for productivity led growth of Indian Maize

The report proposes a sustainable roadmap for achieving "Maize vision 2022" which focuses not only on production and productivity but also on building a competitive maize supply chain. While constraints can be found at every stage of the chain, from research to consumption, all stakeholders will have to act together with scale and speed to create a "Brand India for Maize" which demonstrates India's advantages and capabilities to become a world leader.

Maize - At a Glance

Maize generates employment of more than **650 million** person days at farm

15 million farmers in India engaged in Maize cultivation

Maize qualifies as potential crop for doubling farmer's income

India would require **45 MMT** of Maize by year 2022

Maize is less **water demanding** and gives higher yield per hectare

By growing **Maize farmers** save **90%** of water, **70%** of power compared to paddy

Maize yield increased with CAGR of **5%** and **4%** in **U.S.A.** and Brazil respectively in last **4 years**

Difference in Maize yield between India and world is **130%**

Feed industry growing at a CAGR of ***9%*** *presents huge opportunity for* ***Maize growers***

Maize consumption growing at a CAGR of **11%** in last 5 years: **Poultry feed** accounts for **47%** of Maize consumption

Maize a source of more than **3,500** products including specialized Maize like QPM **"Quality Protein Maize"**

Only **15%** of cultivated area of Maize is under irrigation

Bihar and **Tamil Nadu** has almost reached **100%** hybridization in Maize

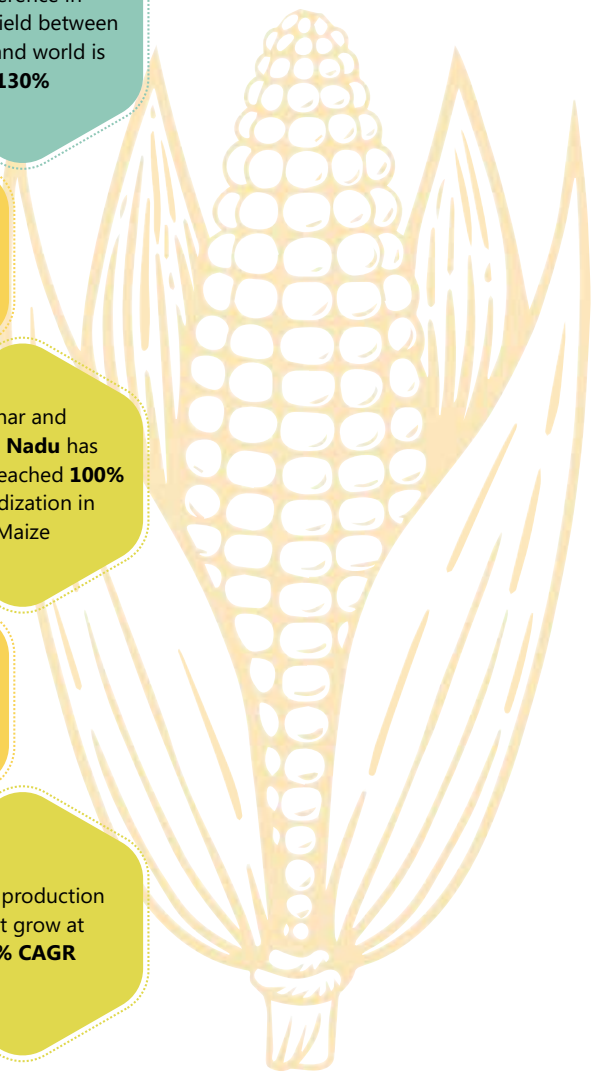
Maize contributes **11%** to total size of Indian seed industry

Global Maize production reaches **1040 M MT**

India stands at **5th rank** in Maize hybridization

5-7% of Maize produced in India **lost** due to **improper storage**

Maize production must grow at **15% CAGR**



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Executive Summary



Maize is the second most important cereal crop in the world in terms of acreage and is called the '**Queen of Cereals**'. Global maize production touched approx. 1040 million MT in 2016-17, wherein, US has been the leading producer, followed by China, accounting for about 38% and 23% respectively. India contributes around 2% of this production chart with a quantum of 26 million MT in 2016-17.

In the Indian context, not less than **15 Million** farmers are engaged in maize cultivation and it generates employment for more than **650 million person-days** at farming and its related business ecosystem levels. Importantly, maize contributes more than 2 per cent to the total value of output from all agricultural crops.

The crop is less water demanding than other similar cereals and being a 'C4' as well as 'day-neutral plant', it gives higher yield per hectare in a shorter period and can be grown in any season. The multiple utilities of maize as a 'food', 'fodder' and 'feed' makes it further more demand friendly and insulates it against low demand situations. **These unique characteristics of maize make the crop a suitable crop candidate for enhancing farmer's income and livelihoods in India.**

The current maize production scenario highlights presence of hybrid maize at about 65-70 percent acreages and most of it accounts for feed and industrial grade Maize, while food grade Maize is produced using traditional cultivars (OPVs). In the recent years, although the rate of adoption of hybrids has slowed down, but farmers continue to replace traditional cultivars/old hybrids with the newer higher-yielding hybrid varieties.

States such as Karnataka, Rajasthan, Andhra Pradesh and Madhya Pradesh, contribute towards **half of the total maize acreage** in the country. The aforementioned states including Bihar account for almost **2/3rd of the national maize** production. However, it is very pertinent to observe that the national productivity of maize is considerably lower than the global standards. **India stands almost half the global yield standards** and therefore there lies immense scope for improvement in the strategically important crop in the country.

On the demand side, Maize consumption has increased by **2 percent** over previous year reaching it to a figure of **24 Mn MT** during **FY 2016 –17**. This cumulative demand comprises of **13.5 Mn MT from poultry feed, 1.8 Mn MT from starch, 1.2 Mn MT from ethanol**, and balance for food, seed and other usage. Specifically, the feed industry growing at a CAGR of 6-7% globally and in India at CAGR of 9% presents a huge opportunity for maize growers. In order to meet the domestic consumption needs only, India would require 45 Mn MT of Maize by the year 2022.

In order to meet the desired demand levels and enhance farmer's income, FICCI has come up with **Maize Vision 2022**, encompassing backward and forward linkage strategies to bring paradigm shift in crop economy. These strategies have been developed in consonance and in sync with opportunities and future considerations existing across **maize value chain**. ***The maize value chain actors who are essential components of the backward and forward linkage chains and thereby are addressed adequately in the Maize vision 2022.***

Backward linkage strategies include interventions in Seed, Farm mechanisation, Research and Development, Irrigation, Crop insurance and other farm inputs. Forward linkage strategies encompass processing / milling, procurement and storage and retailing. These overall strategies have been devised to **achieve 3 key outcomes: a) Meeting domestic demand, b) increased farmers' income and c) putting an imprint of Indian Maize on global map in terms of quality competitivenes.**

Interventions identified for seed sector include large scale adoption of Single Cross Hybrid (SCH) technology, cluster based seed production through seed producer groups and forging Public Private Partnership (PPP) opportunities in ensuring availability of quality Maize seeds. Creation of enabling infrastructure through **dedicated seed cold storages** is an area that need further improvement and require lot of attention for improving the back end support system infrastructure for maize.

Thrust areas of interventions identified in **Research and Development** (R&D) are key biotechnology interventions required for improving maize productivity in significant terms. Innovation in R&D could bridge the existing average yield gaps between global and Indian maize crop bringing incremental gains to cultivators.

In farm mechanization, forging PPP opportunities for establishment of Maize based **silage making units, Maize based Skill Development Centers (SDCs)** and **Maize based farm machinery banks** have come out as possible avenues for investment. These avenues need to be tapped and scaled up to decrease the usage of animate labor and increase mechanization in Maize.

Developing crop specific strategy for MIS (micro irrigation systems) expansion in Maize and supporting solar based irrigators' cooperative enterprise could enhance yield as well as farmers' income. Developing crop specific loan and insurance products, and need based **ICT** interventions could be potential avenues for private sector participation. Promoting PPP in extension and marketing would be a successful model with win –win for government, private players and Maize growers through better transfer of technology and assured procurement of produce at remunerative prices. Scaling up of Public Private Partnership for Integrated Agriculture Development **(PPPIAD)** initiatives in Maize could increase the value chain profitability.

On forward linkages, installation of Maize dryers and promoting modern storage techniques like silos are needed as infrastructures for better storage and PHM (post-harvest management) in Maize. Creation of such enabling infrastructures would improve the quality of produce and thereby lead to better price realization for farmers. Need based adoption of Price deficiency

payment (PDP) for growers and **quality based customization of derivative contract post e –NAM integration** would be essential avenues for industry and government to converge and provide a next-level thrust to the sector .

Growing usage of Maize in feed and industrial purposes, particularly Poultry feed and Starch has not only given significant demand support, but has also unfolded lateral avenues for investment through establishment of processing infrastructures in Maize. In this scenario, there exists scope for expanding the product portfolio of Indian Maize starch, improving recovery percentage from the crop, and increasing consumption from beverage and biofuel industry. Policy and investment environment supporting such initiatives would certainly provide significant push to Maize processing and value addition industry.

In totality, as compared to traditional crops i.e. Paddy and Wheat, Maize based industry has grown tremendously, which is largely attributed to the private sector. In order to provide significant push to the sector, an effective implementation of Maize vision 2022 would be of paramount significance. An enabling policy environment with deeper engagements of stakeholders across value chain would be crucial and would trigger the rapid crop growth with necessary momentum for overall agriculture sector.

To realise the potential of maize as 'the future cereal crop', it is necessary to have an amalgamation of strategies and interventions around technological innovations, promoting producer aggregation and linkages, enabling supporting infrastructure, forgoing PPP relations, and facilitating several policy interventions.



A | Importance of Maize in Indian Agribusiness ecosystem

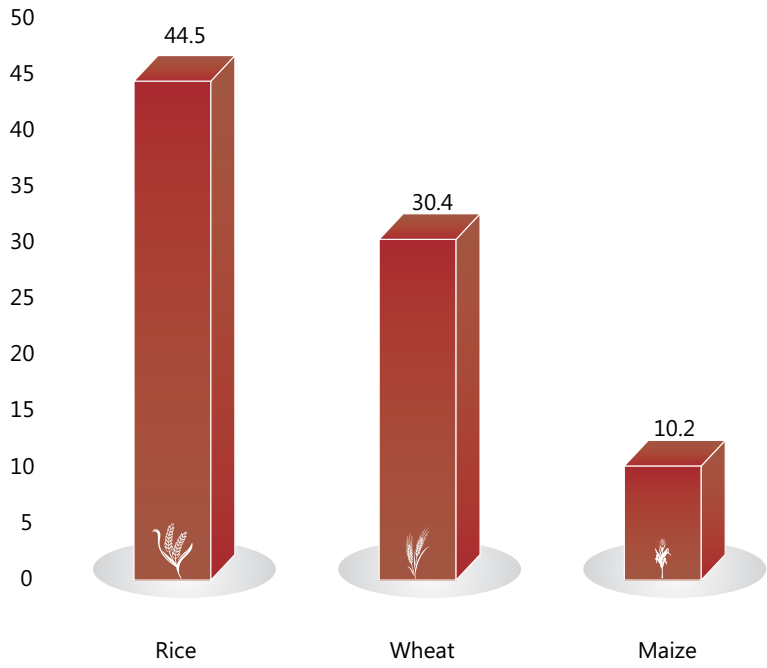
A | Importance of Maize in Indian Agribusiness ecosystem

After paddy and wheat, maize is the third most grown cereal crop within India; however, in terms of overall value, it is one of the most important cereal crops of the world.

The US and China are the first and second largest producers and consumers of maize. The ever increasing use of maize in cattle and feed industry is what puts it apart from other cereal crops globally. The increased use of maize for ethanol production for fuel in US and many European countries adds further value to the crop. Within India unlike various other high value crops, the direct involvement of small and marginal farmers is very intense in the cultivation of maize. Considering the value of output and degree of involvement of maize growers, importance of Maize in Indian Agribusiness ecosystem is immense.

"15 million farmers engaged in Maize cultivation in India."

Exhibit: Maize acreage vis-à-vis acreage of Paddy and Wheat in India in Mn ha



Source: Grain: World Market and Trade, Nov 2017, USDA

"Maize generates employment of more than 650 million person – days at farm."

(a) Importance of Maize in employment generation and value creation:

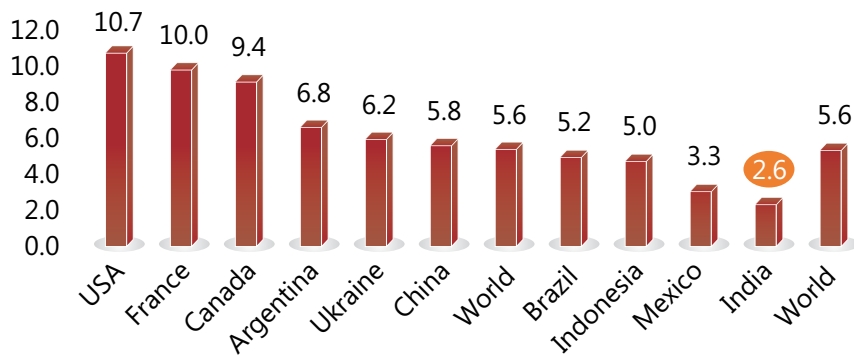
Any positive development in the sector results in benefiting a huge mass of people involved in the agricultural sector. Rough estimates put the figure of farmers engaged in maize cultivation to **15 Millions** in India alone. Further, it has been estimated that assuming, the human labour requirement of on an average 75

person-days per hectare, the crop is also generating employment of more than **650 million person-days** at the farm and downstream the agricultural and industrial sectors in India. It contributes about 2 per cent to the total value of output from all the agricultural crops.

(b) Scope of improvement in Yield potential:

Despite, the dependency of such a significant population in terms of employment generation and diversity in the usage of maize, Indian Maize is performing comparatively low in terms of yield as compared to world average. The depicted graph seeks to captures the yield comparison of most of the major maize producing countries.

Exhibit: Comparative analysis of average yield (T / ha) of key Maize producing countries



Source: Agricultural Statistics at a Glance 2016, DoA ,C & FW

"The difference in Maize yield between India and world is 130%."

The difference in yield between India and world yield for maize is huge and works out to roughly 130%. The difference in yield with the leaders in maize production is even much larger, for example, with US it is more than 400% and with China it is nearly 225%. Interestingly, Argentina and Ukraine with less than half of area under maize than India are able to produce significantly more than India.

The large gap in yield of maize production in India and rest of the countries is quite striking. What is clearly evident is the huge amount of effort required in improving the yield and total production of maize in India. It is imperative for all the stakeholders involved in the maize sector to join hands to leap frog it to a stage where the production is at least able to meet the demand of the domestic consumption.

"Maize qualifies as potential crop in realizing broader vision of doubling farmer's income by 2022."

(c) Potential of Maize in improving farmers' income:

NITI Aayog has identified 7 sources of growth, which could help in doubling farmers' income by 2022: 1) Increase in productivity of crops, 2) Increase in production of livestock, 3) Improvement in efficiency of input use, 4) Increase in crop intensity, 5) Diversification towards high value crops, 6) Improved price realization by farmers, 7) Shift of cultivators to non –farm jobs. On all these 7 identified growth parameters, Maize has visible potential to qualify. Technology adoption has direct correlation with these growth sources, leading to increase in farmers' income.

(d) Nutritional importance of Maize:

Maize can be consumed as food, feed, and fodder and is a source of more than 3,500 products including specialized maize like quality protein maize (QPM), baby corn, sweet corn etc. Due to recent research advancements, the quality protein maize, single cross and 3-way cross hybrids have given a fillip to the nutritional quality of this cereal. The nutritional value of maize has been shown in the table alongside.

Content	%age dry matter basis
Starch	71-72
Protein	9-10
Fat	4-45
Fibre	9-10
Sugar	2-3
Minerals	1.4

Source: NCoMM special report on Maize, NCML, September 2017

"Maize is a source of more than 3,500 products including specialized Maize like QPM (Quality Protein Maize)."

(e) Adaptability of Maize to varied climatic conditions:

Maize is the only food cereal crop that can be grown in different seasons and requires moderate climate for growth. In the country, more than three-fourths of the area to maize production is contributed by eight states, viz Andhra Pradesh, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and Tamil Nadu. Over the past two decades, the crop has witnessed a growing prominence in these states, though with a varying degree, particularly as a feed crop. Maize being a C_4 plants it has a competitive edge over C_3 plants. C_4 plants use 3-fold less water, allowing them to grow in conditions of drought, high temperature, and carbon dioxide limitation. It has been recognised that C_4 plant species (including maize) have a higher optimal temperature for undertaking photosynthesis than C_3 plants due to operation of a CO2-concentrating system that inhibits Rubisco oxygenase activity.

"Being a C4 plant, Maize use 3-fold less water and gives higher yield per hectare even in a shorter period than any other food grain crop."

(f) Suitable Alternative for traditional Rice, Wheat based farming:

Maize is less water demanding than other crops. Being a C_4 plant, maize gives higher yield per hectare even in a shorter period than any other food grain crop. Besides, it can be grown in any season, as it is a day-neutral crop. The favorable weather conditions for winter maize or spring maize may result in gradual replacement of wheat in regions where assured and sufficient irrigation facilities are not available Government has appointed an inter-ministerial panel on crop diversification to help farmers look beyond paddy, which consumes huge amount of water, fertilizer and power. **By cultivating maize, farmers can protect the worsening quality of soil, save 90 per cent of water and 70 per cent of power as compared to paddy and earn far more than they are earning through paddy and wheat.**

(g) Multiplicity of usage pattern of Maize:

	Food	Feed	Fuel	Industrial Use
Maize	7 Mn MT	14 Mn MT	1.2 Mn MT	1.8 Mn MT
Paddy	97 Mn MT	0	0	0
Wheat	94 Mn MT	4.8 Mn MT	0	0
Other coarse cereals	16 Mn MT	1 Mn MT	0	1 Mn MT

Source : Grain and Feed Annual 2017, GAIN Report; (0~ very low amount)

What emerges from the table above is the diverse usage of maize as compared to other cereal crops. Every part of the maize plant has economic value; the grains, leaves, stalk, tassel, and cob can all be used to produce a variety of food and non-food products. Most importantly, it is the growing consumption of maize in the feed industry that sets it apart from all other crops. With the largest global livestock population, India has always remained a feed starved country besides Indian poultry industry specifically eggs and poultry meat is growing at a CAGR of around 6 per cent and 9 percent. Keeping these factors in view, maize continues to remain an important crop for food, feed and industrial purposes.

"Improvement in Maize value chain is crucial for making Indian maize competitive in international market."

(h) Importance of Maize in global trade:

After four consecutive years of bumper exports, Indian Maize exports have slowed down significantly since MY 2015/16 on uncompetitive prices; however, domestic prices have remained firm on strong demand and rising MSPs. FY 2016/17 exports are estimated at 500,000 MT, mostly to neighboring Nepal and seed exports. However, despite the uncompetitive prices of Indian Maize in global trade in last few years, there still remain a huge market in the neighboring countries like Bangladesh and the traditional destinations for Indian maize in South East Asian countries like Malaysia, Singapore and Vietnam. Improvement in the maize value chain across its various stages will be extremely crucial for making Indian maize competitive in international market both in terms of quality and prices.

(i) Rising demands from domestic market:

Maize accounts for the major share of the coarse grain production; showing a steady upward trend over the last decade on growing domestic demand (poultry feed and industrial use) and increasing productivity (better hybrid seeds). Study suggests that growth of the poultry and starch industries and consequent demand from these sectors is likely to outstrip domestic production of Maize in near future. India is likely to continue to import small quantities of food grade Maize (e.g., sweet corn etc.,) and popcorn for the food processing industry due to growing consumer demand and low domestic supplies. This poses a huge challenge in front of maize production scenario in India of meeting the ever growing domestic demand from diverse segments catering to food and non-food usage of maize.

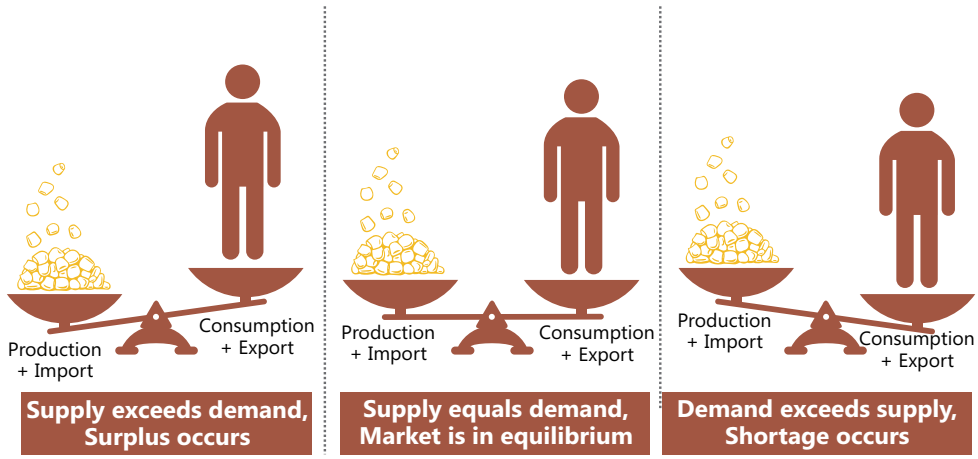
Maize assumes significant importance in not only among food grains, but also for wholesome development of agribusiness value chain in India. It is imperative to understand the existing supply demand economics of Maize globally and in India. Production, consumption and trade scenario analysis are key components of Supply – demand curve and elaborative assessment of same has been presented in next section.



B | Assessing demand supply pattern: Redefining focus on sector

B | Assessing demand supply pattern: Redefining focus on sector

Exhibit: An illustration of supply demand economics



Colour code:-

Strong Demand
Weak Demand
Strong Supply
Weak Supply

Table:- Seasonality of Maize Demand and Supply.

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Demand												
Supply												

Source:- PwC analysis based on GAIN Report 'India: Grain and Feed Annual 2017

Demand and supply in Maize largely depends upon sowing and harvesting season. Strong demand rises during January to March, whereas strong supply occurs twice: March to May for Winter Maize and September to December for Rainy Maize. Moreover, the crop duration ranges between 90 to 150 days, varies from state to state and variety to variety.

"Strong demand rises for Maize during January to March."

Interestingly, it has been observed that poultry farms and feed millers hold stocks for a period ranging from 15 days to 60 days, depending on their mill capacities, financial strength, and receivables cycle. Usually, they purchase and stock maize during the peak arrival season at low prices. This stock is maintained to tide over the peak price months, and buying for regular requirement continues in parallel. Also, Starch manufacturers store it for longer durations, sometimes as long as three months. To some extent, the role of traditional stockist has been taken over by the trading companies, which normally enter into forward trade agreement with the consumers (say, a poultry farm), purchase and store grains during the peak arrival season. These holding pattern, coupled with sowing and harvesting seasonality are majorly impacting the supply demand equation of maize.

Production is a key component of Supply and has direct bearing on its fluctuations. Global and Indian production scenario of Maize has been presented herewith.

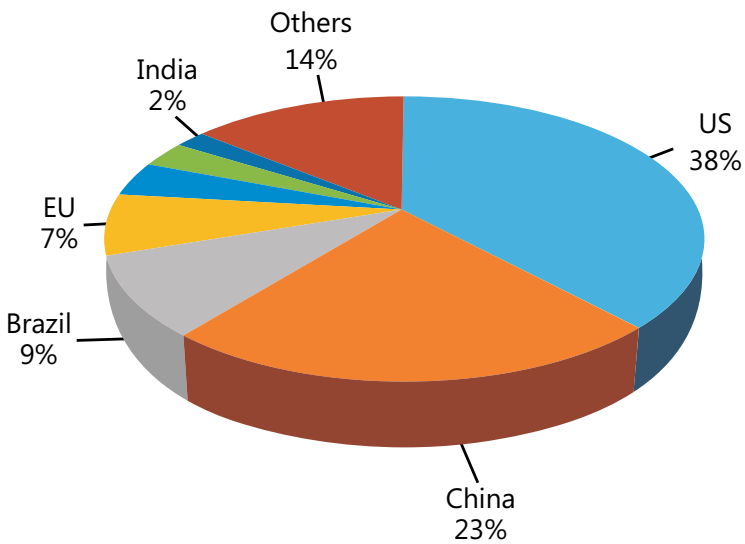
(B.1) Production Scenario: Supply thrust

Global Outlook

Global maize production hovered around 1040 million MT of Maize in 2016-17, however for the current year there are forecasts for a slightly lower Maize area, yield and production.

"Global Maize production at 1040 million MT in 2016-17."

In a global perspective, **US has been the leading maize producer, followed by China, accounting for about 38% and 23%** respectively. On one hand, where US maize production has shown a comparative increase owing to increased plantings; in China, it has declined owing to drought and other adverse and unfavorable climatic conditions.



Source:- USDA, FES Grain and Feed Annual, World Markets and Trade, Jan 2017

"USA is the leading producer of Maize in world, followed by China."

Significant contributions, to overall global production, have also been done by Brazil and European Union (EU) by 9% and 7%, respectively. EU has been experiencing improved yields in for last few years. India contributes 2% to the total world production in maize.

Table covering yield and production of major maize producing nations along with contribution in the world production, is depicted below.

Table:- Comparative analysis of Yield (MT/ ha) and Production (Mn MT) of Maize in leading nations of World

Country	% in world production	Yield/Prod	2013-14	2014-15	2015-16	2016-17	CAGR %
US	38	Yield	9.93	10.73	10.57	10.96	5.06
		Production	351	361	345	384	4.6
China	23	Yield	6.02	5.81	5.89	5.97	-0.42
		Production	218	215	224	219	0.23
Brazil	9	Yield	5.06	5.4	4.19	5.49	4.16
		Production	80	85	67	96	9.54
India	2	Yield	2.68	2.63	2.56	2.54	-3
		Production	24	24	20.5	26	4
World		**Yield**	**5.5**	**5.67**	**5.44**	**5.82**	**2.87**
		Production	**993**	**1018**	**968**	**1040**	**2.34**

"Maize yield increased at a CAGR of 5% and 4% respectively for USA and Brazil in last 4 years."

Observations:-

- Yield has shown significant spurt in US and Brazil in last 4 years with CAGR of 5% and 4% respectively.
- Yield in India has remained stagnant during mentioned time period.

Source: - USDA, Sep 2017 & PwC Analysis.

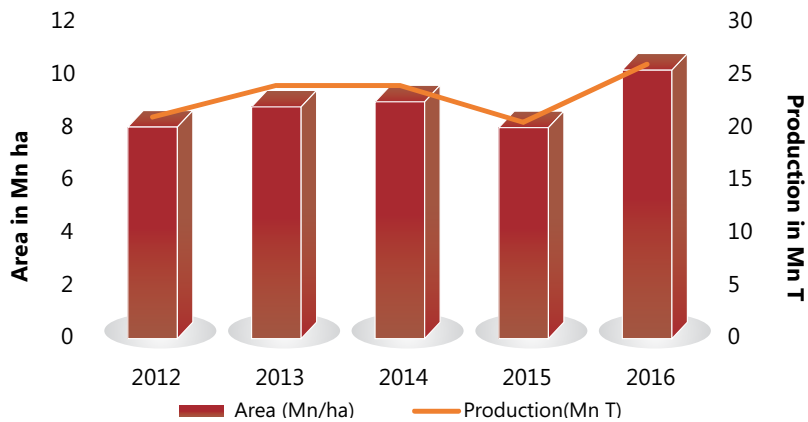
Production outlook in India

Indian maize production depends heavily on the South west monsoon as more than three-fourth of the maize is produced in the Kharif season. Poor monsoon rainfall in 2015 has affected the yield of Kharif maize mainly in Maharashtra, Rajasthan, Gujarat, Karnataka, Andhra Pradesh and Telangana. Dry soils and inadequate irrigation water availability also affected planting of Rabi maize.

Area and Production trend over the years from 2012 to 2016 has been depicted herewith. It could be observed that, although harvested area and production has increased during this period but there is non-uniformity in trend over the last five years.

"Three-fourth of Maize produced in Kharif season, depends heavily on south-west monsoon."

Exhibit: Maize harvested area & production in India in last 5 years



Source:- Ministry of Agriculture, GoI (Year2016) & PwC Analysis

Maize production in the country has taken a hit in 2015-16 due to two continuous years of below normal monsoon rains, followed by drought. India received 14% below normal southwest monsoon rains in 2015, and rainfall was 12% below normal in 2014.

State-wise Maize production

When it comes to Indian states, maize is cultivated in almost all types of agro-ecological regions. **Only 7-8 states together account for more than three-fourths of maize area as well as production** in the country. A regional shift in production has been observed from north to south; Bihar, Uttar Pradesh and Madhya Pradesh were the major maize producing states in 1990s, but during the past two decades, southern states, especially Andhra Pradesh and Karnataka, have become the major maize-producing states.

Only four states: Karnataka, Rajasthan, Andhra Pradesh and Madhya Pradesh, constitute about half of the total maize acreage in the country, and five states, viz. **Karnataka, Andhra Pradesh, Maharashtra, Rajasthan and Bihar**, together account for about 2/3rd of the total maize production. Rajasthan and Madhya Pradesh though have a large share in maize area, but depict a low contribution to maize production in India.

According to the maize production data of recent years, states with more than 10% of maize area are categorized as follows:-

Exhibit: Maize harvested area & production in India in last 5 years



"State-wise meticulous planning required to put Indian Maize on global map."

Productivity Group	Criteria	States	Percentage of Total Area Under Maize in India
High maize productivity states	> 4 T/Ha	Andhra Pradesh & Tamil Nadu	13%
Medium maize productivity states	2- 4 T/Ha	Bihar, Himachal Pradesh, Karnataka, Maharashtra, Odisha, Punjab, West Bengal.	40.2%
Low maize productivity states	< 2 T/Ha	Chhattisgarh, Gujarat, J&K, Jharkhand, MP, Rajasthan, UP.	43.8%
Other coarse cereals	16 Mn MT	1 Mn MT	0

Source:- Assessment of Maize situation, Outlook and investment opportunities in India (Ranjit Kumar, K. Srinivas, N. Sivaramane)

The reason behind such a low yield (< 2 T/Ha as mentioned above in case of low productivity states) is that in these states, maize is grown as a rain fed crop. Secondly, it is used mainly as a **food crop**, for which **traditional** or **composite varieties** are preferred. Lesser usage of hybrids coupled with lower nutrient usage and risk of water unavailability leads to the lower productivity.

In order to understand the maize cultivation practices and emerging trends across states, one state has been picked up from high, medium and low maize productivity classification and has been explained below:

Productivity Classification	States/ Region	Probable contributing factors to the production scenario
HIGH	> 4 T/Ha 	• Maize cultivation under **assured irrigated conditions *(insulation from vagaries of monsoon)*** • Emerged as an important Rabi crop ***mainly for feed and industrial purposes***, due to the large set up of poultry industry in the region. ***(increased industrial demand)*** • Maize area in the state increased almost three-times in the past 10 years, mainly due to ***rapid hybridization (technological interventions)*** • **Demand support & conducive price of maize grain for the local poultry** industry, which was erstwhile sourced from Andhra Pradesh, Karnataka and sometimes from Bihar. ***(local demand promotion)***
MEDIUM	Bihar 	• Rabi maize **(>400 thousand ha)** is prominent than that Kharif maize **(>230 thousand ha)**; and the state is an important source for Rabi maize. • Rabi maize has comparative advantage over Kharif maize due **to low** infestation of insect, pest and diseases as well as slow growth of weeds. **(Agro-ecological factors)** • Kharif maize is dependent on Monsoon and large maize growing tracts are prone to flood ***(Natural & Geographical factors)***
LOW	Chhattisgarh 	• All maize-growing districts are low yielding because of **very low adoption of hybrid maize**, as the crop is produced mainly for human consumption. ***(Lack of technological breakthrough)*** • The state government also promotes composite seeds through State Seed Corporation and not the promising hybrids from the private sector, which limits the yield growth.

"Rabi Maize has comparative advantage over kharif Maize due to low infestation of insect, pests and diseases."

It is pertinent for policy makers and Agri- sector value chain actors to emulate the factors leading to better performance in high productivity states and bring the moderate and lower states at par.

Although, Bihar comes under moderate / medium productivity range in average terms, but the state has witnessed significant growth in terms of production and acreage expansion in last decade.

Bihar: Setting an example through Corn revolution

The current market size of hybrid corn seed in Bihar is estimated at 1, 60,000 Q (>INR 400 Cr. in value terms) and is assumed to reach 1, 75,000 Q at the end of 2021-22 with CAGR of 2%, while discounting crop shifting and market price factors. Backed by suitability of high yielding Rabi Corn, Bihar has witnessed corn revolution in last decade. In this, almost 50% of the market size is limited to few private players (MNCs) due to their diverse varietal portfolio, suited to different agro-ecological profiles of state. While technology — planting of high-yielding single-cross hybrids — has played a major role in raising Bihar's maize production, the breakthrough, has also came with surge in export demand.

The export boom benefited Bihar's farmers in terms of price realisations, which soared from Rs 400 to Rs 1,200 per quintal between 2005 and 2012. The stretch from Purnia, Katihar and Bhagalpur to Madhepura, Saharsa, Khagaria and Samastipur – north of the Ganga and on either side of the Kosi – emerged as a corn belt where many farmers, big and small, harvested 50 quintals or more per acre. That was comparable to the 180-200 bushel yields in the US Midwest heartland of Illinois, Iowa and Indiana (one bushel equals 25.4 kg).

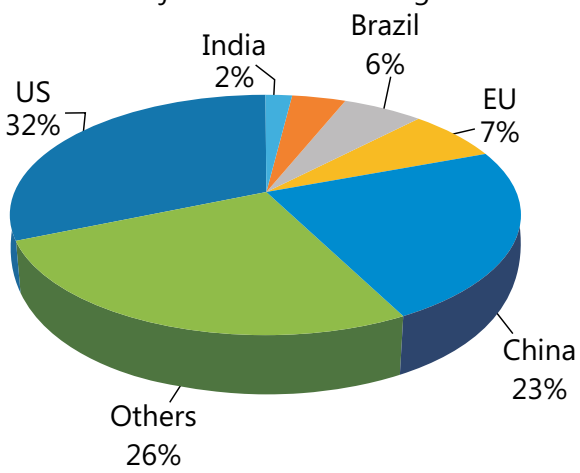
"Planting high yielding single-cross hybrids played a major role in raising Bihar's Maize production."

"Consumption", industrial and /or retail is a key factor deciding demand for Maize, and this demand in turn creates a 'pull' in terms of prices which drives the farming decision for farmers. Global and Indian scenario of Maize consumption has been presented herewith.

(B.2) Consumption Scenario: Demand Pull

Global outlook

Exhibit: - Major maize consuming nations in the world.



In global perspective, **US has been the leading consumer, followed by China, accounting for about 32% and 23%** of the entire maize consumption of the world.

Maize consumption is high in the EU and Brazil, at 6% and 7%, respectively. India accounts for 2% of the total world consumption.

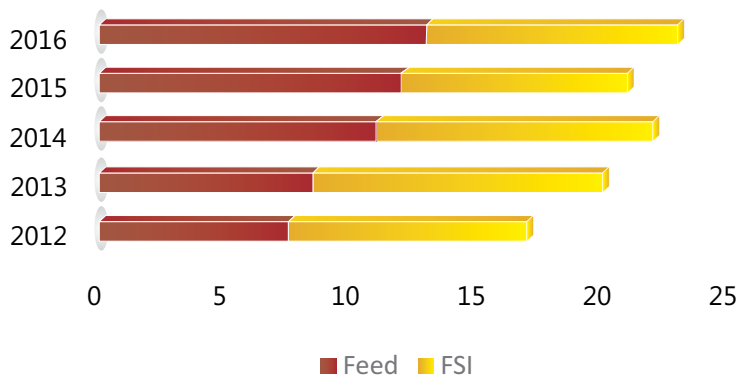
"Feed Industry growing with a CAGR of 6 – 7% globally and 9% in India, presents huge opportunity for Maize growers."

Source: - USDA, FAS Grain, World Markets and Trade, Jan 2017 & PwC analysis

Consumption outlook in India

More than two third of the maize produced in India is consumed for feed and other industrial uses. Feed industry with a CAGR of 6-7% globally and within India at a CAGR of 9% presents a huge opportunity for maize growers. With the largest global livestock population, India has always remained a feed starved country. Besides, the Indian poultry industry i.e. eggs and poultry meat sector, is growing at a CAGR of around 6% and 9% respectively. Keeping these factors in view, maize will continues to remain an important crop for food, feed and fodder purposes.

Exhibit: - Maize Consumption Trend in India in last 5 years (in Mn T)



"Consumption of Maize in India increased with CAGR of 11% in last 5 years."

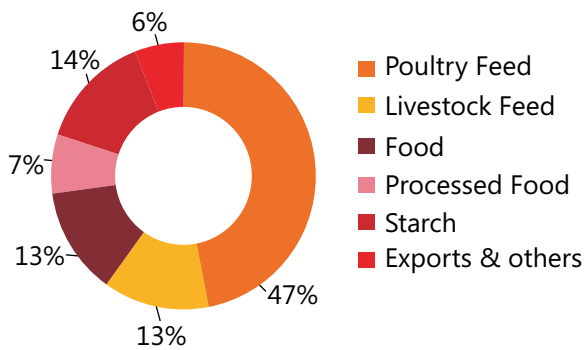
FSI : food, seed and industrial purposes

Source:-Ministry of Agriculture, GoI & PwC Analysis

- In the last few years, the usage of maize for feed has assumed focus. About 65-70% of maize produced in the country is used by the poultry, livestock, and food and starch industries.
- Overall consumption of Maize in last 5 years has increased with CAGR of 11%.
- It is interesting to note that, over this period of 5 years, feed consumption has increased with CAGR 20% with significant demand from Poultry industry, whereas FSI segment has increased with only 2% CAGR.

"Poultry feed accounts for 47% of total Maize consumption in India."

Exhibit:- Sector-wise Maize Consumption in India



Source:- NCML Report on Maize & PwC Analysis; 2016

Maize consumption in India can broadly be divided into three categories viz. **feed, food and Industrial** non-food products (mainly starch). This consumption aspect has been depicted with the help of a pie-chart herein.

Feed accounts for about 60% of the maize consumption in India. The most important use and demand driver of maize is ***poultry feed which accounts 47%*** of total maize consumption. Livestock feed accounts for 13%. The food consumption accounts for 20% of Maize consumption, with direct consumption being 13% and that in form of processed food being 7%.

The non-food industrial products account for the remaining 20% of India's maize consumption. ***Starch is the most important in this category accounting for 14%*** of the total maize consumption. The remaining 6% is accounted for exports and other industrial non-food products.

In addition to Production and consumption, trade too assumes its significance in supply and demand equation of Maize. Import adds to supply, whereas export adds to demand. Global and Indian trade scenario of Maize has been presented herewith.



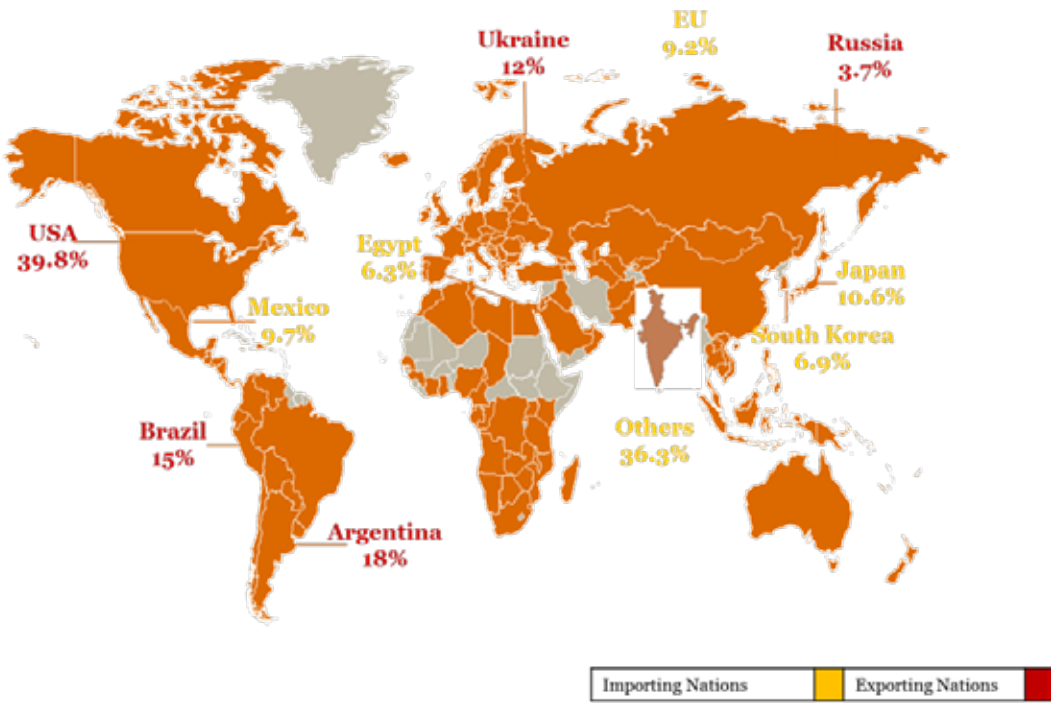
(B.3) Trade Scenario: Import and Export patterns

Global trade outlook

The structure of the world maize market can be characterized as one with a high level of concentration in terms of exports but very low concentration on the import side. The main reason for this development is the fact that those countries which usually have significant maize surpluses for exports are relatively few in number, while those relying on international markets to meet their needs for domestic animal feeding purposes by importing maize (as a primary feed ingredient) are many.

"USA: world's largest Maize exporter contributing 40% to global share."

Exhibit: Major maize exporting and importing nations



Source:- USDA, FAS Grain: World Markets and Trade, Jan 12, 2017

"Brazil, a major Maize importing nation earlier, became a main exporter to world in recent years."

Over the past few years, several countries improved their market share in international trade, whereas new countries entered the world market at a quick rate. Brazil, a major maize importing nation earlier, became a main exporter of maize to world markets in recent years. **The United States is the world's largest maize exporter which accounts for roughly 40 percent of the global share**, followed by Argentina. Brazil, the Republic of South Africa and Ukraine are among a few other countries which often have surpluses for exports.

While international trade accounts for only 10 percent of world maize production, it represents over one-third of total cereal trade. Global trade in maize has increased significantly over the past two decade. **Global exports for Maize and major exporters in the last five years is shown in the table below:**

Total exports in Mn MT	2013/14	2014/15	2015/16	2016/17	CAGR
Argentina	13	18	22	23	33%
Brazil	22	22	35	20	-5%
Russia	4	3	5	5.5	17%
Ukraine	20	20	16	21	2%
United States	51	46	52	56	5%
World Total	**130.83**	128.39	144.91	141.7	4%

Source: Grain: World Market and Trade, Nov 2017, USDA (pg. 22)

"Argentina and Russia have emerged as major exporting nations, since last 2-3 years."

Argentina and Russia have emerged as major exporting nations in the last 2–3 years, whereas Brazil's exports have declined in the last few years.

Meanwhile, most countries in Asia are net maize importers. Japan is the world's leading importer for 2016-17. The strong growth in the livestock industry, relaxation in trade barriers along with rising incomes are the major supporting factors behind the fast growth in Asian imports. African countries are also the major importers of maize.

Trade outlook for India

Indian Maize is uncompetitive in the international market due to relatively weak international prices. But, the domestic prices have remained firm on strong demand, rising MSPs, and tariff and non-tariff barriers to import. ***Market sources report that Indian Maize is currently about $30 per MT more expensive than competing Maize from other origins.***

"Indian Maize is about $30 per MT more expensive than competing Maize from other countries."

India's import scenario

India was a net importer of maize till late 1980s, as production growth in the country was not enough to meet the growing demand from poultry and other sectors and has imported 0.1 Mn M T Maize in 2016- 17.

The government of India is likely to take a call on allowing import of maize under the tariff rate quota. Maize currently attracts 50% customs duty, making imports unviable. **If the government allows import of maize under the Tariff Rate Quota, there is a possibility that traders may import the grain during the non-harvest season.**

India's export scenario

After four consecutive years of bumper exports, Indian Maize exports have slowed down significantly since FY 2015- 16 on uncompetitive prices. FY 2016- 17 exports were estimated at 0.5 Mn MT.

A large chunk of Indian maize (85-90% of total export) is ***exported to the South-East Asian countries*** like Indonesia, Vietnam, Malaysia, Taiwan, etc. and the remaining 10-15 per cent is exported to the Middle-East countries and Bangladesh, Nepal, Bhutan, etc.

Producing maize cultivars suiting to the importing countries, maintaining stringent quality standards in the entire supply chain from farm to the port in cost effective manners may help in achieving the higher export share in the region.

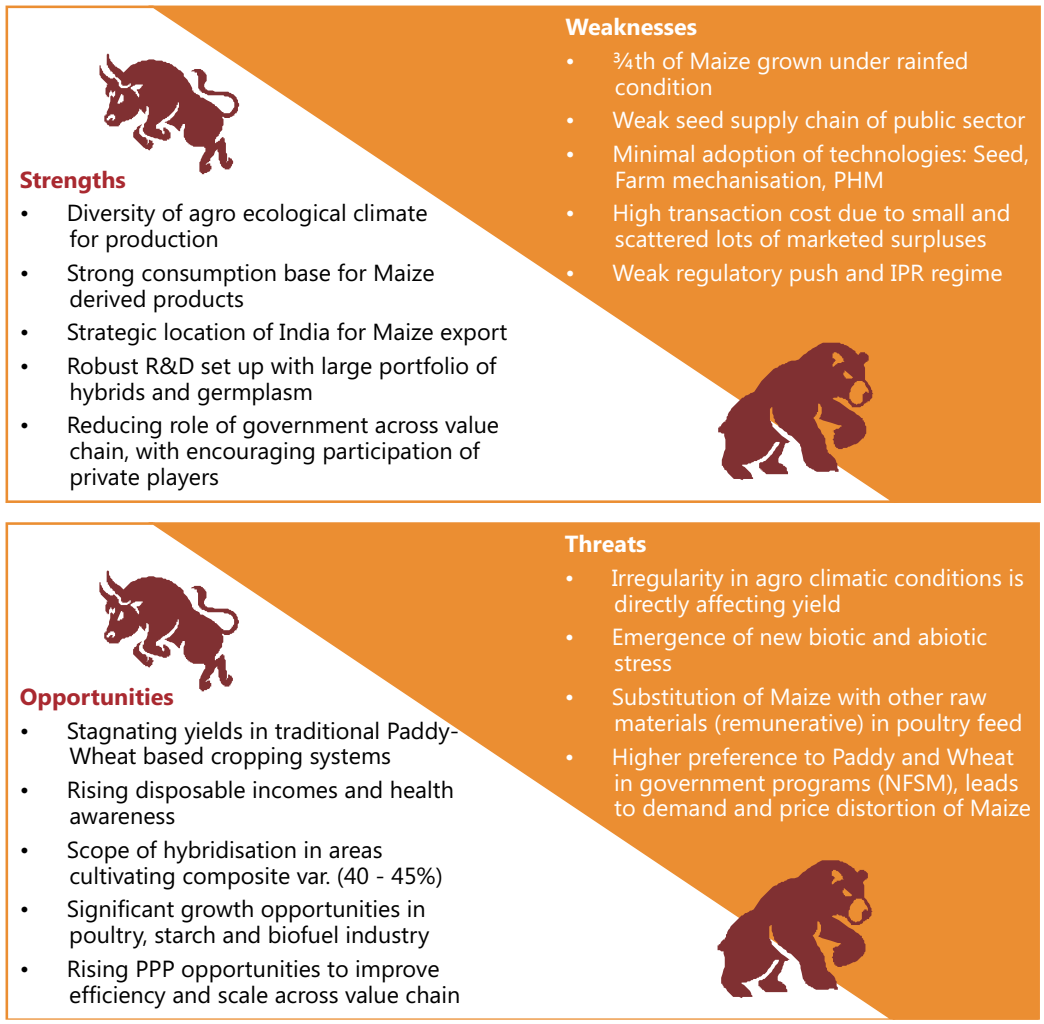
Assessment of supply demand situation of Maize clearly reveals that India is one of the serious players among maize producing nations in terms of production, consumption and trade. Looking at rising demand from domestic market need for positioning in global trade and unfolding growth avenues across value chain, FICCI has formulated Maize vision 2022, addressing needs of industry and stakeholders involved.



Time to bring paradigm shift in Maize sector

Sectoral constraints and demand projections

Exhibit: SWOT analysis of Maize sector in India



Although, Indian Maize industry has several inherent strengths and has opened up multitudes of opportunity avenues across value chain; starting from back end to front end, the sector is grappling with few external as well as internal setbacks. Out of several bottlenecks, lower productivity of Maize as compared to other countries is worrisome and calls for a significant leap in near future.

Maize productivity in India: Concerns

Exhibit: Comparative analysis of yield of major Maize producing countries



World | 5.6

USA | 10.7

France | 10.0

Canada | 9.4

Argentina | 6.8

Ukraine | 6.2

China | 5.8

Brazil | 5.2

Indonesia | 5.0

Mexico | 3.3

India | 2.6

Source: Agricultural Statistics at a Glance 2016 & PwC Analysis

The gap between the yield of Indian maize and that of leaders in maize production is rather wide. Maize yield in India has reached only 2.6 MT /ha, which is strikingly low as compared to that of the US, where the yield has reached up to 10.7 MT / ha. With less than half of acreage under maize cultivation as compared to the area under cultivation in India, Argentina and Ukraine are able to produce more than double the yield of Indian maize.

> *"Hybridization has direct and positive correlation with yield enhancement."*

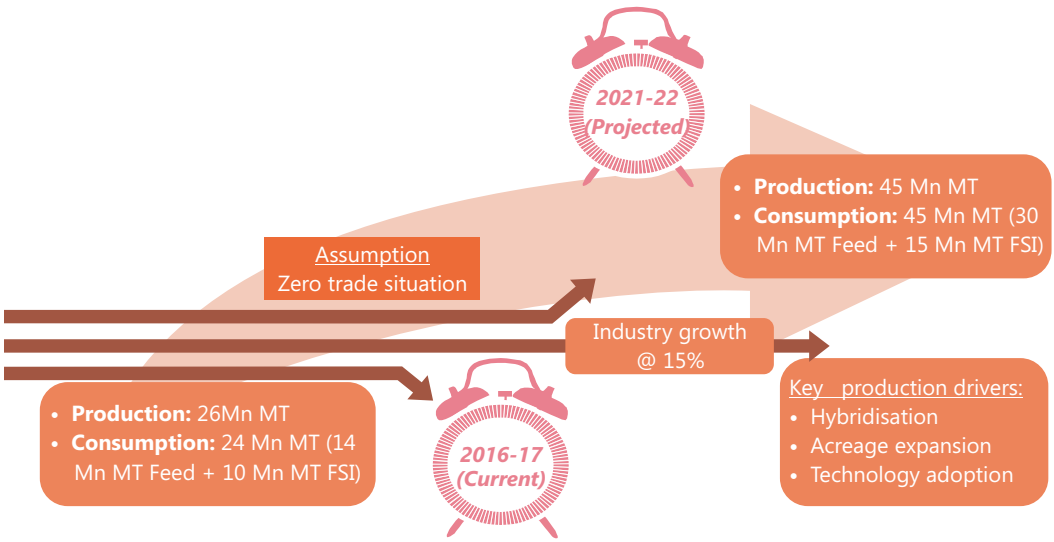
In India, a large part of the maize area is either under low-yielding composites or traditional varieties or hybrids are not performing well in these regions. This low yielding situation calls for rapid hybridization, as hybridization has direct and positive correlation with yield enhancement.

In order to assess the quantum of yield enhancement, it is imperative to understand the future consumption demand and production requirement for sector by 2022. **In addition to rapid hybridization, other production drivers have been identified, which would drive the sector in the near future.**

Demand projections and future drivers for Maize sector:

According to industry estimates, India would require 45 Mn MT of Maize by the year 2022, of which 30 Mn MT will be for feed and 15 Mn MT will be demanded by FSI (Food, Seed and Industry).

Exhibit: Future projections for Maize sector in India



- In order to achieve projected demand of 45 Mn MT of Maize by 2021-22, production must match with demand, assuming zero trade situation.
- This signifies that production must grow at 15% CAGR to suffice the domestic demand.

Keeping in view, the CAGR growth for maize production from 2012-16 was 3%, projected CAGR growth rate for next 4-5 years with 15% appears improbable unless some dramatic interventions occur. Few of these interventions, required for rapid sectoral growth has been elaborated in next section.

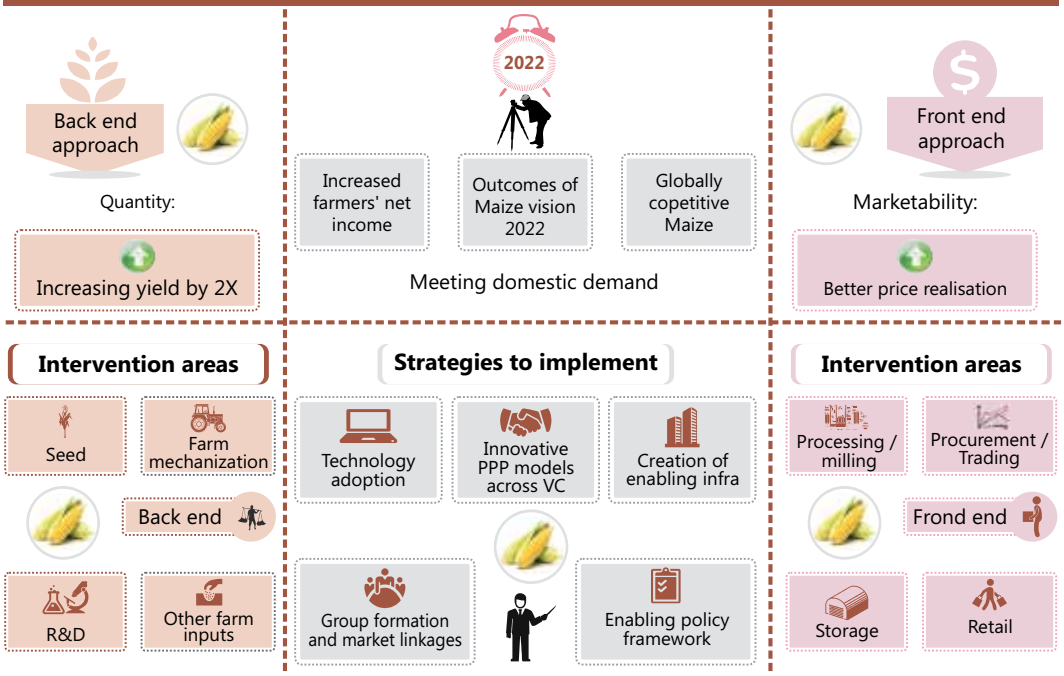


C | Maize Vision 2022: Strategies to bring paradigm shift in sector

C | Maize Vision 2022: Strategies to bring paradigm shift in sector

Although, India has achieved maize production level of 26 Mn MT, it would require 45 Mn MT of Maize by the year 2022, of which 30 Mn MT will be for feed and 15 Mn MT will be demanded by FSI (Food, Seed and Industry). This signifies that production needs to grow at 15% CAGR to suffice the domestic demand, which in turn, could be possibly met through significant leap in existing yield level. Simultaneouly, with an ambitious target to double the farmers' income by 2022, imporving price realisation for Maize cultivators is also of paramount significance. In order to achieve these twin objectives, ***Maize Vision 2022*** has been exhibited below.

Maize Vision 2022: To double the existing productivity level and improve price realisation of Indian Maize farmers by 2022



"Production needs to grow at 15% CAGR to suffice domestic demand."

Bipronged approach of Maize Vision 2022:

1. **Back end approach**: This approach would be crop specific, focusing upon doubling the current yield level of Maize and would help in matching it with global average (~5.6 MT/ ha). Specific intervention areas touched in value chain would be Seed, Farm mechanisation, Research and Development, Irrigation, Crop insurance and other farm inputs.



2. **Front end approach:** Front end approach is market specific and would focus on improving price realisation for maize farmers. Intervention areas covered in this approach would be processing / milling, procurement and storage, retailing etc.

Possible outcomes of Vision 2022 would be meeting domestic demand, increased farmers' income and putting an imprint of Indian Maize on global map in terms of quality competitivenes.

In order to achieve Maize Vision 2022, Strategies have been devised in such a way that it would address the needs of industry (Seed, Farm machinery, insurance, commodity exchanges, warehousing, Post- harvest service providers, consuming industry like starch and poultry) as well as other stakeholders (farmers, farmer groups / FPOs, government, academicians and researchers) engaged directly or indirectly with value chain.

"Bi-pronged approach addressing the needs of back end as well as front end is crucial to realize Maize Vision 2022."

Following are the key strategies to implement the Maize vision 2022:

- **Technology adoption**: Rapid adoption of technology in terms of hybridization, advancements in genomics and molecular breeding, next generation mutation techniques, adoption of RNAi technology for insect resistance, virus resistance, aflatoxin resistance etc. are few potential areas which would abridge the yield gaps and would bring incremental gains to maize cultivators.
- **Group formation and market linkages**: With high impetus on promotion of FPOs / FPCs in Budget 2018, seed production clusters in select pockets of countries, especially in Telangana, could emerge as formal institution like Seed Producers' Companies (SPCs) / Seed Producers' organizations (SPOs). Once a formal institution is created, it would be facilitated by both public and private players in more effective manner.
- **Creation of enabling infrastructure**: Creation of dedicated seed cold storages for Maize, creating modern storage structures like Maize silos, establishment of Maize value added units would be possible avenues in creating enabling infrastructure.

- **Innovative PPP models across Value Chain**: Public Private Partnership (PPP) in ensuring availability of quality maize seeds, establishing maize based Skill Development Centres (SDCs), promoting extension are several future considerations that would help in achieving Maize vision 2022.
- **Enabling policy framework**: Important policy decisions like Rashtriya Krishi Vikas Yojana (RKVY), National Food Security Mission (NFSM) and National Food Security Act, taken by the GoI have significant impact on maize production. The National Food Security Act, 2013 aims at ensuring legal rights to food and nutritional security to every citizen of the country. This may boost up the demand for maize grain, particularly of QPM. Enabling policy interventions by state governments like Setting up of Maize dryers by Government of Punjab in all the Mandis and 50% subsidy to maize growers on its purchase has provided considerable push to the sector.

In addition to the above strategies to implement Maize Vision 2022, deeper engagements and collaboration among key stakeholders across the value chain will be necessary for the overall development of the sector.

Detailed opportunities and future considerations for each intervention areas across maize value chain have been elaborated in next section.

"Enabling policy interventions at state level can provide considerable push to the Maize sector."





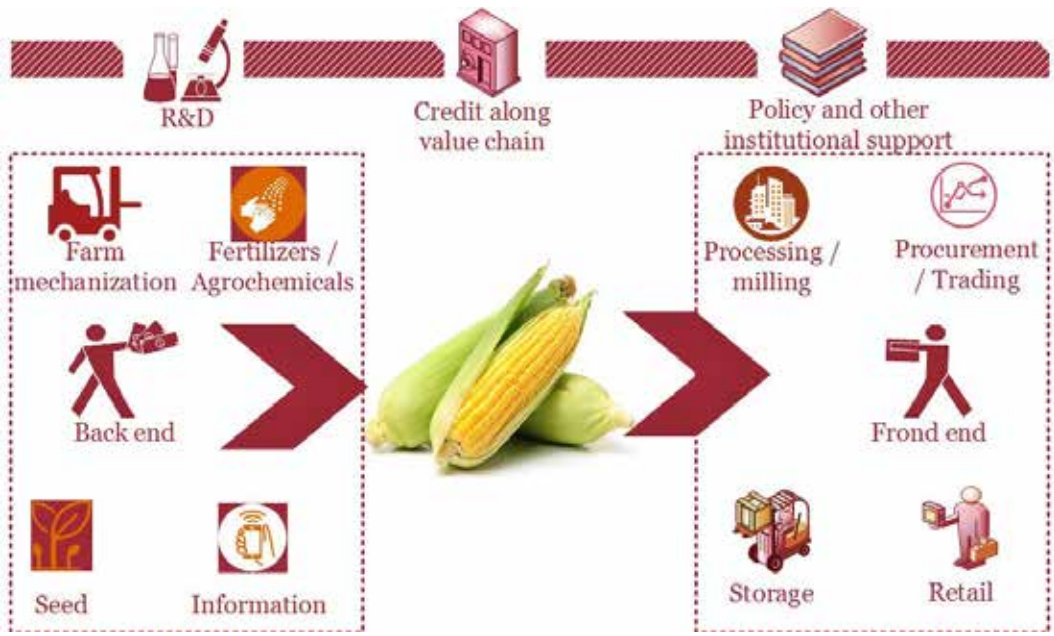
D | Addressing demand patterns: Capturing technological trends in Maize value chain

D | Addressing demand patterns: Capturing technological trends in Maize value chain

Technology plays an important role for creating high-impact and sustainable initiatives focused on improving productivity, competitiveness, entrepreneurship, and growth of Small-Medium Enterprises (SME) in agriculture. Maize has witnessed serious technological interventions, both at the back end and the front end of value chain.

"Integration of Maize value chain through effective backward and forward linkages can bring a dramatic improvement in Maize sector."

Exhibit: Detailed analysis of Maize value chain



- Back end of value chain comprises of seed, farm mechanization, fertilizers, agrochemicals, irrigation, information and other farm inputs.
- Front end encompasses storage, Post-harvest management (PHM), procurement and processing.
- Research and Development, credit, policy and other institutional support span across the value chain.

(D.1) Value Chain development initiatives: Back end

Value chain development is one of the potential drivers for the Indian agriculture including Maize sector. Lack of quality farm inputs and inefficient farming techniques result in inferior produce. As mentioned in earlier sections, the current yield levels in Maize are much lower compared to other Maize growing nations like USA and Argentina, which is largely attributed to limited technological interventions in farm inputs. Although, new business models and potential growth opportunities have evolved around Maize cultivation, but there is long way to go to achieve the productivity level equivalent to high yield countries.

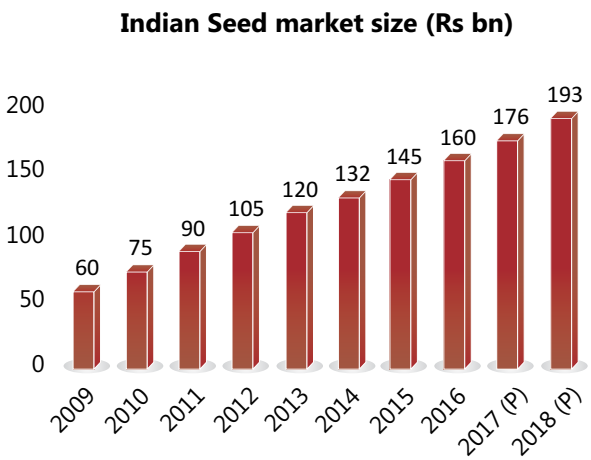
"Strong backend is important to achieve the productivity level equivalent to high yield countries."

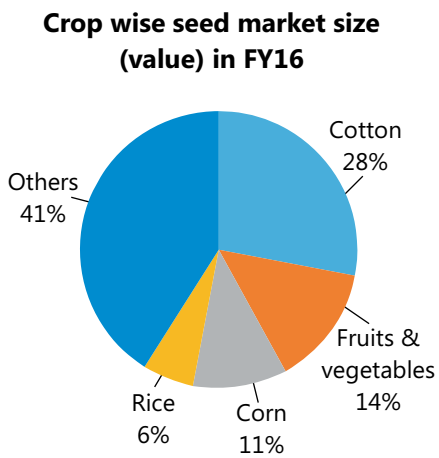
Rapid hybridization, cluster based seed production, dedicated seed cold storages for Maize, Public Private Partnership (PPP) in ensuring availability of quality Maize seeds are new dimensions, that have emerged in Maize Seed industry. In farm mechanization, Maize based **silage making, Maize based Skill Development Centres (SDCs)** and Public Private Partnerships to promote **Maize based farm machinery banks** have come out as possible avenues of investment. Rationalizing usage of other critical farm inputs like fertilizers, agrochemicals and irrigation have significant contribution in bringing overall profitability from crop. Promoting PPP in extension and marketing has created win –win situation for state government, private players and Maize growers through improved transfer of technology and assured procurement of produce at remunerative prices.

(D.1.1) Seed: carrier of technology in production

The Indian seed industry, over the years, has evolved by adopting and innovating upon scientific advancements in variety development and quality seed production.

Exhibit: Position of Maize in Indian seed market





"Maize seed sector contributes 11% of total size of Indian seed industry."

- The industry has grown at a rapid pace of 18 percent over the period 2009-2016 and reached Rs. 160 billion in FY 2016-17 on account of rapid adoption of Bt cotton hybrids, **Single cross Maize hybrids** and hybrid vegetables.
- In terms of value, Maize seed sector contributes 11% of total size of Indian seed industry.
- Hybrid maize is majorly dominated by private sector, wherein the biggest pie (>3/4th) is served by 5-6 multinationals and remaining by 250 private sector players.

Source: Indian council of Food and Agriculture, New Delhi; Industry estimates and PwC analysis

Exhibit: Comparative analysis of crops on the basis of hybridization and SRR

Crop	% of total seed business (Value terms)	2014/15	2015/16
Cotton	28	95	100
Fruits & Vegetables	14	15 - 90	100% (hybrid)
Maize	11	>60	60% (OPV)
100% (Hybrid)	51	46	52
Rice	6	5	40% (OPV) 100% (Hybrid)
Others	41	Varies	Varies

Source: Industry estimates and PwC analysis

"India stands at 5th rank in Maize hybridization in world."

Hybridization has remained one of the key driving factors for Indian Seed industry, including Maize. Like Cotton, Maize has also witnessed rapid hybridization, which commensurate to increased SRR.

Future considerations / Potential Growth Opportunities for Maize mechanization:

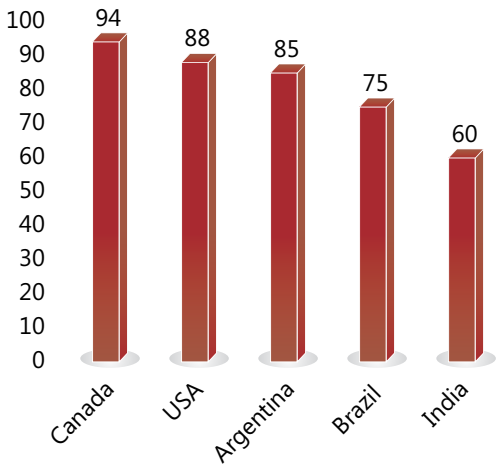
(a) Hybridization: Fostering future growth in Maize

After the promulgation of New Seed Policy in late 1980s, many private seed companies came into operation and started producing and marketing hybrid maize. Hybridization in maize crop in India varies between **23-100%, highest for Bihar and Tamilnadu (100%), whereas lowest for Madhya Pradesh (23%).**

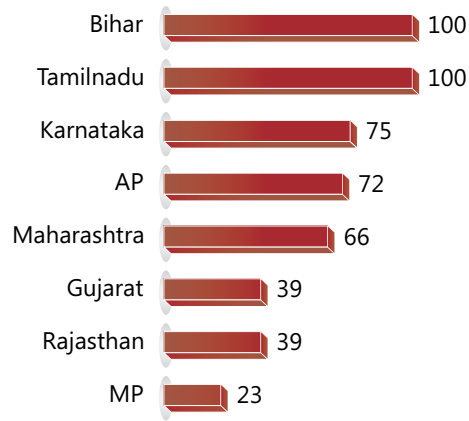
As Maize varieties have shifted from Composites to double cross hybrids to Single cross hybrids over the years, there has been marked improvement in yield, with SCH yield has reached > **10 MT / ha** in selected pockets of Bihar. Although, Hybridization has contributed in exponential development of sector, India still stands at 5th rank in terms of Maize hybridization and considerable scope exists to expand it further.

Exhibit: Analysis of hybridization % in Maize in India

Global scenario of Maize hybridization (%)



State wise Maize hybridisation %



- Bihar and Tamilandu has performed comparatively well in terms of accepting hybrids and reached almost **100**% hybridization in Maize.
- In Gujarat, MP and Rajasthan, it is almost equal preference for composite and hybrids, as in tribal or underdeveloped regions, farmers prefer local/ composite varieties, and in developed regions, hybrids are cultivated for commercial purposes.
- In Madhya Pradesh, farmers still prefer to grow local or composite varieties, which are mainly retained for domestic consumption.

"Bihar and Tamil Nadu have reached almost 100% hybridization in Maize."

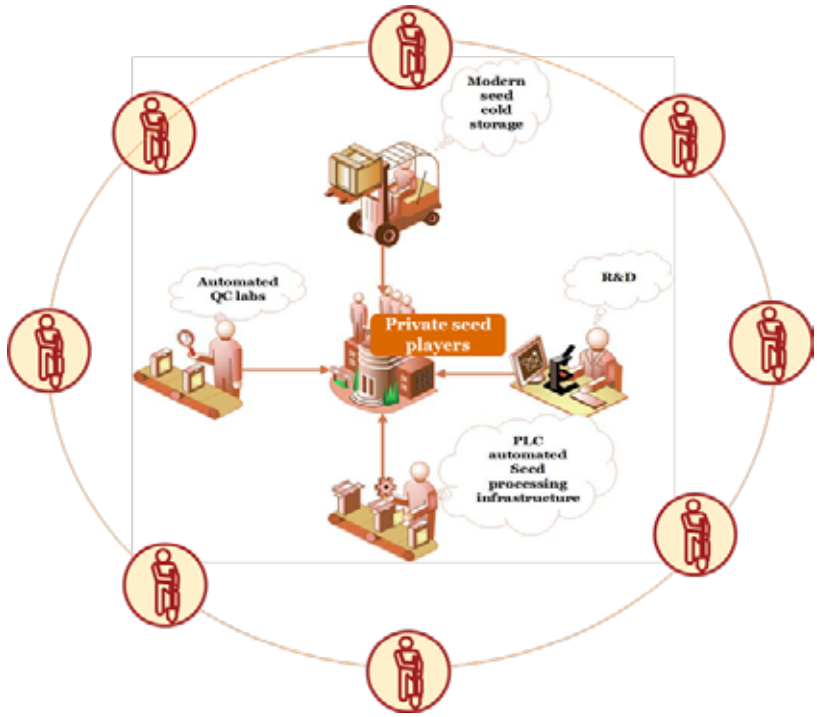
Source: Industry estimates 2016 and PwC analysis

With rising demands from poultry and starch based industry, there exists significant opportunity for hybridization in states with poor penetration.

(b) Seed production hubs: Promoting seed production in clusters

In India, there are more than 500 private seed companies operating at different levels. Most of the hybrids of maize in India are produced and/or sold by the private companies. Study suggests that, the top five companies that are engaged in maize seed production and marketing are multinationals and occupy 58% of pie. The share of other small and local seed companies is 40%. The private seed companies for maize in particular are located in Andhra Pradesh, Karnataka and Maharashtra, where the farmers have turned into seed producers on contract basis and the entire stretch of villages has been converted into **"Seed Production Hubs"** and **"Seed Production Villages"**.

Exhibit: An illustrative representation of Seed production hubs



With high emphasis on promotion of FPOs / FPCs of government in Budget 2018, these seed production hubs could emerge as formal institution like Seed Producers' Companies (SPCs) / Seed Producers' organizations (SPOs). Once a formal institution is created, it would be facilitated by both public and private players in more effective manner.

"With high impetus on promotion of FPOs, the Seed Producer's Companies (SPCs) can also emerge as a formal institution."

(c) Dedicated Seed Cold Storages for Maize

Andhra Pradesh, being the hub of private seed companies both national and multinational, dedicated cold storages for high value seeds, majorly hybrid maize have come up in the state. Some of them have state-of- the-art facilities, where all the operations are at par with global standards. The commercial maize seed is stored under the controlled temperature of 10-15°C with relative humidity of 40-50 per cent evenly distributed under one roof. With the entire operation of seed palletization and racking being handled by the Material Handling Equipment (MHEs), the physical impact on seed can be minimized. The companies also ensure an online access to the clients for information related to inventory and storage environment. Separate environment-controlled facilities are also provided for the parent seeds, in which, the viability of seeds is maintained up to 3-4 years. Such cold storages offer third party services for several seed companies under a single roof.

In addition to seed production hubs / clusters, these dedicated cold storages may come up in states with high market potential for Maize, in order to avoid reverse logistics cost borne by Seed companies in case of sales return.

(d) Promoting PPP to ensure timely availability of hybrid Maize seeds

The Government of Odisha launched the project **"Golden days"** in September 2010 in partnership of private seed organizations in **5 districts** to promote hybrid maize. Under the programme,7 leading seed companies, local, national as well as multinationals were engaged for 20 different districts to ensure timely availability of hybrid maize seeds and proper training and extension, with a total outlay of **Rs. 121 million** for procurement of seeds alone. In 2012, after realizing the success in improving the crop yield, the state government re-launched the project under RKVY under PPP IAD Scheme, and 6 more seed companies were brought on the board.

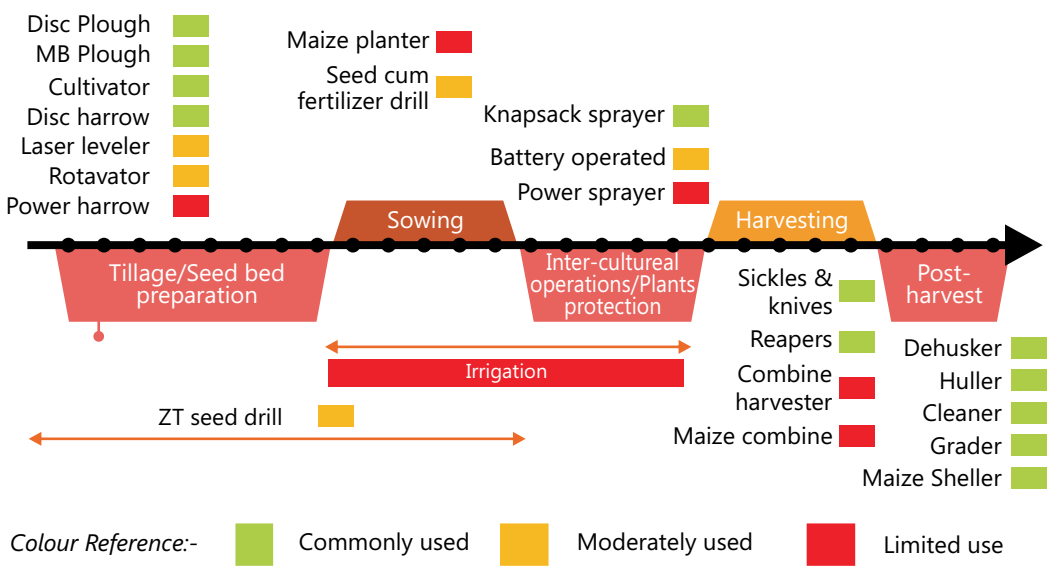
The successful implementation of this project has opened up avenues for both state government and private players to effectively collaborate and ensure timely availability of maize seeds to the farmers.

(D.1.2) Farm mechanization: crucial with reducing animate labour

"Timely availability of hybrid Maize seeds will require intensification of efforts across the board."

Farm Mechanization emerges as an important **technological intervention** for bringing in the desired productivity push in the Agricultural sector including Maize crop in the country. Farm mechanization in maize cultivation has increased in all the states. Although, it is mainly the use of tractors for field preparation, in some of the states like Andhra Pradesh, Bihar, Gujarat, Rajasthan and Tamil Nadu, **Maize based combined harvesters and Maize planters have also made inroads.** Therefore, use of machine labour varied widely across the states. In Tamil Nadu, the maize hybrids have spread very fast during past 3-4 years, therefore, expenditure on machine labour was also quite high to furnish the farm operations on time, even though use of human labour has not declined in the same proportion.

Exhibit: Status of Maize mechanization in India



Future considerations / Potential Growth Opportunities for Maize mechanization:

(a) Maize based Skill Development centers: Pressing need for CHS

Limited availability of skilled hands as technical service providers is the key constraint in promoting CHS (Custom Hiring Services) in country. GoI has given minimum impetus on capacity building and skill enhancement of service providers and operators of precision farm equipment like Maize combine harvester, Maize planter, Laser leveler etc. Few private sector initiatives like Skill Development Centers in MP are doing well in this direction. At these centers, private players organize and impart training on operations and maintenance of precision farm equipment on day-to-day basis.

Basis this successful MP model, GoI may contemplate running such Skill Development centers (SDCs), especially in Maize by engaging suitable private players.

(b) Maize silage making: Promoting mechanization in Dairy Sector

Mechanization is at a very nascent stage in the dairy industry but can be applied successfully at milk production level like milking parlors, spreading slurry, harvesting of grass, **Maize based silage preparations** etc. Considering the high nutritional value of Maize, several dairy farmers in Punjab have mechanized maize based silage making end to end. These farmers are using specialized tractors of **high HP (>65)** for Maize silage preparation, and initiative has been promoted by Punjab government through special incentive for these high HP tractors, used for silage purpose. Training and capacity building on silage preparation are being imparted by private sector, especially seed players on package of practices. ***Emergence of such lateral avenue could be replicated by other states with high impetus on dairy farming and in turn the maize industry will thrive better.***

> *"Maize based skill development centers and enabling infrastructure important for Maize sector."*

(c) Promoting PPP in running Maize based Farm machinery banks for small and marginal farmers

Government of Gujarat has introduced a Public Private Partnership (PPP) model and has signed a Service Lease Agreement with farm equipment major 'John Deere India Private Limited' (JDIPL) on **BOOT** (Build, Own, Operate, Transfer) basis under the **'Vanbandhu Kalyan Yojana'** in January 2011 as a 5-year project. This project has majorly targeted **tribal maize farmers of Gujarat, producing Maize for domestic consumption**. The company has opened up Agriculture Implement Resource Centers across Gujarat, with tractors along with a set of **13** implements, a trained operator and maintenance staff. The farmers have to bear the **operating costs** only. **Instead of subsidizing implements, Government of Gujarat has subsidized usage fee or rental charge of equipment.**

Looking at the success of project, it is inferred that such initiatives could be replicated in states with high population of small and marginal farmers, engaged in Maize farming.

(D.1.3) Irrigation: imperative for yield and income enhancement

Irrigation is one of the critical farm input, especially in regions with low water table. Water Use Efficiency (WUE) is the key technical parameter, taken into consideration for deciding irrigation method and has direct bearing on yield enhancement. Overall water use efficiency ranges from 50-70% in case of sprinkler irrigation and 80-90% in case of drip irrigation systems, compared to 30-35% efficiency of surface irrigation. Thus micro irrigation systems are a clear winner in water use efficiency.

Although, the total potential of micro irrigation in India is estimated at around 69 Mn ha, the coverage of micro irrigation is 8.15 Mn ha only. Achieving this potential will not only result in improved efficiencies of water, energy and fertilizer usages, but also enhance productivity and farmer incomes.

With the current target of achieving 0.5 Mn ha/annum coverage under **Pradhan Mantri Krishi Sinchayye Yojana (PMKSY)**, it would take a very long time to realize the potential estimates of micro irrigation in India. In order to fasten the expansion process, crop specific strategy including Maize needs to be formulated.

"Although total potential of micro irrigation in India is estimated at 69 Mn ha, the coverage of Micro-irrigation presently is 8.15 Mn ha."

Source of energy for irrigation is another factor, which has direct bearing on cost of cultivation and net income. In most of the states, grid based electricity for irrigation is heavily subsidized and leads to huge burden of subsidy on the state exchequer. In this wake, emergence of **Solar Pump Irrigators' Cooperative Enterprise in Gujarat** has set an example for other states through reducing the agricultural electricity consumption from the grid. This model not only enhances the irrigation capacity of state through Solar energy, but also promotes farmers' additional income by sale of surplus power to grid.

(D.1.4) Extension: connecting link from lab to land

Effective extension is an important farm input in bringing technology developed in researcher's lab to farmer field. For example, in order to increase the productivity of maize in tribal districts, namely, Udaipur and Banswara, the State Government of Rajasthan launched a project called '**Golden Rays**' from Kharif-2009 in the public-private partnership mode. Under this project, **Extension support** for the adoption of the recommended package of practices and market support for assured procurement of the produce were provided by the private sector companies. More than **one million farmers** have been benefitted under this scheme and the productivity of maize has improved substantially in the project districts.

This calls for significant future emulation by other states and private players.

(D.1.5) Crop insurance and credit: risk mitigation levers

Availability of timely and cost-effective adequate credit to the farmers is one of the most important factors for the adoption of modern technologies in maize cultivation. The Kisan Credit Card (KCC) Scheme, introduced in August 1998, is

considered as an innovative credit delivery system aiming at adequate and timely credit support from the banking system to the farmers in a flexible, convenient and cost-effective manner. The Scheme is being implemented by all the District Central Cooperative Banks, Regional Rural Banks and Public Sector Commercial Banks throughout the country. A revised KCC scheme was introduced in March 2012 in which KCC passbook has been replaced by ATM-cum-debit card to all eligible farmers. With increase in internet penetration and digital literacy of rural population, crop specific loan product for Maize needs to be developed.

The government has taken a decision to cover at least **50%** of the area under crop insurance through the **Pradhan Mantri Fasal Bima Yojana (PMFBY)** by 2018. This is a much-required step, but an uphill task. Crop insurance has some important benefits, particularly that it can help offset a reduction in yield as well as total crop loss, besides creating a new market where the private sector can play an active role. Deployment of modern technology such as drones and remote sensing for rapid assessment of damage to crops for quick payout of compensation is vital to develop the faith of the farming sector in crop insurance products.

(D.1.6) Research and Development: bringing innovations in the supply chain

Post liberalization of global economy, the private sector has emerged as a key player in agricultural research. While public sector institutions continue to concentrate on developing appropriate technologies, the private sector tends to focus on crops that would generate profitable returns. At global level, Maize is one of the most extensively researched commodities by multinational seed corporations, as it allows maximum 'value capture' due to prevalence of hybrids. The Indian seed industry is yet to develop research capabilities of global scale and has to scout for 'technology providers' to stay competitive.

"Scientific advances in Maize Research: Crucial to build climate smart Maize Value Chain."

Bio technology: Game Changer event

A major global development with respect to maize is widespread adoption of transgenic cultivars in last twenty years. Maize hybrids with transgenic traits are planted in 17 countries in an area of 57.3 Mn ha, which amounts to 33% of global maize acreage. More than 80% of the area under maize in the USA, Canada, South Africa and Brazil is under transgenic cultivars. Traits like multiple insect resistance, herbicide tolerance, drought tolerance, enhanced lysine, modified amylase and male-sterility are already available to maize growing farmers of many countries for cultivation. Other important traits like next generation of insect resistance, nitrogen use efficiency, low phytate, high oil, biofortification etc. are in advanced R&D pipeline. It is clear that the Indian farmers would lose the competitive edge vis-a-vis their global peers, if such traits are not available to them. Currently, in India, private sector developers are conducting multi-locational field trials of transgenic maize for insect resistance and herbicide tolerance traits.

In addition to transgenic cultivars, advancements in genomics and molecular breeding, next generation mutation techniques, adoption of RNAi technology for

insect resistance, virus resistance, aflatoxin resistance etc. are few potential R&D areas which would abridge the yield gaps and would bring incremental gains to maize cultivators.

Technological innovations: Solutions for climate change impact

With limited natural resource and changing climate, India would have to increase its maize production from the current levels, while mitigating adverse impacts. Being, a C4 crop, maize is better adapted to the vagaries of the climate. Productivity and sustainability of maize-based systems can be further improved by suitable technological innovations. These innovations include Single Cross hybrid technology and application of novel molecular tools in maize improvement programs. Few of the thrust areas in research and innovation like molecular breeding and targeted mutagenesis for developing traits for biotic and abiotic stress have already been mentioned in section earlier.

(D.1.7) Other farm inputs: fertilizers and Agro-chemicals

"Being a C4 crop Maize is better adapted to vagaries of Climate."

The rapid diffusion of maize hybrids as well as relatively high dose of fertilizers application are often considered to be the driving force for better yield in high potential zone. It has been observed that where farmers have adopted hybrid seeds, the quantity of fertilizer application has also been higher even more than the recommendations. Though the farmers are facing problems of insects like stem borers and hoppers and diseases like rust and spot, the application of pesticides on crops is limited, as they don't have awareness about the economic threshold levels (ETL) of pest attack.



(D.2) Value Chain development initiatives: Front end



Front end of value chain comprises of storage and PHM, procurement and processing. Installation of Maize dryers and promoting modern storage techniques like silos have been identified as ongoing and future avenues for better storage and PHM in Maize. Price deficiency payment (PDP) and customization of derivative contract are new generation procurement and marketing arrangement for Maize, which would further evolve post e –NAM integration. The recent productivity gain in Maize through hybrid varieties has mostly been realized for feed/industrial grade Maize, with limited varietal improvement in food grade Maize. Growing usage of Maize in feed and industrial use, particularly Poultry feed and Starch has not only given significant push to demand side, but also has unfolded lateral avenues for investment.

"Efficient post harvest management solutions can give significant push to Maize sector."

(D.2.1) Storage and Post-harvest management: minimizing losses

Future considerations / Potential Growth Opportunities for storage and Post-harvest management (PHM):

(a) Maize dryers: Emerging need for better price realization

Manual handling and poor storage infrastructure at farm level lead to increase in moisture content of Maize up to 20%, which should ideally be up to 13%. It is therefore, imperative to install maize dryers in the proximity of farm, which could be utilized for reducing moisture before storage. Foreseeing the problem of agricultural sustainability in future, the **Government of Punjab (GoP)** has directed the agriculture department to set up maize dryers in all the mandis at a cost of **Rs. 150 crores (USD 2.7 million)**. In addition to this, GoP is also giving **50 per cent subsidy** to maize growers on the purchase of portable maize dryers, as part of state's crop diversification programme. ***Other state governments may take similar PPP (through grants/ subsidy) initiative as an innovative post-harvest management practice.***

"5-7% of Maize produced in India lost due to improper storage. Use of scientific warehousing for Maize can reduce the losses to as low as 0.5-1%."

(b) Maize Silos: Modern storage techniques

Most of the farmers use Sun-Drying method for Maize which is directly affecting the quality and marketability. Invariably Maize suffers Aflatoxin issues due to improper drying and gets rejected. Proper Driers attached to silos are the basic needs to address this issue. If we analyze end to end solution for storage, silos score over flat warehouses even in terms of cost. Modern silos are not only required to add the storage facility for meeting the storage requirement but also to modernize the existing storage system to reap the benefits of the scientific methods of storage. This will also reduce the intermediaries in supply chain and increase the overall efficiency of supply chain.

In consideration of significant production level of Maize in state, Government of Bihar pioneered a dedicated Silo scheme for Maize "**Maize Silo Scheme**", which has now been incorporated with Bihar Industrial Investment Promotion Policy (BIIPP), 2016.

Name of the scheme	Salient features	Incentives
Maize Silo scheme	• For average silo storage capacity of 5,000 MT, with proposed cost of Rs. 2.00 crore; • For long term storage of maize in silos;	• Incentive @ 35 % capped to a maximum of Rs. 70.00 Lakhs;

Establishing modern silo complex involving high end receiving, storage and dispatch infrastructure would be prospective avenue of modern storage infrastructure.

(D.2.2) Procurement: collecting the produced

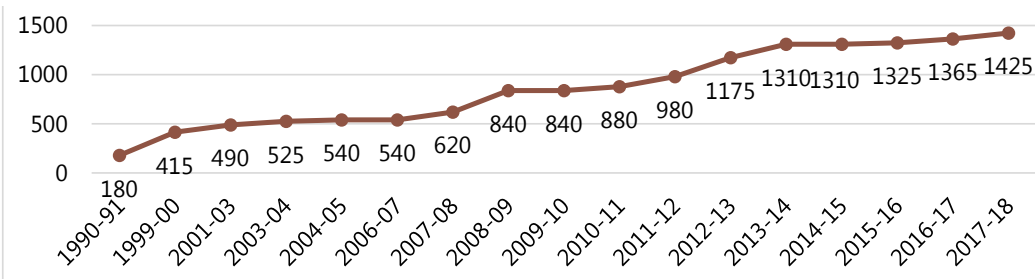
Future considerations / Potential Growth problem

"MSP of Maize increased by almost 130%from 2007-2017."

(a) Price deficiency payment: An effective solution to mitigate risks associated with MSP based purchase

Between 2007 and 2017, the MSP of Maize increased by almost 130% (from Rs 620 to Rs 1425/qtl). A sharp increase was seen in 2008-09, and then in years 2012 & 2013. For the 2017-18 season, the minimum support price of maize has been increased to Rs 1,425 per quintal from Rs 1365 per quintal in 2016-17.

Exhibit: Trend analysis of Maize MSP (in Rs / quintal)



Source: National Collateral Management Services Ltd & PwC analyis

The constraints associated with MSP based purchase are (a) limited geographical coverage (b) actual procurement being restricted to a few crops such as paddy and wheat despite announcements for 20-plus crops. In 2017, the mandi prices of maize in Punjab fell below the Minimum Support Prices (MSP) because of bumper production in the cropping year and heavy pre-monsoon showers. In case of without any procurement by state or central agencies, farmers resorted to distress selling. In order to address this constraint, NITI Aayog has suggested a new system, called 'Price Deficiency Payment' (PDP) where differences between MSP and market prices could be paid to farmers in case mandi prices fall below MSP.

A similar pilot initiative called 'Mukhya Mantri Bhavantar Bhugtan Yojana' has been undertaken in Madhya Pradesh. Following a sharp fall in crop prices over the 2016, which fueled farmer protests in Madhya Pradesh, the state government had launched the price deficiency scheme last year which directly compensates farmers when they sell their produce below MSP set by the government.

Similar initiatives could be scaled up and adopted by other state governments to mitigate the risks associated with price fluctuations in Maize.

(b) Customization of derivative contract: New generation marketing arrangement for Maize

After the introduction of commodity derivative markets by the Government of India in 2003, the first commodity derivative contract was launched for maize by various commodity derivative exchanges. The limited control and regulation on maize by the government (as it is considered non-food cereals), long shelf-life of grain and ease of standardization & gradation have also helped in this transition to bring the maize trade on commodity exchange in spot as well as derivatives markets.

The maize traded in futures market platform are mainly feed-industrial grade maize. In line with market demand and practical issues related to delivery of erstwhile food grade maize, the commodity exchanges changed their maize contract to industrial grade/feed grade in 2012. Modifications and customizations of contract, suited to market requirement has played pivotal role in creating more value, for both farmers and private players.

"New Marketing arrangements for Maize can play vital role in creating more value both for farmers and agribusinesses."

(c) Post e-NAM integration

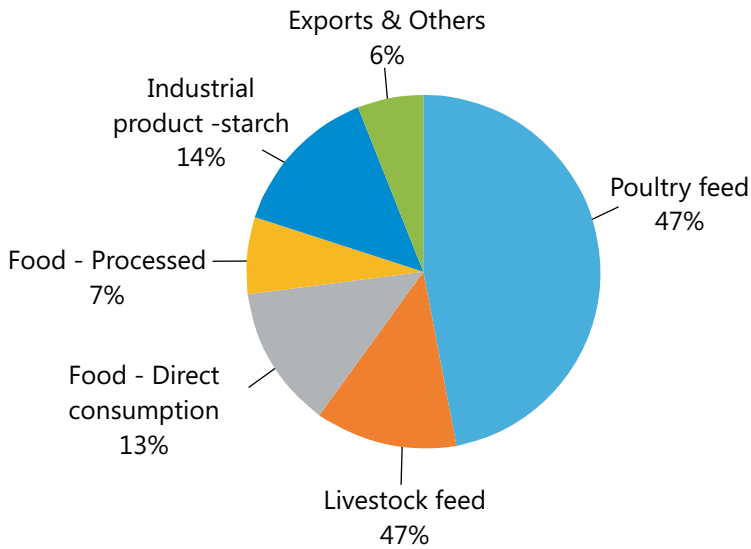
An efficient price direction to the futures market would be available, and the transparent futures prices will aid in production/sales decision of the farmers and thereby perfectly sync the signaling and response behavior of markets and stakeholders. This would open avenues to introduce exchange-specific quality standards alongside other broad grades to be introduced to encourage the farmers not only to grade and sell their produce, but also to encourage them to produce better quality crop and meeting exchange standards.

(D.2.3) Processing: adding value to enhance realisation

Over the last two decades, Maize is increasingly being used for feed and industrial use, particularly poultry feed and starch. Poultry industry has been growing by about 4-5 percent per annum on higher consumer demand for animal proteins due to a growing economy and expanding middle class.

The starch industry, largely catering to textile production, is growing at 3-4 percent on domestic and export demand. Maize is also used to produce traditional foods, snacks, and savories.

Exhibit: Segment wise consumption of Maize 2016-17



"Poultry feed and starch: Main consumers of Maize."

The demand of maize depends largely on demand as feed for poultry and livestock, and partially on its direct demand for human food and industrial uses.



Location and segment wise classification of Maize based industry has been tabulated below:

State	Poultry and feed	Starch	Other uses
Andhra Pradesh	Hyderabad, Karimnagar, East & West Godavari	Hyderabad, Medak, Nizamabad, Samalkot	-
Bihar	Bhagalpur, Barauni, Gaya, Muzaffarpur, Patna	Patna	-
Chhattisgarh	Bastar, Jagadalpur, Raipur	Raipur, Rajnandgaon	
Gujarat	Gandhinagar, Jamnagar	Ahmedabad,Valsad, Rajkot,Vadodara	Panchamahal
Haryana	Barwala, Jind, Karnal,Panipat, Safidon	Faridabad, Yamuna Nagar	Sonipat
HP	Jachh, Kangra, Parwanoo, Una		Shimla
Karnataka	Bangalore, Davangere, Hospet, Bellary	Belgaum, Shimoga	Haveri, Raichur
MP	Bhopal, Indore, Jabalpur, Shahdol	Indore, Ratlam	Chindwara, Shajapur
Maharashtra	Mumbai, Pune, Sangli	Dhule, Jalna, Miraj, Sangli, Sirola	Nagpur
Odisha	Bhubneshwar, Cuttack	Cuttack	-
Punjab	Khanna, Rajpura	Phagwara	Ludhiana, Sangrur
Rajasthan	Udaipur, Jaipur	Jodhpur, Madanganj, Udaipur	Chittorgarh
Tamil Nadu	Chennai, Coimbatore,		
Namakkal, Madurai, Tiruppur	Coimbatore, Salem	Salem	
UttarPradesh	Agra, Ghaziabad, Saharanpur	Agra, Aligarh, Lucknow, Noida	Jaunpuri
West Bengal	Kolakata, Siliguri	Dalkhola, Malda	Raiganj

"Feed Industry growing at a CAGR of 8%."

Maize outlook in Feed industry: Current status

India has emerged as one of the largest and fastest growing compound feed markets in the world. The feed industry is growing at a CAGR of 8%, with poultry, cattle and aqua feed sectors emerging as major growth drivers. According to estimates by leading industry sources, the demand of animal protein and dairy products in India has increased the **compound feed consumption** volumes to **28** million tons by **FY 2017 - 18**.

In general, the major raw materials that are used as ingredients for preparing animal and poultry feeds include Maize, Wheat, Bajra, Soybean, Sugarcane, Oil

seeds, Soybean followed by rapeseed, groundnut, deoiled rice bran, sunflower meal, cottonseed cake, wheat bran and some non-vegetarian sources. Maize is the main source of energy in poultry feeds.

Region	Ingredients for preparing poultry feed meal
North India	Maize (60%) + soybean (25%) and rest of farm gate wastages e.g. Rice./ Wheat / Meat meal
East India	Maize (60%) and mix of rice/ sorghum etc
West India	Mix of Maize + soybean
South India	Maize (65%) + Soybean (30%) and rest of it is oil, groundnut, sunflower residues, fish meal

Source: Indian Feed Industry, Revitalizing Nutritional Security, 2017, Yes Bank

The aforementioned ingredient mix for preparing poultry feed meal clearly indicates that Maize is the most important and sought after raw material in all parts of India. Rising consumption of maize by the industry would lead to a spurt in its demand.

Maize outlook in starch and biofuel industry: Current status

Global sales of starches and derivatives were estimated to be **US$ 62.9** billion in 2015. The market is expected to reach **US$ 77.4** billion by 2018 growing at a compound annual growth rate (CAGR) of **7.1%** during 2015-18. There has been a positive trend during the past two decade in the wet milling industry. India currently has installed starch manufacturing capacity of 13,000 TPD. The industry is witnessing increased investment leading to enhanced capacity and higher M&A.

"Global market for starch and derivatives expected to reach US $ 77.4 billion by 2018."

I. **Growth in industries using starch as raw material:** Industrial sectors which are demand driver for the starch industry are doing extremely well & expected to continue the uptrend.

Pharmaceutical	Textile industry	Paper industry	Food industry
• Dusting media for various type of coating as well as binder & filler for capsules & tables • An efficient dry – binder in dry granulation techniques	• Provide stiffness & add weight to clothes • Used in conjunction with thermoplastic or thermosetting resins to obtain a permanent finish	• Used for sizing as well as to increase the paper strength • An adhesive in pigmented coating for paper and paper board to enhance the printability and appearance of the paper	• Used for thickening sauces, gravies, puddings and pie fillings. • Numerous applications in baking industry, provides strength to ice cream cones

II. **Per capita consumption:** Per capita starch consumption in India is **1.5 Kg as compared to global average of 6.1 kg.** The consumption in India is nearly one fourth in comparison to China, thereby indicating enormous scope of growth.

III. **Changing consumer behavior:** Rising health consciousness among consumers leading to a consumer preference for products using Maize starch & derivatives due to their nutritional superiority.

IV. **New industrial applications:** Modified starch suited for various specific applications resulting in higher efficiency and better quality of end products. E.g. application of cationic starch in paper industry is resulting in lower fiber loss, better printability and use for starch in manufacturing ethanol.

Future considerations / Potential Growth Opportunities for Maize processing:

About **14 per cent of maize production** is used as a raw material for starch manufacturing, pharmaceutical starch, etc. The Indian starch industry is still at a nascent stage and derives about **40** products from Maize, whereas more than **800** products of starch and starch derivatives are being derived in the international arena. Starch is manufactured from Maize by wet or dry milling, the recovery of which is around **60-65** per cent. The usage of sweeteners derived from maize starch is increasing, and is more so when sugar prices are high.

According to 2015-16 industry estimates, **3 Mn MT** of maize is used for industrial purpose, which includes 2 Mn MT for starch industries and **1 Mn MT for ethanol and beverage industry**. In India, more than two dozen starch manufacturers; around one dozen biofuel companies (in Maharashtra and Andhra Pradesh) and hundreds of other maize-based food and feed companies are operating.

Scope of expanding product portfolio from Indian Maize starch, improving recovery percentage, harnessing cross elasticity advantages during high sugar prices and rising consumption from beverage industry would certainly provide significant push to Maize demand.

(D.2.4) Retailing: reaching the end consumer

The rapid growth of retailers in emerging markets has led to more efficient supply chains, including less waste, lower prices for the consumer and safer food. Although many retailers are expanding internationally, others are primarily home-based and growing rapidly on the back of their domestic markets. This sector is not as global as the other stages in the value chain. Depending on the food type, retailers may source Maize and maize value added products from any of the three previous steps in the value chain: food / feed companies, traders and farmers. As the primary interface with the consumer, in addition to responding to consumer preferences, retailers can play a significant role in influencing them, especially in matters concerning healthy eating and sustainability.

Vertical integration has proven as successful business model for food as well as feed companies engaged in maize value chain. With high impetus of Corporate Social responsibility, retailers have moved beyond only trade. An illustrative tabular representation has been made to understand the extended roles and responsibilities of maize value added food retailers.

Value chain parameters[30]	R&D (Creating great tasting, high quality foods)	Agriculture (Good Agriculture Practices)	Suppliers (Ingredients for foods / materials / packaging)	Manufacturing & packaging (Preparing and packaging foods)	Marketing & Sales (creating awareness and interest)	Distribution (Storing and delivering foods)	Consumers (Satisfaction and delight)
Food and nutritional security	Food quality & safety						
							Health & well being
					Responsible marketing		
	Mitigating food losses and wastages						
Sustainability	Climate change						
	Natural resource conservation						
	Sustainable agriculture				Sustainable agriculture		

Future considerations for retailers lie in providing end to end solution on climate smart agriculture to increase yields and improve climate resiliency for smallholder farmers involved in supply chain. Sustainability would be key consideration along with conserving natural resources and sourcing responsibly.



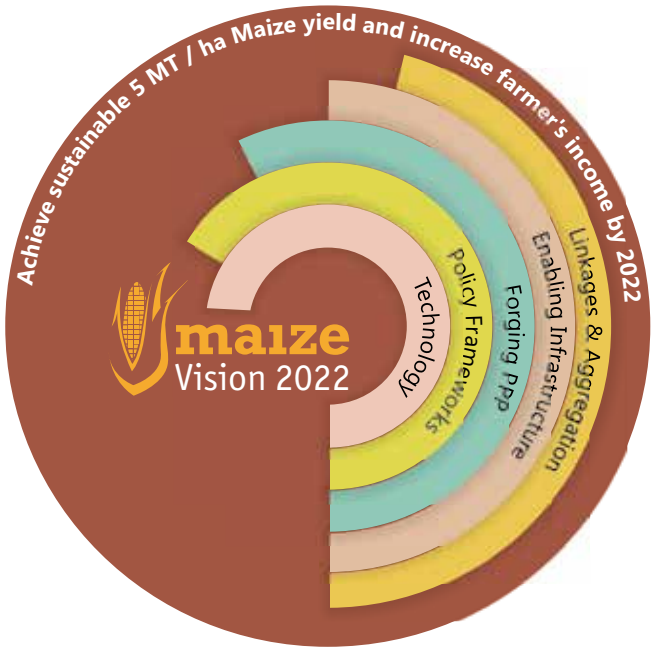


E | Way forward

E | Way forward

In order to provide significant push to the sector, an effective implementation of Maize vision 2022 would be required. In addition to production push through rapid technology adoption, formation of farmer groups and market linkages, creation of enabling infrastructures, innovative PPP models across value chain and creating an enabling policy environment would be necessitated for overall sectoral growth.

Strategies outlined in Maize Vision 2022 have been devised in such a way that it would address not only the needs of industry (Seed, Farm machinery, insurance, commodity exchanges, warehousing, Post- harvest service providers, consuming industry like starch and poultry) but also of other stakeholders (farmers, farmer groups / FPOs, government, academicians and researchers) engaged directly or indirectly with value chain.



Key strategies of Maize Vision 2022

Strategy 1: Enabling technology drivers to catapult maize production

1. Large scale adoption of Single cross hybrid technology:

In order to address productivity concern mentioned in earlier sections, adoption of single cross hybrids (SCH) at faster pace is requisite. In India, only 30% area under maize is sown with SCH. Adoption of such hybrids is higher in South India, where seed production is concentrated and hence availability is not an issue. Private Seed industry thus has to be incentivized to expand in other agro ecologically suitable regions, where hybrid seed production is possible. Evolving around ICT enabled extension would play a major role in technology adoption and dissemination till last mile reach.

2. Assessing Biotechnology as an enabler to increased Maize productivity

Traits like multiple insect resistance, herbicide tolerance, drought tolerance, enhanced lysine, modified amylase and male-sterility are already available to maize growing farmers. Other important traits like high nitrogen use efficiency, low phytate, high oil, bio fortification etc. are in advanced R&D pipeline of private sector. Private players have to be supported in both fiscal

and non-fiscal terms to conduct multi location trials and related field trials. Regulatory and IPR regime needs to be strengthened to create an enabling environment for researchers and breeders.

Advancements in genomics and molecular breeding, next generation mutation techniques, adoption of RNAi technology for insect resistance, cell wall engineering, virus resistance, aflatoxin resistance etc. are other focus areas in Maize Research & Development (R&D), which require prioritization and time bound strategies for implementation.

Strategy 2: Facilitating producer aggregation and market linkages

The private seed companies for maize are located majorly in **Telangana, Andhra Pradesh, Karnataka and Maharashtra**, where the farmers have turned into seed producers on contract basis and the entire stretch of villages has been converted into "**Seed Production Hubs**" and "**Seed Production Villages**".

With high impetus on promotion of **FPOs / FPCs** in the Union Budget 2018, crop as well as seed production clusters in select pockets of the country , could emerge as formal institution like Maize Producers' companies (MPCs) / Maize Seed Producers' Companies (MSPCs). Once a formal institution is created, it could be facilitated by both public and private players in more effective manner. Successful business models around industry FPO linkages could be explored, implemented and scaled up.

Strategy 3: Supporting enabling dedicated infrastructure

Creation of dedicated seed cold storages for Maize, installing Maize dryers, creating modern storage structures like Maize silos, establishment of Maize value added units would be possible avenues in creating enabling infrastructure.

1. **Creation of dedicated seed cold storages for Maize:**

   Government should incentivize seed storage infrastructure companies to take up initiative in seed cold storage infrastructure for certified as well as foundation seeds. To support seed cold storages, Power tariff subsidy and warehouse receipt financing in seeds stores needs to be promoted. Such dedicated storage facilities are more needed in the seed consuming states, where because of lack of such infrastructure, reverse logistics cost is immense.

2. **Installation of maize dryers for better price realization:**

   Manual handling and poor storage infrastructure at farm level lead to increase in moisture content of Maize up to 20%, which should ideally be up to **13%**. Private players have to be incentivized to install maize dryers in the proximity of farm, which could be utilized for reducing moisture before storage. In addition to this, State governments may also plan to **subsidize portable maize dryers** to growers on its purchase.

3. **Promoting maize Silos for Modern storage techniques**

   Modern silos are not only required to add the storage facility for meeting the storage requirement but also to modernize the existing storage system to reap the benefits of the scientific methods of storage. This will also reduce the intermediaries in supply chain and increase the overall efficiency of supply chain. State governments may devise and promote initiatives similar to the '**Maize Silo Scheme**' of the Government of Bihar.

4. **Establishment of Maize value added units:**

Considering the high nutritional value of Maize, Maize based silage making units could be promoted around dairy farmers with end to end mechanization. The feed industry is growing at a CAGR of **8%**, with poultry, cattle and aqua feed sectors emerging as major growth drivers. Similarly, Scope of expanding product portfolio from Indian Maize starch, improving recovery percentage, and rising consumption from beverage and biofuel industry would certainly provide significant push to Maize processing and value addition. Although, Industrial policies of state governments enable establishment of such units, additional fiscal and non-fiscal supports could be extended to provide necessary fillip.

Strategy 4: Forging innovative PPP models across Value chain

Public Private Partnership (PPP) in ensuring availability of quality maize seeds, establishing maize based Skill Development Centres (SDCs), promoting extension, running maize based farm machinery banks are several future considerations that would help in achieving Maize vision 2022.

1. **Promoting PPP to ensure timely availability of Seeds:**

On the lines of Project Golden Days in Odisha and PPPIAD scheme of SFAC, both state governments and private players need to identify and collaborate effectively to ensure the timely availability of quality seeds to farmers.

2. **Establishment of Maize based Skill Development centers:**

GoI has given impetus on capacity building and skill enhancement of service providers and operators of precision farm equipment like Maize combine harvester, Maize planter, Laser leveler etc. Few private sector initiatives like SDCs in MP are doing well in this direction. Basis this successful MP model, GoI may contemplate running such Skill Development centers (SDCs) for Maize in PPP mode.

3. **Promoting PPP in running Maize based Farm machinery banks for small and marginal farmers:**

Instead of subsidizing implements, Government of Gujarat has subsidized usage fee or rental charge of equipment for small and marginal farmers through Agriculture Implement Resource Centre, established on PPP mode. Looking at the success of project, it is inferred that such initiatives could be replicated in states with high population of small and marginal farmers, engaged in Maize farming.

4. **Promoting PPP in extension and marketing support:**

On the similar lines of Project Golden Rays in Rajasthan, extension support for the adoption of the recommended package of practices and market support for assured procurement of the produce could be formulated and implemented in PPP mode.

Strategy 5: Improved policy framework to unleash the potential

Need based adoption of Price Deficiency Payment (PDP) system, Scaling up of Pradhan Mantri Krishi Sinchayye Yojana (PMKSY), Scaling up of Pradhan Mantri Fasal Bima Yojana (PMFBY) and quality based customization of maize derivative contract post e- NAM integration would be possible avenues for industry and government to intervene and would provide lateral push to the sector.

Important policy decisions like Rashtriya Krishi Vikas Yojana (RKVY), National Food Security Mission (NFSM) and National Food Security Act, taken up by the GoI have significant impact on maize production. The National Food Security Act, 2013 aims at ensuring legal rights to food and nutritional security to every citizen of the country. This may boost up the demand for maize grain, particularly for QPM. Smooth implementation and grounding of such ambitious scheme will not only benefit the ecosystem at large, but will also bring in desired benefits to the Maize value chain.

Improved policy towards bio-fuels, investment promotion in Maize industries, better regulatory framework, IPR protection methods and ways to tackle the grey markets in seed supply chain have tremendous potential to support the maize sector. Devising practical ways to implement PDP (Price Deficiency Payment systems) and enhanced MSP (Minimum Support Prices) in maize will further corroborate the crop uptake amongst farmers. This also needs to be supported through future and derivative market development which would support the development of transparent price discovery mechanism and alternate commodity markets.

Maize, as a cereal holds tremendous potential and scope not only in increasing the farmer's income but also through providing assured raw material supplies to the upstream Agro-industries. It is a 'future cereal' which can perform better in situations of 'global warming' (as it's a C-4 plant) and at present is the one important cereal which is utilized as food, feed and fodder across the world.

Going forward, the crop needs more impetus and support from all concerned stakeholders for better growth and shared benefits to all concerned actors in the value chain right from farm to fork.



Experts' Insights

Improving Maize Productivity through Research Innovations



Dr. Sujay Rakshit
Director, ICAR- Indian Institute of Maize Research

Co-authored by Dr. Chikkappa G. Karjagi, ICAR-IIMR

> *"The need of the hour is to develop climate resilient hybrids with enhanced water and nutrient use efficiency under changing climate."*

Introduction

Maize is the most versatile crop which is used as food, feed, fodder and in recent past as source of bio-fuel. Currently, 1037 million MT of maize is being produced together by over 170 countries from an area of 185 million ha with an average productivity of 5.62 t/ha. In India, the total maize produced during 1950-51 was around 1.73 million MT, which has increased to 25.90 million MT by 2016-17 which is close to 15 times higher. The average productivity during the period has also increased by 4.5 times to 2563 kg/ha from 547 kg/ha during the period (1950-51 to 2015-16). However, the current yield levels are much lower than the World average. There are ample opportunities to enhance the yield levels of maize in India through development, popularization and adoption of new and improved technologies.

Strengthening the pre-breeding activity to develop stress tolerant hybrids

The need of the hour is to develop climate resilient hybrids with enhanced water and nutrient use efficiency under changing climate. In order to achieve this, there is need to harness genetic diversity which was not fully unlocked till today. In this regard, identification of desirable alleles for traits of economic importance like resistance/resilience to biotic and abiotic stresses followed by their mobilization into new cultivars through pre-breeding approach will play an important role. Incorporating traits imparting tolerance to drought, water logging, high temperature etc. in high yielding backgrounds can play a crucial role in sustainable yield enhancement in long-run. Thus, simultaneous selections under combination of stresses should be the strategy to develop cultivars. In order to achieve this there is need to screen germplasm for combinations of stresses under controlled conditions suited for a target environment at managed screening sites by following standardized protocols.

Use of frontier technologies for enhancing genetic gains

Integration of the revolutionary tool of doubled haploidy (DH) with marker assisted selection (MAS) and marker assisted recurrent selection (MARS) coupled with high throughput precision phenotyping of traits of interest has potential to accelerate breeding cycle to breed new cultivars. Use of decision-support systems/tools for faster decision making can offer new opportunity for enhancing genetic gains and breeding efficiency. For example high throughput phenotyping coupled with high throughput genotyping opens up the opportunity to identify genomic regions contributing stress tolerance through genome wide association mapping (GWAS). Genomic selection (GS) opens-up new opportunities towards developing improved hybrids. Genetically modified (GM) maize is another frontier tool with immense potential. Herbicide tolerant GM maize has specific potential to reduce production cost particularly during kharif season. CRISPER CAS technique provide us new tools to engineer native genes selectively without much disturbance of native genome. These tools have opened-up new horizon of opportunities for maize improvement especially to develop new cultivars with resistant to biotic and abiotic stresses

Resource conservation technologies

Conservation agriculture offeroffers an opportunity to plant full season maturity cultivars, by reducing the time lag between two crops. It further cuts down the cost on fossil fuel, improves organic carbon, enhance nutrient use efficiency, conserve moisture. It helps to reduce pollution due to burning of fossil fuel and improves environmental safety. However, the long-term impact of conservation agriculture on dynamics of soil micro-flora, insect pests and diseases, etc. are needed to be studied under different cropping systems. In addition, the mapping of niche areas for adoption of conservation agriculture practices and cropping systems also need be established to promote farmers acceptance and technology targeting.

Improving Maize Productivity through Research Innovations



Mr. Sanjay Kaul
MD & CEO, National Collateral Management Services Limited (NCML)

"Approximately 5%-7% of maize produce in India is lost due to improper storage. Use of scientific storage methods can reduce these losses to as low as 0.5%-1%."

Maize is a major feed grain and widely used as poultry and livestock feed in India. It is used commercially in production of starch and ethanol. As per various reports by CIPHET and FAO approximately 5%-7% of maize produce in India is lost due to improper storage. Use of scientific storage methods can reduce these losses to as low as 0.5%-1%.

In India, large quantity of the maize produce is currently being procured & stored by Feed millers, Starch millers and other trade participants in storage conditions which are too a large extent sub-optimal. Regional capacity mismatch and traditional & inefficient storage infrastructure at farm level further complicate the problem. This coupled with adverse climatic conditions at the time of harvest in most of the maize producing belts in the country create a unique situation of grain arriving in the market with high moisture content making it difficult / unsuitable for long term storage. Maize grain storage can be extended more than 2 years without any significant reduction in quantity and quality if the grain is received for storage at right grain moisture and scientific storage. However, the majority of farmers sells off their maize grains cheaply soon after harvesting due to anticipated losses in storage and /or non-availability of proper drying and storage facilities in rural areas. Improved storage structures that can prolong the storage duration until market prices for grains are favourable are the need of the hour in the country.

Technological advancement is now playing a vital role in stimulating growth with vertical scientific storage structures gradually replacing the traditional horizontal flat-bed warehouses for agricultural storage.

NCML has taken the lead in the creation of modern bulk silo capacity and emerged as the largest private sector player in the creation of this capacity. NCML is ready with silo complex of 36000 MTs capacity duly equipped with facilities like Dryer and Chiller for safe and efficient preservation of Maize at PURNIA, Bihar. This modern and scientific means of storage structure has been created while taking into consideration the International Best Practices available globally for grain storage and handling.In this structure, the grains in bulk are unloaded on the conveyor belts and, through mechanical operations, are carried to the storage structure.



NCML's newly constructed Silo Complex at Pumia is tthe largest puclic silo complex for maize in the country

Silo is a vertical tank like structure made of steel for bulk storage of food grains in controlled atmosphere. Silos offer several advantages depending upon their layout and automation. Silos require 1/3rd of the land as compared to conventional warehouses. The storage of grain in a silo is possible for long periods without quality loss or damage through various biotic and abiotic factors. If food grains are stored in silos and transported in bulk, losses due to theft, pilferage and transportation would be negligible compared to food grains storage in bags in conventional warehouses.

Because of mechanisation, silos use less labour in operations, handling is rapid and the overall operating cost low. Being a closed structure, preservation of maize in a silo through chilling technique can be carried out more easily, efficiently and effectively. Lately Chilling technique is gradually becoming more popular method of grain preservation in sub-tropical countries like India over traditional method of grain preservation which essentially include periodic aeration coupled with fumigation as it is not only cost effective but is more safe, easier and efficient way of grain preservation. Further, it also supports storage of Maize in bulk storage with grain moisture up to 14.5% as against the requirement of 12% (required when stored in bulk).

Traditionally, Indian farmers use Sun-Drying method for corn which is exposed to vagaries of nature and many a times the entire harvest gets rotten due to climatic catastrophe. Invariably Indian corn suffers Aflatoxin issues due to improper drying and gets rejected besides huge destruction in value.

Silos having Drier facility can effectively address the issue of handling large volumes of high moisture grain received from the farm gate during the harvest period which usual extends up to a period of 45-60 days.

Maize storage Parameters	
Safe moisture upper limit at which maize can be stored	13% (Equilibrium moisture content at 70% RH (temp. 27 degree Celsius)
Maximum Stack height	In layers: 16 In metres: 4.2
Quantity required for physical analysis	50 gms

Storage losses can be classified in two categories: Direct losses, due to physical loss of commodities; and indirect losses, due to loss in quality and nutrition. Both abiotic factors (temperature, humidity) and biotic factors (insect, pest, rodents, fungi) cause storage losses. Therefore, recommended post- harvest handling and storage involve the manipulation of the above factors in order to obtain high quality maize grains. Moisture content and temperature are amongst the most crucial factors affecting the storage life of maize.

Maize may be stored safely in bag storage in traditional flatbed warehouses at about 13% moisture content at about 27-degree Celsius temperature (ambient storage temperature).

Maize is relatively more susceptible to Aflatoxin contamination than other cereals. Aflatoxin contamination is encouraged by: • Inadequate drying • Physical damage due to poor shelling/threshing methods • Poor storage methods (exposure to moist condition) • Insect infestations. Aflatoxin cannot be seen with a naked eye. However, suspect materials tend to: • Be rotten • Be mouldy • Be discoloured Have unpleasant smell • Have bitter taste • Have poor milling quality • Be warmer than room temperature. Losses due to mould • Loss of weight • Loss of quality (smell, taste, colour, nutritional value, germination) • Further increase in temperature and moisture, causing more grain deterioration.

Silo complexes are more suitable as they can prevent several problems listed above. In the coming period, it is expected that silo complexes will increasingly be used for corn storage due to the large number of benefits and improved warehousing quality.

Corn Revolution in Bihar



Mr. Anand Jha
CEO, Pristine Mega Food Park Pvt. Ltd.

"Harvesting window of Rabi Maize in Bihar is unique as it does not overlap with harvesting of Maize in any other Maize producing States. Maize processing and storage infrastructure are important to encash the production potential of the State."

Importance of Maize: Maize is a cereal crop which is cultivated widely throughout the world and has the highest production among all the cereals. Maize production in India has grown at a CAGR of 5.5 per cent over the last ten years from 14 Mn MT in 2004-05 to almost about 26 Mn MT in 2016-17. Maize is the third most important food grain crop in India and accounts for about 10% of total cereal production besides rice (42%) and wheat (38%).

Bihar is one of the traditional maize-growing states in India accounting for almost 10% of India's total production. As per the statistical data of Govt. of Bihar, Maize production in Bihar is estimated at about 1.6 Mn MT. Though maize is cultivated across all districts in Bihar, districts including Begusarai, Samastipur, Khagaria, Purnea, Bhagalpur, Madhepura and Saharsa together accounts for about 50% of State's total Maize production. The Farm economy in the State, therefore, depends immensely on the overall Maize production and productivity as well as the livelihood of the farming community in the State.

Incidentally, these districts are also the historically flood-prone areas during rainy season and fall north of the Ganges. Maize is grown throughout the year in Bihar and all three seasonal crops of maize are cultivated. However, the Rabi season crop of Maize is the USP of the state. Harvesting window of Rabi Maize in Bihar is unique as it does not overlap with harvesting of maize in any other maize producing States and hence provides for an 'Exclusive Availability Window' of Maize crop.

As regards the processed derivatives of Maize, there are about 9 types of processed products derived from wet milling of Maize that includes corn starch, malto dextrin, dextrin, dextrose monohydrate, sorbitol, liquid glucose, high maltose syrup, dextrose syrup and anhydrous dextrose. In terms of Industrial consumption, Paper Industry, Textile, Pharmaceutical, Cattle & Poultry Feed & Food Industry together accounts for consumption of over 90% of Maize derivatives. Therefore, domestic demand, supply dynamics and pricing trends of Maize is linked to performance of these industrial segments to a great extent. Due to absence of such established industrial segments in Bihar, the downstream processing of Maize is negligible within the state leading to export of almost 90% of total production to other states such as Gujarat, Tamil Nadu, Haryana, Maharashtra, Karnataka, Andhra Pradesh and Punjab.

The existing supply chain, logistics and warehousing infrastructure in Bihar possess critical challenges to post harvest losses particularly in view of a very large maize cargo movement during the season. There is only one Silo based storage system in State in Purnea set up by NCML. Majority of the Warehouses are of brick & mortar structure and lack in meeting standard norms for quality storage and warehousing for effective cargo management. Another issue is fragmented and low average capacity of warehouses which leads to multiple storage points in each production cluster that causes multiple handlings and post harvest losses. Above issues can only be resolved by creating large warehousing and silo infrastructure in major producing clusters backed by rail based cargo movement to minimize the post harvest losses and in creating a strong supply chain infrastructure in the State.

Affordable, Accessible, Asian (AAA) Drought Tolerant Maize Project

A collaborative program between CIMMYT and Syngenta AG, sponsored by Syngenta Foundation for Sustainable Agriculture



Mr. Herve Fernand Emmanuel Thieblemont
Regional Seed Business Development Manager, Syngenta Foundation for Sustainable Agriculture (SFSA), Thailand

"The ultimate goal is to ensure that the use of the newly developed hybrid – TA5084 will increase the Maize yield from 1.5T/ha to 2.5T/ha, and generate an additional income of $150/ha."

In 2010, CIMMYT and Syngenta decided to co-develop a specific maize breeding program to make hybrids of tropical maize available at an affordable price to poor-resource smallholder farmers. The objective was to create drought tolerant varieties that yield about 80% of the best hybrids and about double in yield of popularly grown open pollinated varieties (OPVs), commonly cultivated in rain-fed, drought prone areas in India.

After several years of intense R&D activity such as the identification of the lines possessing genes of drought tolerance (CIMMYT material); the introgression of this abiotic trait into lines possessing traits for high yield (SYT material), the program team has field-tested a number of promising 3-way cross hybrids and identified a few that are well adapted, drought tolerant and high yielding. These trials are placed in a contiguous region lying across three neighboring states of Gujarat, Madhya Pradesh and Rajasthan. The trial network is currently handled by local seed partners and the coordination is led by Syngenta Foundation. One promising variety has been selected: TA5084, and pre-positioned during the 2017 Kharif by two seed partners. The commercial launch will take place during the 2018 Kharif season. More than 20 seed partners are already engaged to introduce on a larger scale and to promote this new tolerant variety in the three targeted states.

The ultimate goal is to ensure that poor-resource small holders, using currently OPV will increase their yield from 1.5T/ha to 2.5T/ha, and generate an additional income of $150/ha

- **TA5084 hybrid profile**
  - Maturity: 120 days
  - 50% Flowering at 80 days
  - Plant height: 204cm
  - Ear insertion: 98 cm
  - Grain color: Orange Yellow
  - Grain texture: semi-flint
  - Shelling: 77%





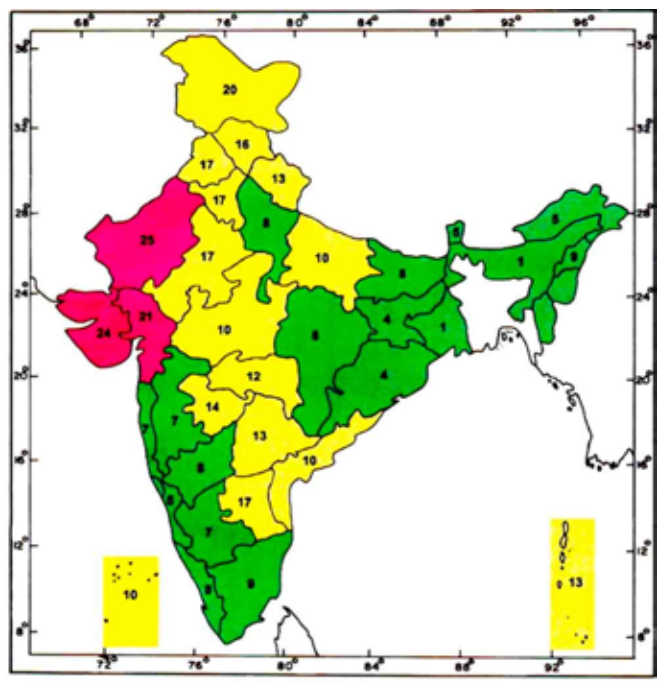









AAA
Maize
AFFORDABLE · ACCESSIBLE · ASIAN
AAA
Maize


PROBABILITY OF OCCURRENCE OF DROUGHT (%)
AND DROUGHT PRONE AREAS
CHRONICALLY DROUGHT PRONE AREA
(PROBABLITY OF OCCURRENCE OF DROUGHT MORE THAN 20%)
FREQUENTLY DROUGHT PRONE AREA
(PROBABILITY OF OCCURRENCE OF DROUGHT 10% TO 20%)
LEAST DROUGHT PRONE AREA
(PROBABILITY OF OCCURRENCE OF DROUGHT LESS THAN 10%)

References

- *Kumar, R., Srinivas, K., & Sivaramane, N. (2013). Assessment of the maize situation, outlook and investment opportunities in India*
- *IIMR. Vision 2050*
- *Press Information Bureau, MoA and FW, GoI. (2017).*
- *USDA FAS. (2017). Grain and Feed Annual*
- *USDA ERS. Feed outlook: January 2017*
- *Prasanna, B. M., Vasal, S. K., Kassahun, B., & Singh, N. N. (2001) Quality protein maize. Current Science 81:1308-1319; Vasal, S. K. (2002). Quality protein maize: Overcoming the hurdles*
- *P. K. Kataki and S. C. Babu. Food systems for improved human nutrition: Linking agriculture, nutrition, and productivity. 193–227. Food Products Press: an imprint of the Haworth Press, Inc.*
- *M, Dominique. (28 October 2016). No need to panicoid: C4 photosynthesis could increase crop yields https://blogs.biomedcentral.com/on-biology/2016/10/28/no-need-panicoid-c4-photosynthesis-increase-crop-yields/*
- *Crafts-Brandner, S. J, & Salvucci, M. E. (2002). Sensitivity of photosynthesis in a C4 plant, maize, to heat stress*
- *Geofin Commtrade Ltd. (June 2016). Maize special report*
- *USDA FAS. (January 2017). Grain: World markets and trade*
- *Wayan, S. I., Basuki., N., Sugiharto, A. N, & Soegianto, A. (2015). Estimation of Genetics Variance Components from Composite and Hybrid Maize (Zea mays L) Hybridization*
- *NITI Aayog, GoI. (2017). Doubling farmers' income-Rationale, strategy, prospects and action plan*
- *Singh, S., Damodaran, H. (4 June 2015). Bihar: An unlikely corn revolution. The Indian Express. Retrieved from http://indianexpress.com/article/india/india-others/bihar-an-unlikely-corn-revolution/*
- *Ministry of New & Renewable energy, GoI. Dhundi Village in Gujarat shows the way for cooperative solar enterprise*

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Knowledge Report on Maize sector has stimulated great interest among readers since FICCI organized first India Maize Summit in 2013. We are pleased to present the FICCI PwC knowledge Report: Maize Vision 2022 on occasion of 5th edition of India's Maize Summit, which is the outcome of six month process that engaged stakeholders in outlining a vision and worked intensively to identify priorities for action. We would like to acknowledge inputs received from the people whose names are listed below.

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FICCI provides a platform for networking and consensus building within and across sectors and is the first port of call for Indian industry, policy makers and the international business community.

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