FICCI

YES BANK



Boosting Growth of India's Maize Ecosystem

Key Imperatives

TITLE	BOOSTING GROWTH OF INDIA'S MAIZE ECOSYSTEM - KEY IMPERATIVES
YEAR	April, 2021
AUTHORS	**YES BANK** Food and Agribusiness Strategic Advisory & Research Team (FASAR), YES BANK **FICCI** Jyoti Vij, Deputy Secretary General, FICCI Ruchira, Joint Director and Team Leader – Agriculture, FICCI Shikha Dutta, Assistant Director - Agriculture, FICCI
COPYRIGHT	No part of this publication may be reproduced in any form by photo, photoprint, microfilm or any other means without the written permission of YES BANK Ltd. and FICCI
DISCLAIMER	This report is the publication of YES BANK Limited ("YES BANK") and FICCI so YES BANK and FICCI have editorial control over the content, including opinions, advice, statements, services, offers etc. that is represented in this report. However, YES BANK, FICCI will not be liable for any loss or damage caused by the reader's reliance on information obtained through this report. This report may contain third party contents and third-party resources. YES BANK and/or FICCI take no responsibility for third party content, advertisements or third party applications that are printed on or through this report, nor does it take any responsibility for the goods or services provided by its advertisers or for any error, omission, deletion, defect, theft or destruction or unauthorized access to, or alteration of, any user communication. The contents are provided for your reference and information purposes only, and are not intended to substitute professional advice in relation to the subject matter. The reader/buyer understands that except for the information, products and services clearly identified as being supplied by YES BANK and FICCI, YES BANK and FICCI do not operate, control or endorse any other information, products, or services appearing in the report in any way. All other information, products and services offered through the report are offered by third parties, which are not affiliated in any manner to YES BANK or FICCI. The reader/buyer hereby disclaims and waives any right and/ or claim, they may have against YES BANK or FICCI with respect to third party products and services. YES BANK and FICCI make no representation or warranty, express or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, title or non – infringement. Any literary or artistic work and/or any other similar pictorial and visual representation or any combination thereof contained/published in the report are intended to be the fair use of such work for the sole purpose of education and/or research as permissible under the extant laws and are not used with an intention to infringe/violate any copyright, trade mark or such other Intellectual Property Rights of any nature whatsoever of any author/proprietor. However, YES BANK and FICCI make no representation or warranty that the contents of such documents, articles are free from error or suitable for any purpose; nor that the implementation of such contents will not infringe any third party patents, copyrights, trademarks or other rights. In no event shall YES BANK and FICCI or its content providers be liable for any damages whatsoever, whether direct, indirect or otherwise , including without limitation, damages arising from the access and/or use or inability to access and/ or use content and/or any service available in this report. Maps (if any) depicted in the report are graphical representation only and do not purport to be the political map of any nation or state and are not drawn to scale.
CONTACTS	**YES BANK Ltd.** Registered and Head Office YES BANK Tower ONE International Center, 15th Floor, Senapati Bapat Marg, Elphinstone (W), Mumbai - 400 013 Tel :+91 22 3366 9000 Fax :+91 22 2421 4500 Northern Regional Office 9, Nyaya Marg, Chanakyapuri, New Delhi - 110 021 Email : fasar@yesbank.in Website: www.yesbank.in **FICCI** Agriculture Division Federation House, Tansen Marg New Delhi-110001, India Tel: +91-11-23487415 Email: agriculture@ficci.com Fax: +91 11 2376 5333, 23721504

MESSAGE



Mr. Ravishankar Cherukuri

Vice President Marketing, Bayer Cropscience &
Chair of Maize Initiative

Dear Fellow Maize Enthusiasts,

In the last decade or so, Maize has gone from ~ 8 M Ha to ~ 9 M Ha in cultivated area. As predicted, domestic demand for maize grew faster than supply, and exports dipped to negligible from a peak of 4-5 Million Metric Tons. Despite being reasonably protected from imports (most global trade in corn is GM), farm gate prices of Maize have been volatile, ranging between 900-2400 Rs/quintal. Poultry demand is admittedly cyclical, but these price variations have been equally due to supply volatility.

If we want corn farmers to confidently embrace new technology, aim for the highest possible yields, and compete for the massive corn trade flowing into our neighborhood, we need to protect them from these uncertainties. MSP de-links production from the market demand. We need a more robust price signal instead, and insurance against weather, yield, price and revenue risks. If we could also invest into post harvest infrastructure, Indian farmers could grab 10% of Asian corn imports.

If this is achieved via ~25% yield improvements, a back of the envelope calculation shows farmer income increase of ~25,000 Rs per farmer, as per my back of the envelope calculation. By adding 7-8 MMT of export to 28 MMT of local sales, and ensuring our farmers are competitive on price and quality, we can literally add 50% + to farmer incomes.

I believe we can achieve this in this decade. My invitation to you is to please think “how”, what risks we should guard farmers from, and what your organizations role could be in this journey.

MESSAGE



Dr. Ajai Kumar

Head of Government and Industry Affairs, South Asia
Corteva Agriscience

Last few years have seen a revolution in Indian Maize sector. India 's corn productivity has increased significantly over the last decade. Presently , average productivity of maize in India is around 3 MT/ha . Such improvement in productivity level has been witnessed due to adoption of hybrid varieties by farmers and efforts made by the private sector.

Still there is a long way to go to achieve the productivity level equivalent to high yield countries. Rapid adoption of technology in terms of hybridization, advancements in genomics and molecular breeding, next generation mutation techniques, are few potential areas which would abridge the yield gaps and would bring incremental gains to maize cultivators. Secondly Kharif Maize crop being tropical, is susceptible to infestation by weeds and insect pests. Of late, infestation of Fall Army Worm has caused havoc in maize growing belts across the country. Poor pest management practices, including lack of seed treatment is resulting in high loss due to pest attack. Therefore conscious attention towards pest management is equally important.

Given the growing demand for maize and the diverse end-uses, it is critical that coordinated efforts need to be taken for development of this sector.

MESSAGE



Mr. Ryan LeGrand

President and CEO
U.S. Grains Council

The U.S. Grains Council is pleased to be a partner in the 7th edition of the FICCI Maize Summit and contribute to the Maize Vision report, which identifies opportunities and challenges within the Indian maize industry and offers recommendations to grow this sector.

The U.S. is the largest corn producer in the world, with over 96 million acres (39 million ha) of land reserved for corn production. Although corn (or maize, as it's known throughout much of the world) is grown in nearly all 50 states, production is primarily concentrated in the northern and Midwestern states —collectively known as the U.S. Corn Belt.

Yet, corn is much more than just a crop - it represents a source of income for the millions of farmers in the country. Its diverse uses create value added products like dry distillers' grains with soluble, and ethanol which revitalize the U.S. industry and economy.

The Council's mission is to develop markets, enable trade and improve lives. The Council works closely with local feed manufacturers and agriculture producers to build capacity for more and higher-quality feed demand. The goal of these programs is to accelerate the sustainable growth of local industries using coarse grains and products. This in turn increases overall demand for grain and meets rising demand from consumers for better food.

The Council supports free trade while understanding there are critical constraints and challenges confronting end-user industries. In these challenging times, it is critical to develop and implement new approaches and technologies that not only provide a growing global population access to adequate nutritious, safe, and affordable food but, creates value added products, preserves natural resources and minimizes negative environmental impacts.

We look forward to growing the U.S.-India trade relationship and U.S. farmers are ready to support Indian farmers and industries.

FOREWORD



Dilip Chenoy

Secretary General
FICCI

Around the globe, known as “Queen of Cereals”, Maize is considered to be one of the most important cereal crops. In India, it ranks third as the most important food grain after Rice and Wheat.

The crop holds immense potential for food and nutritional security. It provides the right avenue for crop diversification and also for increasing farmer income, especially for small and marginal farmers in the rainfed areas.

It is critical to note that the domestic demand for maize is growing at a much faster rate than the production. Over the last decade, while consumption of maize grew at a CAGR of 5.6%, production grew at just 2.9%. This makes it imperative to identify and address the key barriers that are hindering the growth of the Indian maize ecosystem. It also warrants a collaborative public-private action to be taken up for bridging the inevitable demand-supply gap that is expected to challenge the maize ecosystem in the near future.

FICCI, through the India Maize Summit series, has strived to create a common platform that can be utilized by the diverse stakeholders to delve on the dynamics of the Maize sector in India and identify pathways to enhance competitiveness of the Maize value chain.

The Report attempts to identify the critical pain points faced by the stakeholders across the maize supply chain and suggest specific action steps. These steps, if implemented, can significantly boost growth of the maize sector. It is our strong belief that this report will be a useful reference point for co-creating a meaningful roadmap and pathway that can boost growth, development and prosperity of all stakeholders across the Maize ecosystem.

FOREWORD



Prashant Kumar

Managing Director & CEO
YES Bank Ltd.

The versatile contribution of maize to India's socio-economic equilibrium is significant. Empirical evidence suggests that maize is the third most important food grain in our country (after rice and wheat) and the fastest growing cereal crop in terms of area, production and productivity. Domestic maize production has grown from less than 10 million tonnes in the mid-1990s to more than 27 million tonnes in the last couple of years. More importantly, only 27% of this crop is cultivated under irrigated conditions, compared to 94% of wheat and 60% of rice respectively. This indicates that maize has the ability to generate better farmer income mainly for resource poor farmers - who are vulnerable to vagaries of monsoon. It also reflects the crop's intrinsic ability to adapt to varied agro-climatic conditions.

From the demand side, while maize is a key source of food and nutritional security, especially in traditional growing areas, only about 20% of domestic production is used for food, while more than 75% is utilized for industrial purposes – including 60% for animal feed industry, 14% for starch industry and a small portion for bio-ethanol production. This demand is projected to increase in coming years due to increasing industrial consumption of maize.

These intrinsic multi-functional characteristics have catapulted maize as the focus crop that could be leveraged to solve a myriad range of challenges faced by Indian agriculture, including - augmenting farmer income, managing surplus food grain production, crop diversification to address deteriorating soil and water resources, ensuring energy security and attracting private sector investment to boost employment in rural India.

However, India's maize ecosystem faces critical challenges across the value chain that hamper holistic growth and development of the sector. While factors such as limited adoption of hybrids, inadequate plant health management and low farm mechanization are adversely impacting productivity at the farm end; poor farmer price realization due to poor post-harvest management, lack of adequate infrastructure (especially for bulk storage, transport and marketing), lack of integration and scale in operations are affecting efficiencies at the marketing end.

The Government of India has taken numerous proactive initiatives to safeguard the interests of farmers as well as promote private sector investment across the agriculture sector. While most of these initiatives have positively impacted the maize ecosystem, there appears to be a need for a focused, public-private co-created strategy to address the multifaceted demands of the maize sector – such that diverse stakeholders across the value chain actualize the true socio-economic potential of this crop.

YES BANK is pleased to collaborate with FICCI for the 7th edition of India Maize Summit, wherein this knowledge report on "Boosting Growth of India's Maize Ecosystem-Key Imperatives", is being released. The report identifies critical challenges being faced by various stakeholders across the value chain and puts forth key recommendations that could play a meaningful role in boosting the growth of this sector. I sincerely believe that this report will serve as a repository as well as a reference document for developing an actionable roadmap to harness the true potential of the maize ecosystem in India.



CONTENTS

1	**Executive Summary**	**10**
2	**Introduction**	**13**
2.1	Importance	13
2.2	Global Scenario	14
3	**Indian Maize Scenario**	**20**
3.1	Supply Trends	21
3.2	Demand & Consumption Trends	26
3.3	International Trade	31
3.4	Government Initiatives & Policies	32
4	**Growth Drivers and Challenges**	**37**
4.1	Factors driving growth of maize ecosystem	37
4.2	Key challenges across the supply chain	39
5	**Key Imperatives for sustainable development**	**45**
6	**Acknowledgment**	**53**
7	**References**	**54**
8	**Abbreviations**	**55**





01

EXECUTIVE SUMMARY

This report captures a snapshot of global demand and supply scenario of Maize, deep dives into it's ecosystem dynamics in India, identifies critical bottlenecks faced across domestic value chain and suggests key interventions that, if addressed, could significantly boost income security, growth and development for all participants across the domestic maize supply chain.

Globally, maize is amongst the most widely produced and consumed cereal crops. In 2019, about 1.15 billion MT of maize was produced covering an acreage of about 197 million Ha[1] across 170 countries. During this year, global consumption of top three cereals (maize, wheat and rice) stood at 2,365 million MT of which maize held about 48% share. Over the last decade, both global production as well as consumption increased at a CAGR of about 3.4%. Just above 15% of global production was traded internationally with about 89% exports contributed by five exporters - USA, Brazil, Argentina, Ukraine and European Union.

India ranks 4th and 7th in terms of global maize acreage and production, contributing to about 4.6% and 2.4% respectively. Maize is the 3rd most important food grain for our country (after rice and wheat). It is the fastest growing cereal crop in terms of area, production as well as productivity. Over the last few decades, maize cultivation has shifted from being grown only during the kharif in traditional areas (such as Rajasthan, Uttar Pradesh and Bihar), primarily to be used as food, to being grown across non-traditional areas (such as Andhra Pradesh, Madhya Pradesh and Karnataka), across seasons and majorly produced for industrial use. However, the production system continues to be largely rain-fed. Over the last decade, maize consumption in India grew at a CAGR of 5.6% while production grew at just about 2.9%. Maize off-take by the feed industry grew fastest at a CAGR of 8.8% followed by industrial segment (primarily starch), which grew at a CAGR of 6.2%. Off-take for food grew at a CAGR of 0.8%.

With domestic demand for maize growing faster than production and the fact that maize provides the right opportunity for crop diversification and increasing farmer income (specially for small and marginal farmer in rainfed areas), there is an imminent need to identify and address key barriers hindering growth of the Indian maize ecosystem. Multiple challenges across the value chain are impacting farm prices on one hand, while constraining the availability of good quality produce to the consumer at reasonable price on the other.

[1] *Source: FAOSTAT*

Based on emperical evidance and detailed discussion with stakeholders across the value chain, eight key challenges have been identified. These include:

Level	Key Challenges	Description and Details
Farm level	• Low productivity • Relative unattractiveness constraining wider crop adoption • Skewed production due to seasonality	• Yield is at 3.1MT/ha compared to global average of 5.8MT/ha. 70% rainfed. • Just 60% usage of hybrid seeds compared to 100% in USA, Brazil and upto 86% in Bangladesh, SCH yet to be adopted in large scale • Poor pest management (weeds, Fall Army Worm). No seed treatment • Low mechanization (for sowing & harvest just about 5-7%) • Cost of Cultivation higher than Sorghum, Bajra & even Rice & Wheat • Limited area under production in rabi
Post-harvest handling / Marketing	• Low farmer price realization due to poor quality management • Inefficient access to markets due to fragmentation	• Quality loss due to unscientific harvesting, shelling, drying and farm level storage techniques • High moisture content at the time of sale • High intermediation as land holdings are fragmented and produce quantity per farmer is low making it uneconomical to transport to market • Inefficient price discovery as produced sold at village level
Storage & Transport	• Multiple handling points and high cost of logistics due to poor bulk storage and logistics infrastructure	• Poor storage conditions result in rodent & pest attack and aflatoxin build-up • Lack of bulk storage and transportation infrastructure leading to multiple handling and high cost of transport
Processing	• Challenge of right quality & quantity at right time and price	• Varietal quality mismatch. Low starch content, high moisture content and low grain weight • High cost of raw material due to involvement of large number of intermediaries • Fluctuating prices, seasonal availability and import restrictions • End products not competitive in international market
International Trade	• Uncompetitive price of Indian maize at global level and import restrictions	• Higher price due to strong domestic demand and rising MSPs resulted in slowing down of exports due to uncompetitive price • Quality not at par with international standards • High import duty and lack of quota allocation to certain industries at the time of shortage. Source of origin issues.

Discussions with various stakeholders across industries reveals 11 key actionables, which if addressed, can bring about sustainable development of the maize ecosystem. These include:

Farm level Interventions

01 Developing and implementing a roadmap for acreage expansion and crop diversification- *A "Maize Atlas" to be developed based on agroclimate, varietal characteristics and industry requirement matrix.*

02 Driving productivity improvement & Good Agricultural Practices- *An enabling policy environment to be developed for efficient and timely introduction of high yielding varieties, introduction of effective IPM offerings (such as seed treatment) and promoting public-private extension programs.*

03 Investing heavily on "On-farm / farm proximate post-harvest quality management"- *Private investment in moisture testing, quality testing, modern and cost effective dryers and scientific storage infrastructure to be promoted through various government schemes such as Agri Infrastructure Fund, ODOP programs and MOFPI's Formalisation of Micro Food Processing Enterprises scheme.*

04 Developing and building capacity of "Maize cluster based farmer collectives and FPOs" - *for improving economies of scale for farmers.*

05 Empowering farmers with strengthened price discovery and price risk mitigation mechanisms – *such as implementing the e-kisan mandi initiative and popularizing farmer price hedging options.*

Off-Farm Interventions

06 Promoting investment in maize focused bulk storage and logistics infrastructure- *A dedicated Kisan Rail for maize and developing large scale integrated bulk handling projects for maize in PPP mode (like those developed for wheat).*

07 Providing maize supply security to industry- *Focus on developing industry specific varieties, involving private sector while developing food safety standards and easing import restrictions specially during shortage.*

08 Incentivizing private sector investment across the value chain - *through various schemes such as Pradhan Mantri Kisan SAMPADA Yojana, AHIDF, PMFME etc.*

09 Leveraging agritech startups to transform the maize supply chain.

10 Exploring and addressing the untapped export potential.

Coordination of Efforts

11 Creating a multi- stakeholder Maize Development Agency to drive focused and sustainable development of the sector.

02

INTRODUCTION

2.1 Importance

The contribution of maize to food security is immense, given that it is a preferred staple food for more than 900 million poor including one-third of all malnourished children globally[2]. In regions such as Latin America and Sub-Saharan Africa, that are dependent on maize as a key staple crop, it serves as an important source of carbohydrate, protein, iron, vitamin B, and minerals. About 120 -140 million farm families, depend on this crop for their livelihoods.

Maize is amongst the world's most widely produced and consumed cereal crops. It is called the 'Queen of Cereal' as it has the highest genetic yield potential among cereals. Given its photo-thermal insensitivity and its genetic amenability to reconstruction, it can be grown in diverse agro-climatic conditions and genetically modified for specific human needs. Consequently, it serves as a key raw material across various sectors – including livestock feed, starch, food processing and bioethanol. Additionally, derivatives of corn starch are actively used in diverse industries including pharmaceuticals, cosmetics, food processing, textiles and paper among others. Various types of maize (refer exhibit1) are cultivated in highly diverse climate and soil conditions across the world.



[2] *Source: https://maize.org/why-maize/*

Exhibit 1: Types of maize



Sweet Corn

- Also called as sugar corn and pole corn due to high sugar content
- Can be eaten on cob and also be canned and frozen
- Harvested 18 to 20 days post pollination when kernel moisture is almost at 70%



Dent Corn

- Also called field corn
- Used in industrial products, livestock feed and food products
- The most commonly grown type in the world



Flint Corn

- Also referred to as Indian or Calico corn
- Kernels range from colors of white to red and consist of hard outer shell
- Commonly grown in Central and South America for food purpose



Pop Corn

- Characterized by a hard-outer shell
- Has minimal soft starch content
- Amenable to popping



Flour Corn

- Primarily used for making corn flour
- Characteristic soft starchy endosperm and a thin pericarp
- Predominantly grown in Andean region (mountain ranges in S. America)



Pod Corn

- Wild maize
- Primarily grown for research purpose to trace genetic root of corn
- Also grown for ornamental purposes and on small scale for snack food

Source: Secondary research, Industry Sources, YES Bank Analysis

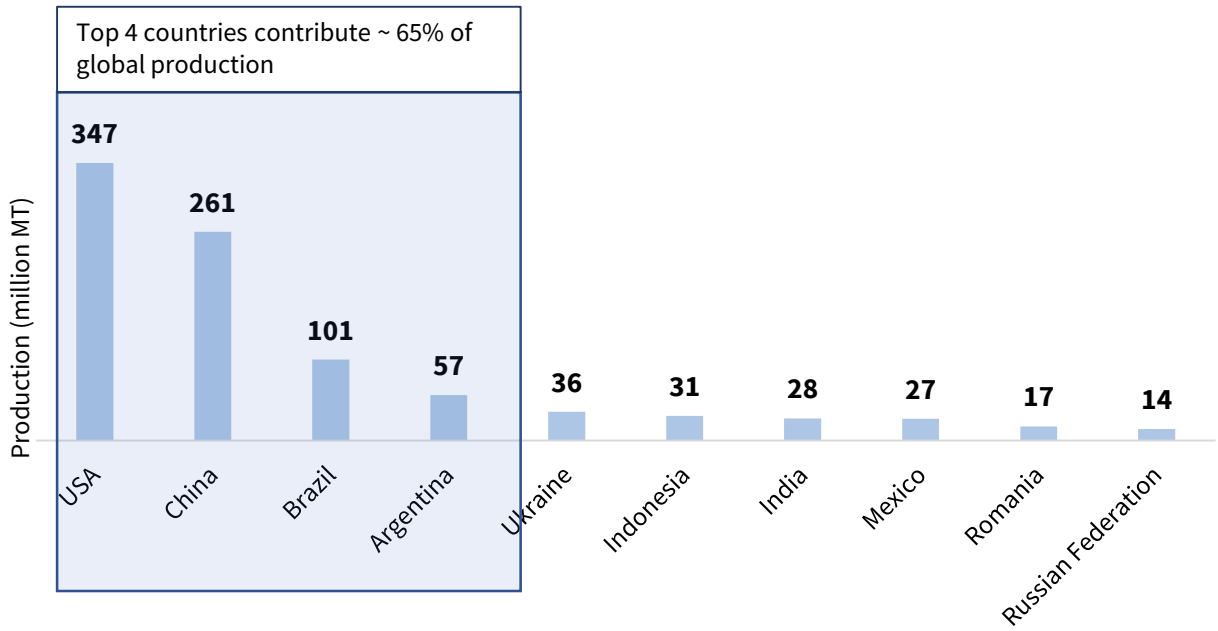
2.2 Global Scenario

Area, Production and Productivity

Globally, maize is the leading cereal crop in terms of production. In 2019, about 1.15 billion MT of maize was produced, covering an acreage of about 197 million Ha[3] across 170 countries. The production of maize increased at a decadal CAGR of 3.4% from year 2009 to 2019. Exhibit 2 highlights the top 10 maize producing countries worldwide. Four countries - The United States, China, Brazil and Argentina together account for over 65% of global production.

[3]*Source: FAOSTAT*

Exhibit 2: Top 10 maize producers (Figures in Mn MT) - 2019



Source: FAOSTAT, YES Bank Analysis

Exhibit 3: Key factors that are expected to drive maize production in top 4 countries

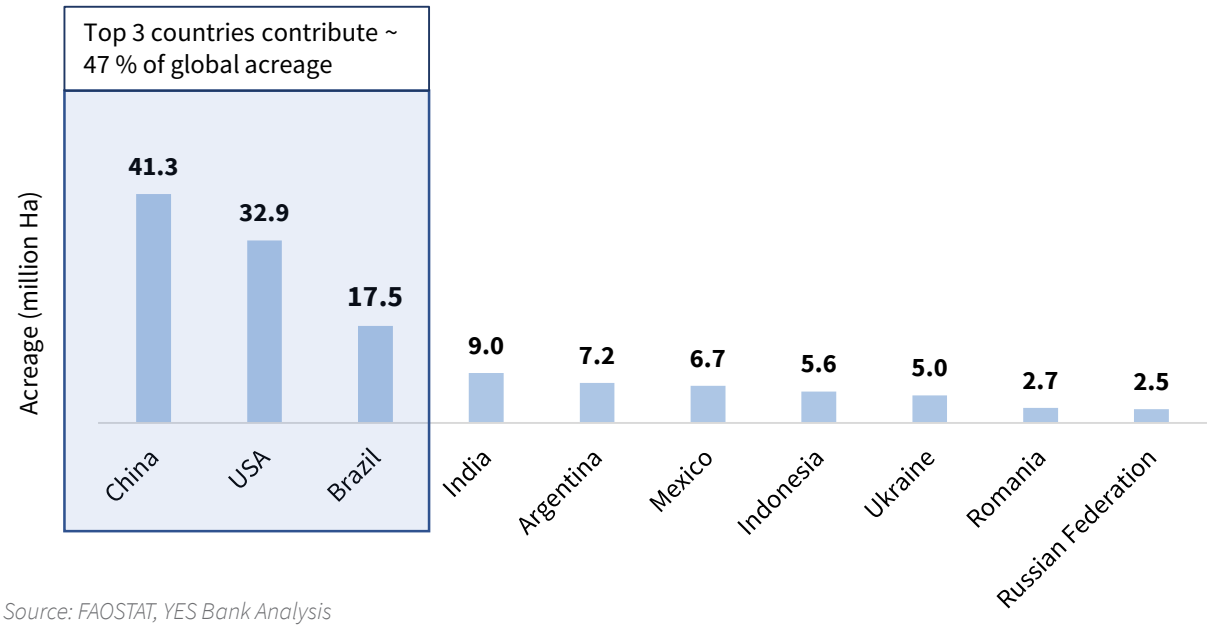
USA	Planted area is expected to remain stable and production increase is expected mainly on account of higher yield.
China	Although China will contribute the most to increase in global maize output, production in China is projected to grow much slower (2.1% per annum) as compared to ~4.5% in the previous decade. In 2016, China changed its maize policy, eliminating the market price support system which was operational since 2008. The reasons for the policy change included the need to reduce the extremely large (and deteriorating) maize stocks, unsustainable farming practices, and environmental concerns. As an alternative, China adopted a direct maize subsidy policy and replaced its stockpiling programme with market-oriented purchasing. This is impacting growth in production.
Brazil	Increase in maize production would be largely driven by higher acreage of 2nd crop maize.
Argentina	Increased production is expected to be sustained primarily due to larger planted area (new agricultural land and multi-cropping) as well as productivity increase.

Source: OECD-FAO Agricultural Outlook 2020-2029

The global acreage under maize cultivation has increased from 159 million ha in 2009 to 197 million ha in 2019, growing at a CAGR of 2.2%[4] (1.3% lower that growth in production over the same period). Clearly, increase in production has been largely driven by improved yields. Three countries, namely, China (21%), USA (17%) and Brazil (9%), account for more than 47% of global acreage under maize (refer exhibit 4).

[4]*Source: FAOSTAT*

Exhibit 4 : Area under maize cultivation in Mn ha (top 10 countries) - 2019



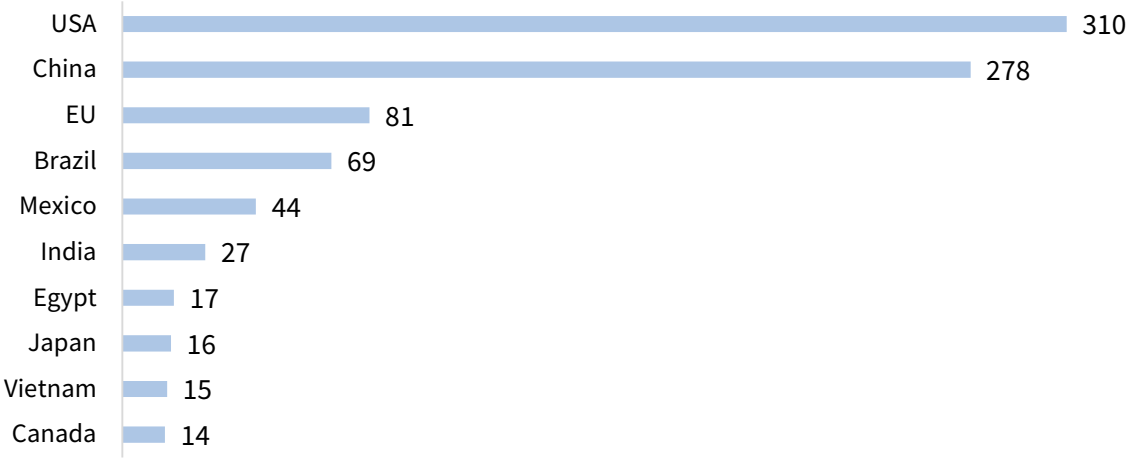
Source: FAOSTAT, YES Bank Analysis

Over the last decade, global average productivity has grown from 5.1 MT/ha (2009) to 5.8 MT/ha (2019) at a CAGR of 1.2%. In the year 2019, among the top ten maize producing countries, the highest yields were recorded by USA with average productivity of 10.5 MT/ha followed by Brazil at 7.9 MT/ha. India's maize productivity was at 3.1 MT/ha, which is lowest within this set of ten countries.

Consumption

In the year 2019, the global consumption of top three cereals (maize, wheat and rice) stood at 2,365 million MT of which maize held about 48% share. Over the last decade, global maize consumption has increased from ~808 million MT (2009) to ~1,134 million MT (2019) growing at a CAGR of 3.4%. Exhibit 5 highlights the top 10 maize consuming nations. Developing countries contributed about 60% of the total demand while developed countries contributed to 40%[5]. Top three consumers included USA (27%), China (25%) and EU (7%).

Exhibit 5: Top 10 maize consumers (Mn MT) – 2019

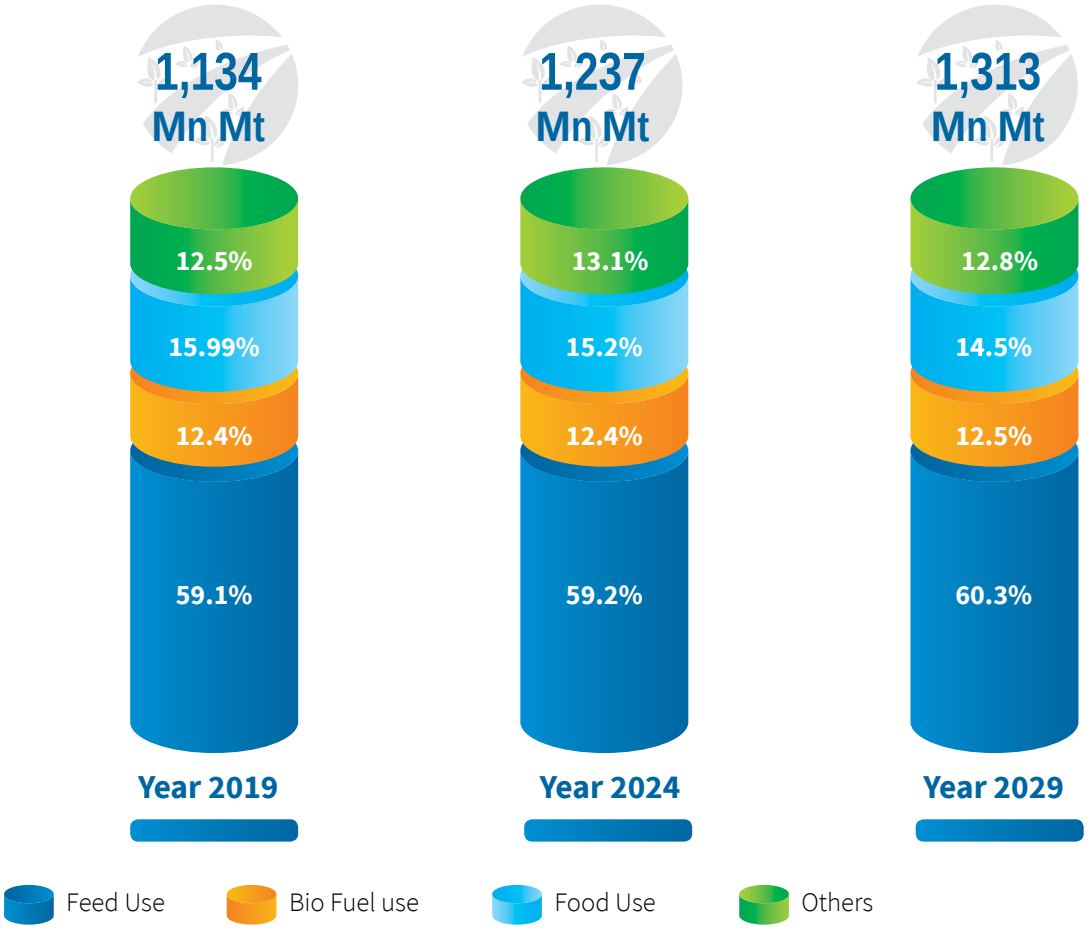


Source: USDA Grain and Feed Annual, March 2021

[5]*OECD-FAO Agricultural Outlook 2020-2029*

Animal feed segment is the major consumer of maize across the world. According to OECD-FAO Agricultural outlook year 2020-29, in the year 2019, around 59% of the total maize (Exhibit 6) was consumed by the feed industry as compared to 16% and 12% for biofuel and food respectively. By 2029, the global maize consumption is expected to increase by ~16% with share of maize used in animal feed to further increase to ~60.3% chiefly due to fast expanding livestock sectors in developing countries. Share of human food consumption is expected to marginally decrease. Growth of maize for biofuel production is expected to be limited, as current biofuel related policies may not support further expansion from major producers.

Exhibit 6: Trends in sectoral off-take of maize

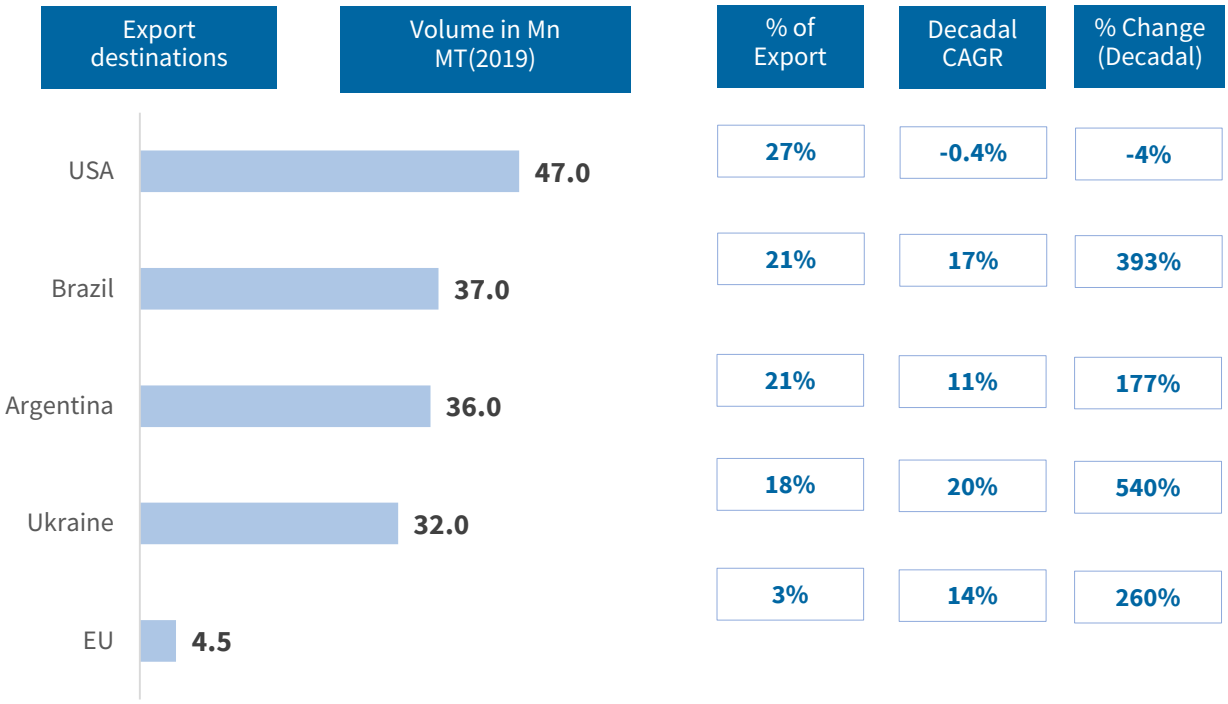


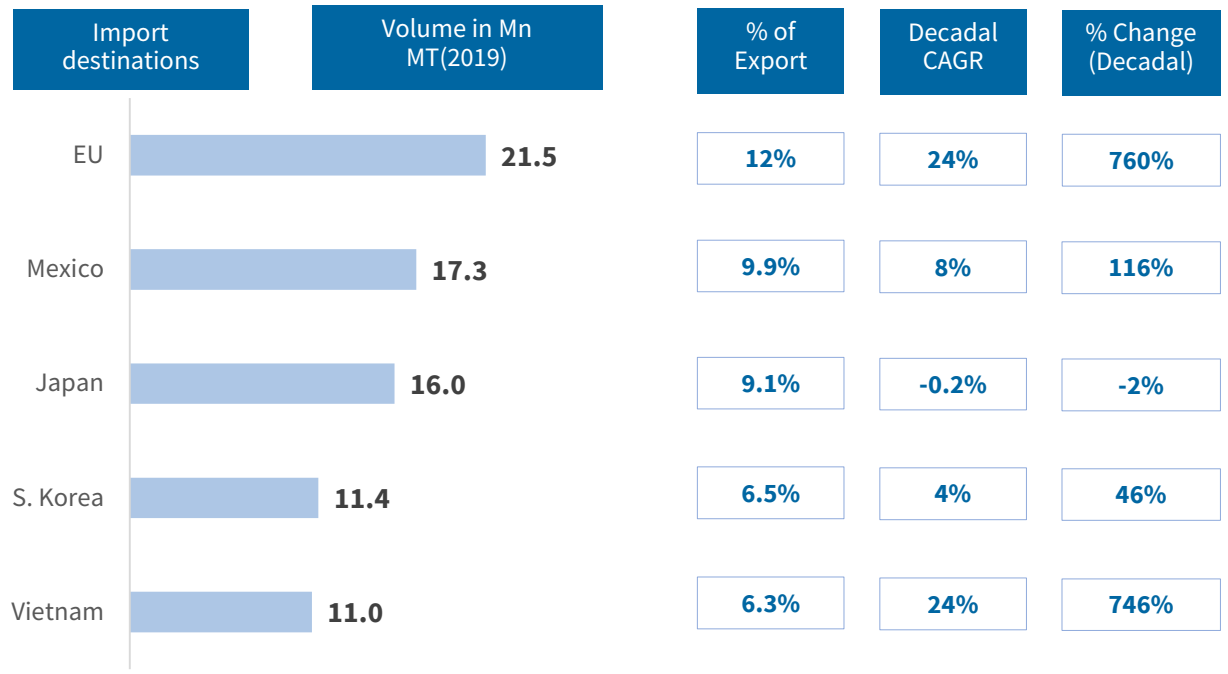
Source: OECD-FAO Agricultural outlook year 2020-29

Global Trade

During trade year 2019-20 (Oct- Sep), about 175 million MT of maize was traded across countries. Top 5 exporters contributed to about 89% of the global exports, led by USA, Brazil, Argentina Ukraine and European Union. Top 5 importers contributed about 44% of global share led by EU, Mexico, Japan, S. Korea and Vietnam (refer exhibit 7).

Exhibit 7: Top maize exporters and importers- Year 2019-20





Source: USDA Grain Report June 2020 and June 2010

Key factors influencing global consumption, trade and prices of maize are captured herewith (exhibit 8).

Exhibit 8: Key factors influencing global demand of maize

Factor	Influence	Influence
Increasing population	• Increased consumption of food on account of 11% expansion in the global population by 2029 • Increased demand for products that use maize as raw material (Ex. poultry feed, industrial starch etc.)	Positive ✓
Raising income resulting in dietary shifts	• Higher consumption of animal protein – resulting in higher demand of animal feed • Socio-economic driven growth for fish and meat in China expected to see an 11% increase in daily per capita availability and significantly drive global demand	Positive ✓
Growth of Nations – Specially China	• Global economy will grow at an average rate of 3.4% over the next ten years. • High economic growth in countries such as China, India and other SE Asian countries resulting in high demand for animal feed, bio-fuel, starch and other maize based products.	Positive ✓
Energy security	• Rapid growth in energy demands and environmental concerns associated with the use of fossil fuels driving growth of bioethanol industry • However, due to emergence of electric & hybrid vehicle, biofuel use of maize is expected to expand only slightly over the coming decade	Positive ✓
Increase demand for other industrial usage	• Maize has an increasing importance in the production of bioplastic for food packaging, bottles, kitchen utensils, straws etc. • Other use of maize will increase by about 20% over the projections period (2017-18 to 2029) as per OECD report 2020-29	Positive ✓
Government policies and trade agreements	• Policy impact on stock (such as in China) • Ethanol production policy (such as in USA) • Trade agreements and arrangements (specially between USA and China)	Either ways
USA and US Dollar prices	• USA is the largest producer and exporter. Changes in production or dollar price impact trade	Either ways
Climate	• Changes in climate and weather patterns have severe impact on maize yields. This in turn impacts global availability and price	Negative

Source: USDA, OECD-FAO, Industry discussions, YES Bank analysis



03

INDIAN MAIZE SCENARIO

Maize is ranked the 3rd most important food grain crop in India after rice and wheat. Globally, India ranks 4th in terms of acreage and 7th in terms of annual production, contributing ~4.6% and 2.4% to world acreage and production respectively.

Over the last few decades, maize cultivation has shifted from being grown only during the kharif in traditional areas (such as Rajasthan, Uttar Pradesh and Bihar), primarily to be used as food, to being grown across non-traditional areas (such as Andhra Pradesh, Madhya Pradesh and Karnataka), across seasons and primarily for industrial use. However, the production system continues to be largely rain-fed, with most of the cultivation primarily being carried out by small and marginal farmers. The average land holding of maize in India is estimated to be about one ha[6]. We also have a very small percentage of Zaid maize (Summer maize), largely in Uttar Pradesh, but the data for the same is not well documented.

Maize has been the fastest growing cereal crop in India in terms of area, production as well as productivity (refer exhibit 9). Between the year 2010-11 and 2019-20, while acreage, production and yield of maize have grown at a CAGR of 0.6%, 2.9% and 2.3% respectively, that of food grains as a whole has grown at -0.2%, 2.0% and 2.2%. This performance in maize crop has been driven by three key factors.

Strong support from government for crop diversification and Minimum Support Price for farmers

Strong growth in demand from Poultry Feed and Starch Industry and

Significant improvement in adoption of HYV seeds resulting in increased productivity.

[6]*Source: https://iimr.icar.gov.in/maize-statistics-india/, average land holding for the year 2015-16*

Exhibit 9: Comparative assessment of area, production and productivity trends

	In the Year 2019-20			CAGR (2010-11 to 2019-20)		
Crop	**Acreage (Mn Ha)**	**Production (Mn MT)**	**Yield (MT/ Ha)**	**Acreage**	**Production**	**Yield**
Paddy	43.46	117.47	2.7	0.2%	2.3%	2.1%
Wheat	31.05	106.21	3.4	0.7%	2.3%	1.5%
Jowar	4.48	4.38	1.0	-5.4%	-5.1%	0.3%
Bajra	6.77	8.9	1.3	-3.8%	-1.7%	2.2%
Maize	**9.00**	**28.08**	**3.1**	**0.6%**	**2.9%**	**2.3%**
Ragi	0.97	1.68	1.7	-3.1%	-2.9%	0.2%
Barley	0.7	1.88	2.7	-0.2%	1.4%	1.6%
Above Cereals	96.43	268.6	2.8	-0.3%	1.9%	2.3%
Pulses	27.87	23.02	0.8	0.6%	2.6%	2.0%

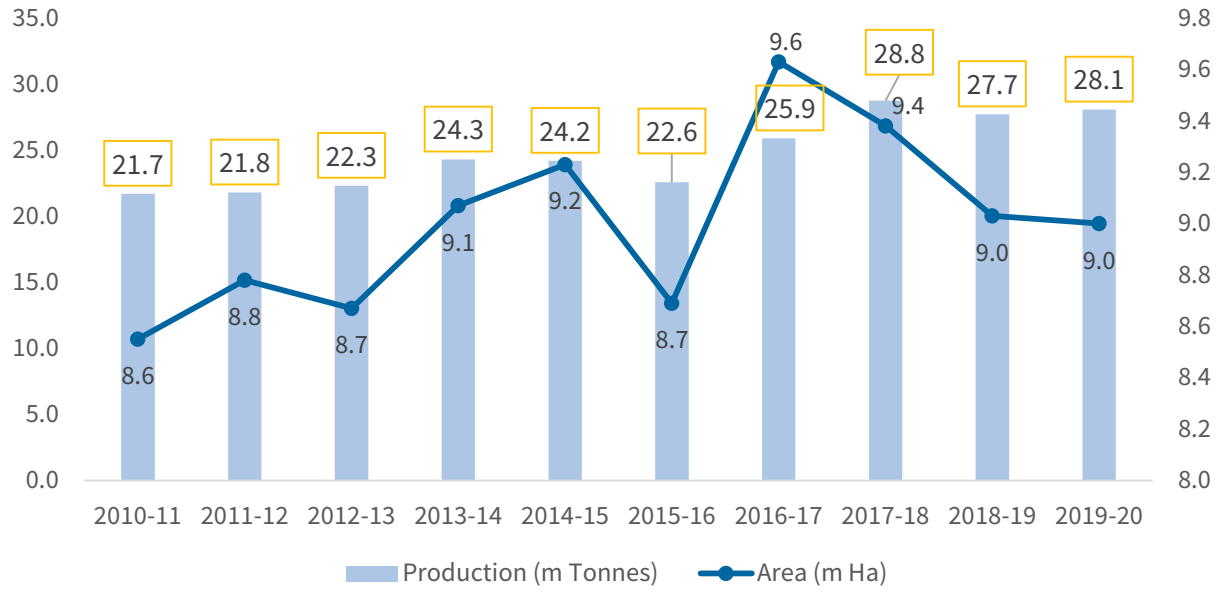
Source: Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare

3.1 Supply Trends

Area, Production & Productivity

In the year 2019-20, maize was cultivated across about 9 million ha across India with national production touching 28 million MT[7]. Over the period (2010-11 to 2019-20), production increased at a CAGR of 2.9% while acreage under cultivation has grown by just about 0.6%. Exhibit 10 highlights trends in area and production of maize crop in India from year 2010-11 to year 2019-20.

Exhibit 10: Decadal trends in area and production of maize in India



Source: Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare

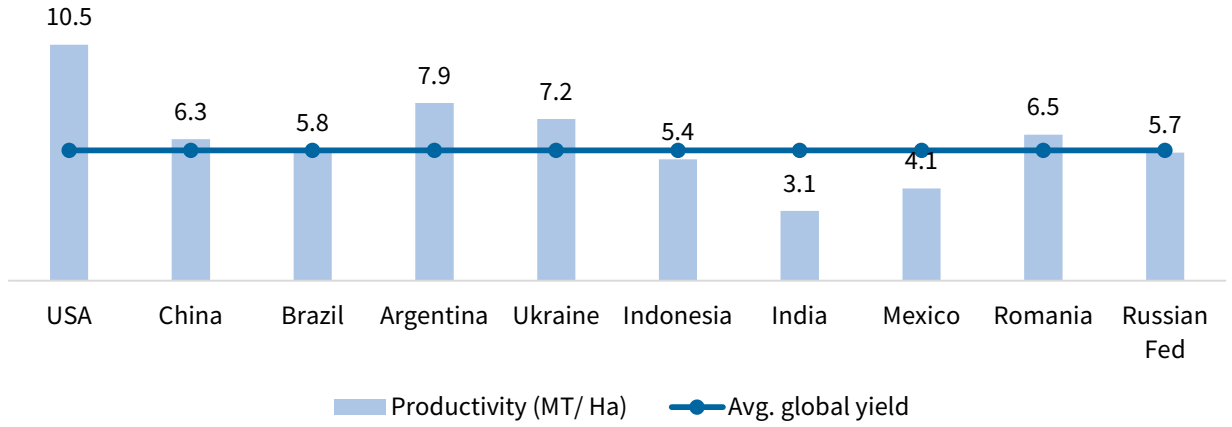
[7]*Source: IIMR*

Clearly, increase in production has primarily been driven by improved yields, which enhanced from 2.5 MT/ha to 3.1 MT/ha over the period - principally drive by use of high yielding variety seeds.

Maize farmers, mostly in non-tradition areas, have expanded the usage of improved hybrid seeds. Since the early 1990s, many private seed companies have been focusing on developing HYVs, primarily single cross hybrids that could replace traditional varieties and old hybrids. According to market sources, hybrid corn, which is mostly feed and industrial grade corn, accounts for 60% or more of the planted area in India, while food grade corn is produced using traditional cultivars in traditional maize consuming states in the northern parts of India.

However, productivity remains much lower than global average of 5.8 MT/ha. An overview of yields across top 10 maize producing countries is depicted in exhibit 11.

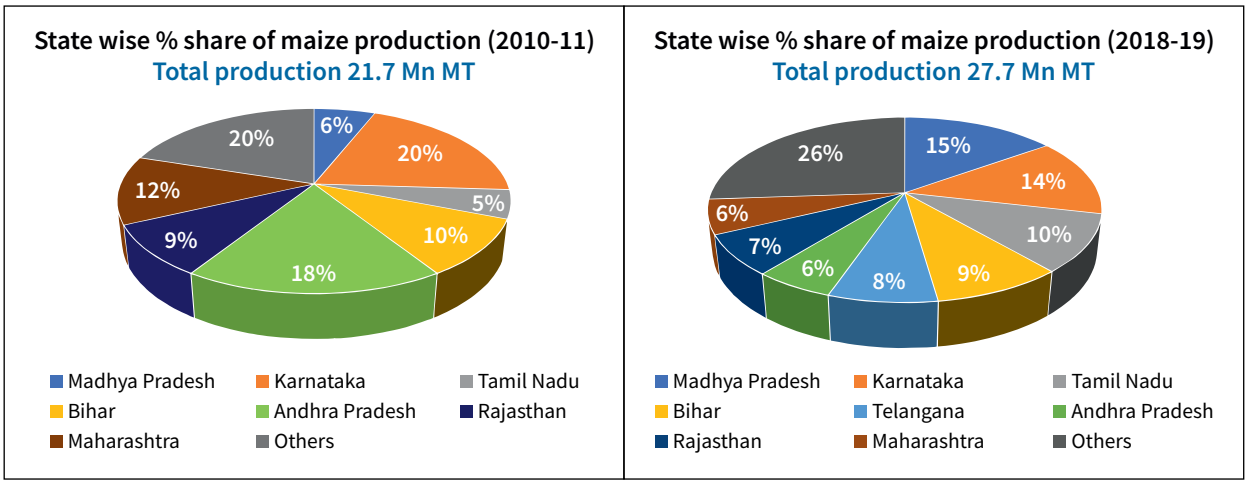
Exhibit 11: Productivity of top maize producing countries (2019)



Source: FAOSTAT, YES Bank Analysis

Maize is cultivated throughout the year in all states of the country. In terms of regional distribution, top 5 states contributed close to 55% of India's total maize production in 2018-19, with Madhya Pradesh (15%), Karnataka (14%), Tamil Nadu (10%), Bihar (9%) and Telangana (8%) topping the list (refer exhibit 12). Over the period 2010-11 to 2018-19, Madhya Pradesh contributed the most to growth in production, growing at a CAGR of 15%, followed by Tamil Nadu (14%), and Bihar (2%).

Exhibit 12: State wise trends in maize production (2010-11 to 2018-19)



*Source: Ministry of Agriculture and Farmers' Welfare, GoI, YES Bank Analysis, *AP and Telangana data combined for Year 2010-11*

Kharif remains the main season for cultivation of this crop, contributing to more than 80% of acreage and about 70% production[8]. However, in past few decades, rabi maize has gained a significant prominence in total maize production in India (Exhibit 13 captures the crop calendar for maize across states in India).

Exhibit 13: Crop calendar of Maize

States		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
AP	Sowing												
	Harvesting												
Bihar	Sowing												
	Harvesting												
Gujarat	Sowing												
	Harvesting												
Haryana	Sowing												
	Harvesting												
Himachal	Sowing												
	Harvesting												
Karnataka	Sowing												
	Harvesting												
MP	Sowing												
	Harvesting												
Maharash-tra	Sowing												
	Harvesting												
Odisha	Sowing												
	Harvesting												
Punjab	Sowing												
	Harvesting												
Rajasthan	Sowing												
	Harvesting												
UP	Sowing												
	Harvesting												
WB	Sowing												
	Harvesting												

Sowing of kharif maize | Sowing of rabi maize | Harvesting of kharif maize | Harvesting of rabi maize

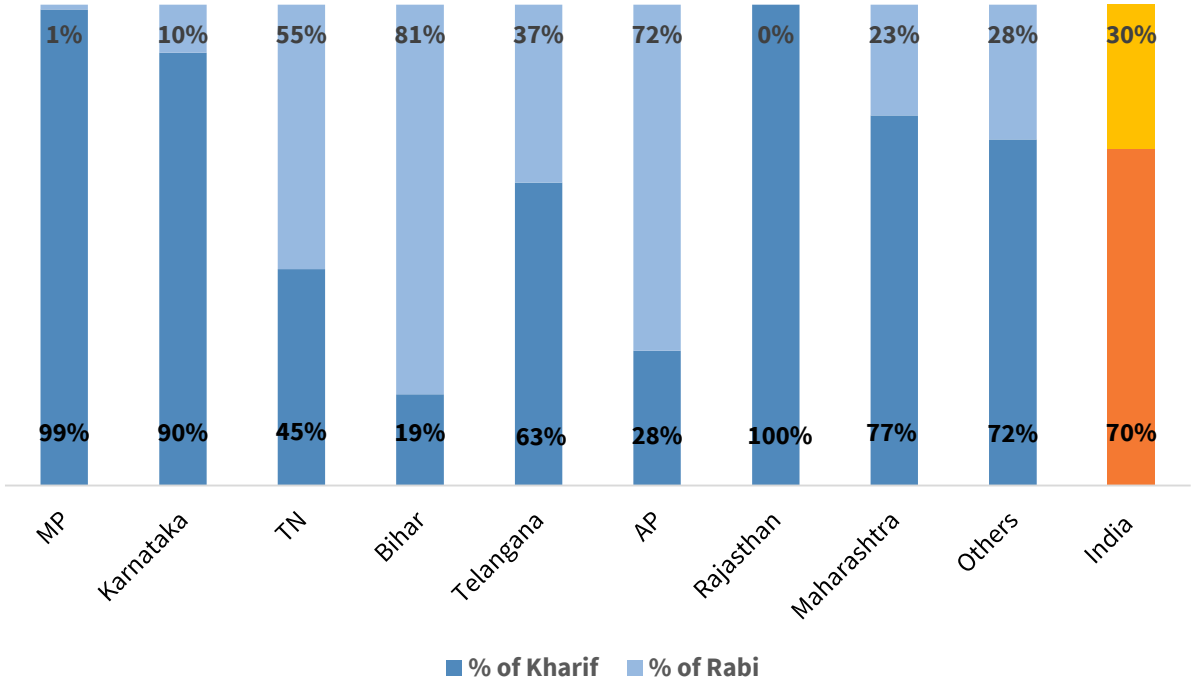
Source: ICAR, Crop Science Division

Kharif maize faces higher biotic and abiotic stress in comparison to rabi. Since 2018, fall army worm attack has increased significantly in India, especially during the kharif, causing significant crop loss. Such biotic factors and abiotic stresses caused by vagaries of monsoon adversely impact kharif maize, resulting in kharif productivity hovering around 2.7 MT/ ha as compared to 4.4 MT/ ha during rabi.

Maize cultivation is primarily taken up in kharif in most states in India – including Madhya Pradesh, Rajasthan, Karnataka and Maharashtra among others, while the states of Bihar, Andhra Pradesh, Tamil Nadu and Telangana contribute significantly to rabi production. Together, these four states contribute to about 65% of the rabi maize production in India. Individually, more than 80% of Bihar's and over 72% of Andhra Pradesh's maize production is in the rabi season (refer exhibit 14).

[8] *https://iimr.icar.gov.in/wp-content/uploads/2020/03/Maize-production-system-book.pdf*

Exhibit 14: State wise % share of kharif Vs rabi crop production in India



Source: Ministry of Agriculture and Farmers' Welfare, GoI, YES Bank Analysis

Post-harvest handling and Supply Chain scenario

The marketed surplus of maize produced in India is estimated to be close to 90%[9]. However, marketed surplus varies depending on the region and usage. In non-traditional areas, where maize is produced primarily as a commercial crop, the marketed surplus estimated to be about 95% while the same for certain regions in Rajasthan where the crop is grown mainly for food consumption is below 50%[10].

Important post-harvest operations for maize include drying, threshing, winnowing, grain storage, transportation and milling. Despite technological advances, large proportion of farmers follow traditional post-harvest practices, such as sun drying instead of using solar driers, manual and animal based threshing instead of mechanized threshing and traditional farm level storage instead of proper storage. In addition, there is significant intermediation between farmer and maize grain purchaser (processors and global traders), many farmers sell their produce to village level aggregators, who further sell them to Commission Agents in mandis. The produce is then supplied either directly or through traders to processors.

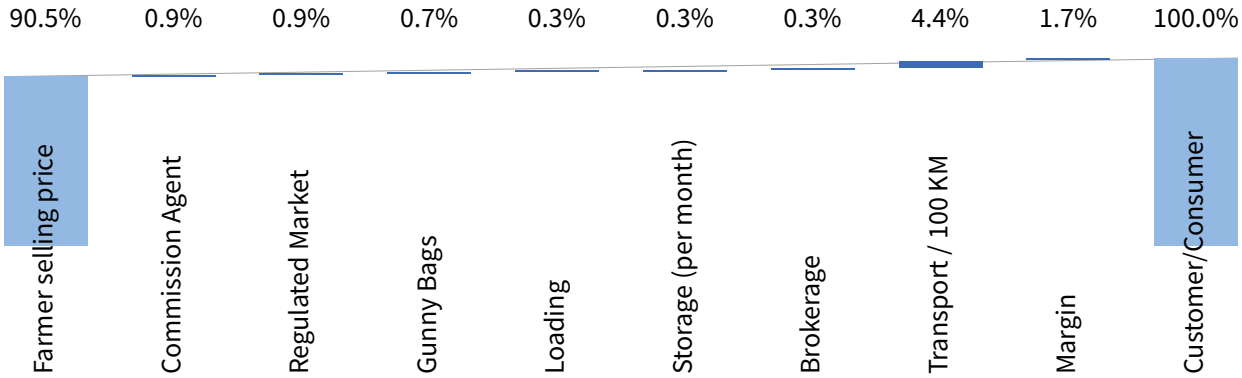
While a number of initiative have been taken up by the government as well as private sector to improve farmer's access to markets – such as launch of e-NAM platform for electronic trading, e-commerce platforms for direct procurement and e-marketing platforms – the reach of these initiatives is thinly spread – resulting in low impact. However, going forward, these initiatives, in conjuncture with financial initiatives such as warehouse receipt financing are expected to significantly improve farmer's access to markets and therefore farmer income.

Exhibit 15 depicts the share of various activities and stakeholders in the consumer rupee across the commercial maize supply chain (for industrial use). While the farmer price realization is estimated to be about 91 % of the customer price, the cost of transportation is estimated to be the highest at 4.4% (for 100 KM distance). Cost of storage could also increase with the specific need to store the produce for 4-6 months.

[9]*Source: Assessment of Marketed and Marketable Surplus of Major Foodgrains in India, 2017, Vijay Paul Sharma & Harsh Wardhan, IIM (A)*

[10]*Source: Industry sources*

Exhibit 15: Intermediation, cost and price markup across the maize value chain (industrial use, share in consumer rupee)

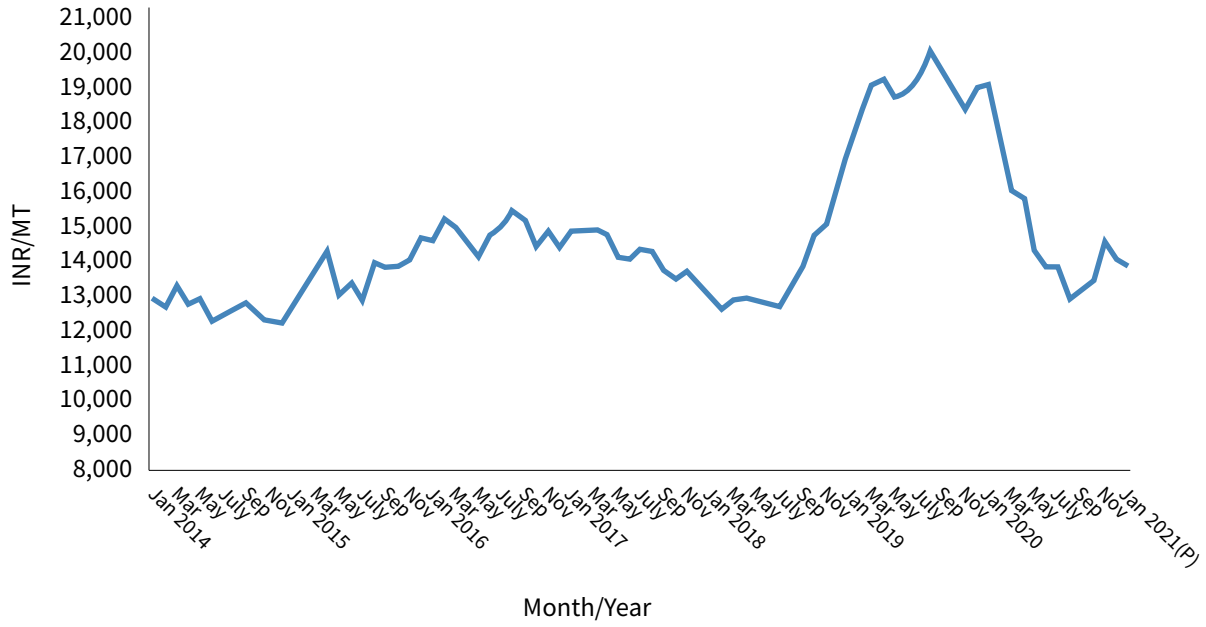


Source: https://naarm.org.in/wp-content/uploads/2016/07/Assessment-of-the-Maize-Situation-outlook-and-investment-opportunities-in-India.pdf (figures are updated based on current MSP of Maize)

Maize Commodity price trends

An overview of the maize commodity prices in India since 2014 is depicted in exhibit 16 below. There has been a wide variation in market prices, ranging from about INR 12000/MT to INR 20,000/MT. From its peak of INR 20,000/MT in September 2019, maize prices have dropped to about INR 13,000/MT in the mid of 2020. Since then, there has been a gradual, yet tentative recovery in price.

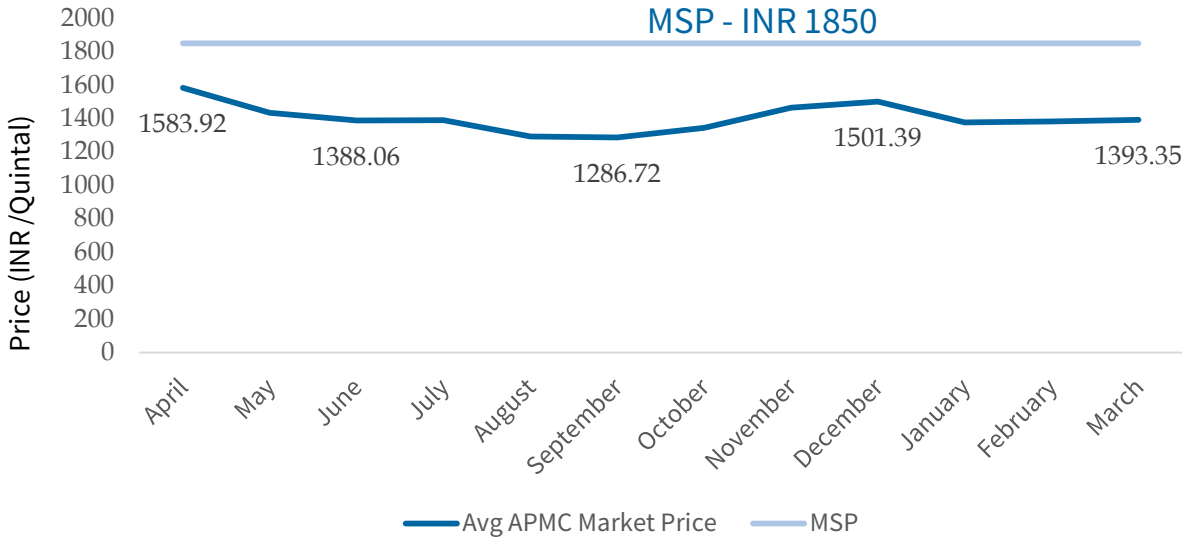
Exhibit 16: India National Average Maize price



Source: Ministry of Agriculture and Farmers' Welfare, Agricultural Marketing Information Network

The market price of maize is highly influenced by the MSP fixed by the government. While for the most part, market price tends to be in line with MSP, at times it could be lower than the MSP. For instance, in the year 2020-21, the average market price tended to be below the government's MSP (refer exhibit 17).

Exhibit 17: Comparative assessment of MSP vs APMC Market Price of Maize – (2020-2021)

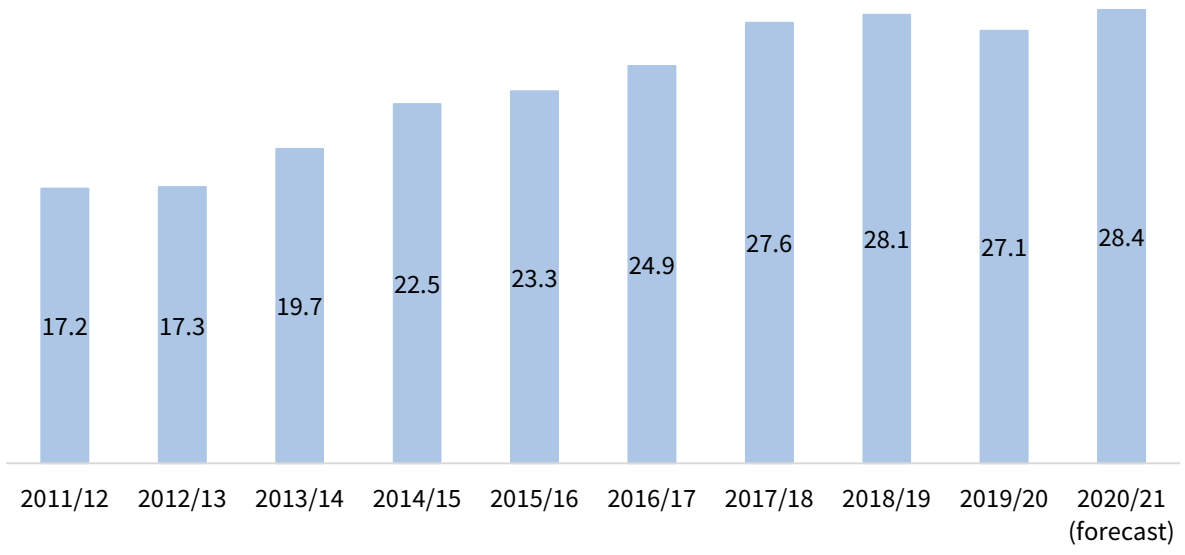


Source: Agmarknet

3.2 Demand & Consumption Trends

International Grain Council (IGC) report reveals that about 27.1 million MT of maize was consumed in India in the year 2019/20. This is forecasted to reach 28.4 million MT in the year 2020-21. Over the last two decades, India's growing economy and expanding middle income consumers have been fueling demand for meat / animal protein (poultry and livestock sector) and clothing (starch sector). This, in turn, has been driving demand for maize crop in India. Exhibit 18 depicts the trend of maize consumption in India.

Exhibit 18: Decadal representation of maize consumption in India- All figures in Mn MT

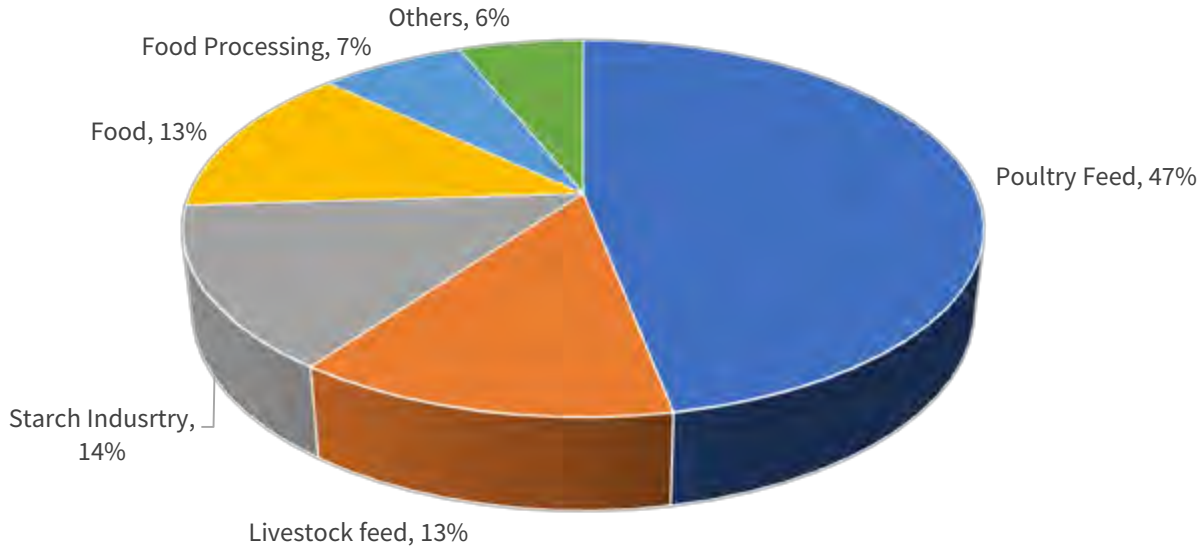


Source: International Grain Council, USDA

In the period between 2011-12 and 2020-21, maize consumption grew at a CAGR of 5.6%, which was much higher than the growth rate of domestic production. Maize off-take by the feed industry grew at the fastest pace at a CAGR of 8.8% followed by industrial segment (primarily starch), which grew at a CAGR of 6.2%. Off-take for food grew at a CAGR of 0.8%.

Exhibit 19 depicts the total maize consumption in India. Bulk of the maize production in India, approximately 47%, is used as poultry feed. Of the rest, 14% is used in starch industry, 13% is used as livestock feed, 13% for food purpose, 7% as processed food and 6% for export and other purposes.

Exhibit 19: End use wise contribution to maize consumption in India (2018-19)



Source: Indian Institute of Maize research



An overview of the key trends in each of these sectors and their impact on maize demand is captured herewith

Sector	Key characteristics and trends	Impact on maize demand
Feed Industry 	• Maize is used extensively as the main source of calories in animal feed formulations as it leads to the highest conversion of dry substance to meat, milk and eggs vis-à-vis other cereal grains. • With its low protein and crude fiber content, it is ideal for poultry. • In the poultry feed industry maize constitutes about 60% of the feed and therefore is a critical raw material. • With projected growth rate of 8% in feed sector, particularly in poultry, demand for maize is expected to grow exponentially. • Growing Indian economy and expanding middle income consumers is driving demand for meat/animal protein derived from the poultry and livestock sector. • India has grown to be the 5th largest egg producer globally and 18th largest producer of broiler chicken.	
Starch 	• Maize has about 60-65% per cent starch content, which makes it suitable raw material for starch processing. • Maize starch and its derivatives have wide utility across food, paper, pharmaceutical, textile industry, cosmetics, adhesives, bio-plastic. • High value derivatives include corn glucose, Corn Oil, Dextrose and Sorbitol • In the food sector, maize starch and derivatives are used as sweetener, flavor & colour enhancer, thickening agent and stabilize, inducer of crispiness, bulkiness/carriers, anti-crystallization, texture, humectant, dusting, and extrusion etc. in baby food, bakery, beverages, confectionery, dry soups, in a variety of products, such as custard, desserts, sauces etc. • The per-capita starch consumption in India is estimated to about 1.5 kg / annum, compared to 64 kg in US and 6 kg globally. • The starch industry in India has a crushing capacity of approximately 6.5 million MT. India is expected to reach a volume of 8.5 million MT by 2026, with a CAGR of 9% (2021-2026).	

Sector	Key characteristics and trends	Impact on maize demand
Processed Food 	• Due to product innovation and consumer health consciousness, the focus is shifting towards snacks that are mostly baked or roasted. Ingredient, such as corn, is used for these processed snacks and savories. These snacks are comparatively low in bulk density and are popularized as high-fiber and comparatively low-calorie healthy snacks. • Demand food grade corn for processed food is estimated to be growing in double digits due to its use for cornflakes (as breakfast cereal and RTE savouries), extruded snacks, traditional namkeen), popcorn, frozen sweetcorn etc. • Frozen sweet corn and baby corn, which are the niche varieties of corn, are the other two categories that are showing double digit growth owing to their health benefits and exotic nature.	
Food 	• White maize is traditionally used for preparation of maize flour. • In traditional areas such as Rajasthan, maize is primarily grown for preparation of maize flour – which in turn is used for preparation of traditional food such as "makki roti". • Availability of rice and wheat through the public distribution system at low prices is resulting in higher consumption of these cereals in place of maize. However, maize continues to hold a prominent position in the kitchens of traditional maize growing areas. • Growing demand for coarse grain fortified or multigrain flour is expected to drive demand in urban areas.	
Ethanol 	• The Indian ethanol market is projected to grow from USD 2.50 billion in 2018 to USD 7.38 billion by 2024, exhibiting a CAGR of 14.50% during 2019-2024, on the back of increasing ethanol use in applications such as fuel additives and alcoholic beverages • Due to Fuel Blending Program (BFP), that ethanol production may increase by three to five folds in the coming future. The government has set targets of 10% bio-ethanol blending of petrol by 2022 which is further targeted to reach 20% by 2025. • 0.8 million MT of corn is currently used to make whisky grade alcohol. India is also exporting grain based alcohol (which includes rice too) • India's domestic ethanol program uses molasses (a sugar industry byproduct) as feedstock. • In year 2020, GoI allowed use of grain such as rice and corn for producing ethanol for fuel. Recently, government has announced extension of subsidized credit to grain based distilleries as well to boost ethanol production for bio-fuel.	

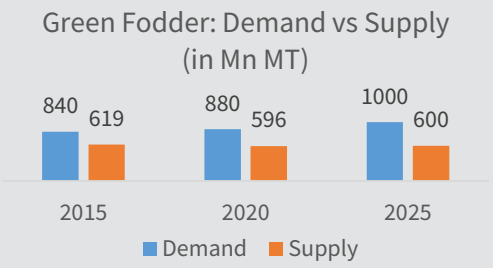
Sector	Key characteristics and trends	Impact on maize demand
Fodder and Silage	• Dry stalks and shanks of maize can be used as fodder and feed. These can also be used in the preparation of silage for lean season. • The quality of maize fodder is considered better than that of sorghum and pearl millet, as the latter crops possess anti-quality components such as HCN and oxalate, respectively. • Silage maize (crop duration of 80 days) is being considered a good option for addressing fodder shortage. Current market size for silage maize is estimated to be about 5 million MT (approximately 1 million ha of area under fodder cultivation) (refer exhibit 20 – a case study on maize for silage). • With dairy sector growing at about 4 to 5%, and the increasing shortage faced for fodder, demand for silage maize is expected to grow.	

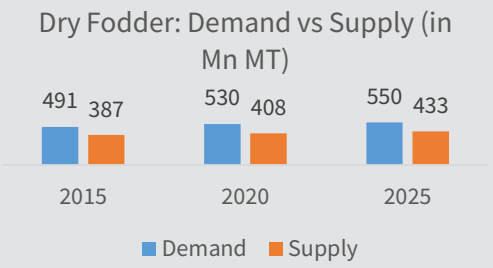
Exhibit 20: Case Study – A case for maize silage development in India

As per 20th livestock census, livestock population in India reached to 535.78 million which is 4.6 per cent increment from 2012 census. As per Indian Institute of Maize research data, India is facing deficit of 32 per cent in green fodder and 23 per cent in dry fodder in 2020. The deficit will further increase to 40 and 21 per cent for green and dry fodder respectively by 2025[11].

Supply and Demand scenario of Dry and green fodder in India

Maize silage is a digestible and edible forage with consistent quality, higher yields and more energy content as compared to other forage. It also has higher shelf life of two years. Whole-plant maize silage is a choice ingredient used universally in dairy cattle rations. It is preferred, not only because of its intrinsic high-energy value (up to 50 percent more energy compared to dried maize kernels) and good supply of fiber, but also because higher yield realization when the whole plant is harvested. Government should work in collaboration with seed companies to provide high quality silage suitable seeds to farmers and incentivize farmers to undertake mechanized silage preparation. Punjab government has launched a new scheme to provide 40% subsidy to the farmers on the Silage Baler-cum-Wrapper machines through the Punjab Dairy Development Board to promote the dairy farming sector in the state.





Source: International Grain Council, USDA

Source: IIMR, Industry interactions, YES Bank Analysis

[11]*Vision 2050 National Institute of Animal Nutrition and Physiology (http://nianp.res.in/static/docs/Nianp_vision_2050.pdf)*

Exhibit 21: Usage and Application of Maize in Food Processing Industry

Maize is processed either by using Dry milling or Wet milling. Both these procedures accomplish separation of the germ from which corn oil is obtained and removal of the hull that constitutes most of the high fiber portion.

Dry milling is a process for producing high purity starch from maize, which eliminates the long steeping times required for wet milling. The dry-milled products find use in many applications, such as in cereals, snack foods, pancake mixes, cookies, biscuits and in the brewing industry.

Major industrial products include:

Product	Application
Corn Starch	Thickener, binder, filler, stabilizer, Sweetener
Modified Corn starch	Instant meal, cosmetic, confectionery, Beverages, ceramic & construction, paper glues, weaving & textile etc.
Corn Flour	Bakery dusting, Bread and batters, Beverage, Confectionery, baby foods, Snack
Corn gluten meal	Cattle feed, Fish meal
Corn grits, puffs, flakes	Breakfast cereals

Promoting Dry/ wet milling of maize will increase India's export of corn starch and corn flour to South Asian, South East Asian and Middle East Countries. It will also reduce import of Poly Lactic Acid as it provides alternative to plastic.

PMFME Scheme for promoting setting up of maize based small scale industries

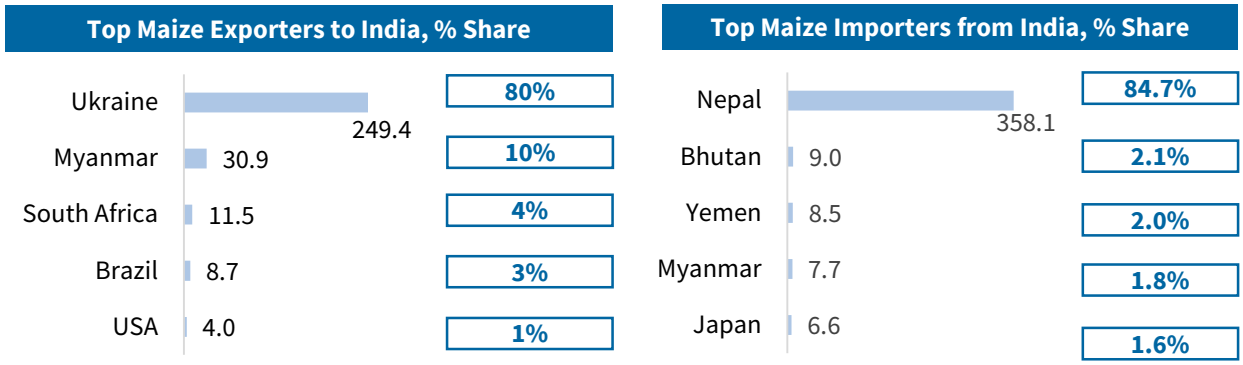
- Pradhan Mantri Formalization of Micro Enterprise Scheme (PMFME) is launched in FY 2021 with an overall outlay of INR 10,000 Cr, scheme plans to formalize 2 lakh micro food processing units in next 5 years and will support FPOs, SHGs and Producers Cooperatives along their entire value chain
- Under this scheme One District One Product (ODOP) structure has been adopted to identify one product for the district and to promote it in terms of inputs procurement, availing common service and marketing of products, processing etc.
- **For following five districts, maize has been identified as ODOP for promoting maize based SMEs:**

  Panchmalal, Gujarat; Chhota Udaipur, Gujarat, Bhilwara, Rajasthan; Giridih, Jharkhand; Aurangabad, Maharashtra

3.3 International Trade

India imported about 310 thousand MT of maize in the year 2019 worth USD 75 million. Ukraine was the major exporting nations to India in the year 2019. Also, India exported ~423 thousand MT of maize during the same period worth ~USD 146 Mn. Top countries who imported maize from India were Nepal, Bhutan, Yemen, Myanmar and Japan. Exhibit 22 highlights the top 5 maize exporters to India and top 5 importers from India.

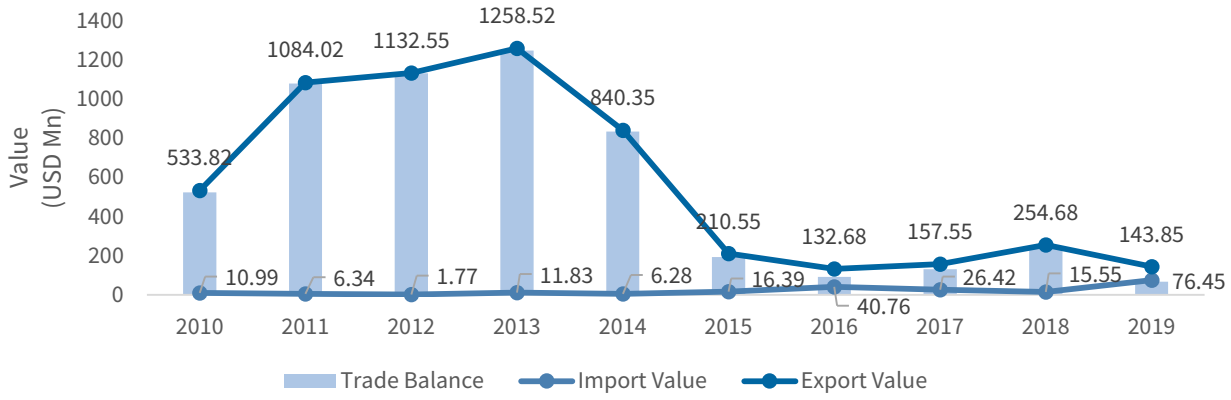
Exhibit 22: Top 5 Maize trade partners for India- Quantities in '000 MT, Year 2019



Source: ITC Trade Map (for HS Code 1005)

Maize used to contribute significantly to India's agri-export basket in the past. In the year 2011, Indian maize exports crossed the USD 1 billion mark and touched a peak of USD 1.26 billion in 2014 (refer exhibit 23). However, strong domestic demand, and the fact that MSP was higher than global prices, has resulted in drastic reduction in exports.

Exhibit 23: Maize – Import and export trends



Source: ITC Trade Map (for HS Code 1005)

From an imports perspective, the source of origin of maize imported into India is restricted- so as to prevent entry of genetically modified produce. FSSAI issued a notification in August 2020 to ensure only non GM food crops are imported in India accompanied with Non-GM origin cum GM free certificate. Moreover, maize imports attract an import duty of 15% under Tariff Rate Quota (TRQ) and 50% duty out of the TRQ. However, given that consumption is growing faster than production in the country, and the fact that there are long periods of non-availability during a year due to seasonality, the Government provides for Import quota for select industries (such as poultry) on an adhoc basis. During such periods of shortage, certain industries, such as the starch industry, suffer significant shortage of raw material. Starch industry import corn under advance license system (industry can import without any duty but have to necessarily export about 1.8 times the value of imports post value addition).

3.4 Government Initiatives & Policies

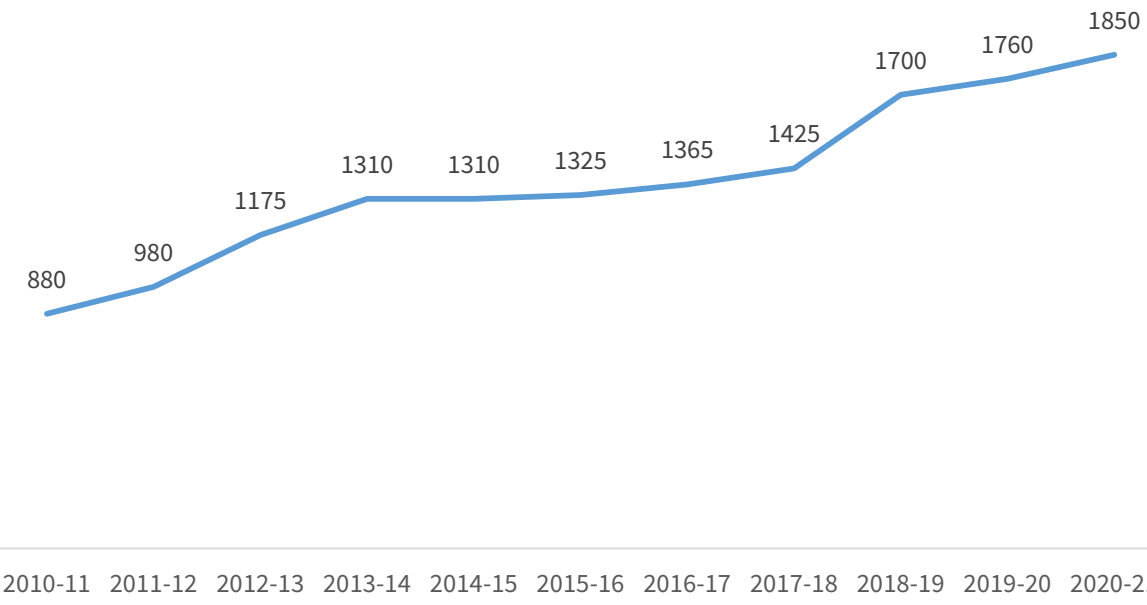
With a strong focus on doubling farmers' income while conserving natural resources by promoting sustainable agriculture, Government of India has rolled out several policy initiatives, schemes and programmes that benefit

the entire agrultural ecosystem. Maize stakeholder discussions suggest that six initiatives stand out in terms of impact on Maze supply and demand. These include 1) Minimum Support Price 2) Maize as an alternative crop for diversification and 3) Promoting formation of FPOs 4) The three Farm Acts 5) e-NAM & e-Kisan Mandis and 6) Promoting Agri-Startups

Minimum Support Price for maize

The Government of India provides for a Minimum Support Price for maize cultivators so as to protect farmer income and promote cultivation of maize. Over the last decade, the minimum support price for maize has been increased from INR 880/ Quintal(in 2010-11) to INR 1,850/ Quintal(in 2020-21) at a CAGR of 7.7% (refer exhibit 24).

Exhibit 24: Decadal trends in Minimum Support Price provided for maize (INR/Quintal)

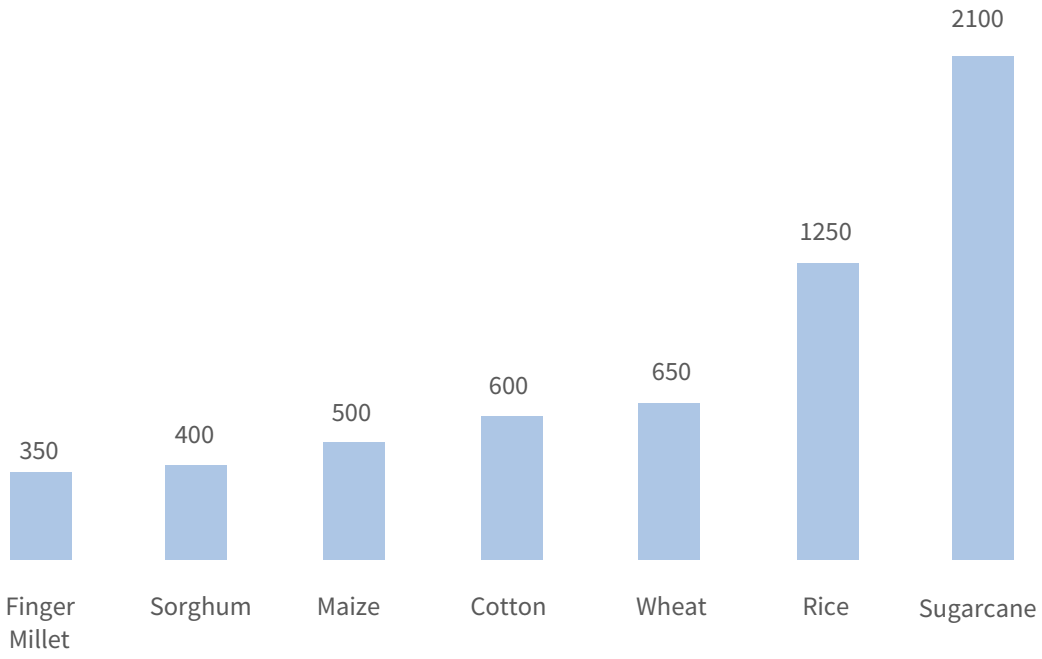


Source: Farmer's portal, CACP, Ministry of Agriculture & Farmer's Welfare

Promotion of maize as alternative for crop diversification

With food grain production at a record high and the concerns of soil and water resource degradation looming large, policy makers are looking at sustainable options for increasing farmer income on one hand while balancing surplus management of rice and wheat on the other. Maize is considered a promising option for diversifying Indian agriculture, especially in rice dominated states such as Punjab and Haryana, given its low water requirement (refer exhibit 25), growing demand in the domestic and international market as well as amenability to adapt to various agro-climatic conditions. For example, Govt. of Haryana launched "Mera Paani, Meri Virasat Yojana" in the year 2020 to incentivize farmers for crop diversification. Under this scheme government provides financial assistance of upto INR 7000/- per acre to promote maize in place of paddy aimed at conservation of water. Farmers who produce alternative crops to paddy were offered a 80% subsidy on Micro & Drip irrigation system.

Exhibit 25: Relative water requirement of various crops (in mm of rainfall)



Source: IIMR, ICAR

However, certain critical factors that are being closely reviewed as Government rolls out maize as a crop diversification alternative include- the crop's high waterlogging susceptibility, specially during the early stages of growth – making it unsuitable for black soils or regions with high water table and its comparatively high cost of cultivation vis-à-vis bajra, sorghum, rice and wheat.

To address these challenges, the Government as well as the private sector are focusing intensively on introduction of hybrid varieties that have high yield potential and are tolerant to waterlogging and other biotic and abiotic stresses - such that the cost of production comes down and net farmer revenue increase.

Promoting collectivisation and the formation of FPO

With a view to reduce cost of production, improve market linkages and increase farmer income, Government of India has been focusing on building farmer collectives such as FPOs and farmer cooperatives. While initiatives to promote formation of FPOs have been in progress since a decade, a dedicated Central Government scheme namely "Formation and Promotion of 10,000 FPOs" for implementation across the country. The scheme provides for a cluster based approach to FPO formation and has instituted "Clister Based Business Organisations" to handhold and professionally run these FPOs for a period of five years from the time of creation. TO bring in crop focus, specialized FPO produce clusters are being allocated for formation of FPOs.

Industry discussions reveal that development of maize clusters for specific Industries (such as for feed & starch) and development of maize FPOs could significantly catalyze the process of crop planning, extension, quality control and traceability for maize, facilitating strategic direction for contract farming and large-scale integration of small farms in supply chains for generating optimal value both for the farmers and the industry.

The Three Farm Acts

For decades now, Government of India has been trying to implement reforms in the agricultural sector to boost farmer incomes and address agrarian distress. Two key focus areas have been - deregulating the sector and

solving agricultural marketing constraints so as to improve farmers' access to markets. National Commission on Farmers (NCF) was constituted in year 2004, under chairmanship of Professor M.S. Swaminathan to address the nationwide farm distress in India. NCF submitted its report in 2006 and made recommendations including reforms in land holdings, irrigation infrastructure, farm productivity, credit & insurance availability, employment generation etc. Keeping in view farm produce related NCF recommendations, Central Government brought out what have come to be known as "The Three Farm Acts". In the process of preparation of this report, consultation was held with various industry players relevant to the maze value chain. Exhibit 26 depicts the three Acts, their main objective and industry perception on their impact on maize ecosystem.

Exhibit 26: The Three Farm Acts & Industry perception on their impact on maize eco-system

Product	Application	Perception of Impact
Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020	Allows intra-state and inter-state trade of farm produce outside physical premises of APMC markets, where state governments are not allowed to levy any market fee, cess	• Positive • Industry can explore direct purchase from farmer hence reducing multiple intermediation and handling costs • Savings on mandi related fees and taxes can be used for farmer extension as well as better farm prices.
Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Act, 2020	Provides a framework for farmers to engage in contract farming with companies	• Positive • Industry can engage in direct buying arrangements with farmers including conducting extension activities, implementing GAP, assuring sourcing of quality produce as relevant to industry
The Essential Commodities Amendment Act, 2020	Allows the central government to regulate supply of certain food items only under extraordinary circumstances, taking away restrictions on stocking	• Currently not relevant to maize ecosystem

Source: GoI released literature review, Industry

e-NAM & e-Kisan Mandis

Digitisation of the agri-value chain has been a key focus are for the central government. One of the key initiatives that could have a significant impact on farmers' price discovery and markets is the e-NAM initiative – an electronic trading portal which intends to integrate all APMCs across the country through a common online marketing platform – so as to facilitate a transparent online auction process. Industry discussions reveal that this initiative, along with the promotion of e-kisan mandis, could transform the way maize is traded in India, if implemented widely and efficiently.

Promotion of agritech startups

Agritech start-ups are playing a key role in addressing deep rooted challenges across the agri-value chain by identifying and introducing innovative technologies, business models and digital solutions such as artificial intelligence, internet of things, Big Data analytics. These solutions are transforming the way agricultural produce is cultivated, sourced, traded, marketed and consumed.

Through the "Start-Up India" initiative, Government of India has put in significant effort to facilitate Agri-Tech startups grow. In addition to a detailed action plan that addresses provides for an enabling eco-system for star-ups (such as setting up incubators, building innovation centres, funding support through Fund of Funds and Credit Guarantee Funds, Tax exemptions, self-certification for compliance, creating a start-up India hub for sharing of knowledge and access to funds and calling for grand challenges). In agriculture space, for instance, DPIIT in collaboration with Ministry of Agriculture has launched an Agriculture Grand Challenge inviting solutions on 12 problem statements. Winners of the challenge have received mentorship, free of cost incubation for a period of 3 months, opportunities to conduct pilot programs and funding support in the form of grants. In May 2019, NABARD announced an investment of INR 700 crore (USD 100 million) venture capital fund for equity investment in agriculture and rural-focused start-ups. This strong focus on promoting agri-tech start-ups is expected to build efficiencies across the maize value chain.

Other select initiatives

In addition, the Government has introduced a number of schemes for the agricultural sector that have significant impact on the production, distribution and off-take of maize. Exhibit 27 depicts some of these interventions.

Exhibit 27: Illustrative list of Government Initiatives impacting the maize ecosystem

Focused efforts on improving farm Productivity & Farmer Income

- ICAR R&D – introduction of high yielding & stress tolerant varieties.
- Pradhan Mantri Krishi Sinchai Yojana for development of irrigation sources in drought prone areas. & Micro Irrigation Fund Scheme.
- National Mission for Sustainable Agriculture (NMSA) – for improving agricultural productivity in rainfed areas
- Soil Health Card and Fertilizer subsidy
- PM-Kusum: to install the Renewable energy capacity, to power the agriculture pumps.
- Pradhan Mantri Fasal Bima Yojana (PMFBY) for crop insurance & KCC for access to credit
- Pradhan Mantri Fasal Bima Yojana (PMFBY): Putting up a common data infrastructure for farmers in the country.

Building post harvest Infrastructure

- Gramin Bhandaran Yojna for creating adequate post harvest storage facilities
- e-NAM & e-Kisan Mandies for farmer price discovery and access to market
- Atmanirbhar Bharat package for common infrastructure through the Agri Infrastructure Fund
- Promoting Maize dryers at APMCs for improving quality
- MOFPI's Formulation of Micro Enterprises scheme – supports FPOs for development of infrastructure and primary processing

Promoting Investments in Processing Infrastructure

- MOFPI's Pradhan Mantri Kisan SAMPADA Yojana
- Animal Husbandry Infrastructure Development Fund (AHIDF) incentives investment in animal feed processing facilities
- Pradhan Mantri Matsya Sampada Yojana incentivizes investment in fish feed processing units

Source: GoI websites, Industry, YES Bank Analysis



04

GROWTH DRIVERS AND CHALLENGES

The review of current scenario as captured in the previous chapter indicates that there are six key factors that are driving growth of the maize ecosystem.

4.1 Factors driving growth of maize ecosystem

1. Intrinsic characteristicss of Maize

- Adaptable to varied agroclimatic conditions
- Generates better farmer income than other coarse grains
- Lesser water requirement than rice and wheat – hence good for crop diversification
- Amenable to genetic and molecular engineering to suit human needs
- Diverse end-use of commodity (feed, starch, food processing, bio-fuel etc)

2. Production and supply strengths

- Availability of diverse agro-climatic conditions to grow diverse varieties
- Productivity improvement on account of introduction and better adoption of high yielding varieties
- Better farmer access to factors of production (credit, quality plant protection chemicals etc)

3. Evolving post -harvest supply chain

- More efficient aggregation due to formation of cooperatives and FPOs
- Increasing investment in bulk storage and trading infrastructure (including e-trading and e-marketing platforms)

4. Increasing consumption

- Population growth resulting in higher food consumption
- Dietary shifts demanding high animal protein
- Increased demand for starch and it's derivatives for food processing, textiles, paper industry etc.
- Health consciousness demanding healthy snacks and breakfast cereals
- Energy security demanding use for biofuel production

5. Favourable policy environment

- Numerous schemes for doubling farmer income
- Promotion of maize as an alterative for crop diversification
- Three Farm Acts
- Make in India focus promoting investment

6. Growing private sector participation across the supply chain

- Farm inputs
- Contract farming
- Storage and logistics infrastructure
- E-markets and e-commerce platforms
- Growing Agritech Start-ups ecosystem to address specific challenges
- Growing investment in feed, starch and food processing

4.2 Key challenges across the supply chain

With domestic demand for maize growing faster than production and the fact that maize provides the right avenue for crop diversification and increasing farmer income, there is an imminent need to identify and address key barriers hindering growth of the Indian maize ecosystem. Multiple challenges across the value chain are impacting farm prices on one hand, while constraining the availability of good quality produce to the consumer at reasonable price on the other. Exhibit 28 provides a snapshot of challenges across the value chain.

Exhibit 28: Snapshot of Challenges across maize value chain in India

Level	Key Challenges	Description and Details
Farm level	• Low productivity • Relative unattractiveness constraining wider crop adoption • Skewed production due to seasonality	• Yield is at 3.1MT/ha compared to global average of 5.8MT/ha. 70% rainfed. • Just 60% usage of hybrid seeds compared to 100% in USA, Brazil and upto 86% in Bangladesh, SCH yet to be adopted in large scale • Poor pest management (weeds, Fall Army Worm). No seed treatment • Low mechanization (for sowing & harvest just about 5-7%) • Cost of Cultivation higher than Sorghum, Bajra & even Rice & Wheat • Limited area under production in rabi
Post-harvest handling / Marketing	• Low farmer price realization due to poor quality management • Inefficient access to markets due to fragmentation	• Quality loss due to unscientific harvesting, shelling, drying and farm level storage techniques • High moisture content at the time of sale • High intermediation as land holdings are fragmented and produce quantity per farmer is low making it uneconomical to transport to market • Inefficient price discovery as produced sold at village level
Storage & Transport	• Multiple handling points and high cost of logistics due to poor bulk storage and logistics infrastructure	• Poor storage conditions result in rodent & pest attack and aflatoxin build-up • Lack of bulk storage and transportation infrastructure leading to multiple handling and high cost of transport
Processing	• Challenge of right quality & quantity at right time and price	• Varietal quality mismatch. Low starch content, high moisture content and low grain weight • High cost of raw material due to involvement of large number of intermediaries • Fluctuating prices, seasonal availability and import restrictions • End products not competitive in international market
International Trade	• Uncompetitive price of Indian maize at global level • Import restrictions	• Higher price due to strong domestic demand and rising MSPs resulted in slowing down of exports due to uncompetitive price • Quality not at par with international standards • High import duty and lack of quota allocation to certain industries at the time of shortage. Source of origin issues.

FARM LEVEL CHALLENGES

Low farm productivity

Though maize yields have increased significantly over the last decade, average productivity of maize in India is around 3 MT/ha whereas it is around 10 MT/ha in USA, Canada and France and around 6 MT/ha in China. While productivity is better for rabi crop (at 4.4 MT/ha), that of kharif crop, especially for maize used for food consumption, is low. Key barriers to increasing productivity include:

1. Low adoption of hybrid seeds, especially single cross hybrids

- While area under hybrid seeds has increased over years, just about 30% of the area is under Single Cross hybrid whereas it is 100% in case of USA and Argentina.

  Madhya Pradesh, Rajasthan, Chattisgarh, Gujarat, where maize is primarily grown for food consumption, use composite seeds resulting in low productivity. Productivity in Madhya Pradesh and Uttar Pradesh is average 2.5 MT/ha and 1.9 MT/ha respectively between 2014-2018 compared to that of 6.6 MT/ha for Tamil Nadu. Moreover, the focus on developing HYV and providing extension services for maize grown for food purposes in traditional geographies is low.

Exhibit 29: Maize acreage under Hybrid Seeds

States	Area (Mn Ha)	Hybridization %
Andhra Pradesh	0.178	95%
Bihar	0.825	95%
Punjab	0.16	95%
Karnataka	1.291	89%
Chhattisgarh	0.252	85%
Uttar Pradesh	0.754	84%
West Bengal	0.114	79%
Tamil Nadu	0.287	65%
Jammu & Kashmir + Ladakh	0.197	63%
Telangana	0.47	63%
Maharashtra	0.961	55%
Odisha	0.233	54%
Assam	0.047	53%
Himachal Pradesh	0.29	52%
Rajasthan	0.884	42%
Haryana	0.049	41%
Gujarat	0.383	39%
Madhya Pradesh	1.542	39%
Jharkhand	0.254	30%
Arunachal Pradesh	0.044	11%
Uttarakhand	0.025	<1%
India Total	**~9.0**	**~60%**

Source: Industry ballpark estimates (Year 2020)

2. **High dependency on rainfed cultivation.**

- About 70% of maize crop is sown in kharif and is prone to vagaries of monsoon that impact productivity. Technological advances, such as drought tolerant varieties and modern irrigation techniques are yet to be popularized and adopted on large scale to significantly mitigate crop loss. Just about 26.7% of Indian maize acreage is irrigated compared to 60.4% for total cereals and 52.6% for total food grains[18].

3. **Inadequate plant health care and pest management**

- Kharif crop being tropical, is succeptible to infestation by weeds and insect pests. Of late, infestation of Fall Army Worm has caused havoc in maize growing belts across the country. Poor pest management practices, including lack of seed treatment is resulting in high loss due to pest attack.

4. **Access to credit:**

- Availability of timely, adequate and cost-effective credit to farmers is one of the most critical factors of production in maize. While the government has taken up a number of initiatives to improve access to credit to farmers, inability of small farmers to access credit to spend on good quality seeds, fertilizers, pesticides and fungicides etc. affect yield as well as quality of maize produced in the country.

5. **Low mechanization:**

- Currently, India's level of mechanization is at 40% compared to 90% across the developed nations. Adoption of mechanization varies widely across states, with higher usage of combined harvester and planters in Bihar, Gujarat and Tamil Nadu compared to states such as Madhya Pradesh, Chhattisgarh and Odisha depending largely on manual labor for these activities.

Relatively low economic attractiveness constraining growth of acreage under maize

Cost of Cultivation of maize is higher, compared to other coarse grain cereal crops such as sorghum and finger millet as well as crops such as rice and wheat (refer exhibit 30). This attribute makes maize a relatively less preferred crop in traditional coarse grain growing areas as well as in areas where the Government is attempting to shift the cropping pattern away from rice-wheat to maize.

Exhibit 30: Comparative analysis of crop economics

Crop	Cost of Production (INR/ha)	Gross Revenue (INR/ha)	Net Revenue (INR/ha)
Rice	31,142	46,791	15,648
Wheat	25,382	56,422	31,039
Maize	35,505	53,363	17,858

Source: CACP, Ministry of Agriculture and Farmers' Welfare (2019-20), Gross revenue based on MSP – 2019/20

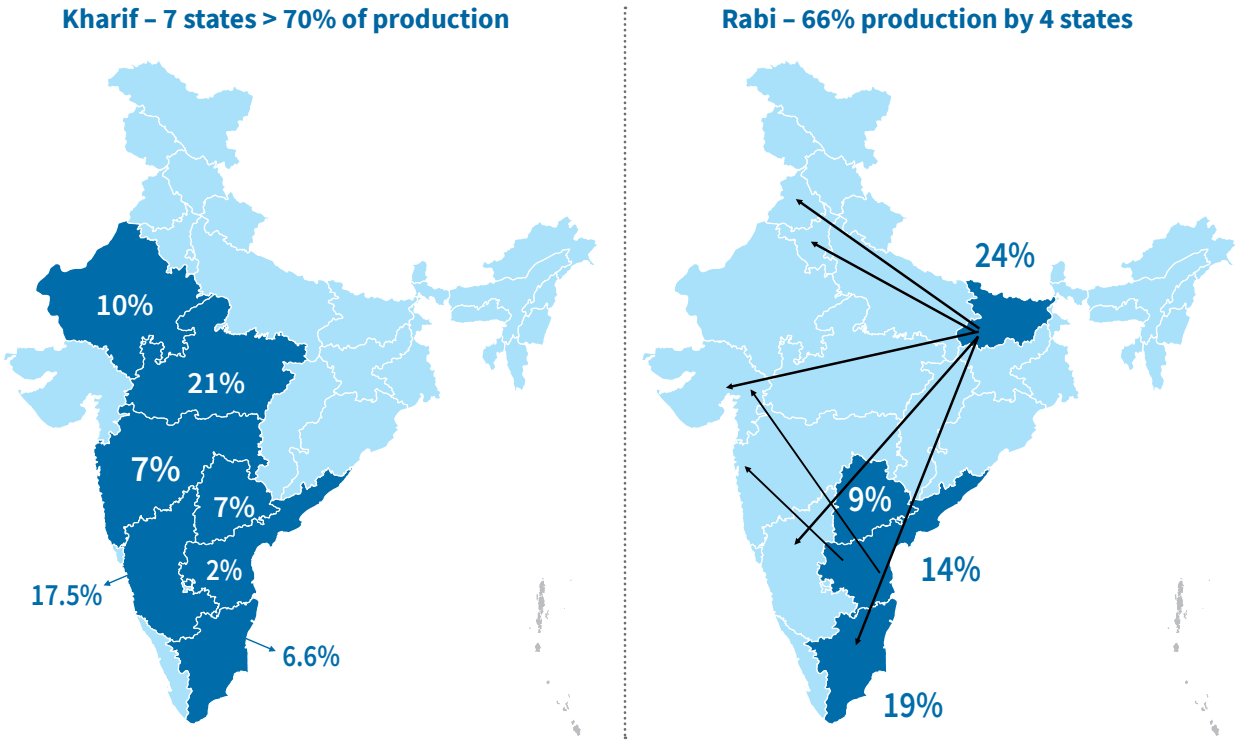
Note: Cost of production is calculated based on data provided in CACP report of Ministry of Agriculture and Farmer Welfare. For rice, wheat and maize the cost of production taken for the calculation are INR 12.08 per kg, INR 8.66 per kg and INR 11.71 per kg respectively. The yield for rice, wheat and maize were 2,578 kgs per ha, 2,931 kgs per ha and 3,032 kgs per ha respectively. MSP used for calculation of gross revenue for rice, wheat and maize were INR 18.15 per kg, INR 19.25 per kg and INR 17.6 per kg respectively.

[18]*Source: Agricultural Statistics at a glance – 2019, data for the year 2015-16.*

Acreage & production skewed to kharif while demand is throughout the year

More than 80% of the demand for maize is from industries such as animal feed, starch and food processing. Demand for raw material is throughout the year, while production is highly skewed to kharif. In fact, close to 57% of rabi production in the year 2018-19 was from three states of Bihar, Tamil Nadu and Andhra Pradesh (refer exhibit 31). Bihar alone contributed to about 24% of rabi production. Moreover, there is a 5-months windows of no fresh arrivals between seasons (July-September and January-February).

Exhibit 31: Seasonality impact on movement of maize in rabi



Source: MoA&FW, Industry, YES Bank Analysis

Disclaimer: THE MAP is only a pictoral representation of India and the states of India and is not drawn to scale. Investment and commercial decisions should not be taken on the basis of illustrations in the map. The map is only impression of seasonality impact on movement of maize in India. YES BANK Limited shall not be liable for any loss or damage whatsoever, including incidental or consequential loss or damage of, or in connection with, any use of or reliance on the information from this map

CHALLENGES IN POST-HARVEST HANDLING AND LOGISTICS

Post-harvest handling plays significant role in crop value chain. Effective post-harvest handling guarantees adequate quality of grains with proper moisture content and aflatoxin free produce. Currently inadequate post-harvest handling and marketing result in following challenges:

Low farmer price realization due to poor quality management

Poor post-harvest handling by farmers result in poor quality – such as high moisture content, high foreign matter and impurities of animal origin, damaged grains, weevilled and pest infested grains etc. After the harvesting process, maize requires drying for 10-15 days to reduce the moisture levels to 13%-14%. Most of the farmers practice sun drying and improper drying results in higher moisture content of upto 18%, making the produce susceptible to fungal infection and high aflatoxin content. These factors result in poor farm price realization and high wastage.

Fragmentation resulting in poor aggregation and inefficient farmers' access to markets

In India, maize farmers are predominantly small and marginal, with average land holding of less than one hectare. As the maize quantity produced per farmer is low, small & marginal farmers depend on village level agents for aggregation and market access. Low scale of operations and thinly spread agricultural markets in certain states results in high intermediation and lower than potential farmer price realization. While the Government is keenly focused on developing FPOs to address this issue, the reach and spread is still at a nascent stage and FPOs are yet to mature enough to significantly contribute to addressing the issue of efficient post-harvest aggregation.

Cost inefficiencies due to poor bulk storage and logistics infrastructure

The post-harvest storage, marketing and logistics infrastructure is insufficient to handle maize at a large scale. For instance, most of the transportation is in bags, due to lack of bulk handling facilities. In addition, the rail wagons are not designed to handle maize in bulk. High seasonality of production on one hand and year round demand (specially for poultry and starch industry) on the other, results in significant pressure on the storage and logistics infrastructure.

With the advent of commodity exchanges and futures market in the maize sector and the significant efforts put in by the government to build post-harvest infrastructure, the entire gamut of handling, storage and transport system of the grains is slowly changing. Going ahead, supporting policy changes, an efficient and integrated bulk handling and storage (silo) system is expected to increase the shelf-life of grain, reduce wastages and cost of handling and make the commodity export ready.

CHALLENGES FACED BY PROCESSING INDUSTRY

The aforementioned farm level and supply chain challenges impact efficiency of all the industries dependent on maize as raw material. Availability of right quantity and quality of raw material at the right price and right time is a critical prerequisite for building competitive advantage. However, varietal and quality mismatch, high cost of raw material due to involvement of large number of intermediaries, fluctuating prices, seasonal availability and import restrictions strongly impact cost efficiencies of these industries.

That said, each constraint has varying degree of impact for each industry. An overview of select critical challenges that impact on various industries that use maize as raw material is captured herewith.

Feed Industry

- Quality : Average grain count for Indian maize stands at ~450 grains / 100 grams, whereas grain count for US number 2 maize grade is generally in the range of 295 – 300 grains/ 100 grams making it more suitable for feed industry
- Corn with high moisture cannot be used for poultry feed because it affects quality and reduces storability of feed
- Lack of availability of raw material for 4 - 5 months and skewed rabi production results in high storage and transportation costs
- Usage of competitive grains such as Bajra & barley in cattle feed and Sorghum, wheat and rice in poultry feed when prices of maize are too high
- Lack of bulk logistics infrastructure and need for multiple handling

Starch Industry

- Quality - Starch content in Indian maize is low close to 63 – 67% compared to 73% in US number 2 maize grade
- High domestic maize prices resuls in starch derivatives being uncompetitive in the international market
- High import duty and lack of import quota allocation during shortage resulting in poor capacity utilization and high costs
- Lack of clear guidelines on source of origin for imports impacting sourcing plans

Food Processing Sector

- Lack of focused R&D for development of high yielding flour maize varieties suitable for food consumption. Hence, productivity is low.
- Non-availability of right quality maize required for processing – specially for extruded snacks and popcorn. Significant quantity of maize is imported for this purpose.

INTERNATIONAL TRADE RELATED CHALLENGES

Over the last few years, exports from India have been negligible due to significant domestic demand.

On the import front, factors such as high customs duty (upto 50%), restrictions on origin of produce (GMO free) under FSSAI notification, zero tolerance guidelines – with no LLP set and expectation of a declaration on GMO from source nations hinder industries' efforts to secure their raw material supply through import – even during situations when there is shortage of corn in the country.



05

KEY IMPERATIVES FOR SUSTAINABLE DEVELOPMENT

Maize lends unmatched flexibility in cultivation, product diversification, processing, marketing, distribution and value creation for participants across the supply chain. This flexibility coupled with growing demand can be better harnessed for accelerating farmer income and natural resource conservation by addressing key challenges that stakeholders across the value chain face.

Discussions with various stakeholders across industries reveals 11 key actionables, which if addressed, can bring about sustainable development of the maize ecosystem. These include:

Farm level Interventions

01 Development and implementation of a clear strategic roadmap for acreage expansion and crop diversification

02 Driving productivity improvement & Good Agricultural Practices

03 Investing heavily on "On-farm / farm proximate post-harvest quality management"

04 Developing & Building capacity of "Maize cluster based farmer collectives and FPOs"

05 Empowering farmers with strengthened price discovery & price risk mitigation mechanisms

Off-Farm Interventions

06 Promoting investment in maize focused bulk storage and logistics infrastructure

07 Providing maize supply security to Industry

08 Incentivizing private sector investment across the value chain

09 Leveraging agritech startups innovations to transform the maize supply chain

10 Exploring and addressing the untapped export potential

Coordination of Efforts

11 Creating a multi-stakeholder Maize Development Agency to drive focused and sustainable development of the sector

1. Develop and implement a clear strategic roadmap for acreage expansion and crop diversification

The focus on utilizing maize as an alternative for crop-diversification and focus on expansion of maize area in drought prone and rain fed areas for augmenting farmer income calls for a detailed mapping of agro-climates (including weather conditions, soil conditions, water logging propensity etc.) vis-à-vis the varieties that are most suitable for these agro climatic ecosystems. Care should be taken to avoid areas which are not suitable for optimal yields and have climate related risks. For instance:

- Certain belts of Bihar consistently face rabi maize crop failure due to low temperature (below 50C). This could happen in Punjab and Haryana as well when maize is cultivated in the winter season. The government could evaluate options of partnering with private sector, specially seed companies, and create awareness on the time of plantation of rabi maize in the country in accordance with the predictions on the impact of temperature variation on the crop.
- Water logged conditions are not suitable for maize. While promoting replacement of kharif rice with maize, it is critical to avoid areas which are prone to waterlogging.

From the industry perspective, maize has different end-uses, requiring different product traits and quality parameters. For instance, the maize quality required for feed sector (focused on energy content) is different from that of starch industry (focused on starch content) and that of food processing sector (focused on malleability and pop ability). Industry also faces acute shortage of maize during many months of the year requiring area expansion under the right varieties across geographies and more so in rabi season.

Addressing the crop acreage expansion plan would require a clear roadmap that would include:

- Mapping of the agro-climatic as well as supply chain requirements and identifying specific focus geographies for promotion of specific varieties of maize that would cater to the requirement of each industry.
- Developing a farmer and farmland database utilizing the Pradhan Manti Fasal Bima Yojana initiative that is being implemented by the government in this regard
- Publish a “Maize Atlas” to serve as guide for production of maize in India – which suggests the right “variety-geography-season mix for maize cultivation”. The “maize atlas” could catalyze the process of crop planning, promotion and regulation for maize, facilitate strategic direction for contract farming, FPO formation and large-scale integration of small farmers into an organized maize supply chain.
- Partner with private companies and research institutions (such as CIMMYT) to research and introduce maize seeds resistant to water logged conditions and low temperatures.
- Research, document and popularize geography specific inter-cropping options
- Invite private sector participation in extension and development in each focus geographies using SFAC PPP – IAD scheme or the “Golden Day Programme” approach of Odisha, “Golden Ray” scheme of Rajasthan, “Project Sunshine” of Gujarat and “Makka Vikas Pariyojana” of Madhya Pradesh government. Under these schemes, State govt. did partnership with leading seed companies to ensure timely availability of hybrid maize seeds and proper training and extension.

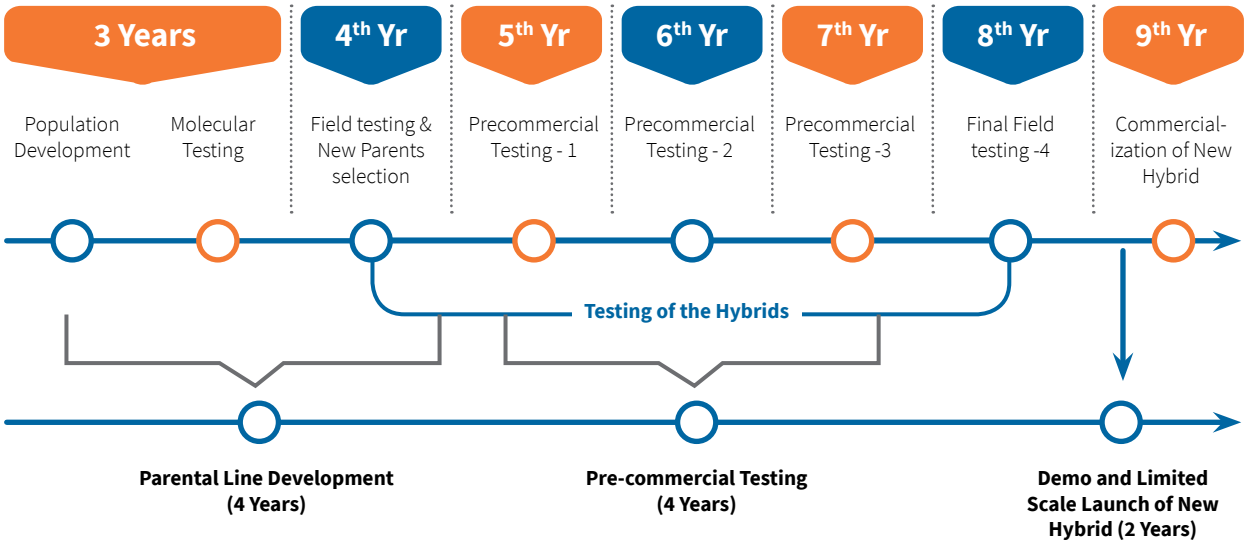
2. Drive productivity improvement and GAP

The potential of maize to yield better is significantly untapped in India. With an average productivity of 3.1 MT/ha, and a much lower yield of about 2.5 MT/ha in the kharif, there is a need to drive productivity improvement

through better adoption of technological advances made across factors that influence farm production of maize. Productivity improvement coupled with strong knowledge transfer on good agricultural practices, could double (if global average productivity is achieved), or even triple (if productivity levels of USA are achieved), the maize production in India. Moreover, adoption of efficient technologies and practices could reduce the cost of cultivation per unit. For instance, the average cost of production of is estimated to be lower than INR 10/Kg while that in India is estimated to be about INR 12/Kg. Key actionables to improve productivity include:

- **Seed**: Strong focus on introduction and wide-scale adoption of High Yielding and stress tolerant hybrid seeds– with focus on Single Cross Hybrid Introduction. Focused drive is needed to deliver high yielding varieties for crops cultivated in traditional areas for food purposes and high yielding stress tolerant crops cultivated in rainfed kharif. Towards this, while private seed companies could play a critical role in introducing globally best quality hybrids, governments need to review repetitive procedures (such as the need for a three year confirmatory trial for any hybrid seed being introduced into the state, in spite of it having been tested and approved elsewhere in the country). As shown in Exhibit 32, hybrid seed development involves long breeding process and usually takes 9-10 years to develop new commercial hybrid. This also include rigorous testing of hybrids for 5 years to develop high quality data on G X E (Stability & region fit). A further 2 to 3 year confirmatory trial requirement increases cost of seed as well as carries the risk of obsoleteness for private companies – as hybrid maize development has stiff competition. Two to three years of university testing required by states for commercialization across states increased overall time period to 12-13 years. Common and standard set of procedures/guidelines for faster approval would ensure predictability to the Seed Industry and help in bringing new germplasm faster to the market that will further help farmers in realizing the benefits of improved yields and better returns.

Exhibit 32: Stages wise time period requirement for hybrid seed development and testing



Source: Industry Sources

- **Setting up of high-quality standardized labs at state level** to carry out complex tests like DNA fingerprinting for accurate prediction of hybridity and faster approval of hybrid seeds.
- **Strengthening enforcement mechanism under Plant Varieties and Farmers' Rights Act** (PVP&FR) to protect against illegal copying of patents: The Protection of PPVFRA plays a prominent role in seed regulation in terms of introduction of intellectual property rights in India. Since India has taken a strong stand and chose to enact its own regime instead of adopting the International Union for the Protection of New Varieties of Plants (UPOV), there is need to uphold the strengthening of the PVP&FRA keeping rights of both farmers and breeders, with the changing times. Strong PVP&FRA regulation and prevention of illegal copy of patents will provide confidence to introduce best of hybrid varieties into India. There is need to establish harmony among the PVP&FRA, the Seed Bill and the Biodiversity Act.
- **Review benefits versus concerns with regard to Genetically Modified maize**: There is a large gap in productivity as well as stress tolerance between GM maize and non-GM maize. A socio-economic viability study needs to be done and a policy level stakeholder dialogue reinitiated to re-evaluate the impact of introducing GM maize into India on farmer income versus the general concerns associated with its introduction.
- **Plant protection**: A key hindrance to high productivity, specially in the kharif, is high levels of pest infestation – particularly weeds and Fall Army Worm (FAW). While private sector needs to play a key role in creating awareness on integrated pest management, the government needs to speed up the process of approving the introduction of differentiated methods for IPM (for instance, a number of molecules are available globally for management of FAW through seed treatment. However, their introduction into Indian market is delayed due to the long registration process).
- **Farm mechanization**: In addition to soil management operations, maize is well amenable to use of mechanized planting and harvesting. With increasing shortage of labour, and the cost efficiencies that farm mechanization brings in, it is critical to facilitate farmers adopt mechanized farm management practices. While a number of efforts, such as promotion of Custom Hiring centers and provision of subsidies for mechanization, the penetration of farm mechanization is yet to take off in maize. There is a need to closely study the requirement of small farmers and develop cost effective machines that are best suited to small farm conditions.
- **Irrigation**: Measures like large scale adoption of micro-irrigation and leveraging solar energy in maize production can contribute to augment production and productivity. Government's policies in these areas can be effectively utilized by maize growers with the help of institutional support (Pradhan Mantri Krishi Sinchayye Yojana etc.).
- **Access to finance and insurance**: Small farmers lack the wherewithal to meet the credit underwriting requirements of organized credit providers. However, a number of agri-fintech startups have developed innovative tools for assessing the credit scores and facilitating farmers' access to credit. Industry could play a significant role by anchoring such initiatives and tying up with banks to provide access to credit. They could support in popularization of Kisan Credit Card (KCC), use of digital banking and fintech solutions to ensure credit availability for maize cultivation.

3. Invest heavily on Post-Harvest Quality Control & Management

Most of the maize used by industry ultimately flows into the human food value chain. A key challenge faced by industry is availability of good quality maize, with the right moisture content and that which is free of mycotoxins. However, unscientific post-harvest practices, such as sun drying, lead to high moisture content,

which when combined with poor post-harvest storage, lead to fungal growth and mycotoxin development. Consequently, when a farmer reaches a warehouse or a processing unit with his produce, often, the price offered to him is much lower than his expectation – as his produce does not match the quality requirement specified. Following actions could strongly augment quality management:

- Start quality management at seed level. Evaluate development of mycotoxin resistant varieties and specific varieties suitable for specific industries.
- In light of the new farm acts, private players need to re-assess the option of carrying out contract farming on large scale so as to manage quality and in the process facilitate farmer increase his income.
- Explore and popularize innovative solutions for assessment of quality at farm level. A hand held, low cost device that can measure various quality parameters – such that farmer can take action to meet quality requirements before transporting to market or warehouse.
- Promote farm level deployment of maize dryers and scientific storage. The subsidy given through the Agriculture Infrastructure Development fund could be used by FPOs and Industry partners to set up procurement centers and e-mandis having scientific drying, handling and storage facilities.
- Strongly invest in scientific post-harvest bulk storage – that protects produce from pest attack, moisture exposure and mycotoxin development.

4. Develop & Build Capacity of "Maize Cluster Based Farmer Collectives"

Farmer collectives, such as cooperatives and FPOs are an ideal pathway to address the challenge of low economies of scale faced by farmers. Action steps include:

- Development of specialized "Maize FPOs" in maize clusters. These FPOs could further specialize for specific industries (for instance Starch maize FPOs or Poultry maize FPOs) and could be supported and promoted by the industry.
- Policy level discussion on allowing private sector to take up stake in FPO companies. This would help in building professional capacity of FPOs as well as provide them the wherewithal to access organized credit and markets.

5. Empower farmers with strengthened price discovery and price risk mitigation mechanisms

Maize as a commodity is prone to significant price fluctuations. More so because commodity prices are dependent on poultry sector – which in itself is prone to fluctuating demand. In this context, it is critical that farmers are empowered to access market price information and also to mitigate their risks. Key interventions suggested in this regard include:

- Build a wide network of basic hardware infrastructure and popularise e-platforms such as e-kisan mandis and agritech e-procurement platforms such that farmer has transparent access to market price and markets
- Build a vibrant ecosystem that could stabilize prices. Steps could include:
    - Facilitating a more liquid hedging mechanism for maize by way of public sector also participating in NCDEX stock exchange market while procuring maize

- SEBI has allowed options on goods including maize. Government could popularize the benefits of options among maize farmers and come forward to subsidize the premium that farmer would have to pay for purchase of options. This will help farmers hedge their price risk.

6. Promote investment in maize focused bulk storage and logistics infrastructure

A key challenge faced by maize industry is the lack of bulk handling, storage and transportation infrastructure. This results in high intermediation for long distance transport and multiple handling operations. Development of bulk storage and handling capacity is critical for building efficient maize value chain. Key intervention suggested include:

- Promote private sector investment in developing scientific bulk storage infrastructure. The initiative taken up by FCI for wheat and rice could be extended to maize
- Maize players could be allowed to utilize the bulk handling infrastructure already developed for PDS.
- Specialized large scale integrated bulk handling projects, including collection centres, material handling infrastructure for handling bulk quality of maize like silos and wagons could be developed on a PPP model – as in the case of rice and wheat.
- Replication of Kisan Rail Model for Maize will help in timely movement of maize from point of production to point of consumption. This ultimately help in maintaining quality of maize by maintaining moisture requirement as per Industry parameters.

7. Provide maize supply security to Industry

Availability of sufficient quantity of right quality maize at the right time is a critical parameter for efficient industry operations. However, in addition to challenges of non-availability of maize during most part of the year, there are strong restrictions on import of maize as well. Key interventions suggested for improving Industry's access to sufficient raw material include:

- Invest in development of more acreage under maize – specially for rabi season
- Focus on developing industry specific corn varieties. For instance, waxy corn or glutinous corn (type of field corn characterized by its sticky texture when cooked as a result of higher amounts of amylopectin). It is used in food industry for preparation of desserts and adhesives and as a replacement for tapioca crop. It is also used in preparation of animal feed as presence of high amount of amylopectin make it more digestible than other varieties of dent corn. Waxy corn has found increasing usage in printing and textile industry.
- Consider viable alternatives while developing quality standards: Maize Fiber/CGF which is the important by-product produced during starch processing is a major ingredient for cattle feed. The upcoming FSSAI and BIS regulation restricts usage of any raw material for cattle feed formulation having aflatoxin level above 20 ppb. Stakeholder discussion reveal that it would be more practical to lay this limit at an overall level than at individual component level.
- Rationalise import duties and regulations such that industry can import during shortage. Suggested action steps include:
    - Review and rationalize the high levels of import duty being imposed on maize (50%).
    - While providing for TRQ quota for imports, develop a scientific mechanism based on statistical

models to arrive at the level of quota to be provided and how much to import. In addition to poultry sector, TRQ quotas need to be considered for starch and other industries.

- Review the import quarantine norms in order to match international standards. For instance, Aluminum Phosphide as fumigant is used in many parts of the world, but such produce is restricted from being imported into India (as only methyl bromide fumigated material is allowed).

- Review import source of origin regulations. Indian regulations mandate that only non-GM maize can be imported. However, unlike in Europe (which defines that 99.1% non-GMO is acceptable), India does not have a LLP for maize. Also, Indian regulation requires a declaration from the source country that the produce is non-GMO and the location from where it is sources does not cultivate GM crop. This requirement needs to be reviewed as it is difficult to get such declaration from source countries.

8. Promote private sector investment across the maize value chain

The Government of India has launched a number of schemes to promote private sector investment in post-harvest storage and processing of agricultural produce. Given the socio-economic importance of maize, investments in this crop value chain could be considered eligible for various incentives. For instance:

- Focused promotion of MOFPI's "Formulation of Micro Enterprises Scheme" for setting up collection centres for maize – which have modern dryers, storage facility, testing facility etc.
- Incentives for setting up storage infrastructure to maize processors to set up warehouses near processing facility inside plant premises.
- Inclusion of starch based derivatives as eligible products for various MOFPI schemes.

9. Leverage Agri-Tech Startup innovations to transform the maize supply chain

Agritech startups are transforming the world of agriculture by introducing innovative approaches to solve specific problems. Handholding and promoting the start-up ecosystem could yield significant returns towards building efficiencies across the maize value chain. With a view to catalyse start-up interest in the maize value chain, following actions are suggested:

- Create a maize specific start-up accelerator – in a PPP mode, with significant private sector participation
- Run a maize supply chain grand challenge and cohort
- Develop a maize innovations sandbox

10. Explore the untapped potential of exports

Maize holds high potential for exports, given that India is geographically well positioned to serve the maize importing South East Asian Nations as well as China – a key maize importer in the region. While this commodity did contribute to significant exports about 5 years ago, touching an export value of USD 1.26 in 2014, increasing domestic industrial consumption and high domestic farm prices has made the commodity unavailable as well as uncompetitive in the global market.

However, it is critical for policy makers to review the need to develop a vibrant international trading ecosystem for maize such that this channel acts not just as a source of increasing farmer income but also providing the pathway for off-take during periods of glut, if any. At the least, maize clusters specifically focused on exports could be created to address niche markets – such as countries requiring GMO free produce.

11. Create a multi-stakeholder "Maize Development Council or Task Force" to drive sustainable development of the sector

Maize is a multifaceted crop, serving diverse socio-economic needs and diverse industries. Given the growing demand for maize and the diverse end-uses, it is critical that coordinated efforts need to be taken for development of this sector, such that requirements of multiple stakeholders, including farmers, policy makers, supply chain actors and the industry are addressed. To bring in the focus that maize as a crop deserves, it is proposed that a Maize Development Council or Task Force be instituted in India, with significant board level representation from the private sector and Industry associations. This Taskforce could be mandated to set the overall direction for develop of the sector, right from drawing out the research priorities, to developing strategies to balance demand supply mismatches that could occur in the future.

These eleven action steps, if implemented in a co-creation mode – with strong inter institutional partnership as well as public-private partnership, could unleash the true potential of the maize ecosystem in India to deliver not just better farmer income – special to the small farmers in vulnerable rainfed areas, but also play a pivotal role in conserving natural resources, generating gainful employment across industries and providing for energy security.

6. ACKNOWLEDGMENT

We would like to acknowledge inputs received from

Mr. T R Kesavan
TAFE Ltd

Mr. Ravishankar C
Bayer Cropscience Ltd

Mr. Aromal Jkoshi
Roquette India Pvt Ltd

Mr. Ram Sirohi
Bayer Cropscience Ltd

Mr. Chirag Gupta
4700 BC Popcorn

Ms. Vedika Kapoor
Corteva Agriscience

Dr. Ajai Kumar
Corteva Agriscience

Mr. Amit Sachdev
US Grains Council

Mr. Rajvir Singh Rathi
Bayer Cropscience Ltd

Mr. Tarun Gakhar
Kelloggs India

Ms. Jaishree Nilkhan
Roquette India Pvt Ltd

Ms. Vaishali Chopra
Bayer Cropscience Ltd

7. REFERENCES

- Ministry of Agriculture and Farmers' Welfare
- FAOSTAT
- OECD
- USDA
- Indian institute of Maize Research
- Indian Council of Agricultural Research
- Indian Institute of Management-Ahemdabad
- The National Academy of Agricultural Research Management (NAARM)
- Agricultural Marketing Information Network
- AGMARKNET
- International Grain Council, USDA
- National Institute of Animal Nutrition and Physiology
- ITC Trademap
- Industry sources/discussions

8. ABBREVIATIONS

AHIDF	Animal Husbandry Infrastructure Development Fund
Bn	Billion
CACP	The Commission for Agricultural Costs & Prices
CAGR	Compound Annual Growth Rate
CGS	Corn Gluten Feed
CIGAR	Consultative Group for International Agricultural Research
CIMMYT	The International Maize and Wheat Improvement Center,
CWC	Central Warehousing Corporation
DPIIT	The Department for Promotion of Industry and Internal Trade
EU	Europian Union
FAO	Food and Agriculture Organization
FAW	Fall Army Worm
FCI	Food Corporation of India
FIDF	Fisheries and Aquaculture Infrastructure Development Fund
FPO	Farmer Producer Organization
FSSAI	The Food Safety and Standards Authority of India
GAP	Good Agricultural Practices
GM	Genetically Modified
GMO	Genetically Modified Organisms
ha	Hectare
HYV	High Yielding Varieties
ICAR	Indian Council of Agricultural Research
ICRISAT	The International Crops Research Institute for the Semi-Arid Tropics
IPM	Integrated Pest Management
KCC	Kisan Credit Card
LLP	Low Level Presence
Mn	Million
MOAFW	Ministry of Agriculture and Farmers' Welfare

MOFPI	Ministry of Food Processing Industries
MSP	Minimum Support Price
MT	Metric Ton
NABARD	National Bank for Agriculture and Rural Development
NCDEX	National Commodity & Derivatives Exchange Limited
NMAET	National Mission on Agricultural Extension and Technology
NMSA	National Mission for Sustainable Agriculture
OECD	Organization for Economic Co-operation and Development
PDS	Public Distribution System
PMFBY	Pradhan Mantri Fasal Bima Yojana
PPP	Public Private Partnership
PPP-IAD	Public Private Partnership for Integrated Agricultural Development
PVP&FR	Plant Varieties and Farmers' Rights Act
R&D	Research and Development
SFAC	Small Farmers Agribusiness Consortium
SWC	State Warehousing Corporation
TRQ	Tariff Rate Quota
UPOV	Union for the Protection of New Varieties of Plants



Established in 1927, FICCI is the largest and oldest apex business organisation in India. Its history is closely interwoven with India's struggle for independence, its industrialization, and its emergence as one of the most rapidly growing global economies.

A non-government, not-for-profit organisation, FICCI is the voice of India's business and industry. From influencing policy to encouraging debate, engaging with policy makers and civil society, FICCI articulates the views and concerns of industry. It serves its members from the Indian private and public corporate sectors and multinational companies, drawing its strength from diverse regional chambers of commerce and industry across states, reaching out to over 2,50,000 companies.

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.



YES BANK is a 'Full Service Commercial Bank' providing a complete range of products, services and technology driven digital offerings, catering to Retail, MSME as well as corporate clients.

YES BANK operates its Investment banking, Merchant banking & Brokerage businesses through YES SECURITIES and its Mutual Fund business through YES Asset Management (India) Limited, both wholly owned subsidiaries of the Bank. Headquartered in Mumbai, it has a pan-India presence across all 28 states and 8 Union Territories in India including an IBU at GIFT City, and a Representative Office in Abu Dhabi.

For more information, please visit the Bank's website at http://www.yesbank.in/