

Production and processing of maize



Maize is the third largest planted crop after wheat and rice. It is mostly used and traded as a leading feed crop but is also an important food staple. In addition to food and feed, maize has wide range of industrial applications as well; from food processing to manufacturing of ethanol.

Maize grown is primarily of three types

Grain or field Maize,

Sweet Maize used mainly as food

Popcorn.

There are four types of Grain Maize: (a) Dent Maize has a pronounced depression or dent at the crown of the kernels, (b) Flint Maize has the hard starch layer entirely surrounding the outer part of the kernel, (c) Flour, or soft, Maize contains almost entirely soft starch, with only a very thin layer of hard starch and (d) Waxy Maize has a wax-like endosperm

1. 1 Global Maize Production

The total area under maize cultivation in the world is 139 million hectares with a production of 598 million MT (mMT). Major producers are USA (240mMT), China (125 mMT), European Union (39 mMT), Brazil (37 mMT), Mexico (19 mMT), Argentina (14 mMT) and India (11 mMT). Among all cereals, maize occupies the fifth largest area, fourth largest in output and third largest in yield. Over the past two decades, global maize production has increased by nearly 50 percent, or 1. 8 percent annual compound growth rate.

1. 2 India Maize Production

India is the tenth largest producer with a production of 11.10 mMT from an area of 6.6 million ha. The average yield in India is 1.77 MT/ha which is very low as against 7 MT/ha in temperate areas of developed economies and 3.8 MT/ha of global average. Maize is cultivated in almost all states in the country. Andhra Pradesh is the leading producer in India followed by Karnataka, Bihar, Maharashtra, Tamilnadu, Rajasthan, Madhya Pradesh and Gujarat in the year 2009-10. The crop is grown both in Kharif and Rabi seasons in India with a share of 85 per cent and 15 per cent, respectively. Since the maize is rain dependent, it is mainly grown during kharif season. Maize Area, Production and Yield in India have seen a phenomenal growth over the last five decades and India has emerged from being a net importer to levels of self sufficiency.

1. 3 Price Analyses of Maize for last five years

If we examine the price trend of maize in Indian market, prices will be on their peak during the months of July-August. From August onwards prices start declining owing to start of kharif season. Price of maize mainly depends upon supply demand structure. One important thing that is visible from the trends is that from the last 3 years price fluctuations within a year is showing same trend. Government announces MSP (minimum support price) of maize every year and the prices are showing an upward trend. The continuous demand for maize in poultry industry and lesser predicted area in the kharif helped the prices to rule around higher side.

1. 4 Utilization pattern of Maize in India

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The below figure depicts the utilization pattern of maize in India. A major portion (46.5%) is used as poultry feed, followed by 33% for human consumption and 11% animal feed. Only 9% is used in starch industry and 0.5% in brewery industry

1.5 Milling of Maize

Wet milling produces Maize oil, Maize steep liquor, Maize gluten feed and Maize gluten meal. In contrast to wet milling, dry milling produces only carbon-dioxide and distillers dried grains soluble as by-products but has become the favoured approach for Maize ethanol production due to lower start-up costs.

Maize kernels are degerminated by grinding or centrifugation to produce seed germ which produces Maize oil. The starch, gluten and fiber is left after degermination, from which gluten is used to extract Maize gluten meal which is a high-protein animal feed, starch undergoes liquification and saccharification followed by fermentation to form Maize gluten feed when combined with fibres. Fermentation also results in formation of ethanol.

The most striking new development has been the rapid expansion in the ethanol industry which has also brought about a sudden increase in the supply of Distillers Grains (DG). Under the dry-milling process, when maize is fermented to alcohol, around one-third of the Dry Matter (DM) is recovered in co-products which, in turn, are further processed into a variety of feed ingredient products. The conversion from DM to DG involves starch fermentation which eventually produces two feed co-products: Maize Condensed Distillers Solubles (CDS) and Maize Distillers Dried Grains with <https://assignbuster.com/production-and-processing-of-maize/>

Solubles (DDGS), which are rich in essential nutrients such as protein, fat, minerals.

Aside from Distillers Grains, which result from the dry milling process, there are several other maize co-products used in feed rations, mostly derived from the more traditional wet milling process. One ton of maize through wet milling produces 29 kg of Maize oil, 241 kg of 21% protein gluten feed, and 46 kg of 60% gluten meal. In addition to it, either one among starch (571 kg) or sweetener (589 kg) or ethanol (402 kg) can be produced.

The most common ones are:

Maize Gluten Meal: Dried high protein (almost 60 percent) feed source. It is a residue from maize after the removal of the larger part of the starch and germ, the separation of the bran by the process employed in the wet-milling manufacture of maize starch or syrup. It is commonly used by the poultry industry, farm animal feed in fish and pet food. It is also used in cattle feed.

Maize Gluten Feed: Is that part of the commercial shelled maize that remains after the extraction of the larger portion of the starch, gluten, and germ by the processes employed in the wet milling manufacture of maize starch or syrup. It is used in complete feeds for dairy and beef cattle, poultry, swine and pet foods.

Maize Seed Cake: With over 17 percent protein, it is considered ideal feed for breeding chickens, ducks, geese, pigs, fish, and other livestock.

Maize Germ Meal: Typically contains more than 20 percent protein and 9.5 percent fiber. It has an amino acid balance that makes it valuable in poultry and swine rations. It is also used as a carrier of liquid feed nutrients.

Liquid Feed Syrup: It is a highly concentrated feed syrup; high in protein and energy. This product is typically added to enhance an animal feed ration.

2. OUR BUSINESS MODEL

Maize has multiple uses both for domestic as well as industrial purposes. The usage pattern as seen earlier in the report varies for human direct consumption to industrial chemical production mainly in the form of ethanol/alcohol. Since maize is a multi-seasonal crop i. e. it is harvested in both the season of rabi and kharif so we have the liberty of designing a business which has the capacity to consume maize throughout the year. When we worked out the financials for the main industries based on maize, we found out that out of ethanol, starch and poultry feed businesses the most profitable are poultry-feed from maize and ethanol from maize stover. So we would be making ethanol from stover and poultry feed from the maize, in this way we would be utilizing whole of the maize plant material and providing the farmers with a much better returns that what they are getting at present.

	Product Cost incurred(Rs. Per tonne)	Revenues(Rs. Per tonne)	Profit(Rs. Per tonne)
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Maize(whole)	9000	10500	1050
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Poultry feed	9400	12000	2600
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Starch 10000 12000 2000

In the initial phase we propose to use the maize stover (the left out part of the plant after the grains are removed) for the production of fuel grade ethanol which is procured by the government oil marketing companies under a contractual basis at pre-determined prices set by them. The maize grains are stored in silos which could be sold post-harvest season when the prices goes up by 20-30% ever year, which is evident from the price variation cycle shown above (fig 3). Presently we are using maize stover as raw material but straw of other crops like wheat, rice and millets having cellulose content can also be used as starting material in ethanol production. If we ever face shortage of maize stover in our plants capacity utilization then we can procure other raw materials from the same farmers.

The location which we are planning to setup our plant is in the Dhaod district of Gujarat. This area has the highest maize production in the state along with the bordering areas of Madhya Pradesh. This is geographically near to the industrial areas of Vadodra and Ahmedabad, which are large consumers of starch and bio-fuel ethanol (As large oil refineries operate near Vadodra so we would not be having any problem in selling the ethanol in markets. And starch based industries are located in and around Ahmedabad which consumes starch in large quantities).

The procurement of maize along with Stover would lead to an increase in the working capital requirement but that would be offset by the increased revenues from the sale of that maize. Also the solid matter that would be left out as an affluent during the fermentation process would be useful as

feedstock material. The carbon dioxide produced will be sold as industrial CO₂ which will make the whole process of ethanol processing a clean development process, with zero carbon emission. As depicted in the table 1 below, total cost/litre of ethanol is lowest from maize stover for equal amount of raw material consumed.

Input Procurement (Rs/ton)	Enzyme Cost (Rs/ton)	Ethanol Yield (Litre/ton)	Total Cost (Rs/Litre)
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Sugarcane	640	Negligible	72.9
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Maize	8500	Negligible	450.11
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Maize Stover	2000	700	300.7
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3. ETHANOL FROM MAIZE STOVER

3.1 Customer value proposition:

Our main customer is government that would be procuring ethanol from our plant. The customer value that we are creating is the availability of ethanol throughout the year for successfully implementing the E5, E10 and gradually E20 grade ethanol. The ample amount of availability would help in reducing the dependency on imported fuel that we are consuming right now. Also mixing of ethanol into diesel reduces emission from vehicles as it has higher per cent age of oxygen in it. There is a huge deficit of around 650m litres of ethanol for blending in diesel. The bio-fuel policy of India, states that by 2017 the country should fully implement the E20 standards for EBP. E20 means blending 20% ethanol in the diesel, but at present ethanol is not sufficient for

even meeting the E5 standards. As the production of fuel ethanol comes under the category of bio-fuel as defined by the ministry of non-renewal energy, government of India, so we would be eligible for a 25% rebate on capital investment.

3. 2 Demand and Supply of Ethanol :

When will the oil run out? Various estimates put this anywhere from 20 years from now to less than a century in the future. The shortfall in energy might eventually be made up by developments in nuclear fission, fuel cells and renewable energy sources, but what can substitute for gasoline and diesel in the internal combustion engine powered vehicles that will continue to be built worldwide till then? Hence the bio-organic chemists have begun to crystallize, unlocking the vast chemical larder and workshop of natural microbes and plants to invent the technologies required for industrial-scale production of bio-ethanol . Maize accumulates starch that can, after hydrolysis to glucose, serve as the substrate for ethanol fermentation. Maize starch is a more expensive carbon substrate for bio-ethanol production, but if maize stover is used as starting material for ethanol production then it is economically more viable. The product has a potential rival in the form of bio-hydrogen which could provide the only workable solution to meeting global energy supplies and mitigating carbon-dioxide accumulation but it is still in a nascent stage.

Globally, ethanol has been used as an automotive fuel since the early 1900. However, the usage of ethanol as fuel gained momentum only after the 1970s with the launch of the Pro-alcohol programme in Brazil. Until 1975, the

year of the launch of the Pro-alcohol programme in Brazil, the ethanol market was predominantly beverages and industrial. Thereafter, the fuel ethanol market grew substantially and it accounted for 80 % of the world ethanol production in 2010.

The global ethanol industry with 19, 227 mn gallons of production during CY09 has grown substantially over the years due to the focus on bio-fuels. During the period of 1975-2009, the global production of ethanol grew at a Compounded Annual Growth Rate (CAGR) of 11. 86%. The rising crude oil prices, coupled with the increasing quest for energy security and reducing green house gas emissions have fuelled the global ethanol industry. The United States of America and Brazil are the two major ethanol producers across the globe. These two countries together accounted for almost 89% of the total global ethanol production in 2009.

The fermentation route using sugary or sugar-yielding material and yeast has been in practice in India since long for the production of alcohol or Ethanol. Most of the Ethanol produced (almost 95%) is through the fermentation route. Grains like rice, corn or maize, barley-malt, rye, wheat, sorghum etc., starchy bulbs and vegetables like cassava (tapioca) and potatoes are commonly used for producing ethanol under the fermentation route in India. In India, ethanol is mostly produced from molasses obtained during the process of crushing sugarcane.

3. 3 Classification of ethanol:

Ethanol can be classified on the basis of uses, production route and on the basis of composition:

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1. On the basis of the uses, it can be classified as beverage ethanol, industrial ethanol and ethanol fuel:

a. Beverage Ethanol: ethanol used in alcoholic spirits such as vodka and shochu.

b. Industrial Ethanol: ethanol used as a feedstock for alcohol-based chemicals such as paints and inks.

c. Ethanol fuel: ethanol used as an automotive fuel (can be used for blending with petrol).

2. On the basis of the production route ethanol can be classified as fermented ethanol and synthetic ethanol.

3. On the basis of the composition, ethanol can be classified as hydrous and anhydrous. (Hydrous ethanol contains about 5% of the water content whereas anhydrous ethanol contains 0.5% of the water content)

Year

Petrol demand Mt

Ethanol blending requirement (in metric tons) Diesel demand Mt Biodiesel blending requirement (in metric tons)

@5 % @10% @20 % @ 5% @10% @20%

2006-2007 10.07 0.50 1.01 2.01 52.32 2.62 5.23 10.46

2011-2012 12.85 0.64 1.29 2.57 66.91 3.35 6.69 13.38

2016-2017 16. 40 0. 82 1. 64 3. 28 83. 58 4. 18 8. 36 16. 72

3. 4 Process description

The maize stovers are generally harvested during the month of September October in kharif season maize and in March- April for Rabi season maize. The maize stovers can be kept in the open after the harvest as the requirement is round the year in the factory. But the use of concrete slabs over which the stovers are kept will be a good option to minimize the spoilage. Sometimes the polythene sheets can be used to prevent spoilage from rainfall. The requirement of the stovers is 1000 MT/day.

1. Washing of the stovers: The first process in the factory is the washing of the stovers to remove the dust, soil etc. The water is sprayed on the stack of stovers in high pressure and thus the soil and other solid particles are removed.

2. Pretreatment & Hydrolysate conditioning: After washing of the stovers they are sent for pretreatment. By this process most of the hemicellulose parts of the stovers are converted into soluble sugars like xylose, mannose, arabinose, and galactose using dilute sulfuric acid at high temperature. After reaction there is formation of aldehydes which is over limed by adding lime, the pH raise to 10 and thus gypsum is formed which is filtered out and the hydrolyzate is mixed with the solid before sent to saccharification and co-fermentation.

3. Presteamer at low pressure: Before sending to the reactor the pretreated stovers are passed through the steam at low pressure to remove the non-

condensable that can take up space in the reactor. The low pressure steam is passed by the valve for 20 minutes and then the stover is flash cooled and sent to the reactor.

4. Reactor: In the reactor first the stovers are steamed and then the acid is added to the reactor. Before adding the acid to the reactor the concentrated acid is diluted.

5. Saccharification and co-fermentation: These are two different processes:

i. Saccharification In this process the cellulose is converted to glucose with cellulose enzyme. It is a collection of enzymes and comprises of endoglucanase, exoglucanase and beta-glucosidase. *Trichoderma reesei* is the bacterium which is used for the commercial production of enzyme cellulase. The whole process takes 24 hrs.

ii. Co-fermentation The formed glucose and other sugar is fermented to form ethanol. The bacteria used in this step are *Z. mobilis* which acts as a biocatalyst and will ferment glucose and xylose in ethanol. This whole process takes 36hrs.

6. Distillation, dehydration, evaporation and solid liquid separation:

Distillation is accomplished in two columns the first, called the beer column, removes the dissolved CO₂ and most of the water, and the second concentrates the ethanol. Fermentation vents (containing mostly CO₂, but also some ethanol) as well as the beer column vent are scrubbed in a water scrubber, recovering nearly all of the ethanol. The scrubber effluent is fed to the first distillation column along with the fermentation beer. The leftover

liquid and the slurry are sent to the waste water treatment plant from where the water is recycled for further use.

3. 5 Financials of ethanol production

We have a total installed capacity of 90000 tonnes per annum, of which the capacity utilization in the initial years would go up from 50% to 90% in the subsequent years. The fixed cost is 50crores which is 39% of the total investment required. Raw material cost is 43% in the first year of the total investment. Warehousing cost and other variable costs including that of salaries and transportation, etc. amounts to 3% and 8% of the total cost respectively. The profit after tax in the first year of operations totals to around 24crore. The break-even point is achieved in the second year of operations

Year % 2011 2012 2013 2014 2015

Installed Capacity (ton/year) 90000 90000 90000 90000 90000

Capacity utilisation 50% 60% 70% 80% 90%

Ethanol production(ton/year) 45000 54000 63000 72000 81000

Price(Rs/ton) 24000 24000 24000 24000 24000

Revenue(Rs in Crore) 108 129. 6 151. 2 172. 8 194. 4

(Rs in Crore)

Fixed Cost 39 50

Raw Material 43 55. 5 66. 6 77. 7 88. 8 99. 9

Warehousing 3 3. 6 3. 6 3. 6 3. 6 3. 6

Transportation 1 1. 7 2. 0 2. 4 2. 7 3. 0

Direct Labor 2 2. 1 2. 1 2. 1 2. 1 2. 1

Admin Costs 1 0. 7 0. 7 0. 7 0. 7 0. 7

Energy Costs 2 2. 3 2. 7 3. 2 3. 6 4. 1

Waste Disposal 1 1. 1 1. 1 1. 1 1. 1 1. 1

Other V. C 8 11. 5 12. 2 13. 0 13. 8 14. 6

Total Cost 128. 4 91. 1 103. 8 116. 4 129. 1

Benefit – Cost -20. 4 38. 5 47. 4 56. 4 65. 3

4. MAIZE STARCH PROCESSING:

Maize is generally processed to manufacture Maize starch by wet milling method the world over. The by-products of starch manufacture, like Maize oil, Maize steep liquor, gluten etc. are the important value added products.

The average processing capacity of the units in India is 200 MT of maize / day. There are plants with as high crushing capacity as 400 MT/day.

However, there is no plant in the country with crushing capacity of less than 100 MT/ day. The selection of technology is very important as regards to the viability of the unit is concerned.

Critical Factors in setting up a maize processing plant include Raw Material, Land, Water, Steam, Technology and an Effluent treatment plant. A plant of 100 MT of wet milling maize crushing capacity per day is considered as a minimum viable unit. A unit of this capacity will produce the following products. The plant will function in 3 shifts per day and 8 hour per shift. Keeping in view, the nature of activity the capacity utilization of 50%, 70% and 90%, during first, second and third year onwards can be achieved easily. The project cost for setting up of a 100 MT wet milling of maize per day has been assessed at Rs. 14. 32crores (Refer to Annexure 4 for details.)

5. POULTRY FEED FACTORY

The poultry feed plant of the capacity of 30000 tons/year. The total capital investment is about Rs. 60lacs. In the first year the expected revenues are around 18crores, this is at the annual capacity utilization of 50%. The PAT is 2. 63crore and the NPV of the project comes out to be 18. 93crore at the discount rate of 15% per annum. (Refer to annexure 3 for details).

6. ECONOMIES OF SCALE, SCOPE AND INTEGRATION

Economies of Scale: Producing Ethanol from Corn at low levels is not financially viable. We need to increase the production levels for a sustainable and a profitable business. Therefore the Economies of Scale have to be high but they are still comparatively less than other Manufacturing industries. It relies heavily on the cost of corn and other energy inputs. High Economies of scale helps us in reducing transportation as well as Marketing costs.

Economies of Scope: Maize oil, Gluten Feed, Gluten meal, Starch and Ethanol can be produced through wet milling method. Ethanol is produced from corn stover. Starch can be used for producing various other products. Producing Ethanol from Corn at low levels is not financially viable. We need to increase the production levels for a sustainable and a profitable business. Therefore the Economies of Scale have to be high but they are still comparatively less than other Manufacturing industries. It relies heavily on the cost of corn and other energy inputs. High Economies of scale helps us in reducing transportation as well as Marketing costs.

Economies of Integration: Forward integration involves processing of maize stover to produce ethanol. Wet milling of maize is done to produce starch. Maize can also be used to produce poultry feed.

7. RISKS INVOLVED:

Supply Side Risks

Price Impact on Input Cost: At this point, ethanol plants are dependent on a constant supply of maize for their survival in fuel production. This gives the supplier the ultimate industry power until we achieve alternative feasible sources. The elasticity of demand is inelastic in most cases, or at least until the price of corn rises to the point where ethanol plants would be very unprofitable in production. The price is given for the input and we don't have much choice in refusing because ethanol plants need to run as close as possible to capacity in order to be most efficient. In this scenario, ethanol will be passed off at a higher price, but also the ethanol plants will eat some of the cost in order to stay competitive.

Demand Side Risks

Government Policy: Right now Government offers incentives to blenders who buy from Ethanol plants; in case there is any change in policy there could be a decrease in the demand of ethanol from blenders. Government currently does not allow companies to import ethanol from foreign market to meet their domestic requirements, in case there is any change in this policy there could be a decrease in demand of ethanol from various ethanol plants in our country.

Competition: With increase in competition, the supply demand gap currently in the market will decrease, which will lead to less demand of ethanol from various plants. Competition exists in the form of ethanol produced from Jatropha and other plants.

8. PORTER S 5 FORCE ANALYSIS OF THE INDUSTRY

9. VALUE ADDITION

Value can be added to the product by form, place and time. In our case we are producing ethanol from maize stovers. The different value additions in our project are-

1. By form

We are processing maize Stover, which has very less economic value to the farmer and converting it into ethanol. The value is added by processing cheap maize Stover to ethanol, which has high price and demand. Thus by processing, the form is changed leading to value addition in the produce. We

would be using the maize grains for production of poultry feed which is found out to be a viable option.

2. By place

We are adding value to the Maize stover by taking it from the farms to the factory gate. The stover in farms does not fetch much value but once it reach to processing unit, it can be converted into ethanol, which is more valuable. We are also procuring maize grains from the farmers and selling it in the market, where, we can fetch comparatively more value.

3. By time

We are procuring maize grains during the harvesting season when prices are normally low. The grains will be then stored for the period of four months and afterwards sold at higher prices. Thus storing the maize for some time will provide us comparatively more value.

10. SOCIAL IMPACT

1. By procuring Maize Stover from the farmers, which is otherwise has a low economical value to them, we are providing with the additional source of income to the farmers. The additional benefit to the farmers is expected to be around Rs. 2000-2500 per acre .

2. The ethanol produced by us finds its use as the additive in petrol. The addition of ethanol will reduce the emission of green house gases proportionately, thus our product is eco-friendly.

11. SCOPE OF CO-OPERATIVE

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The back bone of our business model is the continuous supply of maize throughout the year. In order to attain maximum utilization capacity of the plant we need a high and undisruptive supply. The location where the plant would be set is surrounded by villages indulged in rain fed agriculture practices, and they are our raw material suppliers. These types of practices are risky for our business model, so in order to abate the risk Cooperative could be formed. This will help the farmers to reap benefits of the cooperatives. Cooperative will also ensure un-interruptive maize (also Stover of other plants) supply to our plant. This cooperative model would not be maize specific. Backward integration will be done if the results would be as per expectation in the starting years.