Reading Manual for Maize

Under PM FME Scheme

National Institute of Food Technology Entrepreneurship and Management

Ministry of Food Processing Industries

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ABBREVIATIONS & ACRONYMS

Sr:No.	Abbreviations &Acronyms	Full Forms
1.	PM FME	Prime Minister's Formalisation of Micro Food Processing Enterprises Scheme
2.	PVDC	Poly Vinylidene Chloride
3.	PVC	Poly Vinyl Chloride
4.	PET	Polyethylene terephthalate
5.	PA	Polyamide
6.	PE	Poly Ethylene
7.	QPM	Quality Protein Maize
8.	EVAL	Ethylene Vinyl Alcohol
9.	EVOH	Ethylene-vinyl alcohol copolymer
10.	HACCP	Hazard Analysis and Critical Control Point
11.	GAP	Good Agricultural Practices
12.	GMP	Good Manufacturing Practice
13.	SOP	Standard operating procedure
14.	FSSAI	Food Safety and Standards Authority of India
15.	FoSCos	Food Safety Compliance System
16.	FBO	Food Business Operator
17.	FLRS	Food Licensing and Registration System
18.	FSS	Food Set and Sound Nutrition
19.	PFA	Prevention of Food Adulteration
20.	GST	Goods and Services Tax
21.	MoFPI	Ministry of Food Processing Industries
22.	FPOs	Farmer Producer Organizations
23.	SHGs	Self Help Groups

CHAPTER- 1

INTRODUCTION AND PROCESSING

1.1 Maize scenario in the World

Maize is the most important cereal in the world. It is a source of more than 3,500 products including specialized Maize like QPM "Quality Protein Maize". Production scenario of three major crops shows that the growth in maize production in last 20 years is impressive. During 2000, the maize, wheat and paddy were produced in same quantity globally. During 2019, maize was produced 382 m t more than second most producing cereal wheat in the world. This was primarily due to expansion of industrial utilization of maize. At present maize is being cultivated on 197 m ha acreage with a production of 1148 mt and productivity of 5.82 t/ha during 2019 (Fig. 1). The wheat grown on the higher acreage (216 m ha) but has only 766 m t production owing to lower productivity (3.55 t/ha) compared to maize. The paddy as third most important cereal crop has 755 mt production from 162 m ha with productivity of 4.66 t/ha.

1.2 Maize scenario in India

Farmers engaged in maize cultivation in India are estimated to be 150 lakhs. Its cultivation generates >650 million man-days employment at the farm. Being turned to industrial crop, its cultivation and industries run through maize generates employment of over 1000 million man-days in India. It contributes about 2% to the total value of output from all the agricultural crops (http://ficci.in/spdocument/22966/India-Maize-Summit.pdf). Maize contributes 11% to total size of Indian seed industry. India‟s maize productions have been of subsistence level until 2000. The grain maize production area in last decade (2011-19) was ~9.0 m ha (Fig. 2). This excludes area under baby corn, sweet corn, pop corn, green ear, fodder, silage, etc. Thus, maize processing/industrial uses has actually expanded after 2000 and accelerated in last one decade owing to surplus maize production domestically. However, the first starch industry was started back in 1937 at Yamunanagar, Haryana with very low production capacity. Presently, industries have been installed with >1000 tonnes/day maize utilization capacity. The manufacturing of the many modified starch based products have been started in India to cater the growing demand of domestic and international market.

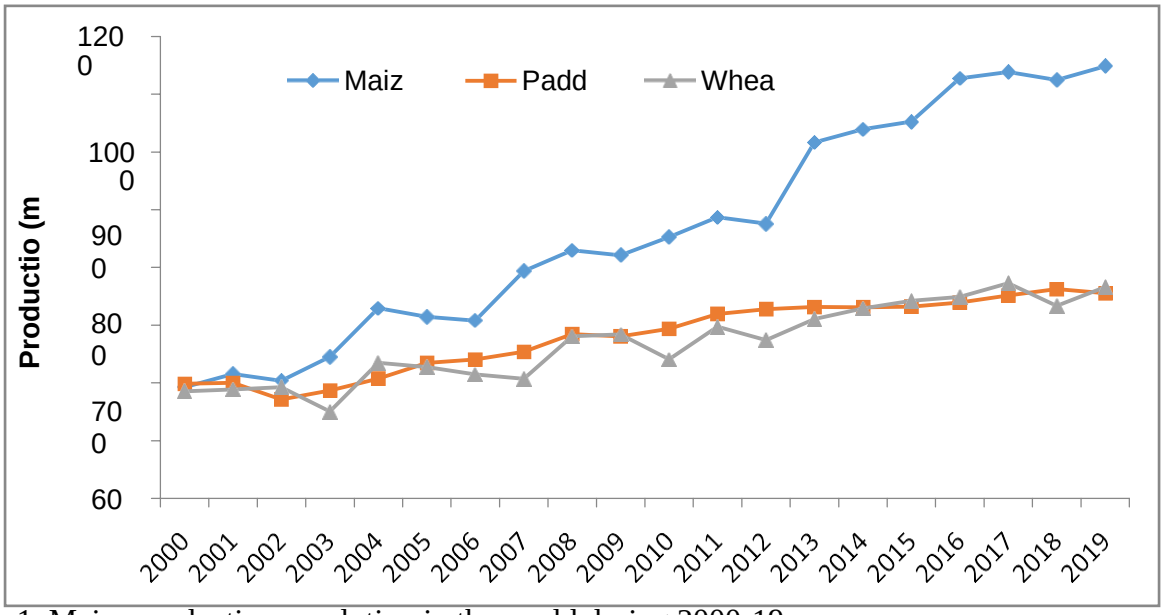


Fig. 1. Maize production revolution in the world during 2000-19.

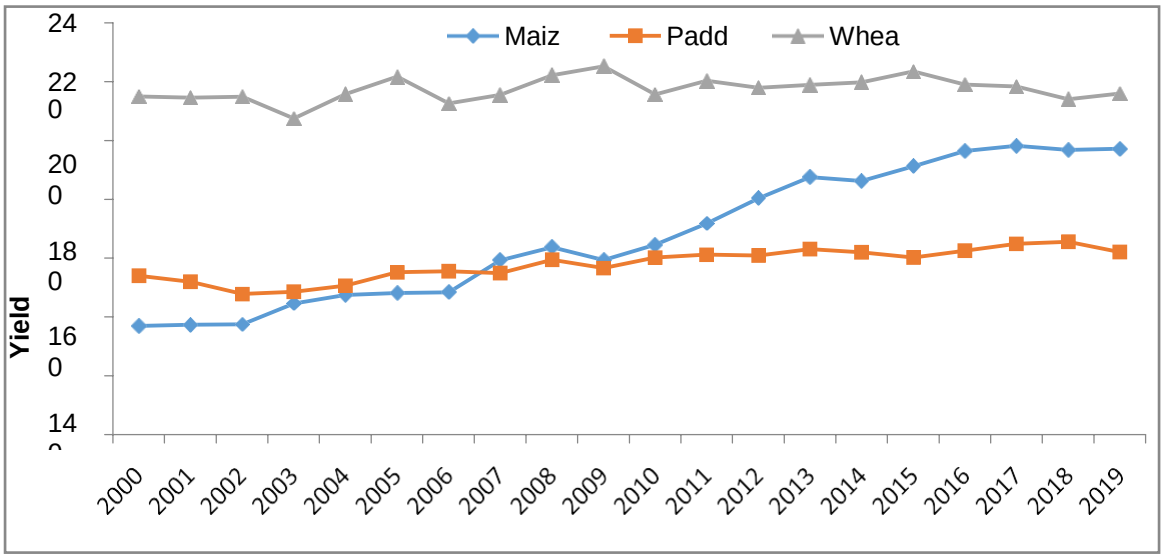


Fig. 2. Maize production scenario in India

The shift of focus by Indian maize research programme towards single cross hybrid ensured continuous growth in its production to sustain or enhance the capacity/growth of maize base industries. In USA, nearly 3500 products while in India over 1000 products are being made using maize directly or indirectly. Therefore, there is vast scope for developing maize agro-based or allied industries. The maize crop provides following key advantages in India:

- No more demand of other crop
- Market lead crop is to survive; address long-term goal of sustainability *wrt* cropping system, natural resources
- Climate change resilient and natural resource efficient
- Most diverse uses in the present and future
- Ethanol for future energy security
- Carbon trading
- Easier production technology
- Demand of value added products: national and international market; starch, chips, feed, baby corn, etc
- Most diverse types with numerous uses having highest yield potential suited to climate change and natural resource saving crop. The crop has advantage of market demand nationally and internationally, which makes it as preferential commodity for crop diversification.

1.3 Maize trade in the world

There are 140 countries in the maize export but the major market value shares in exporters are United States of America (~40%), Brazil (13.5%), Argentina (13.4%) and Ukraine (12.4%). The export from India was at peak during 2012-13 and it touched to ~5 mt (Fig. 3). Afterwards, the rising demand in maize consuming industries like poultry and starch made lesser maize available for export beside rise in crop production domestically.

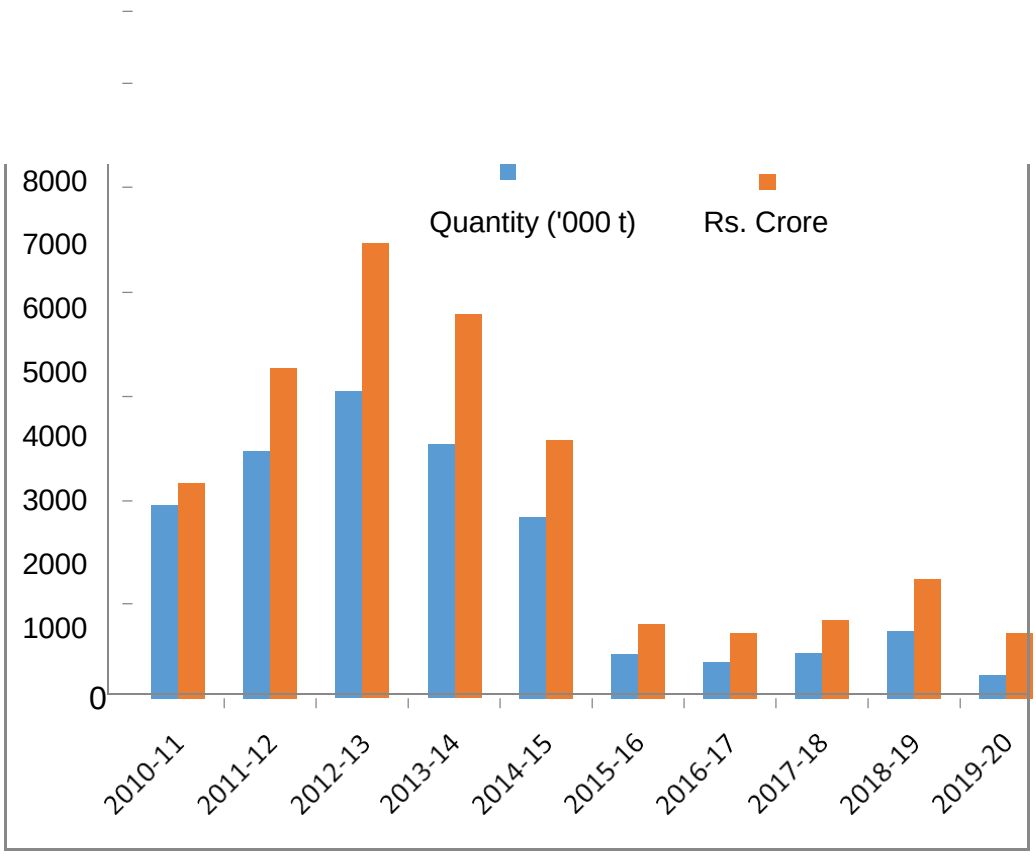


Fig. 3. Maize export form India during last 10 years.

In last one decade, the maize export was at peak during 2012-13 and due to rise in internal domestic demand for fast growing processing industry including poultry feed, starch, food processing, etc the export decreased substantially in last five years. This market can be again tapped by increasing the maize production as the importing countries like Bangladesh, Nepal, Vietnam, Indonesia, Malaysia, Sri Lanka, Bhutan, Myanmar, China, Thailand, etc are in our vicinity.

At present, maize is consumed in poultry feed (47%), cattle feed (13%), starch (14%) and processed food (7%), these sectors utilizes 81% of total maize production in India (Fig. 4). Only 13% if used for the food purpose mainly in traditional maize eating states of central India and hilly regions.

In future, the country has come out with hand to mouth in early era with no surplus for other than food purpose. Therefore, in past, industries were depended on imported maize, which

was costly, foreign dependent, and thus industrial growth stunted. The change in the technology progress after 2000 with renewed emphasis on the single cross hybrid technology lead to surplus maize production. This has lead to enhanced maize based industrial growth and establishment of processing industries of starch, feed, RTE food products, etc. Thus, now it turned from major food crop to major industrial crop that brought maize processing industrial revolution in India. Hence, processing is the alternative to increase farm profitability. The maize crop has potential to achieve doubling farmer's income goal of GoI.

1.4 Maize processing and value addition in India

Maize is used for both human consumption as well as animal feed, and other corn products like starch, grits, flour, meal, and other products which serves as a raw material to major snack industry, which the world use to provide wholesome food and a better life to millions of people around the globe. There are >3000 products in USA while in India only over 1000 products are being made using the maize. In India, a high growth is expected in various linked sector utilizing maize.

1.5 Prospects of maize utilization in next 10 years (2020-30)

Maize is not only food and feed, but also the important industrial raw material. It can be processed into more than 3000 kinds of industrial products. Corn processing can improve industrial structure, increase products value and solve the issues of profitability in agriculture. We can also produce high value product like high fructose corn syrup (HFCS), corn germ oil and refine biological ethyl alcohol. This can provide solution to the energy crisis by using corn as alcohol. The government already permitted mixing of 20% ethanol in petrol and diesel.

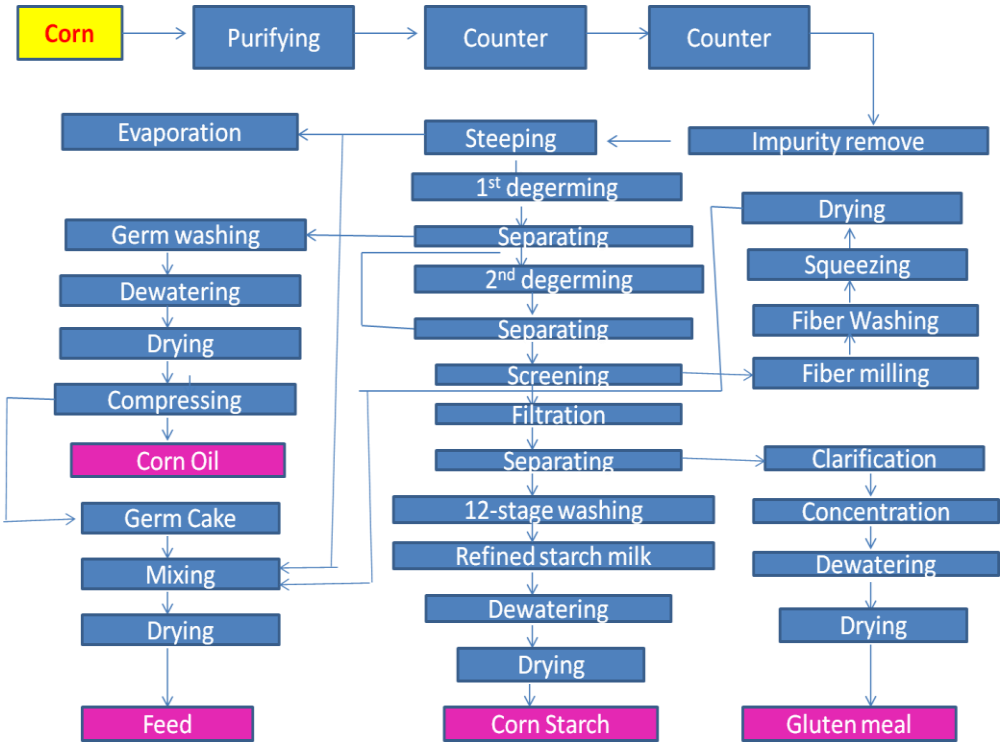
Sectors	**Purpose**	**Annual Growth Rate** (per cent)
Food	Grain	2
	Specialty corn	20
	Formulated food	10
	Dry milling	5
	Wet milling	7

Feed	Feed growth	11
	Poultry broiler	9
	Poultry layer	7
	Dairy	3.4
Brewery	Beer consumption	17.5
Industrial purposes	Higher prices due to diversion for ethanol	Competitive prices

Table 1. Prospects of maize utilization in next 10 years (2020-30).

Maize Starch Industry: Products/byproducts

Maize kernel consists of starch (70-74%), corn oil (3.0-4.5 %), Protein (8.5-9.5%) and Fiber (0.5%) with approximately 14-16% weight is moisture. Corn starch have advantage over other starch of tapioca and potato as it takes relatively short time to form viscous and opaque paste having low ash and protein content. It does not thin down appreciably during process of sizing and can be transformed into very smooth paste in lesser time. No antifoaming agents whileworking with maize starch due to neutral pH range and it is easily dispersed in hydrophilic media.



Corn processing for various products.

Starch is being produced from maize for many years by two general procedures, *viz.*, 1. Dry milling 2. Wet milling. Both dry and wet milling procedures accomplish separation of the germ from which corn oil is obtained and removal of the hull that constitutes the majority 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. The products obtained in starch are mainly as follows:

Cornstarch is a powdered product produced from maize (corn) through soaking, crushing, separation, purification and drying. In fermentation industry, cornstarch is used to produce monosodium glutamate and citric acid, etc. Cornstarch is also broadly applied in metallurgy and casting industries.

1.6 Application of maize starch

1. **In Food Industry**: It is a good source of carbohydrate in the diet and chosen for four reasons. Depending upon the purposes, maize starch is used in canned and Powder soups, instant desserts, custard powder, Ice cream, sauces and gravies, bakery, snacks, baby foods and Baking powder, flavor, encapsulation.
    1) As a thickener
    2) As a binder
    3) As a Filler
    4) As a stabilizer

Uses of corn starch:

- Cornstarch is extensively applied in papermaking and chemical industries as modified starch produced by modified starch industry.
- In fermentation industry, cornstarch is used to produce monosodium glutamate and citric acid, etc.
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The countries that are importing Corn Starch from India are: Indonesia, Saudi Arabia, Malaysia, Nigeria, Sudan, Kenya, UAE, Vietnam, Srilanka, Taiwan, South Africa

Modified starch:

- ❖ Corn starch powder
- ❖ Modified starches
- ❖ Liquid glucose
- ❖ High Maltose Corn Syrup (HMCS)
- ❖ Dextrose Monohydrate
- ❖ Maltodextrine
- ❖ Dextrose Syrup

Uses of the cornstarch in various sectors.

At present, mostly India is dependent on the import of the PLA and establishment of the industries could provide alternative to the plastic. This in turn will help in enhancing maize utilization and profitability to farmers.

Sweeteners: In starch based sugar industry, cornstarch is extensively applied to produce high maltose syrup, high fructose corn syrup (HFCS), maltodextrin, etc. These sweeteners have wide variety of application in processed food, pharmaceuticals, etc.

In India, maize is important constituent of feed industry and 63% maize is utilized for feed industries. This feed is primarily used for the promotion of poultry, pig, fish, buffalo and cattle.

Maize feed: Feed industry growing at a CAGR of 9% presents huge opportunity for Maize growers. Maize consumption growing at a CAGR of 11% in last 5 years: Poultry feed accounts for 47% of Maize consumption. Hence, the growth of the poultry sector in India was largely sustained by the matching growth in maize production due to availability of raw material for feed, which lacked in most of the other Asian and African nations. In coming years, there will be huge demand of feed from neighboring Asian and African nations and India could be a global exporter.

A QPM feed will have added advantage owing to high biological values and reduced cost of production and transportation in such nations and domestic market. The requirement of synthetic lysine could be avoided by use of QPM based maize feed having natural lysine and thus it will make a biologically well-maintained system for better poultry production. Hence, the overall production cost will reduce as well improve the quality meat and eggs. The brand „QPM feed" needs to be exploited nationally and internationally in this direction to achieve sustainability of the poultry value chain and trade.

1.7 Maize semolina

Semolina (Suji) from maize can be used for making many preparations where wheat or rice are conventionally used for different products such as *upama, kesari bath, idli*, *dhokla* like soft cooked preparations. Study conducted at AICRP (Maize) centre revealed that *Idli* and *dhokla* prepared from maize suji are accepted organoleptically by semi trained judges as well as consumers due to its creamish yellow colour and are highly porous in texture due to sparse distribution of pores in case of maize products compared to rice products. Maize suji of medium and large particle size (-20 B.S. mesh) require more cooking time (25-30 min) compared to rice and wheat suji. Hence fine suji (-40 B.S. mesh) is preferred in order to reduce the cooking time to

10 minutes. The swelling capacity and water absorption capacity of maize suji and flour are quite high compared to rice and wheat products. It therefore, requires more water for cooking. The above properties of maize would help to produce and promote maize suji usage, particularly in south India, where suji finds ready use in their culinary practices for sweet and savoury dish preparations.

1.8 Maize flour

The c**oarse or granulated maize** is used in pancake and muffin mixes, corn snacks, cereal products and other baking products.

Many conventional dishes such as thick and thin *porridges*, *pancakes, roti, thallipattu*, sweet and savory preparations etc. are commonly prepared in India. Compared to *porridges, roti* in the form of dry pancake is the most preferred method of use. However, the *roti* of maize cannot be rolled thin due to lack of gluten that contributes for adhesive and extensive properties. Hence, the flour of maize needs to be gelatinized by keeping a heap of maize flour in a boiling water and cooking under low flame for 8-10 minutes. Thus, the dough acquires some adhesive property and can be rolled into quite thin products. A unique property of the maize dough is its ability to hold more water than other cereal dough (maize requires 115 ml water/ 100 g flour, sorghum; 90ml, pearl millet; 85 ml, and wheat; 65 ml/100 g flour). The maize *roti* will have higher moisture content than other cereal *rotis*. Even for getting better textural properties, maize can be mixed with wheat or sorghum flour between 30 and 40 per cent.

The people suffering from wheat gluten intolerance can be provided with suitable dietary option based on QPM maize which has lower gluten and nutritionally superior.

1.9 Corn flour processing industries: It is used to make maize bread, bakery products, mixed infant‟s foods and breakfast cereal, noodles, pasta and other snack foods. Is used for making roti (dry pancake), dumpling, bread, wet pancake, infant‟s foods, biscuits, wafers, as filler and carriers in meat products, and breakfast cereals. Research at AICRP (maize) centre has shown that judicious refining of maize grain will enhance the appearance and eating quality, texture and other organoleptic qualities without affecting the nutritional quality.

Flour and porridge (dalia) is made by varying capacity corn milling plants. This corn flour is being exported to various countries like South Korea, Thailand, Angola, Nigeria, United States, Philippines, UAE, Ghana, United Kingdom and Mal aysia. It is

primarily used as a thickening agent. Mixed with cold liquid, powder is used to make sauces and eliminate the problem of formation of lumps. Highly appreciated in the market for different commercial uses, the Corn Flour Powder is tasteless and contains no wheat or gluten. The Product is light tan in color, bland in taste, fine powder texture and has a clean cereal odor. This powder is made from high quality corn or maize and is Corn flour, corn meal & corn grits are all dry milled corn products. It can be used in product applications worldwide, from breakfast cereals, beer and snack foods, to baked goods and baby foods. The use of the quality protein maize in this industry will improve the nutritional quality of the corn flour and expected to establish premium market. This will help to fasten the growth of this industry in times to come with huge export potential and internal demand.

Corn Flour

Applications of the corn flour are:

- Bakery Dusting
- Breads and Batters
- Pancake and Waffle Mixes
- Beverages, Alcohol
- Confectionery Toppings
- Confections
- Baby Foods
- Snacks, Cereal

The countries which are importing Corn Flour from India are: India exports corn flour to South Korea, Thailand and Angola.

1.10 Maize gluten meal

Corn gluten meal, also called corn gluten powder, mainly consists of corn protein contains a small amount of starch and fiber. Less common corn protein powder particles, powder, orange

yellow, Fried bean flavor, a little tasteless advanced corn protein powder granule, powder, golden brown, have bean fragrance. Due to the different USES and different production technology to produce corn protein flour nutrients, directly affecting the effective utilization and economic benefit of feed formula.

Corn gluten meal

Corn protein powder, protein nutrition is rich, can be used for feed use, compared with feed industry commonly used fish meal, soybean cake, resource advantage, high feeding value, do not contain toxic and harmful substances, does not need to processing, can be directly used as raw material plant sex protein.

The countries which are importing Corn Gluten Meal from India are: **Indonesia, Kenya, Taiwan, Myanmar, Vietnam, Nepal, Japan, Germany, Bahrain.**

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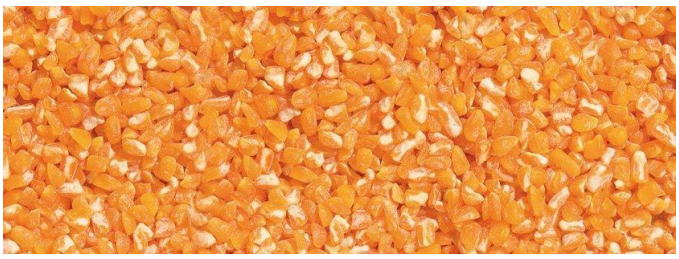
1.11 Maize grits

Grits is a food made by boiling ground maize, and usually served with other flavorings as a breakfast dish, usually savory. It is popular in the Southern United States. Grits is of Native American origin, and is similar to other thick maize-based porridges from around the world such as polenta. Yellow Maize grits that have dietary fiber content and are free from adulteration.



The process flows from screen cleaning, de-stoning, removal of bran, separation of grits and germs and then grading and gravity separation to obtain pure grits and germs. The yield of grits is approximately 70%, powder 10 %, fine grits 10%, germs 7%, bran etc.3 %. Plant is fully mechanised. Capacities available are 50 TPD and 100 TPD. Large grits are used for the manufacture of breakfast cereal corn flakes, for which grits from yellow maize are preferred. Coarse grits and medium grits are used in the manufacture of cereal products and snack foods. Fine grits used in industry it is used as a brewing adjunct. At domestic level, maize grits or hominy grits are used to prepare porridge by boiling with water, preparation of traditional breakfast items such as *kesaribath* (*sweet bath*), *Upama* (*khara bath*), *idli* and *dhokla* preparations. The countries which are importing maize Grits from India are: Saudi Arabia, Thailand, UAE, Egypt, South Korea, Yemen, Japan, Oman, Taiwan, Bahrain

1.12 Corn flakes

At the factory, the corn grits are rolled out into flakes. Those flakes are then cooked, dried and toasted to become Corn Flakes**.** At present, only few multi-nationals dominate the corn flakes business in India. however, we have domestic machinery manufacturer equally good in preparing the product for marketing and export. 500 Kg/hr to 4000 Kg/hr production capacity machines available in Indian market. Rs 50 lakhs base plant can be installed with 30 t/month capacity. These machines are already established at Punjab, Haryana, National Capital Region Delhi, etc. This will generate additional employment as well as ensures affordable corn flakes to the consumers by promoting small-scale businesses entrepreneurs. The variable types of the corn flakes like Choco flakes, honey flakes, etc are being made in small-scale which can be enhanced. Makka Poha, used in snack industries like mixture namken and snacks can also be made though the machines used in corn flakes with little modification. Corn grits can also be produced though this machine, which is in high demand for export. India can become a big cornflakes exporter**.**

1.13 Corn puffs/kurkure/curls: The puffs/kurkure/curls made from maize area liked by the children and demand is increasing. The machines are available I Indian market ranges from Rs 3-10 lakhs with capacity of 100-500 kg/hr. These machines are semi-automatic to automatic where investment can be made as per the requirement. Hence, small businesses can be established under this category, which have opportunity for export potential in future.

Automatic Kurkure making machine.

Table 2. Vitamin and mineral content of maize.

Nutrients	**Per 100 g**
Magnesium (mg)	139.00
Sodium (mg)	15.90
Potassium (mg)	286.00
Copper (mg)	0.41
Manganese (mg)	0.48
Zinc (mg)	2.80
Chromium (mg)	0.004
Carotene (µg)	90.00
Thiamine (mg)	0.42
Riboflavin (mg)	0.10
Niacin (mg)	1.80

Normal maize has high zein fraction (60%) and deficient in essential amino acids *viz.* lysine and tryptophan. Normal maize also have imbalance leucine: isoleucine ratio that affects niacin (essential vitamin) biosynthesis and thus these reasons makes its low biological values and digestibility. QPM is a cheap and natural source of quality protein and it provides solution to the malnutrition of Indian poor masses. Quality of QPM green cob is better than normal maize and nutritionally superior as it has double lysine and tryptophan than normal maize (Table 3). Even QPM is superior to rice and wheat.

Amino Acid	**Amino Acid (mg/g N)**	
	Normal	**QPM**
Lysine	160-180	256-300
Tryptophan	30-40	60-100
Isoluecine	206	193
Leucine	827	507

Table 3. Nutritional Status: Normal vs QPM Maize.

QPM hybrids have been introduced to the farmers across India through „Frontline Demonstration" scheme. The biological value of QPM Maize is double than the normal maize and higher than wheat, rice, and matching with milk for true protein digestibility (Table 2) which helps to reduce feed requirement. This is a cheap source of quality protein and hence reduces the feed cost and solution for malnutrition of poor masses. There is no need of adding synthetic lysine in the feed that has side effect, hence it will provide healthy feed and save the extra cost involve in mixing of lysine in the feed. This will give direct benefits to the feed/poultry industries.

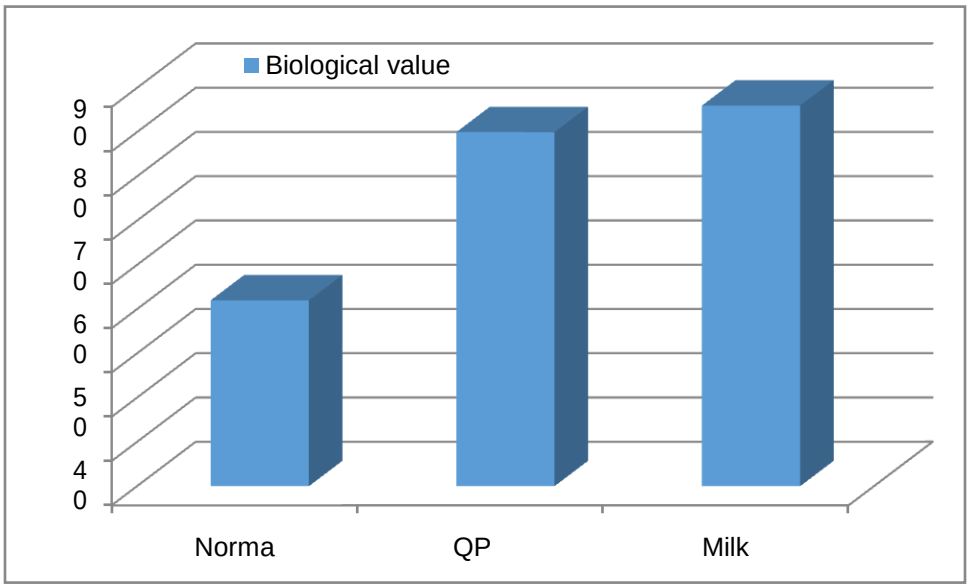


Fig. 12. Protein comparison of QPM over milk and normal maize.

This also provide low cost quality feed for promotion of poultry industry and in future 50% of the world hatcheries are likely to be shifted in India. The expenditure index on the per unit protein production in QPM is much lower compared to animal protein production.

This QPM can be used as food for nutritionally disadvantageous population of the country especially tribal whose primary food is maize. Beside this QPM can be used as nutritionally superior food for children‟s, pregnant and lactating women, adolescent and old age population of the country. Being low cost quality protein compared to milk it meet the energy and protein needs of infants and children and thereby improves growth rates in young children and fulfill protein requirements of adults. Thus, it prevents and cure protein deficiency diseases, Kwashiorkor in young children and marasmus in old. Many value added products of QPM can be prepared viz.; biscuits, kheer, chakli, chips, kurkure, porridge/cheela, sattu, kheer, halwa, upama, malt mix, health mix, rab, khichadi, chakli, sev, ribbon, murrukku, muffins, ladoo, mathari, fryams, bakli, pasta, cake, etc. Hence, this will help in increasing productivity of the human in the country.

Beside this, QPM helps in promotion of poultry and piggery as piglets grew faster than normal maize and thus improves feed efficiency and a solution for low cost quality feed, which reduces feed requirement also. The use of QPM provides affordable quality protein to address nutritional security; hilly areas, tribal, school going kids, adolescents. It can be boon for people facing problem of gluten intolerance.

Fig. 13. QPM chapatti.

1.14 Value addition products of QPM

Several value added products from Quality Protein Maize (QPM) were developed and popularized at AICRP (Maize) Pusa centre. The nutritious products from QPM which includes recipes suitable for eastern region (*Chatpati, maize roll, Chutney, Hilsa corn chat, Pakodi, Jalebi* etc.) recipes for northern region (*Sweet dalia, Khichari, Kheer,* weaning mixture, *laddoo, sev, cheela, dhokla, pasta, fryums* and *poori*), recipes for western region (*dhokla, Bati, Rab, Papadi, Paratha, Gatta, Pakodi, Halwa, sev* and *muffins*) and the recipes for southern region (*Malt mix, Poustic mix, Chakkuli,* sweet and salt biscuits, *chutney* powder , health mix, *idli, dosa Sheera* and *besan laddo*) can be prepared by combining QPM flour or Suji to the tune of 50 to 60% or even 100% in some of the recipes (Singh *et al.* 2011).

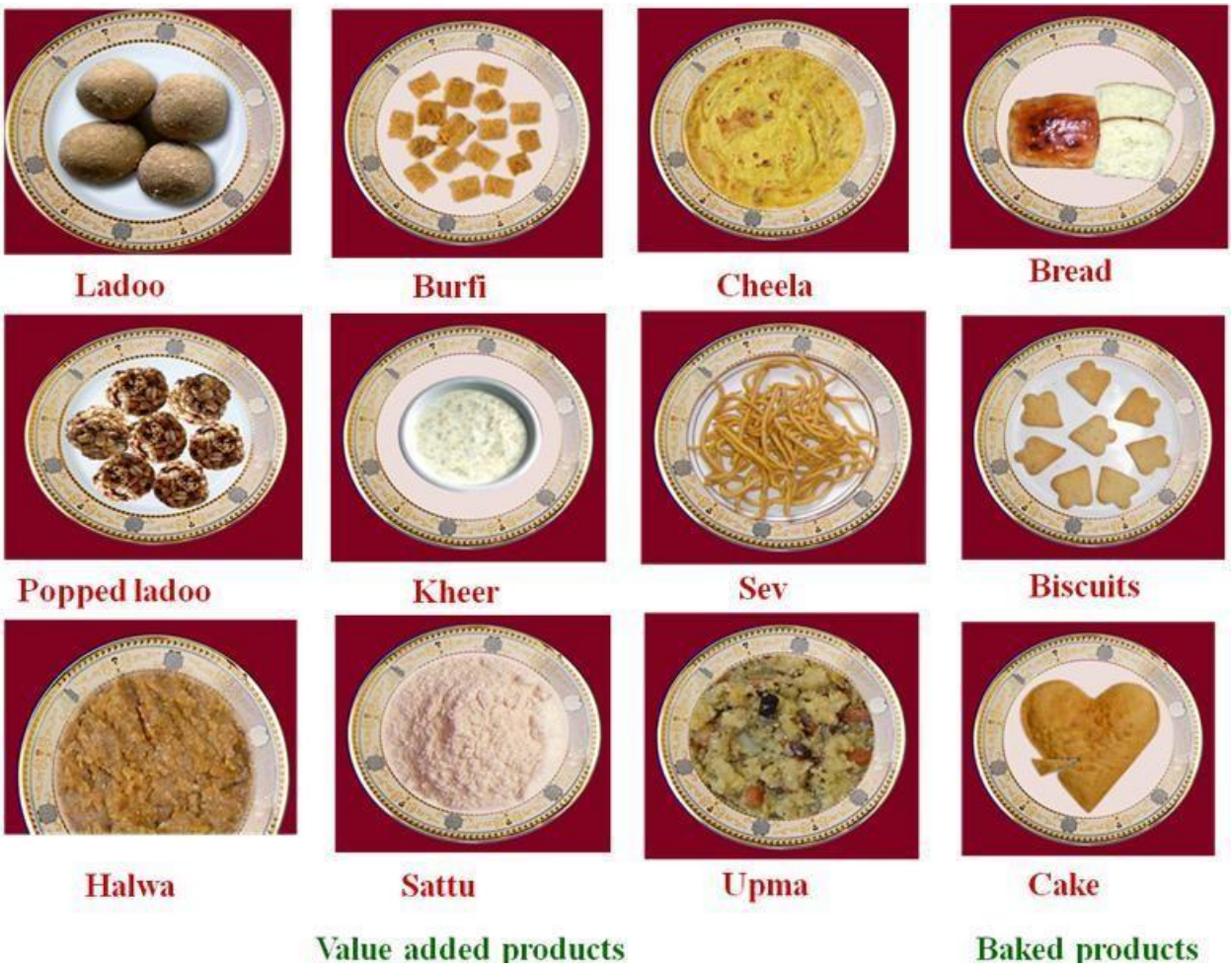


Fig. 14. Value added normal and baked QPM products.

Various QPM based products such as suji, flour, vermicelli, noodles, biscuits, cheese balls and crispies are some the products prepared by trained women SHG‟s and selling on large scale. Some products from QPM have already been developed and commercialized by some entrepreneurs. These commercialized products are Pusa Shakti (QPM chatpati), Dilkush (instant Kheer mix) and Proteino-H (Kadhi mix). There is a demand for QPM suji, QPM idli mix (ready to cook), QPM-vada mix (ready to cook) and Nutri mix from the people of Karnataka. Many other products from QPM are under process of screening based on nutritive value, organoleptic quality as well as marketing potential (Kaul *et al*. 2016).

Fig. 15. Value added extruded and convenience QPM products.

The QPM products must have product profile and literature as follows:

1. Nutritious healthy food
2. Natural lysine enriched
3. High biological value
4. Easily digestible
5. The product must have the above slogans along with name of the product suffixed/prefixed with „QPM". e.g. QPM Poha, QPM Corn flakes, QPM Puffs, QPM Flour, QPM grits, QPM Chocos, QPM Daliya, QPM Feed, QPM Silage, QPM Gluten etc.

Utilization of Quality Protein Maize (QPM): The major utilization of QPM is described as here under:

Food and Nutritional Security:

The QPM can be utilized for diversified purposes in food and nutritional security as infant food, health mixes, convenience foods, specialty foods and emergency ration. It also finds its place in fulfilling the protein requirements of different sections of society (infants, lactating mothers, convalescing patients, kwashiorkor diseased, old persons etc.) to prevent malnutrition. Even for the food and nutritional security of the tribal population, which constitutes approximately 10 % of the total population, where in the majority of the tribal population depends on maize as their basic diet, in these areas the scope for QPM to ensuring food and nutritional security is paramount. Substituting maize with QPM is viable option for ensuring their nutritional requirement. Several studies conducted on human beings and animals revealed the positive health benefits of QPM in their daily diet. Study conducted by Gunaratna *et al* (2010) reported that consumption of QPM instead of maize leads to increase in growth rate such as height and weight by 12 and 9% respectively in infants and young children who belong to mild to moderate nutritional background with maize as their major diet. The increase in height and weight is due to higher biological value of QPM as compared to maize (Table 8). Hence it is high time that policy makers should think of introducing QPM in public distribution system (PDS), in mid day meal programmes in Schools and Aanganawadis to serve balanced food at low cost. Government of India has already started tribal- sub plan (TSP). Under the programme, Indian Institute of Maize Research has initiated the programmes like distribution of QPM seeds, inputs and training programmes on cultivation and preparation of maize value added products in order to create awareness regarding food utility of QPM.

QPM chips: The chips made in corn oil have excellent quality and consumer acceptability and export potential. Already such products are exported to nearly 20 countries by India but still there is huge demand for chips. Low fat content and crunchiness made it acceptable chips in the market.

1.15 Industrial Security

In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products in the world that includes starch, oil, protein, alcoholic beverages, food sweeteners, bio fuel, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc. In India, presently

> 4.0 mt of maize is used for industrial purpose that includes for starch industries and for ethanol and beverage industries. In India, more than two dozen starch industries (Punjab, Haryana, Himachal, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu) and around one dozen biofuel industries (Maharashtra and Andhra Pradesh) and other hundred of maize based industries are operating.

1.16 Nixtamalized maize or lime treated maize or alkali treated maize

The nixtamalization consists of treatment of whole maize with 1% lime (calcium hydroxide) solution. The procudere involves soaking-heat treatment for 30 minutes-overnight soaking-washing to remove extra lime-drying. The grinding of nixtamalized kernels can be done with a hand operated or electric kitchen mixer-grinder for masa preparation form maize kernels. This masa is the base for preparing several traditional products such as tortillas, tamales, etc. The dry masa flour is more stable against rancidity and the shelf life can be until one year in comparison with the whole kernel ground maize flour.

Maize

↓ **Cleaning**

Soak maize grains in 1% lime water

(10 g of lime/litre water)

↓

Heat treatment at simmering temperature for 30 minutes

↓

Leave it for overnight

↓

Wash 3 – 4 times to remove lime

↓

Drying and bring down moisture level to 9-10%)

↓

Store in air tight container

Nixtamalization or alkali treatment process for maize kernel to increase quality and shelf life of corn flour.

Nixtamalization treatment has the following advantages: it facilitates the pericarp removal, controls microbial activity, enhance water uptake, increases gelatinization of starch with improvement in nutritional value through an increased availability of niacin. The research conducted at AICRP (maize) Mandya centre, indicated that the lime treated maize flour could be kept up to three months in LDPE covers without affecting its flavor and roti making quality (Shobha *et al.,* 2012). The process of lime treatment and its advantages to be disseminated through training to SHG"s, FPO and mill owners. At present, the nixtamalised corn or the lime treated corn is being used in India for the preparation of various products such as dumpling, dry pancake, *upama, idli, dosa, dhokla,* snack foods such as *sev, muruku* and *laddu* by suitably combing with pulse and other adjuncts.

Baby corn may be consumed raw or used as an ingredient in various preparations. Different value added products such as *manchuirian, jam, pickle, pakoda, curry, salad, soups, halwa,* canned corns etc. are few examples under wide range of value added products. Recently a process has been standardized at AICRP (Maize) Mandya centre for preparing baby corn candy using 40, 50 and 60^0 brix sugar solution followed by dehydrating the same till the moisture level reaches between 10-12 per cent. Prepared cadies will have a shelf life of six months in MPP pouches.

Baby Corn Pakora

Baby Corn Chat

Baby Corn Cutlet

Baby Corn Halwa

Baby Corn bufri

Baby Corn Salad

Baby Corn Kofta Curry

Baby corn masala

Fig. 18. Baby corn products.

1.17 Sweet corn

Sweet corn (*Zea mays saccharata*) is genotypes with specific endosperm mutation like su and sh. In India, sweet corn green ears are being consumed by direct toasting on fire or boiled in water. Sweet corn kernels often have a wrinkled appearance resulting from a sugary gene, which retards the normal conversion of sugar to starch during endosperm development. Kernel colors vary sometimes being mixed both white and yellow. The endosperm is composed of sweetish starch and characterized by translucent horny appearance during immature stage and after maturity, the kernel becomes wrinkled. Sweet corn cob is harvested around 80-85 days after sowing (milky stage). It contains on an average 25-30% sugar; many sweet dishes such as *halva, kadabu, crunch, salad, jam, pakoda* and such products can be prepared using sweet corn by combining with jaggery, vegetables and such other ingredients.

1.18 Pop corn

Among various types of corn, the most popular being the “Popcorn” (*Zea mays* var. *everata*), is a type of corn that expands from the kernel and puffs up when heated with light crunchy texture. Popcorns are usually consumed as a snack food with or without salt (regular), sweetened (caramel/chocolate corn) or butter like topping. Popcorn consumption has greatly increased in recent years because of the advent of microwavable popcorn and the proliferation of flavored ready to eat products.

Popping is simple and economical processing technique which is traditional and may be adopted easily with improvement in nutritional quality of grain. It is high temperature short time (HTST) treatment which sterilizes product, gelatinizes its starch and develops pleasant aroma to form a ready-to-eat food (RTE) at low processing cost. Popping process not only retains the actual nutritional profile of grains but also markedly enhances its protein digestibility, bio availability of iron and dietary fiber content due to the development of resistant starch. Popping also reduces some of the anti nutrients viz., phytates, tannins, acid detergent fiber, lignin and cellulose (Reddy *et al.*, 1991).

Value addition to pop corn

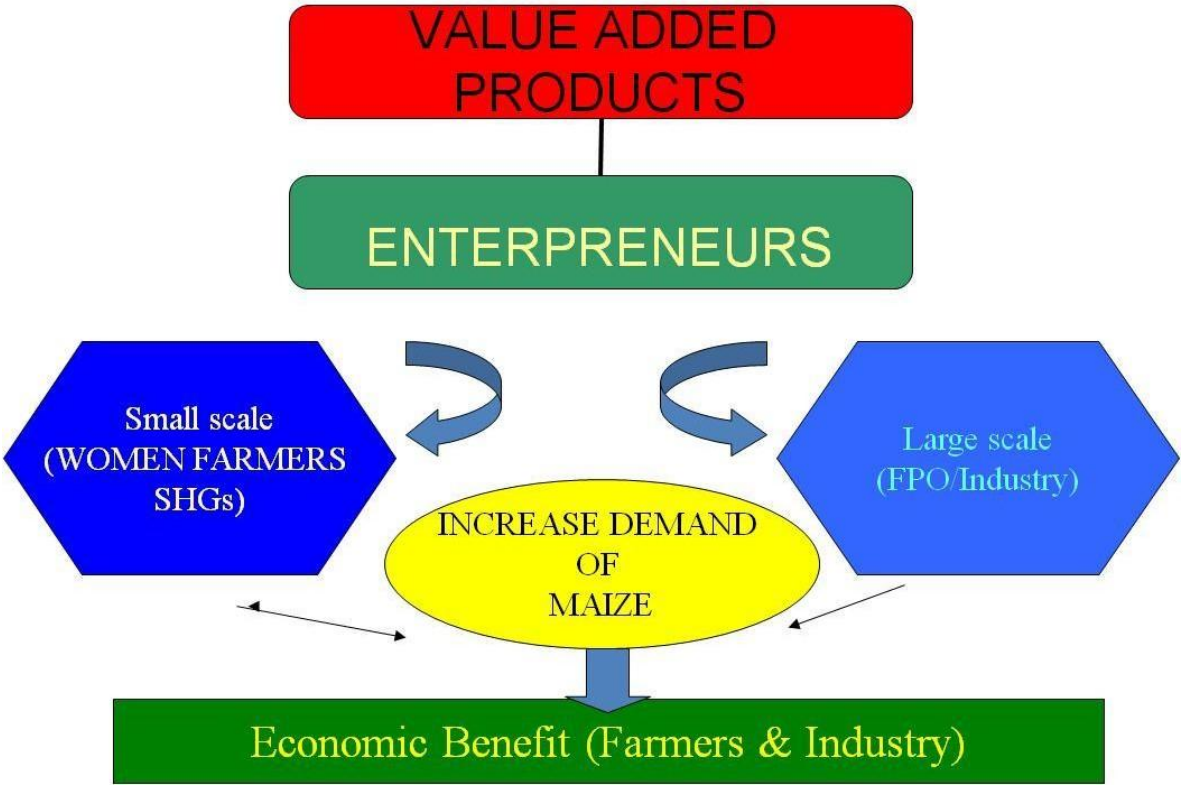
Popped maize contains slightly higher proportion of fiber and hence is suitable for the preparation of high fiber specialty foods. Apart from normal snack, eatable pop corn finds its use in the preparation of sweet popcorn, masala popcorn and popcorn *laddus*. Even the pop corns can be ground to make coarse powder, which can be used for the preparation of many traditional dishes such as *burfi*, pop corn gum *laddu*, pop corn holige, nutria-bars, chocolate-coated bars etc.

Even the health mixes such as energy rich pop mix (prepared by combining with jaggery, copra gratings, poppy seeds and dry fruits with pop corn powder), protein rich pop mix (pop corn powder, puffed bengal gram powder and sugar powder), iron rich pop mixes (popcorn powder, besan powder, garden cress seeds, ragi malt powder and sugar powder) can be popularized by women SHG‟s and also marketing outlets need to be increased for such products.

Nutritive snacks industry in maize:

- Roasted dried maize cobs
- Roasted Sweet corn cobs
- Babycorn pakora
- Popcorn

- QPM biscuits, Kurkure, chips, pasta, mathi, chakli, etc.
- Corn flakes



Entrepreneurship development for maize processing

CHAPTER -2

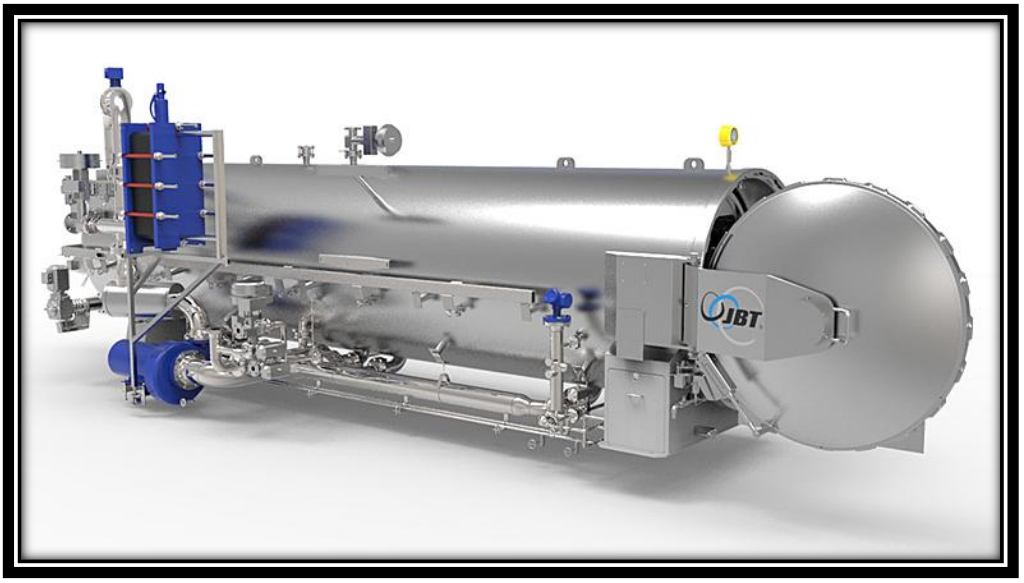
MACHINERIES REQUIRED FOR MAIZE PROCESSING

2.1 HUSKING MACHINE : Corn husking machine is used to remove the husk of the corn.

2.2 DE SILKING MACHINE : This machine is used for the removal for silk from the corn.

2.3 CORN KERNEL REMOVER MACHINE : Removing of kernel from cob is an important steps in processing which is done with help of kernel remover machine. Kernel is separated in well manner to avoid any kind group pulling.

2.4 RETORT : Retort is used for sterilization of can so that microbial load can be reduced.



2.5 GRAVITY SEPERATOR : Gravity separator machine may be used to separate any type of dry bulk particles that are similar in size and shape but differs in weight. Gravity separator are suitable for processing of the seeds of corn, Wheat, rice, soybean, sorghum, various vegetables and other agricultural and sideline products.

2.6 FOOD GRADE CONVEYOR: These are conveyors with food grade belt to maintain food safety standards set by monitoring authorities.

CHAPTER-3
PACKAGING OF MAIZE PRODUCTS

Packaging is an important part of food manufacturing process. It protect the food products from physical ,chemical, biological damages. Without packaging, food handling would be a messy, inefficient and costly exercise and modern consumer marketing would be virtually impossible. Thus food packaging lies at the very heart of the modern food industry.

Packaging Institute International defined packaging as the enclosure of products, items or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle or other container form to perform one or more of the following functions: containment, protection, preservation, communication, utility and performance. If the device or container performed one or more of these functions, it was considered a package.

3.1 Need of Packaging

Packaging performs a series functions:

Containment : The containment function of packaging makes a huge contribution to protecting the environment from the myriad of products that are moved from one place to another on numerous occasions each day in any modern society. Faulty packaging (or under-packaging) could result in major pollution of the environment.

Protection : the primary function of the package: to protect its contents from outside environmental influences such as water, water vapor, gases, odors, microorganisms, dust, shocks, vibrations and compressive forces.

Convenience : Products designed to increase convenience include ready to cook or ready to eat foods which can be reheated in a very short time, preferably without removing the primary package. Thus, packaging helps in convenience of consumer. Convenient packages promote sales.

Communication : Packaging contains a lot of information such name of its manufacturer, product name, terms and uses, date of manufacturing, best before. nutritional information thus helping the consumer to be more informed.

3.2 Types of Packaging

Primary Packaging

- Primary package are those package which directly came into contact with food products. It provides first or initial layer of protection to the food products.
- Examples - Metal cans, tea bag, paperboard cartons, glass bottles and plastic pouches.

Secondary Package

- Secondary package are those package which surrounds or contains the primary package.
- It further used to group primary packages together.
- Act as carriers and many a times also used for the display of primary package.
- Examples are Corrugated case, Boxes.

Tertiary Package

- It contains number of secondary package together.
- Mainly used for bulk handling of food products.
- Example : stretch-wrapped pallet.

Quaternary Package

- Quaternary package is mainly used for handling the tertiary packages.
- It generally includes a metal container which can be transferred to or from ships, trains.

3.3 Packaging of Sweet Corn Products

Packaging of sweet corn bean and its products are mainly done to protect the food products from outside environment especially after the completion of process so that products can retain flavor, aroma, freshness for a longer period of time. Packaging is also done to increase their shelf life. Sweet corn bean products can be packed in wide range material which includes LDPE, PET, glass, aluminum etc.

LDPE

Low-density polyethylene is heat sealable, inert, odour free and shrinks when heated. It act as a barrier to moisture and has high gas permeability, sensitivity to oils and poor odour resistance. It is less expensive, therefore widely used. One of the great attributes of LDPE is its ability to be fusion welded to itself to give good, tough, liquid-tight seals.

PET

PET can be made into film by blowing or casting. It can be blow moulded, injection moulded, foamed, extrusion coated on paperboard and extruded as sheet for thermoforming. Melting point of PET is higher than PP which is around 260°C and due to the manufacturing conditions does not shrink below 180°C. Thus PET is ideal for high-temperature applications. PET is also flexible to low temperature (-100°C). It also act as good barrier of oxygen and water vapour.

Polypropylene

Polypropylene films have better clarity than polyethylene and enjoy superior machinability due to stiffness. Lack of good salability has been a problem; however, PVDC and vinyl coating have been

used to overcome this problem. Some varieties of PP have been specially developed for twist-wrap applications as they have the ability to lock in position after twisting.

Glass

Now a day glass container has been also used for packaging. It has following advantages:

- act as strong barrier to moisture and gases.
- Prevent unwanted odors and microbial growth.
- do not react with food products.
- suitable for heat processing when hermetically sealed
- glass are re-useable and recyclable
- they are transparent to display the contents
- they are rigid, to allow stacking without container damage.

The disadvantages of glass include:

- glass have high weight which increases the transportation cost.
- very much fragile and low resistance to thermal shock as compare to other materials.
- potentially serious hazards from glass splinters or fragments .

Aluminium

Aluminium is used for packaging due its highly malleable properties: can be easily converted to thin sheets and folded, rolled or packed. Aluminium foil acts as a total barrier to light and oxygen odours and flavors, moistness, and germs, and so it is used broadly in food and pharmaceutical packaging, including long-life packs.

Laminate

The laminates can be formed, filled, gas flushed and sealed on a single machine from reel stock. Gas flushing is achieved by saturating the powder with inert gas. The main advantages associated with laminates are lower material cost and lighter material weight. The disadvantages are that laminates do not have the mechanical strength and durability of rigid containers, and there can be difficulty in obtaining a satisfactory heat seal because of contamination of the heat seal area by powder during filling at high speed.

3.4 Some recent development in packaging

Aspectic Packaging

Aseptic packaging is the filling of sterile containers with a commercially sterile product under aseptic conditions, and then sealing the containers so that reinfection is prevented; that is, so that they are hermetically sealed. Application of aseptic packaging involves: packaging of pre-sterilized and sterile product and packaging of a non-sterile product to avoid infection by microorganisms.

The major reasons for the use of aseptic packaging are : to take advantage of high temperature- short

time (HTST) sterilization processes, to enable containers to be used that are unsuitable for in-package sterilization and to extend the shelf life of products at normal temperatures.

Active and Intelligent Packaging

Active packaging is defined as packaging in which subsidiary constituents have been deliberately included in or on either the packaging material or the package headspace to enhance the performance of the package system.

Intelligent packaging is defined as packaging that contains an external or internal indicator to provide information about the history of the package and/or the quality of the food. Sachets and pads are the most widely used forms of active packaging and the various functions which they perform are discussed in the following:

- Oxygen absorber
- Carbon dioxide absorber or emitter
- Ethylene absorber
- Ethanol emitter
- Moisture absorber

Modified Atmosphere Packaging

MAP can be defined as packaging of food items where atmosphere inside the packet has been modified to increase the shelf life of food products. It involves active modification or passive modification. In active modification air is displaced with a controlled, desired mixture of gases, and the process is called as gas flushing. Passive modification occurs due to respiration and the metabolism of microorganisms associated with the food. The package structure normally incorporates a polymeric film, and so the permeation of gases through the film also influences the composition of the atmosphere that develops.

3.5 Labeling

Labeling performs the communication function of packaging, informing the consumer about nutritional content, net weight, product use and so on. Labeling acts as a silent salesman through distinctive branding, as well as facilitating identification at check-outs through the Universal Product Code (UPC).

There various types of labeling which are as follows:

Glued-on Labels : These are the simplest type and consist of sheet material (typically paper), which has been printed and cut to size. They are attached to the package with adhesive, which is applied either at the time of application, or at the time of manufacture, in which case the adhesive is activated with moisture immediately prior to application.

Self-Adhesive (Pressure-Sensitive) Labels : These can be made from paper, plastic or aluminum foil laminated to paper or plastic, and can be produced to adhere to a wide range of materials.

In-Mold Labels : It offers better resistance to heat, moisture and chemical than those labels made from paper. There are also recycling advantages with film labels. IML materials must be able to withstand the container manufacturing process. The heat generated during blow molding presents a challenge to most inks because pigments can change.

Sleeve Labels : A wide range of containers can be sleeve labeled including glass bottles, plastic bottles and metal cans. Sleeve labels shrink into or stretch around contours, penetrate variable geometries and conform to irregular features.

Holographic Labels : Holographic labels that incorporate a hologram have large application in food packaging for both marketing and security reasons, specifically in the areas of anticounterfeiting (authentication) and brand protection. Surface relief and volume are the most common type of hologram. Surface relief holograms exhibit a characteristic rainbow-colored pattern or image. Volume, or reflection, holograms have a very different appearance to surface relief holograms and are generally used for authentication.

3.6 Quality considerations during Packing

Quality control of packed products is the last time the product is checked before reaching the customer.

Documented checking of the packages entails:

- Weight of the package
- Weight of the product
- Arrangement of the product
- Defects; and Moisture content.

The surrounding area is also checked:

- Cleanliness of the handling equipment during processing
- Calibration of the scales (automatic or manual);
- Writing on the packages;
- Satisfactory working of the metal detector (installed on every retail packing line);
- Repackaging installations and marking; and

Qualification for international standards such as ISO and HACCP

CHAPTER- 4
FOOD SAFETY STANDARDS

4.1 FSSAI Registration and Licensing processing

State FSSAI Licensing

The Food Standards and Safety Authority of India (FSSAI) is the supreme authority which is responsible for regulating and supervising the food safety. So it is mandatory to take FSSAI Food safety License Registration as per the law.

Businesses having annual turnover between Rs.12 lakhs to 20 crore can apply for FSSAI state license. Food business operators like small to medium-sized manufacturers, storage units, Transporters, Retailers, Restaurants Marketers, distributors etc. are however required to obtain the FSSAI State License Registration.

Document required:

1. Rental Agreement of Business Premises.
2. ID Proof of the Concerned Person (Aadhaar Card / Driving License / Passport / Voter ID)
3. If any Government Registration Certificates (Company Incorporation Certificate / Firm Registration / Partnership Deed / Pan card / GST / Shop & Establishment / Trade License)
4. If the applicant is private limited company or partnership firm then they should provide MOA & AOA or Partnership deed copy
5. For applying State License any One of the following certificate is compulsory (Trade license, Shop & Establishment, Panchayath License, Corporation License , Municipality License)
6. Nature of Business.
7. FSSAI declaration form

Central FSSAI Licensing:

The Food Standards and Safety Authority of India (FSSAI) is the supreme authority which is responsible for regulating and supervising the food safety. So it is mandatory to take FSSAI Food safety License as per the law. Here we discuss about FSSAI central license. Businesses having annual turnover above 20 crore can apply for FSSAI central license. Eligible food Business Operators like Importers, Manufacturers, operators in central government, Railways, airports, seaports, etc. need to take a Central FSSAI license from Food Standards and Safety Authority of India.

Documents required:

1. Rental Agreement of Business Premises.

2. ID Proof of the Concerned Person (Aadhaar Card / Driving License / Passport / Voter ID)
3. If any Government Registration Certificates (Company Incorporation Certificate / Firm Registration / Partnership Deed / Pan card / GST / Shop & Establishment / Trade License)
4. If the applicant is private limited company or partnership firm then they should provide MOA & AOA or Partnership deed copy.
5. IE Code (Import Export Code) Certificate.(for the category of export and import IE code is compulsory)
6. Authority letter from the company letterhead to the concerned person stating that he is authorized to file FSSAI application.
7. List of food category desired to be manufactured (In case of manufacturers).

Food Safety Compliance System (FoSCos)

A new system launched by FSSAI –which is effective from 01.06.2020. This the best initiative taken by our Government for the best utilisation of the services provided by FSSAI in regulated manner.

- This new system has replaced the existing **Food Licensing and Registration System (FLRS).**
- **FLRS** has been used since 2011.
- Earlier application for getting Food License has been made on
- Till date, **FLRS** has issued 70 lakh licenses/registrations.

Features of FoSCos:-

- It is a cloud based, upgraded new food safety compliance online platform.
- It is a single window system where all facilities are available at one point of time.
- It has been integrated with **FoSCos Mobile App**.
- It saves lot of times while doing compliances regarding Food Safety.
- It will enable the GPS location tagging facility.
- It will also capture the picture in near future.
- RFID will also be utilised to ensure transparent and accountable extension field services such as inspections and sampling.
- It increases the Transparency & Accountability which is most important now days to boost the confidence among people.
- It will also integrated with other GOI's platforms such as GST,PAN,MCA etc., to ensure a 360 degree profiling.
- It will smooth the whole procedure of licensing, registration and compliance without taking so much time and in easiest way.

- Initially, following services will be offered by this new system:
    - Licensing
    - Registration
    - Inspection, &
    - Annual Return.
- Helpdesk facility is also available to clear the doubts and redress the grievance which is called **"Licensing Help Desk".**

Labelling standards

General requirements

1.Every pre-packaged food shall carry a label containing information as required here under unless otherwise provided.

2. The particulars of declaration required under these Regulations to be specified on the label shall be in English or Hindi in Devnagri script: Provided that nothing herein contained shall prevent the use of any other language in addition to the language required under this regulation.

3. Pre-packaged food shall not be described or presented on any label or in any labelling manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character in any respect;

4. Label in pre-packaged foods shall be applied in such a manner that they will not become separated from the container;

5. Contents on the label shall be clear, prominent, indelible and readily legible by the consumer under normal conditions of purchase and use; 6. Where the container is covered by a wrapper, the wrapper shall carry the necessary information or the label on the container shall be readily legible through the outer wrapper.

7. License number shall be displayed on the principal display panel in the following format-

4.2 Labelling:

In addition to the General Labelling requirements specified in above every package of food shall carry the following information on the label, namely-

1. The Name of Food: The name of the food shall include trade name or description of food contained in the package.

2. List of Ingredients: Except for single ingredient foods, a list of ingredients shall be declared on the label in the following manner

(a) The list of ingredients shall contain an appropriate title, such as the term "Ingredients"

(b) The name of Ingredients used in the product shall be listed in descending order of their composition by weight or volume, as the case may be, at the time of its manufacture

(c) A specific name shall be used for ingredients in the list of Ingredients

FSSAI regulation for Maize Products

Thermally Processed Vegetables (Canned, Bottled/Flexible pack / Aseptically Packed) means the product obtained from fresh, dehydrated or frozen vegetables either singly or in combination with other vegetables, peeled or un-peeled, with or without the addition of water, common salt and nutritive sweeteners, spices and condiments or any other ingredients suitable to the product, packed with any suitable packing medium appropriate to the product processed by heat, in an appropriate manner, before or after being sealed in a container so as to prevent spoilage. The packing medium along with its strength shall be declared on the label. The product may be prepared in any suitable style appropriate to the product. The product may contain food additives permitted in these Regulations and Appendices. The product shall conform to the microbiological requirements given in Appendix B. The name of the vegetables used in the product and prepared in any style shall be declared on the label along with the range of percentage of each vegetable used in the product. Drained weight of vegetables shall be not less than the weight given below:—

(i) Liquid Pack

(a) Mushroom	50.0 percent of net weight of contents
(b) Green beans, carrots, peas, sweet corn/ baby corn	50.0 percent of net weight of contents
(c) Other Vegetables	50.0 percent of net weight of contents

(ii) Solid Pack 70.0 percent of net weight of contents

2. The container shall be well filled with the product and shall occupy not less than 90.0 percent of the water capacity of the container, when packed in the rigid containers. The water capacity of the container is the volume of distilled water at 20ºC which the sealed container is capable of holding when completely filled.

CHAPTER- 5
STRENGTHS AND OPPORTUNITIES FOR ODOP STRENGTHENING IN MAIZE

5.1 The selected one district one product (ODOP) for maize in India

State/Crop/District	Year	Season	Area (Hectare)	Production (Tonnes)	Yield (t/ha)
Panch Mahals, Gujarat	2018-19	Kharif	62142	100709	1.62
		Rabi	18466	41752	2.26
		Summer	216	540	2.50
		Total	80824	143001	1.77
Chhotaudepur, Gujarat	2018-19	Kharif	31040	17401	0.56
		Rabi	25105	64771	2.58
		Summer	139	300	2.16
		Total	56284	82472	1.47
Bhilwara, Rajasthan	2017-18	Kharif	158940	361784	2.28
Giridih, Jharkhand	2017-18	Kharif	18415	34068	1.85
		Rabi	20	28	1.40
		Total	18435	34096	1.85
Aurangabad, Maharashtra	2017-18	Kharif	38000	75600	1.99
		Rabi	7800	18500	2.37
		Summer	913	1100	1.20

State/Crop/District	Year	Season	Area (Hectare)	Production (Tonnes)	Yield (t/ha)
		Total	46713	95200	2.04
Nabarangpur, Odisha	2017-18	Autumn	18805	59714	3.18
		Summer	1682	4767	2.83
		Total	20487	64481	3.15
Balrampur, Uttar Pradesh	2018-19	Kharif	2370	2989	1.26
		Rabi	41	115	2.80
		Summer	138	285	2.07
		Total	2549	3389	1.33

Strengths and opportunities for ODOP strengthening in maize.

District	Strengths	Opportunity	Products to be emphasized
Panch Mahals, Gujarat	➢ Traditional maize growing and eating areas ➢ Good number of indigenous products of maize ➢ Home made products and expertise ➢ Round the year raw material availability ➢ Sufficient production scope to run processing and value addition	➢ QPM maize will add nutritional and commercial values to indigenous products ➢ Export opportunity to domestic and international market ➢ Sweet corn production and value addition with trade opportunity to neighboring states and north India in winter. ➢ Nutritious concentrate and silage for livestock industry to reduce the cost of feed and green fodder towards making it more profitable. ➢ Enhancing employment generation and skill	Sweet corn cobs processed, corn grits, corn flakes, Maize biscuits, maize tortia, maize flour, maize *laddu*, *Poha*

District	Strengths	Opportunity	Products to be emphasized
		development for rural masses ➢ Establishment of sweet corn hub	
Chhotaudepur, Gujarat	➢ Traditional maize eating and producer district ➢ Skill and expertise in value addition maize production	➢ Nutritional security for maize eaters ➢ Establishment of the QPM hub	QPM products, Pakode, maize porridge, chhin, dhokla mix, maize *papad*, QPM *kheer* mix, QPM *sattu*, QPM Cheela,
Bhilwara, Rajasthan	➢ Enough maize production within and neighboring Chittorgarh district ➢ Industrial cities in nearby vicinity	➢ Establishment of small entrepreneurship ➢ Good road infrastructure with connectivity by NH-1	Maize *tortia*, maize porridge
Giridih, Jharkhand	➢ Traditional tribal maize eaters districts with various maize products ➢ Nearby Hazaribagh is presently having surplus maize production ➢ This maize can be used for initial processing industries establishment until enhancement of maize production in district itself	➢ Mining industries having conveyance food demand for workers ➢ Improvement of nutritional security of the maize eaters	*Chapatti* for industrial areas, QPM flour; silage; sweet corn; green ear; Corn feed
Aurangabad, Maharashtra	➢ Production of maize in the states	➢ Export potential of the silage and fed to dry	Maize feed, QPM chips,

District	Strengths	Opportunity	Products to be emphasized
	➢ Presence of the strong seed industry in the district for maize ➢ Good connectivity by road/rail/air	areas in peninsular India	corn silage, corn flakes, corn puffs, corn grits
Nabarangpur, Odisha	➢ Good raw material availability ➢ Maize eating populations ➢ Round the year maize cultivation possibilities ➢ Good connectivity with seas shore	➢ Opportunity to arrest conversion of land towards Eucalyptus planting ➢ Enhancing profitability of poultry and fish farming with reduced cost of feed ➢ Export opportunity of feed to West Bengal and NEH states.	Corn feed for fish/poultry, Corn flakes,
Balrampur, Uttar Pradesh	➢ Good soil and water availability for maize production ➢ Maize availability in nearby districts like Baharaich and Gonda	➢ Export of QPM products to Nepal like feed, silage and flour specially	QPM flour, maize feed, maize silage

Targeting of best cultivars of specialty maize available in Indian market in ODOP programme

S. No.	Cultivar	AICRP Centre/ Pvt. Company	Type
A.	**Quality Protein Maize (QPM)**		
1.	Ladhowal Quality Maize Hybrid 1 (LQMH1)	ICAR-Indian Institute of Maize Research Ludhiana (Punjab)	QPM
2.	Pusa HM-8 Improved	ICAR-IARI, New Delhi	QPM

S. No.	Cultivar	AICRP Centre/ Pvt. Company	Type
3.	Pusa HM-9 Improved	ICAR-IARI, New Delhi	QPM
4.	Pusa HM-4 Improved	ICAR-IARI, New Delhi	QPM
5.	PusaVivek QPM-9 Improved	ICAR-IARI, New Delhi	QPM
6.	Shaktiman-5	Rajendra Prasad Central Agriculture University	QPM
7.	Pratap QPM Hybrid-1 (EHQ-16)	MPUA & T, Udaipur	QPM
8.	HQPM-4	CCSHAU, Uchani, Karnal	QPM
9.	HQPM-7	CCSHAU, Uchani, Karnal	QPM
10.	Vivek QPM 9 (FQH 4567)	VPKAS, Almora	QPM
11.	HQPM-5	CCSHAU, Uchani, Karnal	QPM
12.	HQPM-1	CCSHAU, Uchani, Karnal	QPM
13.	Shaktiman-3	RAU, Dholi	QPM
14.	Shaktiman-4	RAU, Dholi	QPM
15.	HQPM-1	CCSHAU, Uchani, Karnal	QPM
B.	**Sweet corn**		
16.	Mithas	Nangwoo Seeds India Pvt Ltd	Sweet corn
17.	Suagr 75	Syngenta India Pvt Ltd	Sweet corn
18.	CP 471	CP Seeds India Pvt Ltd.	Sweet corn
19.	Hi Brix 39	UPL Limited (Formerly Advanta Ltd.), Hyderabad (Telangana)	Sweet corn
20.	Hi Brix-53	UPL Limited (Formerly Advanta Ltd.), Hyderabad (Telangana)	Sweet corn
21.	Central Maize VL Sweet Corn 1 (FSCH18)	VPKAS, Almora, Uttarakhand	Sweet Corn
22.	CANDY (KSCH-333)	Kaveri Seed Company Limited, Secundrabad	Sweet Corn
23.	NSCH-12 (Misthi)	Nuziveedu Seeds Limited	Sweet Corn
C.	**Baby corn**		
24.	G5414	Syngenta India Pvt Ltd	Baby corn

S. No.	Cultivar	AICRP Centre/ Pvt. Company	Type
25.	CP 472	CP Seeds Pvt Ltd	Baby corn
26.	IMHB1539	IIMR, Ludhiana	Baby corn
27.	Central Maize VL Baby Corn 2 (Vivek Hybrid 27)	VPKAS , Almora	Baby corn
28.	HM-4	CCSHAU, Uchani, Karnal	Baby Corn
29.	COBC-1	Tamil Nadu AU, Coimbatore	Baby Corn
D.	**Pop corn**		
30.	GAPCH-21 Mahashweta	Anand Agricultural University, Anand (Gujarat)	Pop corn
31.	Ladhowal Popom Hybrid 3 (LPCH 3)	ICAR-lndian Institute of Maize Research, Ludhiana (Punjab)	Pop corn
32.	Ladhowal Popom Hybrid 2 (LPCH 2)	ICAR-Indian Institute of Maize Research, Ludhiana (Punjab)	Pop corn
33.	DMRHP 1402	IIMR, Ludhiana	Popcorn
34.	BPCH-6	Acharya N. G. Ranga Agricultural University, Hyderabad	Pop corn
E.	**Silage**		
35.	HQPM-4		Silage
36.	DMRH1410		Silage

5.2 Strategy for promotion of ODOP in maize

To promote indigenous maize product towards the dream of for making true global and vocal for local following strategy to be employed in holistic manner.

1. **Specialized zones:** Within the district, special zones for entire value chain right from seed to produce finished products needs to be established for maintain the quality and regular supply of the quality maize for efficient running of the industries. The group for seed multiplication, cultivation, processing, marketing and export to be integrated in holistic manner for making branding successful at all the levels.

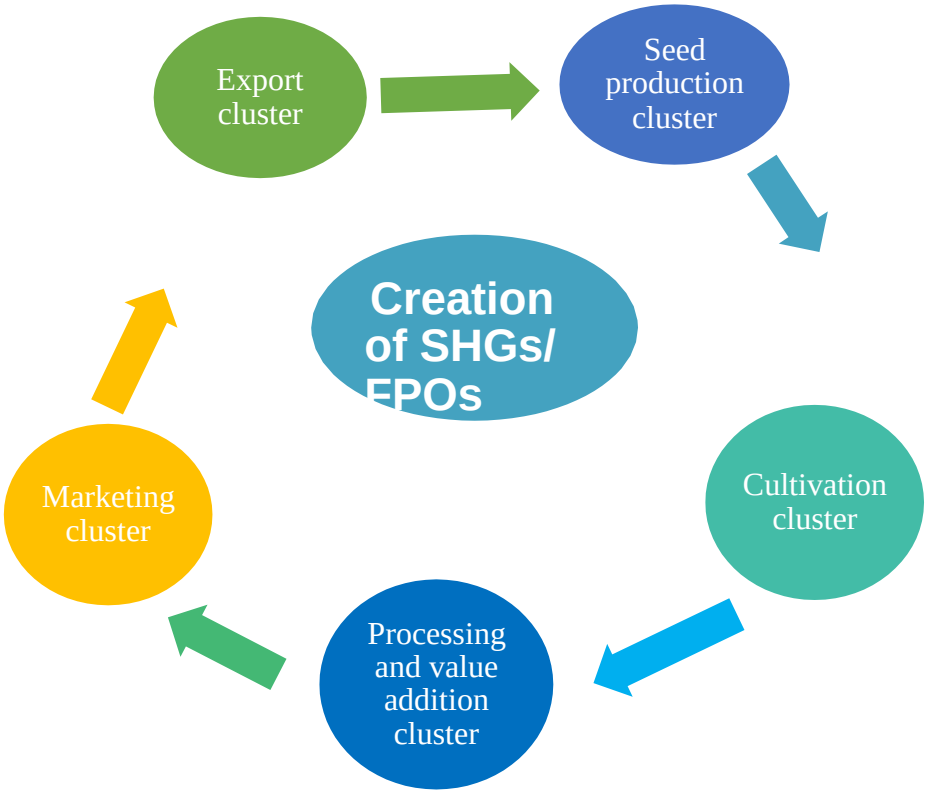


Fig. 20. Different cluster of maize value chain for successful branding and maintenance of quality under ODOP.

2. **Farmer Producer Organization:** The farmer producer organization for branding of different value added and processed products in maize to be made in each districts with a view to provide comprehensive small to medium scale industrial set up and back up by the appropriate policy supports.
3. **Self help groups:** The self-help group, specially made up by women is successful in commercialization of maize based value added products. The self-help groups need to be established in each district with appropriate technical, financial and infrastructure support for production and training of various value added products. It will ensure more of the gender equality and women empowerment under this ambitious programme. In SHGs, the indigenous products with improved technology from the research/development organizations to be adopted.
4. **Involvement of private players and NGOs:** In most of the areas, selected for ODOP in corn have good presence of the private sector organizations and NGOs. The activities of these organizations need to be in line with the government plan to create ODOP in view of creating employment and prosperity of the farmers. The activities of these shall be in harmony with view of strengthening the value chain wrt input, production, quality, continuous raw material supply, packaging material availability, storage etc.

5. **Establishment of SME:** The small or medium scale processing and value addition in maize could also be established to rising demand of the big sectors like feed, flour, maize grits, poha, corn flakes, etc. The investors willing to make such investment in the prioritized ODOP districts needs to be facilitated. It will generate additional employment with enhanced farm profitability by better price realization. This will strengthen the whole value chain of the maize right from input suppliers to producers.

5.3 **Epilogue**

Production enhancement: The maize area expansion in eastern and central India is still in vibrant state and going to register a significant growth in next few decades, which will enhance maize production. The single cross hybrid; technology expansion: coverage of hybrid maize, mechanization, to address issue of climate change and water and power shortage.

Industries establishment: In future, shift in production ecology, needs establishment of the starch and feed industries in eastern Indian states like West Bengal, Bihar, Odisha and NEH states. Being a leading producer Madhya Pradesh, Uttar Pradesh and Rajasthan also have meager presence of maize utilizing processing industries that also needs strengthening.

Providing nutritious food and feed: Quality Protein Maize with its high carbohydrates, fats, better quality protein lends itself as nutritious feed for poultry, livestock, swine, fish etc, which leads to early development of broilers, save energy and feed. This will also save extra cost incurred on synthetic lysine and tryptophan fortification.

Maize based entrepreneurship: The nutritious products developed from QPM can replace the highly priced non nutritious industrial products. These products can also be prepared in villages as a source of rural entrepreneurship.

5.4 Impact of the ODOP programme in maize

1. Employment generation in rural areas
2. Increased income of the farmer produce
3. Reduced the cost of industry for quality raw material availability at their doorstep
4. Continues raw material availability for industrial profitability
5. Nutritious quality products of maize for the consumers
6. Increased domestic as well export demand of maize and its products
7. Revenue generation for the state and national governments
8. Forex earning though competitive export of maize based products

9. Prosperity of the stakeholders involve in maize value chain
10. Improved living standard and livelihood security

CHAPTER- 6

OPPORTUNITIES FOR MICRO/UNORGANIZED STRUCTURE

- Strong domestic demand: Changing lifestyle and food habits due to increased disposable income.
- Supply side advantages: High level of agricultural production. Good quality yields of corn for puffed snacks products.
- Export opportunities: Proximity to key export destinations, greater integration with the global economy.
- Proactive government policy and support

PM-FME SCHEME

- Launched under the Aatmanirbhar Bharat Abhiyan, the Pradhan Mantri Formalisation of Micro food processing Enterprises (PM-FME) Scheme is a centrally sponsored scheme aims to enhance the competitiveness of existing individual micro-enterprises in the unorganized segment of the food processing industry.
- Promote formalization of the sector and provide support to Farmer Producer Organizations, Self Help Groups, and Producers Cooperatives along their entire value chain.
- With an outlay of Rs. 10,000 crore over a period of five years from 2020-21 to 2024-25, the scheme envisions to directly assist the 2,00,000 micro food processing units for providing financial, technical, and business support for upgradation of existing micro food processing enterprises.

Suggested readings:

1. http://agridaksh.iasri.res.in/maize.jsp for recipes of QPM (41), pop corn (13), baby corn (24) and sweet corn (6).
2. https://iimr.icar.gov.in/wp-content/uploads/2020/03/babycorn-English.pdf
3. https://iimr.icar.gov.in/wp-content/uploads/2020/03/babycorn-Hindi.pdf for product and utilization of baby corn.
4. https://iimr.icar.gov.in/wp-content/uploads/2020/03/Proceedings-of-Brainstorming-Workshop-on-Up-scaling-Quality-Protein-Maize-for-Nutritional-Security.pdf
5. QPM bulletin