

Specialty Maize Cultivation Practices for Livelihood Security



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PREFACE

Welcome to the technical bulletin titled "Specialty Maize Cultivation Practices for Livelihood Security". Maize (*Zea mays* L.) has long held a prominent position in global agriculture, contributing significantly to food security, economic stability, and various industrial applications. This versatile cereal crop, cultivated on approximately 197 million hectares worldwide, plays a pivotal role in sustaining the agricultural landscape.

In India, maize ranks as the third most important crop, earning it the title of the 'Queen of cereals' due to its exceptional yield potential among cereals. Maize's adaptability to diverse climates, from tropical to temperate, combined with its C4 classification, has made it a resilient and consistent performer in Indian agriculture. In recent years, India has witnessed remarkable growth in maize production, achieving record-breaking numbers that underscore its importance.

The cultivation of maize in India predominantly occurs during the kharif season, representing 78% of the total acreage. However, the rabi season, despite its smaller acreage share (22%), significantly contributes to overall production. This dynamic is driven by various factors, including demand from the feed, starch, processed food, silage, and ethanol industries, all of which rely heavily on maize.

As maize production continues to rise, it becomes increasingly vital to optimize its cultivation practices, particularly during the kharif season, which accounts for the majority of acreage but lags behind in productivity compared to rabi maize. Addressing this productivity gap and achieving consistent and sustainable growth in maize production is imperative to meet the burgeoning demand.

In this context, this bulletin explores the best crop management practices in speciality maize cultivation across all seasons. It provides valuable insights, guidelines, and recommendations for farmers, agricultural professionals, and policymakers to enhance speciality maize productivity, ensure quality, and foster sustainable agricultural practices.

By implementing the best practices outlined herein, we aim to support farmers in increasing their income, contribute to the growth of the agricultural sector, and ultimately meet the diverse demands of the nation's thriving maize industry. We hope this bulletin serves as a valuable resource and a source of inspiration for all stakeholders involved in speciality maize cultivation.

Authors

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Introduction

Maize is the leading cereal crop in the world with more than one billion tonne production. It surpasses all other food crops in its ability to adapt to the diverse agro-ecological niches and being cultivated from 58° N to 55° S latitude. In India, it holds third rank among the cereals, after rice and wheat in terms of area and production. Traditionally, maize is grown as a kharif crop in India, but from 1970s its expansion started in rabi season and later on in the spring season too. Now, the crop is grown round the year and in all agro-ecologies throughout India. Traditionally maize in India used to be consumed as food crop. However, over time maize has become rather an industrial crop than food crop as over 75% of the maize produced in India is used for industrial purchases, mostly as feed and source of starches. Being industrial in nature maize can ensure higher remuneration.

Other than grain, maize is also cultivated for various purposes like quality protein maize (QPM), and other special purposes known as 'Specialty Corn'. The various specialty corn types are QPM, baby corn, sweet corn, pop corn, waxy corn, high oil corn etc. In India, QPM, baby corn and sweet corn are being popularized and cultivated by the large number of farmers. Baby corn and sweet corn with short to medium duration cropping period can play important role in diversification in peri-urban agricultural systems and nutritional garden. They fit well in integrated farming system, where the byproduct of specialty corn, i.e., green fodder can support livestock very well. It is a key crop in doubling farmers' income as maize can be integrated effectively with dairy, poultry, fisheries and piggery. Specialty corn has a special role in value chain development. The demand for specialty corn in India is growing due to changing consumer preferences, increased health awareness, and the demand for diverse and premium food products. To meet the growing demand, there is a need to enhance specialty corn productivity through adoption of the best production practices by the maize farmers. The brief summary of different type of specialty maize is as follows:

1) Quality Protein Maize (QPM)

Maize grain presents significant shortcomings as a dietary staple, lacking key amino acids lysine and tryptophan necessary for protein synthesis. Additionally, the presence of niacin (vitamin B₃) in an indigestible form led to health issues like Pellagra. Furthermore, diets high in maize can lead to a condition called wet malnutrition, where individuals receive enough calories but suffer from protein deficiencies, ultimately leading to conditions like kwashiorkor. The primary reason for the poor protein quality in maize lies in the dominance of zein, a prolamine found in the endosperm, which constitutes over 50% of the total protein content. Zein is low in lysine and tryptophan while containing an imbalanced proportion of leucine and isoleucine. Consequently, the inadequate proportion of these essential amino acids significantly impacts the biological value of maize protein, as lysine, tryptophan, and threonine are limiting

amino acids in humans and non-ruminants, causing other amino acids to be either excreted or used for energy when they are not in sufficient supply.

As more than 85 % of the maize is used directly for food and feed, the quality has a great role for food and nutritional security in the country. In this respect, discovery of Opaque-2 (O2) and floury-2 (F2) mutant had opened tremendous possibilities for improvement of protein quality of maize which later led to the development of QPM. QPM developed from a mutant maize has nearly twice the amount of lysine and tryptophan. It bears hard kernel characteristics and good taste similar to the traditional grain. QPM offers added nutritional benefits, including increased niacin (vitamin B₃) content and enhanced absorption of potassium and carotene. Moreover, it maintains comparable or superior yield potential to traditional maize varieties. QPM which is nutritionally superior over the normal maize is the new dynamics to signify its importance not only for food and nutritional security but also for quality feed for poultry, piggy and animal sectors as well.

Nutritional value of QPM

Quality protein maize has specific features of having balanced amount of amino acids with high content of lysine and tryptophan and low content of leucine and isoleucine. The balanced proportion of all these essential amino acid in QPM enhances the biological value of protein. True protein digestibility of normal maize (82-91%) and QPM (92%) is nearly identical, but the biological value of QPM varieties (80%) is just double than normal maize (40-47%) which is very close to the milk protein (90%). QPM boasts the highest biological value among all food grains due to its unique composition, as it contains an adequate supply of lysine, an essential amino acid that is deficient in all other cereals, while also providing methionine, another essential amino acid lacking in most pulses. Thus, QPM can help to significantly alleviate malnutrition and enhance overall health in communities that lack access to expensive protein sources such as meat, fish, milk, and eggs.

Amino acid profile of normal maize and QPM

Amino acid	Normal maize		QPM	
	%	% crude protein	%	% crude protein
Methionine	0.17	1.99	0.18	1.81
Lysine	0.25	2.89	0.36	3.70
Tryptophan	0.06	0.73	0.08	0.90
Isoleucine	0.28	3.28	0.30	3.06
Leucine	1.06	12.22	0.87	8.80

Source: Panda et al. (2012)

QPM as feed

QPM is an important feed for monogastric animals like rats, chickens, and swine. It offers advantages such as substituting costly high-protein supplements like soybean or fish meal. Feeding trials revealed that rats fed on opaque-2 maize exhibited substantial weight gain and improved feed efficiency. In poultry, QPM, when supplemented with methionine, outperformed regular maize in terms of growth, weight gain, and feed conversion, highlighting its promise as a valuable poultry feed.

QPM production technology

The production technology of QPM is same as of normal grain maize except isolation. To maintain the purity of QPM, it should be grown in isolation with normal maize.

Field preparation

The QPM crop requires terrain that is adequately aerated, wet, and weed-free. Land preparation comprises one deep ploughing on light-textured soils immediately after the previous winter/summer crop to ensure the timely sowing of the crop. If the soil is heavy, 2-3 deep ploughings at a depth of 50-60cm may be required. Generally, the crop requires 2-4 harrowing followed by planking to make the field clod-free and the best-suited texture for the germination of the crop. During the kharif season, the crop needs to be protected against waterlogging, so shallow furrows should be installed after a specific distance and connected to the main drain. Drains must be constructed out over the slope to prevent water erosion. In other cases, especially in high-rainfall areas, the entire field is ridged and furrowed, with maize seeds sown on the sides of the ridges.

Selection of suitable varieties

There are 9 QPM hybrids of different grain colors have been developed and released in India for their cultivation in different agro-climatic conditions across the country.

Zone-wise recommended QPM varieties

Type/Zones	NHZ	NWPZ	NEPZ	PZ	CWZ
QPM	Pusa HQPM-1 Improved, Pusa HQPM-5 Improved, Pusa Vivek QPM-9 Improved, Pusa Biofortified Maize Hybrid-1, Ladhawal Quality Maize Hybrid 1	PMH1-LP, VLQPM Hybrid 45, Pusa HQPM-1 Improved, Pusa Biofortified Maize Hybrid-1, Malaviya Swarn Makka-1, IQMH 202, Pusa HQPM-5 Improved, Pusa HM-4 Improved	VLQPM Hybrid 45, Pusa HQPM-1 Improved, Pusa Biofortified Maize Hybrid-1, Pusa HQPM-5 Improved, Pusa Vivek Hybrid -27 Improved, Shaktiman-5, Pusa HM-9 Improved	Pusa HQPM-1 Improved, Pusa HQPM-5 Improved, Pusa HQPM-7 Improved, Pusa HM-8 Improved, Pusa HM-4 Improved	Pusa HQPM-1 Improved, IQMH 203, Pusa HQPM-5 Improved, Pusa HQPM-7 Improved, Pusa Vivek QPM-9 Improved, Pratap QPM Hybrid-1
Biofortified (QPM+ Provitamin A)	-	Pusa Biofortified Maize HYBRID 2, Pusa Biofortified Maize HYBRID 3	Pusa Biofortified Maize HYBRID 2, Pusa Biofortified Maize HYBRID 3	Pusa Biofortified Maize HYBRID 3	-

Sowing time

The QPM crop can be cultivated in all seasons, including kharif, rabi and spring.

Season	Ideal sowing time
Kharif	June 20 to end of July
Rabi	Last week of October to first fortnight of November
Spring	First week of February

Sowing method and seed rate

In *kharif* sown maize, raised bed planting is recommended to protect the crop from water logging. Southern side planting is advised on East-West oriented ridge. For proper germination and early vigor, seed should be sown at 3.5-5.0 cm depth. Optimum plant density (33,000/acre) should be maintained by growing the crop at 60 × 20 cm row × plant spacing. Eight kg seed of QPM is needed for planting in one acre area. Prior to sowing, seeds should be treated with fungicides and insecticides to protect the crop from most prevalent seed and soil borne diseases and insect-pests.

Chemical for seed treatment and targeted diseases/pests

Fungicide/pesticide	Dose (per kg seed)	Targeted disease/pest
Bavistin + Captan (1:1)	2 g	Turcicum leaf blight, Banded leaf and sheath blight, Maydis leaf blight etc.
Apron 35 SD	4 g	Brown stripe downy mildew
Captan	2.5 g	Pythium stalk rot
Imidachlorpid	6 ml	Shoot fly
Fipronil	4 ml	Termite
Thiamethoxam + Cyantraniliprole	4 ml	Fall armyworm

Nutrient management

QPM requires a significant amount of primary nutrients, namely nitrogen, phosphorus, and potassium, along with other essential elements like zinc in smaller quantity. Macro- and micro-nutrient requirements of the crop need to be accomplished through use of suitable fertilizers as given in Table below:

Fertilizer application schedule in QPM

Crop stage	Schedule	Fertilizer (kg/acre)			
		Urea	DAP	MOP	ZnSO ₄
Sowing	Basal	23	52	27	10
Knee-high	1 st split	44	-	-	-
Pre tasseling	2 nd split	44	-	-	-

Water management

QPM crops require an optimal water supply ranging from 400 to 600 mm. High or low moisture contents can hinder crop development. Ensuring better crop performance primarily hinges on effective drainage to manage excess water and meeting the crop's requirements during critical growth stages. Adequate moisture at germination, pre-tasseling, silking and grain-filling stages should be ensured through irrigation. If available, the sprinkler irrigation up to knee length stage is very good for maize crop. In ridge-sown crop, irrigation should be given in furrow up to $2/3^{\text{rd}}$ of height of the ridge. When there is little water available, irrigation can be done in alternate furrows without much of a negative impact on the crop output.

Weed management

Weed is one of the significant biotic elements that hinder achieving the productive capacity of maize crop. The percentage of yield losses, which ranges from 25-80%, is greatly influenced by the type of weeds present, the length of the crop-weed competition, and the density of weeds. To reduce the damaging impacts of weeds on agricultural plants, the integration of weed management approaches, combining cultural, mechanical, chemical, and biological techniques, is recommended.

Cultural weed control: Cultural practices play an important role in weed management in maize crops. It comprises several approaches like the selection of a competitive crop variety having well-adaptability and better vigour with appropriate disease and pest resistance; modern tillage practices like zero tillage involving residue cover; appropriate planting time and density; the placement of right amount of nutrient at proper growth stages; adoption of narrower row spacing than conventional system along with suitable crop rotation including cover crops.

Mechanical weed control: After the crop has been sown, weeds are frequently removed with an inter-row cultivator or a rotary hoe during in-row cultivation. Mechanical weed control using tractor mounted implements can only be done during the early crop stages because limited tractor and cultivator ground clearance damage the crop foliage at later growth stages. Working depth of weeding implements should be shallow to prevent plant roots damage. In the western Himalayan region, ploughing in standing crops at 20–25 days of development is referred to as "haloding," which aids in weed uprooting and earthing-up of plants. Additionally, this aids in the creation of furrows, which hold onto precipitation and support the crop during dry spells.

Chemical weed management: Using pesticides to manage weeds in corn is the most crucial step. Herbicides can be sprayed at various times, including before the crop is planted (pre-plant incorporation), after the crop is planted but before emergence (pre-emergence), and following crop emergence (postemergence).

Recommended herbicides for maize cultivation in India.

Herbicides	Dose/ha		Dilution in water (L/ha)	Time of application
	a.i	Formulation		
Atrazine 50% WP	0.5-1 kg	1-2 kg	500-700	0-2 DAS
2,4-D Dimethyl Amine salt 58% SL	0.5 kg	0.86 ml	400-500	25-30 DAS
2,4-D Ethyl Ester 38 % EC (having 2,4-D acid 34 % w/w)	0.9 kg	2.65 L	400-450	25-30 DAS
Halosulfuron Methyl 75% WG	67.5	90 ml	375	25-30 DAS
Paraquat dichloride 24% SL	0.2-0.5 kg	0.8-2.0 L	500	Before sowing in ZT field
Paraquat dichloride 24% SL	0.2-0.5 kg	0.8-2.0 L	500	Directed inter row application at 2-3 leaf stage of weeds
Pyroxasulfone 85% w/w WG	127.5 g	150 ml	500	0-2 DAS
Tembotrione 34.4% SC	120 g	286 ml	500	25-30 DAS
Topramezone 336 g/l w/v SC	25.2 to 33.6 g a.i./ha + MSO adjuvant @ 2 ml/L of water	75 to 100 ml + MSO adjuvant @ 2 ml/L of Water	375	25-30 DAS
Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC	875 g	3500 ml	500	25-30 DAS

Disease management

Out of the 61 main diseases affecting maize, maydis leaf blight, turcicum leaf blight, banded leaf and sheath blight, charcoal rot, bacterial leaf and sheath blight, bacterial stalk rot, Rajasthan downy mildew, brown strip downy mildew, curvularia leaf spot and common rust are the most important diseases in most of the maize growing belts in the India. Below is a table listing suitable fungicides and bactericides for various maize diseases:

Chemical methods for disease management in maize

Disease	Chemical control
Maydis leaf blight	(a) Spray Dithane Z-78 or Zineb @ 2.5-4 g/L water and repeat the spray at 8- 10 days interval, or (b) Spray Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top) @ 1ml/L water and repeat the spray at 15 days interval, if needed.
Turcicum leaf blight	(a) Spray Zineb/ Maneb @ 2.5-4.0 g/L water 2-4 times at 8-10 days intervals, or (b) Spray Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top) @ 1ml/L water and repeat the spray at 15 days interval, if needed.
Banded leaf and sheath blight	Spray Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top 325 SC) 1ml/L of water at 50 DAS or immediately after symptoms appearance and repeat the spray at 15 days interval.
Charcoal rot	Seed treatment with 25g PSB (<i>Pseudomonas striata</i> H-21) and 6 g <i>Trichoderma harzianum</i> or 5 ml Thiram Flo 40 FS per kg seeds before sowing.
Bacterial leaf and sheath blight	Spray of Sheethmar (Validamycin) @ 2.7 ml/L water.
Bacterial stalk rot	Drenching with bleaching powder $\text{Ca} (\text{ClO})_2$ @ 1.5g/15L of water immediately after symptoms appeared.
Rajasthan downy mildew and Brown strip downy mildew	Foliar spray of Metalaxyl + Mancozeb (0.1%) at very first appearance of disease.
Curvularia leaf spot	Spray Carbendazim 12% + Mencozeb 62.7% @ 2 g/L water 35 and 55 DAS.
Common rust	Spray Dithane M-45 @ 2.4-4 g/L water and repeat the spray at 15 days interval.

Pest management

Fall armyworm, maize stem borer, pink stem borer and shoot fly are the four most significant pests affecting QPM crop in India. Maize stem borer infests during the kharif season, pink stem borer in the rabi season, and shoot fly during the spring season. For effective management of stem borers in maize crops, it is advisable to apply Chlorantraniliprole 18.5% SC at a rate of 60 ml per acre between 15-18 days after sowing. Seed treatment with Imidacloprid 600 FS (Gaucho) @ 6 ml /kg or Thiamethoxam 30 FS @ 8ml/kg seed is recommended to control shoot fly. Whorl application of any one of the insecticides viz., Chlorantraniliprole 18.5% SC (80 ml/acre) @ 0.4 ml/L; Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5% ZC (50 ml/acre) @ 0.25 ml/L; Spinetoram 11.7 % SC (100 ml/acre) @ 0.5 ml/L; Emamectin benzoate 5% SG (80 g/acre) @ 0.4g/L is recommended for fall army worm management.

Harvesting and yield

The optimal time for QPM harvesting is when the kernels are fully mature and have reached the desired moisture content (20-30%) and cob husk has dried and turned brown. After harvesting, sun-dry the cobs before proceeding with the shelling process. With effective management practices, it is possible to get 28 to 32 q per acre maize yield.

2) Baby corn

Baby corn is a young finger like unfertilized cobs with one-to-three-centimeter emerged silk preferably harvested within 1-3 days of silk emergence depending upon the growing season. It can be eaten raw as salad and in preparation of different recipes such as chutney, pakora, mix vegetables, pickles, candy, murabba, kheer, halwa, raita, Chinese preparations, etc. It has gained popularity in Continental and Asian cuisines, often used in salads and stir-fries. The desirable size of baby corn is 6 to 11 cm length and 1.0 to 1.5 cm diameter with regular row/ ovule arrangement. The most preferred color by the consumers / exporters is generally creamish to very light yellow (golden color).



Baby corn is nutritive and its nutritional quality is at par or even superior to some of the seasonal vegetables. Besides proteins, vitamins and iron, it is one of the richest sources of phosphorus. It is a good source of fibrous protein and easy to digest. It is almost free from residual effects of pesticides. It is highly remunerative commercial crop that is mainly grown near cities due to its high demand in hotels and restaurants. With changing dietary habits and nutrition consciousness, baby corn demand is picking up in market. Moreover, it is a short duration characteristic (55-65 days) makes it suitable for intercropping and relay cropping. It can be cultivated round the year therefore; three to four crops of baby corn can be taken in a year. Cost of cultivation of baby corn in India is lowest in the world therefore; India can become one of the major baby corn producing country. It has great potential both for internal consumption and export.

Characteristics of baby corn

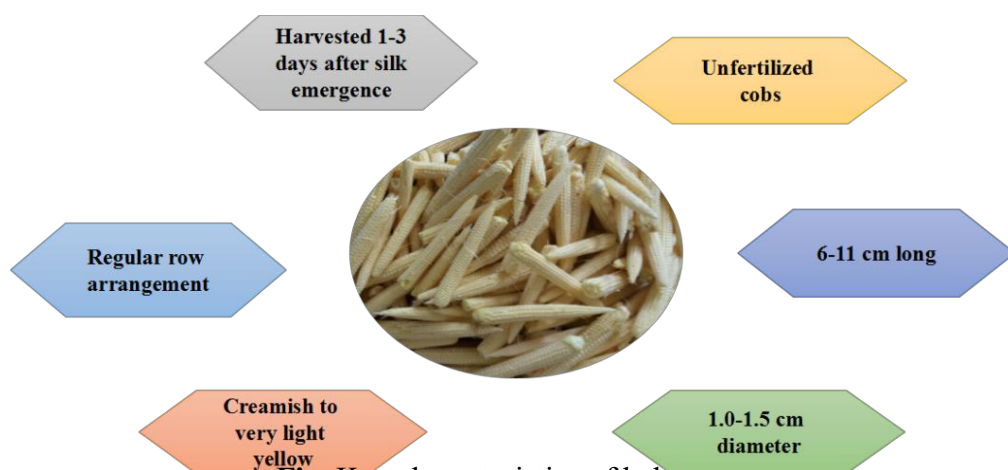


Fig. Key characteristics of baby corn

Health benefits of baby corn

Baby corn is a healthy, nutritious, low-calorie vegetable with minimal fat, making it a valuable addition to daily diets. Baby corn is rich in essential nutrients, including vitamins A, B, C, and E, as well as folate, thiamine, and pantothenic acid. Its low starch content and high fibre make it suitable for weight loss diets, whether eaten raw, steamed, or baked. Baby corn contributes to eye health by providing vitamin A and promotes skin health with its vitamin C content. During pregnancy, its folate content supports proper growth and development. It has soluble fibre that aids in cholesterol reduction and prevents artery blockage. Baby corn also contains essential minerals such as phosphorus, zinc, iron, and calcium, further enhancing its robust nutritional profile. Overall, baby corn is a versatile and nutritious addition to a balanced diet.

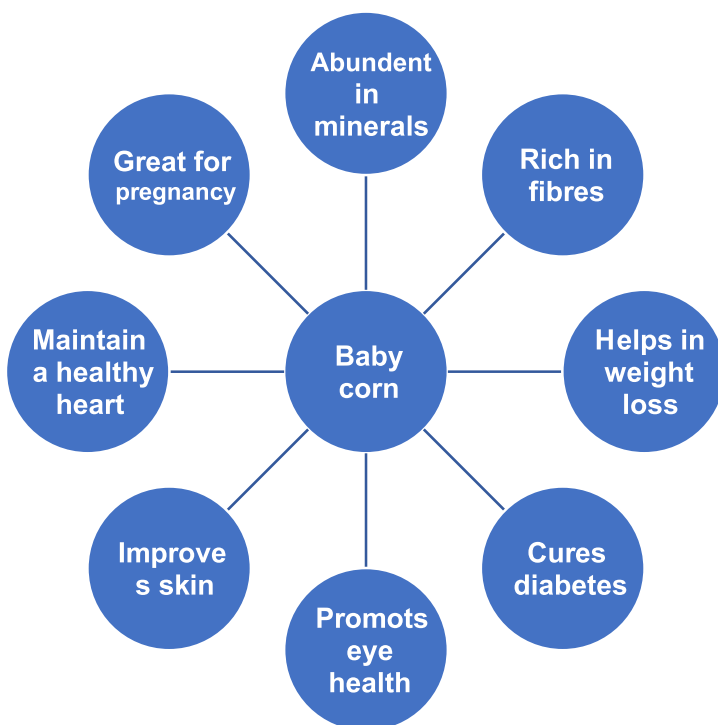


Fig. Health benefits of baby corn

Nutritional composition of baby corn on dry matter basis

Particulars	Baby Corn Hybrid (HM-4)
Moisture (g/100g)	7.37
Crude protein (g/100g)	10.04
Crude fat (g/100g)	4.43
Crude fibre (g/100g)	2.40
Ash (g/100g)	1.34
Total carbohydrates	81.97
Energy (Kcal/100g)	375.67
Total soluble sugars (g/100g)	0.14
Calcium (mg/100g)	17.76
Phosphorous (mg/100g)	197.89
Iron (mg/100g)	2.73

Source: Kawatra and Sehgal (2007)

Baby corn production technology

In general, the cultivation practices of baby corn are similar to grain crop except

- Higher plant population
- Higher dose of nitrogen application because of higher planting density
- Preference for early maturing single cross hybrid, and
- Harvesting within 1-3 days of silk emergence
- Detasseling if fertile hybrids, no need for sterile hybrids

Selection of suitable varieties

Baby corn genotypes exhibit following distinct characteristics that differentiate them from normal corn:

- ✓ Early maturing single cross hybrid
- ✓ Medium stature
- ✓ Prolific (3-4 baby corn/per plant)
- ✓ Responsive to nutrients
- ✓ Stay green
- ✓ Erect leaves suit higher plant population
- ✓ De-husked ear length: 6-11 cm
- ✓ Light yellow/creamish colour
- ✓ Husked to de-husked ratio: 5-6: 1
- ✓ Uniform baby corn in shape
- ✓ Male sterile hybrids for reducing the detasseling cost

Zone-wise recommended baby corn varieties:

Type/Zones	NHZ	NWPZ	NEPZ	PZ	CWZ
Baby corn	Ladhowal Baby Corn Hybrid 3, IMHB 1539, Vivek Hybrid 27, Central Maize VL Sweet Corn 1, HM-4, VL Baby Corn-1, COBC-1, Central Maize VL Baby Corn 2, Pusa HM4 Male Sterile Baby Corn (Shishu)	IMHB 1532, Vivek Hybrid 27, Central Maize VL Sweet Corn 1, HM-4, VL Baby Corn-1, COBC-1, Pusa HM-4 male sterile baby corn, Pusa HM4 Male Sterile Baby Corn (Shishu)	Vivek Hybrid 27, HM-4, VL Baby Corn-1, COBC-1, Central Maize VL Baby Corn 2, Pusa HM4 Male Sterile Baby Corn (Shishu)	Baby corn GAYMH-1, Vivek Hybrid 27, Central Maize VL Sweet Corn 1, HM-4, VL Baby Corn-1, COBC-1, Central Maize VL Baby Corn 2, Pusa HM4 Male Sterile Baby Corn (Shishu)	Baby corn GAYMH-1, IMHB 1532, Vivek Hybrid 27, Central Maize VL Sweet Corn 1, HM-4, VL Baby Corn-1, COBC-1, Central Maize VL Baby Corn 2, Pusa HM4 Male Sterile Baby Corn (Shishu)

Sowing time

Baby corn can be cultivated throughout the year provided the temperature remains above 20-28°C. Under Northern Indian conditions, where winters are quite cold, it's recommended to raise baby corn nurseries inside polyhouses during January, with subsequent transplantation in early February. Crops sown between August to November tend to be more productive, yielding a greater number of harvests. Winter-sown crops fetches higher prices in the market due to reduced competition during this period. Staggered sowing of baby corn is advised to ensure a continuous and extended harvest of baby corn rather than having all the corn mature simultaneously.

Sowing method and seed rate

The crop is typically planted on southern side of ridges following row-to-row spacing of 60 cm and a plant-to-plant spacing of 15 cm. Raised bed planting of baby corn is also popular among the farmers, where they accommodate two rows of baby corn on a 90 cm wide bed. Approximately 9-10 kg of seed is needed for planting one acre of baby corn.

Planting method	Spacing	Plant population (per acre)	Seed rate (kg/acre)
Ridge planting	60 × 15 cm	1,11,111	9-10
Raised bed planting	50-70 × 15 cm	1,11,111	9-10



Baby corn planted on raised bed

Intercropping

In general, short duration varieties of intercrops to be preferred for intercropping with baby corn. In kharif season, cowpea for green pods and fodder purposes and coriander for green leaves can be intercropped with baby corn. During rabi season, baby corn can be intercropped with vegetable crops, viz., spinach, cabbage, cauliflower, coriander, fenugreek, sugar beet, potato, radish etc. Recommended dose of fertilizers of intercrops should be applied in addition to the recommended dose of fertilizers of baby corn.



Fig. Baby corn based intercropping

Isolation requirement

Baby corn crop needs isolation of at least 400 m from normal maize as pollination deteriorates its quality.

Nutrient management

Apply appropriate fertilizers based on soil testing and the nutrient requirements of baby corn. Generally, 60-70: 25:25 kg/acre N:P:K should be applied.

Fertilizer application schedule in baby corn

Crop stage	Schedule	Fertilizer (kg/acre)		
		Urea	DAP	MOP
Sowing	Basal	10	50	40
4 leaf stage	1 st split	26	-	-
8 leaf stage	2 nd split	40	-	-
Before detasseling	3 rd split	32	-	-
After 1 st picking	4 th split	20	-	-

Irrigation management

Irrigation is a critical aspect of baby corn cultivation as it directly influences crop growth, yield, and quality. Seedling stage, knee high stage, silking and picking are the most sensitive stages for water stress and irrigation should be ensured at these stages. Light and frequent irrigations are desirable for the crop.

Detasseling & Harvesting

Tasseling and fertilization diminish the quality of baby corn, and a yield penalty is incurred as a substantial portion of the plant's energy is redirected toward tassel development. Therefore, it is crucial to promptly remove these tassels as soon as they emerge from the flag leaf. De-tasseling should be practiced row-wise. During de-tasseling leaf should not be removed otherwise it hamper baby corn yield. The removed tassels should not be thrown in the field as they possess nutritional values thus must be fed to cattle. Detasseling is not required in male-sterile varieties like Shishu.



Baby corn tassel after de-tasseling



Male sterile baby corn (G-5414)

Baby corn is typically harvested 1-3 days after the silk emerges, at a point when the silk measures approximately 1-2 cm in length. For optimal yield and quality, it is advisable to conduct pickings daily during kharif and on alternate day during rabi season. Baby corn picking should be done in morning or evening hours when temperature and moisture conditions are favorable. During the Kharif season, about 3-5 pickings, while in the rabi season, 6-7 pickings from a baby corn crop may be obtained. The cultivation of baby corn generates various by-products, including tassels, silk, husks, and green plant material after harvest. These by-products are rich in nutrients and can serve as excellent cattle feed, contributing to increased milk yield.



Baby corn picking

Yield

Produce	Yield (q/acre)
Green cob	25-30
De-husked cob	6-8
Green fodder	150

Economics

Parameter	Economics (Rs. per acre)
Cost of cultivation	15,000
Gross returns	37,500/-
Net returns	22,500/-

Note-Selling price of de-husked baby corn-50/-/kg; Fodder 50/-/q
(conservative estimate)

Post-harvest management

To fetch good market price, baby corn needs some post-harvest treatments like de-husking, de-silking, grading and packing. Peel the baby corn by removing its silk and husk. After peeling, baby corn of uniform size and colour should be separated for packing. The packing material should be new and clean and should avoid external damage to the produce. Poly bags, terra pack, tray pack etc. can be used for packing. De-husked baby corn can be stored for a period of 6-7 days under conditions of low temperature (around 5-6 °C) and high humidity (~90 % relative humidity). To extend the shelf life of the produce and facilitate long-term storage and transportation over long distances, processes such as canning, dehydration, and freezing can be done.



Grading and packing of baby corn

Processing

Baby corn can be processed to improve its shelf life. Processing involves various methods and techniques that help preserve the quality and extend the storage life of baby corn. Some common methods of processing baby corn for improved shelf life include:

Canning: Baby corn can be canned, which involves sealing it in airtight containers after blanching or cooking. This process helps to kill bacteria, yeast, and molds, thereby extending the shelf life of the baby corn for several months or even years. Canning is the most commonly used method for processing of baby corn.

Freezing: Baby corn can also be frozen to preserve its freshness. Freezing prevents the growth of microorganisms and enzymatic reactions that can cause spoilage. It typically maintains the quality of the corn for a longer period compared to other methods.

Pickling: Baby corn can be pickled in vinegar or brine solutions. Pickling helps to create an acidic environment that inhibits the growth of spoilage microorganisms and enhances the shelf life while adding flavor.

Drying/Dehydration: Baby corn can be dried to reduce its moisture content, making it less susceptible to spoilage. Dried baby corn can be stored for an extended period and rehydrated before use.

Blanching: Blanching involves briefly immersing baby corn in boiling water, which helps to inactivate enzymes that can cause deterioration. After blanching, the corn can be canned, frozen, or dried.

Preservatives: Food-grade preservatives, such as citric acid or ascorbic acid (vitamin C), can be added to baby corn products to inhibit microbial growth and oxidative reactions, extending their shelf life.

Modified Atmosphere Packaging (MAP): In this method, the air inside the packaging is modified to reduce oxygen levels and increase carbon dioxide levels. This can slow down the deterioration of baby corn.

Vacuum Packaging: Vacuum packaging removes air from the packaging, creating a low-oxygen environment that can help preserve the baby corn's quality and shelf life.

The choice of processing method depends on factors such as the desired shelf life, intended use of the baby corn, and the resources available.

Advantages of baby corn cultivation

Employment generation: The process of baby corn harvesting is labour-intensive and relies on manual operations, providing employment opportunities for rural communities. Additionally, post-harvest tasks such as de-husking, desilking, grading, and packing create jobs for a significant number of individuals.

Regular income: Year-round sales of baby corn, corn straw, inter-crops, and similar agricultural products can offer a consistent source of income to farmers.

Higher profitability: A single baby corn crop can yield earnings of up to Rs. 22,500 per acre in a short span of 2-2.5 months, along with a substantial green fodder production of 150 q per acre.

Fodder for livestock: By-products of baby corn like maize stalk, tassel, silk and husk can be utilized as valuable green fodder. This ensures a year-round supply of green fodder for milch animals without incurring any additional costs.

Higher cropping intensity: Due to its short growth cycle, baby corn can be cultivated 3-4 times within a single year, allowing for a cropping intensity of up to 400%.

3) Sweet corn

Sweet corn is one of the most popular vegetables in the USA, Europe and other developed countries of the world. Sweet corn kernels are typically plump, tender, and juicy with sweet taste, attributed to its higher sugar content compared to field corn. They can vary in color, including yellow, white, and bi-color varieties. Sweet corn is a very delicious and rich source of energy, vitamin C and A. It is eaten as raw, boiled or steamed green cobs/ grain. It is also used in preparation of soup, salad and other recipes. It is becoming very popular in urban areas of country therefore; its cultivation is remunerative for peri-urban farmers. Besides green cobs, the green fodder is also available to the farmers for their



cattle. Generally sweet corn is early in maturity. It is harvested in 70-75 days during kharif season. Green cobs are harvested after 18-20 days of pollination during kharif but the duration may vary season to season. At the harvest time the moisture is generally 70 % in the grain and sugar content varies from 11 to more than 20 %.

Sweet corn production technologies

Site selection

Sweet corn is well-suited for peri urban agriculture because it should be consumed soon after harvest. Areas chosen for sweet corn cultivation should have convenient access to irrigation facilities. Sweet corn crop needs isolation of at least 250 m from normal maize/popcorn as pollination deteriorates its quality.

Sweet corn varieties: Zone-wise recently released sweet corn varieties are listed below:

Type/Zones	NHZ	NWPZ	NEPZ	PZ	CWZ
Sweet corn	NUZI 260, Pusa Super Sweet Corn 2, VL Sweet Corn Hybrid-2, Pusa Super Sweet Corn 1, HSC 1, Win Orange Sweet Corn	NUZI 260	Pusa Super Sweet Corn 1	NUZI 260, Pusa Super Sweet Corn 2, Pusa Super Sweet Corn 1	Pusa Super Sweet Corn 2, Pusa Super Sweet Corn 1

Sowing time

The ideal planting time is June-July in kharif (rainy) and September-October in rabi (winter) season. An increase in temperature to over 35°C during tasseling can result in tassel blast and reduced grain setting. Moreover, at high temperature due to conversion of fructose into polysaccharides sweet corn losses flavour. Due to these reasons, sweet corn cultivation should be avoided during spring season. In Northern Indian conditions, sweet corn planting should be avoided between 15th November to 20th January, when temperature remains below 16°C. Instead, its nursery can be prepared in tunnels using coco pit and subsequently transplanting can be done after 20th January when temperature goes above 10°C. Implementing staggered planting of sweet corn with intervals of 7-10 days ensure a continuous supply to the market and consequently higher returns.

Sowing method and seed rate

The crop is sown at 75 cm row-row spacing and 25-30 cm intra-row spacing. Approximately, 2.5-3 kg seed/acre is required to accommodate recommended plant population of 18,000 to 21,000 plants per acre. When sweet corn is planted downwind from popcorn or field corn, it can develop starchy kernels. Therefore, 10-15 days isolation in sowing time of normal/popcorn may ensures quality sweet corn. Newly procured and healthy seeds should be sown each year because sweet corn seed quality deteriorates significantly within a year.

Transplanting

Seedling transplanting proves advantageous in sweet corn cultivation due to the higher cost of seeds and a reduced plant population. This practice also aids in obtaining early sweet corn for market sale, which often commands higher prices. Nursery should be prepared 3 weeks before the date of transplanting. Transplanting should be done when seedlings reach a height of 15-25 cm. Adequate moisture during transplanting is essential for better establishment of the crop. To prevent damage by ants and other insects, it is recommended to treat the nursery with Furadon @ 15 kg/acre.

Nutrient management

Fertilizer must be applied according to soil test results. As a general guideline, it is recommended to apply 40-50 kg of N, 20-25 kg of P, and 20-25 kg K per acre.

Crop stage	Schedule	Fertilizer (kg/acre)			
		Urea	DAP	MOP	ZnSO ₄
Sowing	Basal	45	45	30	10
25 DAS	1 st split	35	-	-	-
Pre tasselling	2 nd split	20	-	-	-

Weed management

The crop should be kept weed-free during the initial stages of plant growth to prevent significant yield reduction. Achieving efficient weed control for a duration of 20-25 days can be accomplished by applying the herbicide Atrazine at a rate of 400 g ai per acre, typically 1-2 days after the sowing. Post emergence application of Topramezone 33.6% SC at 25 DAS @ 10 g ai/acre is recommended for the late emerging weed control. Tembotrione 34.4% SC and Halosulfuron-methyl 75% WG have phytotoxic effect on some varieties of sweet corn, hence these herbicides are not recommended for sweet corn.

Irrigation management

Sweet corn crop typically requires 4-5 irrigations during kharif and 6-7 irrigations in rabi season. The tasseling and silking are most critical stages for sweet corn. So, it is crucial to avoid moisture stress during the tasseling-silking, as water stress can lead to reduced seed set and may develop barren ears.

Harvesting

The timing of the harvest is crucial for the quality of the final product. Sweet corn is ready for harvest during the milk stage, when the kernels are at the peak of their size, sweetness and tenderness. The cobs are picked at 70-75 DAS during kharif and 80-100 DAS during rabi. At the harvest time the moisture is generally 70 % in the grain and sugar content varies from 11 to more than 20%. Picking should be done in morning or evening hours for optimal quality. Immediately after picking it's essential to promptly transfer the harvested cobs to a cool and shaded area to maintain their quality.

Yield

After the harvest of green cobs, the corn plants retain their greenness and can be easily utilized as fodder. A sweet corn crop can produce 20,000-22,000 cobs and 100-150 q of fodder per acre.

Post-harvest management

The flavor of sweet corn can deteriorate rapidly if stored in high temperatures after harvesting. For instance, when left at room temperatures, sweet corn can lose 50% or more of its sugars within 24 hours. Therefore, it is crucial to transport freshly harvested green cobs immediately to cold storage facilities in refrigerated trucks. This helps prevent the conversion of sugar into starch. Upon arrival at the storage facility the ears should be graded based on their raw size and then packaged in polythene bags for sale in the market.

Processing

The harvested corn is dehusked, removing the outer leaves and husks. It is then thoroughly cleaned to remove dirt and debris. The corn is briefly immersed in boiling water or steam, which helps inactivating enzymes that can cause quality deterioration. This blanching step is essential to preserve the color, flavor, and nutritional value of the corn. After blanching, the corn is quickly cooled to stop the cooking process and maintain its quality. The corn kernels are separated from the cobs. Depending on the desired product, some whole kernels may be left intact, or the corn may be cut into smaller pieces. The processed corn is packaged into containers appropriate for the intended product. Canned corn undergoes a heat treatment process to sterilize the contents and eliminate any microorganisms that could cause spoilage. For frozen corn, the product is rapidly frozen to very low temperatures to preserve its freshness. This process locks in the flavor and texture. After processing and quality control checks, the sweet corn products are labeled with relevant information, including ingredients, nutritional information, and best-before dates.

4) Pop Corn

Popcorn is one of the common snack items in many parts of the world, particularly in cities and is liked because of its light, porous and crunchy texture. Its popularity spans across movie theaters, sporting events, and home entertainment. It's also used in various snack products, such as popcorn balls and popcorn-based cereals. Furthermore, the popcorn flour can also be used for preparing many traditional dishes.

It is consumed fresh, as it has to be protected against moisture absorption from the air. It is hard endosperm



flint maize, having very small and oval/round kernels. Popcorn kernel contains a small amount of moisture trapped inside a tough outer shell. When the kernel is heated at about 170°C, the moisture turns into steam, creating pressure inside the kernel. Eventually, the pressure becomes too great, causing the kernel to burst open, turning inside out, and creating the familiar popcorn shape. Popcorn is a good source of dietary fiber and contains vitamins, minerals, and antioxidants. Quality of pop corn depends on popping volume and minimum number of non popped corn.

Characteristics of pop corn

- ✓ It is hard endosperm flint maize
- ✓ Kernels of pop corn are very small and oval/round in shape
- ✓ When heated at about 170°C, the grains swell and burst, turning inside out
- ✓ Quality of pop corn depends on popping volume and minimum number of non pop corn

Major component of pop corn

Starch	61.0-67.9%
Amylose	27.0-28.5%
Crude protein	8.1-10.5%
Crude fat	3.8-4.6%
Reducing sugar	0.07-0.23%

Health benefits of pop corn

Popcorn is a rich and concentrated source of nutrients such as proteins, minerals, antioxidants, fiber, vitamin B complex, and others, which makes it popular among households as a healthy alternative for breakfast and meals. In addition to fiber, popcorn is also a good source of polyphenols, which are antioxidants that have been linked to better blood circulation and digestive health, as well as a potentially lower risk of certain cancers. However, processed popcorn that has too much butter, oil or salt compromises its health benefits.

Pop corn production technology

The production technology of pop corn is very similar to dent corn/QPM. However, there are specific requirements unique to popcorn cultivation, which are outlined below.

Pop corn varieties: Zone wise recommended pop corn varieties are listed below:

Pop corn varieties: Zone wise recommended pop corn varieties are listed below:

Type/Zones	NHZ	NWPZ	NEPZ	PZ	CWZ
Pop corn	Pant Popcorn-1, Shalimar Pop Corn-1, BPCH-6, VL Amber Pop Corn	GAPCH-21 Maha Shweta, DMRHP 1402, Shalimar Pop Corn-1, BPCH-6	GAPCH-21 Maha Shweta, Shalimar Pop Corn-1, BPCH-6, Ladhawal Popcorn Hybrid 3	Pant Popcorn-1, GAPCH-21 Maha Shweta, BPCH-6, Ladhawal Popcorn Hybrid 3, DMRHP 1402, Shalimar Pop Corn-1	Pant Popcorn-1, GAPCH-21 Maha Shweta, DMRHP 1402, Shalimar Pop Corn-1, BPCH-6, Ladhawal Popcorn Hybrid 2, Ladhawal Popcorn Hybrid 3

Sowing time: Kharif popcorn can be planted from the last week of May to the first fortnight of July. A minimal soil temperature of 10-13°C is necessary for seed germination. Planting later than July 15 often results in a reduction of yield and maximum popping expansion. Early planting permits the crop to mature and reach the desired harvesting moisture of 15-18 percent by early to mid-October. Rabi sowing need to be completed in between October end to middle of November so that the crop can establish itself before the onset of winter.

Sowing method and spacing: The recommended spacing for pop corn is 60 cm X 20 cm. With irrigation facility its population should be between 32,000 to 33,000 plants/ha.

Seed rate: Seed rate for popcorn is lower than that for normal corn because of its smaller kernel size. Generally, five kg seed is sufficient for one acre planting.

Nutrient management: Fertility requirements for popcorn are similar to dent corn/QPM. High nitrogen rates can cause lodging, especially when using less than the recommended rate of potash. Popcorn seedlings grow slower than dent corn, therefore a basal fertilizer application is very important for the crop.

Disease management: Popcorn is more susceptible than field corn to diseases especially stalkrot and ear rot and blue eye disease caused by three types of molds *Penicillium viridicatum*, *P. cyclopium* and *Aspergillus glaucus*. These pathogens not only affect the crop in the field but also hampers stored grains leading to low popping volume, low germination and sometimes make the grain toxic too. This disease is best controlled by proper aeration during storage. Grow resistant varieties and reduce insect damage to cob for control of ear rot disease.

Harvesting: Maximum popping potential of a hybrid can be achieved only if it reaches full maturity. Popcorn matures in 85-90 days in rainy season (kharif) and 95-100 days in

winter season (rabi). Popcorn is typically harvested when the moisture content of the kernels falls within the range of 16-20 percent. Harvesting equipment should be adjusted accurately and carefully so kernel damage is prevented. Damaged kernels do not pop properly and will cause a discount on the grain market

Yield: With good management, 10-16 q/acre popcorn may be obtained.

5) Waxy corn

Waxy corn is a distinct starch variant of regular corn, resulting from a single recessive gene. waxy corn predominantly contains amylopectin, a form of starch characterized by its branched glucose chains. While in normal maize, the starch is nearly 30 percent amylose and the remaining 70 % is amylopectin. It is originated in China but largely used in USA. Waxy corn is mainly used for food and industrial purposes. The food industry utilizes it as a stabilizer and thickener, while the paper industry employs it as an adhesive. Waxy maize typically yields approximately 3.5% less than its normal dent counterparts. It is essential to isolate waxy maize fields from nearby normal maize fields by a minimum distance of 200 meters to prevent cross-pollination.

6) High oil corn

High-oil corn is a valuable source of corn oil, often used to enrich margarine and cooking oils. Most of the normal maize lines have 3- 4 % oil content. In general, lines with more than 6 % oil are considered high oil lines. The corn oil has low content of saturated fatty acid and is considered to be one of the best quality cooking oil. In India more than 60000 tonnes of corn oil is made available for various uses. High-oil corn varieties exhibit elevated protein levels and reduced starch content in their grains. Increased grain oil content also increases energy content per unit of feed, and it reduces the need for expensive dietary supplements. Therefore, high oil corn is good source of animal feed due to its greater energy density compared to normal corn. Feeding trial demonstrated that feeding on high-oil corn grain increased milk production in cattle. In USA the high oil corn is cultivated on contractual basis and remunerative price is paid to the farmers

In India, cultivating high oil corn is not financially viable due to the absence of a premium market price. Generally, in normal maize crop, 15-20 % population of high oil hybrids is used as pollen parent and tassel are removed from normal corn. Due to xenia effect, there is an increase of oil in normal maize. High oil corn field must be isolated from nearby normal/wild maize fields by a minimum distance of 200 meters.

7) Fodder maize

Livestock farming plays a crucial role in India's rural economy, providing livelihoods to millions of farmers and rural communities. Maize is a popular fodder crop due to its rapid growth, abundant biomass yield, and excellent palatability. Maize possesses better nutritional value than rest other non-leguminous fodder crops including sorghum and pearl millet. It contains ample quantities of protein and minerals, and bear superior

digestibility compared to other non-legume fodders. In contrast to sorghum and pearl millet, maize does not contain any undesirable anti-quality components, making it the preferred choice for livestock feeding. Maize fodder can be used at any crop growth stage. Its quality is adversely affected after anthesis. De-tasseling is advised to the farmers for better digestibility and palatability. The tall, leafy and longer duration cultivars are most preferred for maize fodder cultivation. Generally, the farmers grow composite varieties or advance generation of hybrid seed which is economical to the farmers.



Nutritive value of different fodder crops

Crop	Harvesting (DAS)	Crude protein (%)	In-vitro dry matter digestibility (%)
Maize	55-65	8-11	52-68
Bajra	45-55	7-10	55-62
Sorghum	70-80	7-8	57-60
Napier bajra	55-60	7-11	55-60
Teosinte	80-85	7-9	58-62

Source: Gupta et al. (2005)

Fodder maize production technology

Varieties: Tall, leafy and longer duration cultivars are most preferred for maize fodder cultivation. African Tall, J 1006, Pratap Makka Chari-6, J 1007, TSFM-15-5, DFH-2 (multi-tiller producing inter-cross hybrid) are some popular cultivars for fodder purpose.

Sowing time: The cultivation of maize for fodder can be done round the year. It is generally grown from mid of March to mid of September under irrigated condition. Staggered sowing is recommended for supply of green fodder for a long period.

Sowing method: Fodder crop should be sown in rows using seed drill which can help optimize the use of available land and resources. Row planting allows for better light penetration and airflow, which can enhance crop growth and reduce the risk of disease.

Seed rate: To achieve greater fodder yield, it is essential to establish a higher plant population of 89,955 plants per acre. Therefore, comparatively higher seed rate i.e., 20 kg/acre is used for fodder crop.

Spacing: Fodder maize needs close spacing of 30 cm between rows and 15 cm between plants.

Nutrient management: Effective nutrient management is crucial for maximizing the yield and quality of fodder maize.

Crop stage	Schedule	Fertilizer (kg/acre)		
		Urea	DAP	MOP
Sowing	Basal	55	55	30
25-30 DAS	1 st split	55	-	-

Weed management: Atrazine @ 400 g ai/acre may be applied immediately after maize planting to control early flushes of weed. Weed management during later growth stages is not required because the dense planting reduces sunlight penetration, leading to poor weed proliferation.

Harvesting: The timing and methods of harvesting fodder maize are critical to ensure good nutritional quality. Harvesting should be done just after anthesis (at 65-75 DAS). At this stage, the plant has the highest nutritional value and digestibility.

Yield: Under good management practices and optimal growing conditions, 160-200 q/acre green fodder may be obtained.

8) Maize for silage

Quality fodder availability is very essential for ensuring sustainable and cost-effective livestock production. Green fodder is regarded as an affordable source of nutrition for dairy animals due to the steady rise in the price of concentrate feed ingredients and their restricted supply. Providing green fodder throughout the year supports increased milk production and enhances reproduction rate. Round the year green fodder availability is challenging task for dairy farming. Farmers often encounter a shortage of fodder,

particularly during the lean period of May-June and November-December. Therefore, to supply green fodder during lean period, it is desirable to preserve the surplus fodder with minimum nutrient loss through ensiling (silage making). The preservation of fodder silage is an anaerobic fermentative process, which converts soluble plant carbohydrates into organic acids by microbial activity. Thus, silage is the final product of green fodder fermentation.



Advantages of silage

- ✓ Silage enhances livestock productivity by ensuring fodder supply during the lean period.
- ✓ Its quality remains unaffected by weather fluctuations and adverse weather conditions due to the airtight storage.
- ✓ It is a very palatable feed that is slightly laxative in nature.
- ✓ The ensiling process has become more mechanized and is therefore less labor intensive than haymaking.

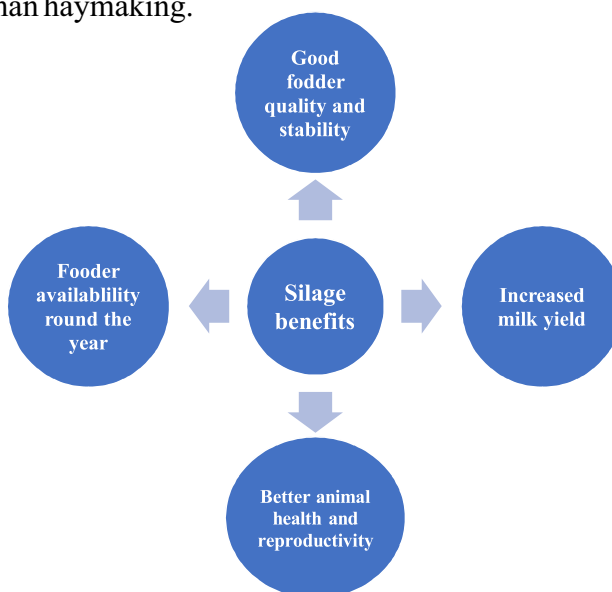


Fig. Advantages of silage

Maize is one of the most desirable crops for silage making, and corn silage has become a prominent and widely utilized ingredient in the dairy industry. The high starch, energy, and water-soluble contents and buffering capacity of maize silage, coupled with its high dry matter yield potential, make it an excellent feed for cattle and sheep. Maize silage has become a profitable venture due to the advancements in mechanized cultivation, which reduce labour demand, and the absence of moisture-related marketing concerns associated with grain maize. Additionally, its early harvest allows for timely farm turnover for the next crops, and its cost-effectiveness as a feed option makes it an ideal choice to sustain the household dairy sector.

Silage maize cultivation practices

Selection of varieties: To achieve a sustainable yield of high-quality maize fodder for silage production, the careful selection of cultivars is a crucial practice. Lodging and stalk rot resistance is one of the most important characteristics for selecting the hybrid to be ensiled. Lodging in maize hampers crop biomass yield and quality and also creates hurdles in crop harvesting. Green leafy cultivar with broad leaf and thin stem, high vegetative growth, more dry matter yield, high protein and less lignin content and good fiber digestibility are most suitable for silage making. Unfortunately, only a limited amount of testing information is available for silage yield and forage quality. To maximize corn silage yield potential, select hybrids with a relative maturity rating up to 10 days longer than a full-season grain hybrid for your area. These hybrids often have a 2 to 4 ton/acre yield advantage over standard maturity hybrids.

Sowing time: The cultivation of maize for silage can be done round the year. It is generally sown from March to June.

Seed and sowing: For optimal silage production, it is recommended to plant the crop at a seed rate of 8-10 kg per acre, using a spacing of 60×20 cm between rows and within row, respectively.

Nutrient management: Maize is very responsive to nutrient application and has slightly high nutrient requirement as compared to other cereals due to high yield potential. Apply 50-60 kg N, 20-25 kg P and 12-16 kg K per acre for good crop harvest. Nitrogen should be applied in three splits at sowing, 30 and 45 days after sowing.

Harvesting: Harvesting time is an important factor in silage making as early harvesting can reduce total biomass yield whereas late harvesting may produce poor quality silage. Maize should be harvested when the dry matter content of the whole crop is between 28-35 per cent. For accessing the dry matter content, harvest a representative sample (200-500 g), weight it, dry it in oven and again weight it. To calculate dry matter content, divide the final weight by the initial weight and multiply the value by 100. Beside these, the 'milk line test' can be used as a guide for silage harvesting. When the line separating the liquid (whitish seed coat) and solid parts (yellowish seed coat) of the grain meet halfway down, the crop is ready to harvest.

Silage making: To ensure good quality silage it is utmost important to harvest the crop at the proper moisture content, correct the leakage in silo, chop the forage to desirable length and do rapid filling, thorough packing and prompt sealing. Forage harvester (CLASS JAQUAR 850 and Zoomlion 3000A) can be used for large scale silage harvesting and chopping. Chopping maize forage crops into 2-3 cm length is ideal for thorough packing and eliminating most air pockets. For small scale silage making, pit silos, trench silo, bunker silo etc. can be used. Further, care should be taken that the pit or containers should be air tight. Generally silage is ready after 45 days of ensiling to feed to animals. The baling method of silage production is ideal for commercial silage making, especially when long-distance transportation of silage is required.



Baby corn as silage: The baby corn maize stalks are green, succulent, nutritious and possess excellent digestibility. In an experiment conducted in our own laboratory at Punjab Agricultural University, Ludhiana. We have evaluated the fodder quality of maize stalks grown for baby corn purpose. The protein content of baby corn stalks were almost equivalent to the maize grown for fodder purpose. Yield potential and nutritional quality of some promising baby corn genotypes grown along with two most common fodder maize varieties viz. African Tall and J-1006 were evaluated in a field study (Choudhary et al.,). Samples were taken at the maturity of I (I harvest) and II (II harvest) of baby corn. The data shows that the nutritional quality of baby corn stalks is almost at par with the maize grown for fodder purpose. Although the biomass of baby corn stalks was little less than the fodder maize J-1006 and African tall, there is little difference in terms of crude protein and IVDMD. The woodiness is also comparable. It means the baby corn maize is as good as fodder maize. Sweet corn little mature than baby corn, still lot of nutrients are present in the sweet corn stalks which makes it utmost fit for utilization in the form of animal fodder.

Value addition

Value addition in maize has a great potential and there are several value added products of maize particularly QPM and baby corn that not only increase the farm income but also provides employment to rural youth and farm women.

Value added products developed using QPM:

Baked products	Extruded products	Convenience foods	Popped products	Traditional products
Bread, cake, biscuit, cookies, muffins	Vermicelli and pasta	Instant idli and dhokla mix, porridge mix and sprouted chaat	Popcorn and popped laddoo	Laddoo, burfi, ghachak, halwa, Kheer, chapatti, sev, mathi, pakora and cheela.

Value added products developed using baby corn

Sweet products	Preserved products	Chinese products	Traditional products
Halwa, kheer, barfi	Jam, chutney, pickle, candy, murrabba	Soup, manchurian, baby corn chilly, chowmein sweet and sour vegetables	Pakoda, cutlet, chaat, salad, dry vegetables, kofta, mixed vegetable, raita.



Value added products developed using sweet corn

High summer scallops	Sweet corn and tomato salad
Organic speedchef	Sweet corn cake
Sauteed green with shallow and sweet corn	Thai Basil and Sweet Corn

Value added products developed using pop corn

Ballpark pop corn crunch	Caramel corn crunch	Chilli corn	Pina colada popcorn
Beach party popcorn	Caramel nut popcorn crunch	Kettle corn	Red cinnamon popcorn
Boston tea party popcorn	Cherry almond popcorn clusters	Patchwork popcorn party mix	Swiss-onion popcorn

The detailed receipt of these value added products are available at:

- 1) Maize AGRI daksh website: <http://agridaksh.iasri.res.in/maize.jsp>
- 2) Bharti Makka App
- 3) IIMR folder "Value added maize products".

REFERENCES

Gupta, B.K., Bhardwaj, B.L. and Ahuja, A.K. (2004). Nutritional value of forage crops of Punjab. Punjab Agricultural University Publication.

Panda, A., Raju, M. V. L. N., Rao, S.V., Goodla, L., Reddy, E. and Sunder, G. (2012). Substitution of normal maize with quality protein maize on growth performance, serum biochemical parameters and carcass characteristics of broiler chickens. Indian Journal of Poultry Science. 47. 183-187.

Kawatra, A. and Sehgal, S. (2007). Value-added products of maize [Quality Protein Maize and Baby Corn]. National conference on "Double Maize Production" organised by IFFCO Foundation, ICAR, DMR, DAC & IFFCL at New Delhi on May 08-09, 2007.

Specialty Maize Cultivation Practices for Livelihood Security



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