Advancements in Mechanized Techniques for Sweet Corn Cultivation: A Review

Abstract

This introduction on sweet corn includes a detailed account of its history, cultivation, and accompanying technologies. Sweet corn, a variety of field corn (Zea mays) with a genetic mutation that results in greater sugar content in its kernels, was initially grown in Pennsylvania in the mid-1700s, with commercial versions developing by 1779. The essay discusses the numerous current kinds of sweet corn, which range in sweetness, color, and genetic alterations for increased resistance to pests and herbicides. The production technique for sweet corn needs careful selection of land, especially in peri-urban locations with well-drained soils, followed by comprehensive site preparation. Sweet corn is planted with precise planting procedures, seed treatment, and spacing requirements to promote maximum development and output. The introduction also discusses the employment of innovative agricultural equipment for land preparation, planting, fertilising, weeding, and plant protection, underlining the necessity for accurate and efficient farming procedures to achieve high-quality sweet corn output.

The essay also elaborates on the need of good field leveling, utilising instruments like the laser land leveler, and contemporary planting methods, such as zero-till planting and the use of pneumatic planters, to boost crop establishment and yield. Additionally, it includes numerous instruments for weeding and plant protection, including cultivators, sprayers, and acoustic devices for bird control, stressing the significance of technology in contemporary sweet corn cultivation.

Keywords: Sweet corn, variety**,** yield, land preparation**,** farming

Introduction

Sweet corn belongs to the same species as field corn (Zea mays) but contains a genetic mutation (or mutations) that results in the corn kernels holding considerably more sugar than typically cultivated field corn (Nguyen, P. *et al.*, 2023). Varieties containing this mutation were

originally found and cultivated in Pennsylvania in the mid-1700s. The first commercial cultivar of sweet corn was supposedly developed in 1779. To capture optimum sweetness, sweet corn is picked before it completely develops when sugar concentration is still high.

Currently there are sweet corn varieties/hybrids with genes for varying amounts of sweetness, varied hues (white, yellow or bicolor) and genetic changes for herbicide resistance and insect control. Genetic breakthroughs have also increased the quality of both fresh and processed food. As an example, there are ultra-sweet cultivars that provide longer shelf life, prolonged marketing windows and the supply of higher-quality goods throughout the year. Sweet corn may be prepared and canned or frozen or sold in the fresh market. Though most wait to harvest full grown sweet corn, a tiny market does exist for the totally edible unhusked baby corn.

Production Technology

Land Selection:

Since sweet corn needs to be used in a short period after harvest it fits well with periutban agriculture. Hence sweet corn may be extremely economically planted in locations around big cities and towns which are frost free throughout the season of cultivation(Revilla, P., Anibas, M, C. and Tracy, F, W., 2021). It may effectively be cultivated in well-drained soils with pH of 5.5-7.0. However, it may be cultivated in various kinds of soil and is relatively salt-tolerant. Places where sweet corns are to be planted must have capability for 5-6 irrigations. Moisture stress, especially during the time of anthesis negatively influence the yield and quality of the output. Since all genes regulating sweet corn are recessive, sweet corn is to be produced at a field isolation of 250 m from other corn or by a tassel date of 14 days.

Land Preparation:

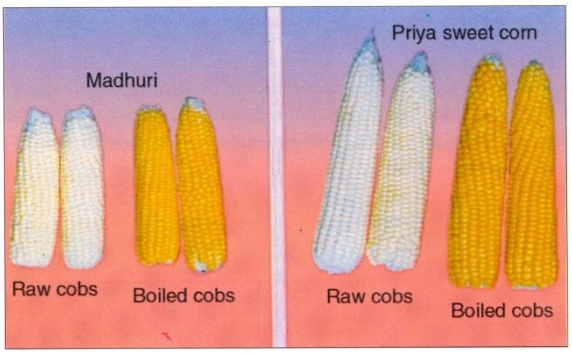
Sweet corn needs vigorous disc ploughing followed by soil leveling initially. Thereafter ridges and furrows have to be set out with an inter row gap of 75 cm. It is advisable to add FYM @5-6 tonnes/ha• during the final ploughing. Seedbed preparation and seed management is crucial for all varieties of sweet corn, but notably super sweets. Good soil to seed contact, uncrusted soil, and appropriate soil moisture help seedlings emerge. Careful seed handling is particularly crucial because if the seed coat is split, solutes seep from the seed, inviting dangerous fungus. Rapid uniform seed emergence also pro-motes uniform maturity(Edun, T, B. et al., 2019).

Time of Sowing:

The planting period is June-July in kharif (rainy) and September-October in rabi (winter) season.

Varieties:

Both white and yellow grain kinds of sweet corn are cultivated. Some of the suggested sweet corn types authorised for cultivation include Madhuri, Priya and Almora sweet corn in India(Rana, B, J., Singh, J. and Kumar, S., 2018).



Popular sweet corn varieties

Seed Rate:

It is recommended to use fresh seed every year since the quality and vigour of the seed significantly decrease within a year, particularly for very sweet varieties. The optimal plant density for maximum production is 45000-60000 plants per hectare, with a row spacing of 75-100 cm and a spacing between plants within the row of 15-30 cm. To achieve this, it is necessary to use 10-11 kilogrammes of sweet corn seed per hectare. Super sweet corn seed includes a huge concentration of sugar, which causes the seed to be crinkled and smaller. Super sweet corn variations have a higher seed count of 500 seeds per kilogramme compared to other sweet corn kinds, which have a seed count of 325 seeds per kilogramme. As a result, super sweet corn varieties will need less seed, namely 5 to 6 kilogrammes per hectare(Burgmans, L, J. and Lill, E, R., 2023).

Seed Treatment:

Applying Imidachloprid 70WS at a rate of 5g per kilogramme of seed effectively controls insect pests for up to 30 days after sowing. Additionally,

treating the seeds with fungicide helps to prevent the occurrence of damping-off fungus.

Sowing Technique:

Two seeds per hill are inserted manually or mechanically about one third from the peak on the side of the slope. Sowing on ridges offers the combined function of water saving and protection against water logging in the first phases to which sweet maize is extremely vulnerable. The recommended planting depth for all cultivars, save for super sweets, is 3-4 cm. For super sweets, the planting depth should be 2.5 cm. Plants are reduced to a single plant per hill around 10-12 days after they have emerged. Normal (su) and sugary enhanced (se) sweet corn should not be planted earlier than 7 to 10 days before the average date of the last severe frost. To ensure adequate pollination, it is recommended to seed a minimum of 3 rows of each type at each planting. Seeds of sh-2 variants are less robust than other sweet corn types, which might lead to lower and irregular crop stand. Researchers have proposed that the diminished vigour is connected to reduced starch stores for germination, fractured seed coats and higher carbohydrates, which leave the seed more vulnerable to diseases(Uğur, A. and Maden, A, H., 2015).

Some Special Features of Sweet corn

In conventional sweet corn cultivars kernel sugar content peak levels endure in the field only for 2 days at 27°C or 5 days at 16°C before sugar is converted to starch. Even if ears are selected at peak sugar concentration, quality diminishes soon after plucking due to loss of sugar. In 24 hours after harvesting, sugar content drops to 8 percent at 0°C and up to 52 percent at 30°C. Thus, it is difficult to collect sweet corn before it becomes starchy and feed it to the customer before sugar levels fall. For these reasons, 'supersweet' cultivars are currently chosen for commercial sweet corn cultivation. These cultivars taste sweeter and convert sugars to starch more slowly on the plant and lose sugar at slower rate after harvest. While all lines with more sweetness than the usual are frequently referred to as supersweets, technically only those lines with the sh2 gene should be labelled 'supersweets'. The name

'shrunken 2' reflects the fact that so little starch is present in the kernel that it looks shrunken, especially when compared to ordinary sweet corn lines with the su-1 gene. Peak sugar levels in sh-2 hybrids vary from 22-40%, compared to 5-11% in conventional sweet corn. It is plausible to anticipate commercial sweet corn harvests in the future to be dominated by sh-2 hybrids, some people claim the sh-2 hybrids are overly sweet and lack the traditional sweet corn taste and soft kernels. However, kernels of many of the latest supersweet releases are as soft as those of normal cultivars. The first supersweets were likewise tougher to cultivate and even the newest sh-2 hybrids challenge the farmer because of isolation needs from other varieties of corn.

Sweet corn cultivars with the se gene give a third choice for roadside marketers or those who will utilise or sell the corn within 1-2 days after harvest. These sugar-enhanced kinds start off with more sugar content than conventional sweet corns, but convert sugar to starch at the same quick pace after harvest. Cultivars which are homozygous for the se gene have peak sugar concentrations of 12-20% whereas those heterozygous for the se gene have sugar levels of just 7-15 percent. The benefits of these cultivars are that they have the same sensitive kernels and creamy texture (often characterised as 'genuine corn flavour'), as ordinary sweet corn, but seedling emergence traits are better and isolation needs less strict than for the sh-2 hybrids. If planted adjacent to normal sweet corns, individual kernels may be like those of the standard sweet corn, although this is far less disagreeable than when starchy, hard kernels emerge on the ear, as is the case when standard sweet corn pollinates sh-2 corn varieties(Troyer, F., 2023).

Land Preparation

Mould board (MB) plough:

It is main tillage equipment which turn the soil, cuts trashes and buries them within the soil. It is also used for rotating and mixing green manure crops/compost/farmyard manure, lime and other soil additives into the soil.

Specifications of MB plough	
Dimension (m)	1.77´0.88´1.09

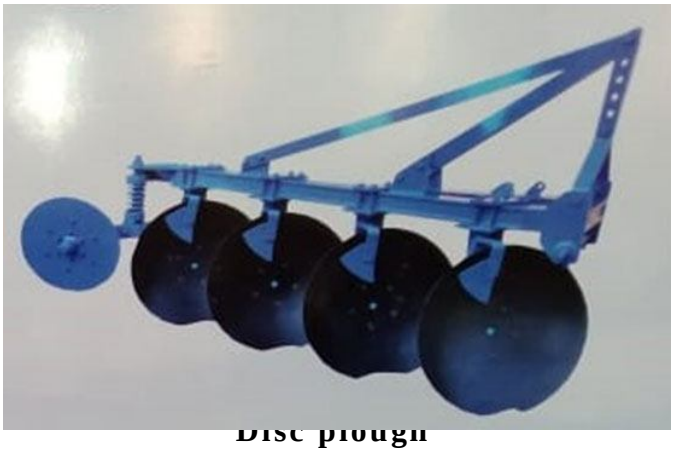
Weight (kg)	253
Power requirement	45 hp tractor
Approx cost (INR)	30,000

MB plough

Disc plough:

Disc plough is also a primary tillage implement which is used in stony, hard and dry, trashy soils and in soil where scouring is a major problem.

Specifications of Disc plough	
Disc size (mm)	600-800
Width of cut per disc (mm)	200-300
Weight (kg)	236-376
Adjustable working width (mm)	600-1200
Working depth (mm)	Up to 300
Disc angle (°)	40-45
Tilt angle (°)	15-25
Power requirement	35-50 hp tractor
Approx cost (INR)	30,000



Disc plough

Tyne type cultivator:

Cultivator is secondary tillage implement used for preparation of seedbed. It is also used for intercultural operation/weeding in wider row crops like maize after adjusting tynes spacing.

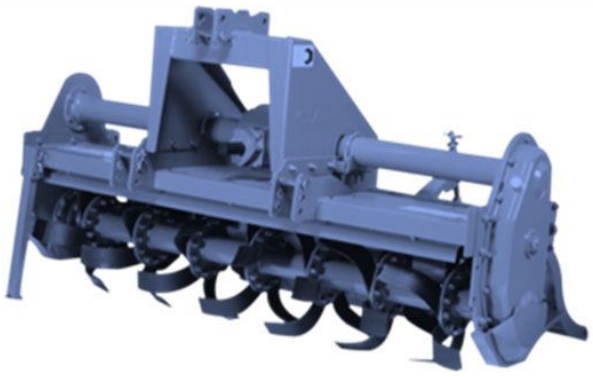
Specifications of cultivator	
Dimension (m)	1.96-3., 0.97-1.56, 1.07-1.35
No of tynes	9-13
Diameter of spring wire (mm)	9.5
Power requirement	35 hp tractor
Approx cost (INR)	25,000-30,000

Tyne type cultivator

Rotavator:

Rotavator carries out secondary tillage tasks like as harrowing and leveling in one operation. It kills weeds, integrates manures/fertilizers and left-over stubble of previous crop, break down bigger clods and pulverizes the soil. It prepares seed bed in one pass therefore saves draft power, time, labour and money as compared to traditional tillage. Rotavator may play an essential function in intensively farmed locations when the time for seed bed preparation is quite small. Continuous use of rotavator may generate subsurface compaction slightly under the operating depth, generating accumulations of water during extreme rain. It decreases land preparation cost by ₹ 1000-1500 per hectare as compared to previous approach(Adamu, H. et al., 2023).

Specifications of Rotavator:	
Working width of rotavator (m)	1-2
Shape of blade	L shape
Orientation of blade (°)	45-47
Total no of flanges	6-8
No of blades per flange	6
Weight (kg)	280-415
Revolution of rotor shaft (rpm)	210-237
Power requirement	35-50 hp tractor
Field capacity (ha/h)	0.25
Approx cost (INR)	65,000 to 80,000



Rotavator

Laser land leveler:

Field with undulating terrain suffers from unequal crop stand owing to uneven seed planting depth and uneven distribution of rainfall. It also leads to runoff and erosion, and non-uniform maturity of crops. Uneven field necessitates more energy and expense in field preparation. Excess soil moisture at lower height promotes water logging and leaching, while moisture shortage at higher elevation inhibits water and nutrients intake. Thus, land leveling is pre-requisite for attaining improved resource use-efficiency. Laser land leveler gives a highly accurate ground leveling and delivers more consistent moisture environment and crop stand. It also save expensive agri-inputs (seed, fertilizer, irrigation etc.). Runoff from field application/rain water coupled with applied agro-chemicals also limited, solving environmental challenges(Zhao, T. and Li, W., 2022).

Specifications of laser land leveller	
Laser Source	< 5mw 635nm
Operating diameter(m)	Above 800
Grade range (%)	–10 to +15 Dual Axes
Grade accuracy (%)	0.015, 3 mm@30 m
Remote control type	Full 2-way communication
Power requirement (hp/KW)	60/45
Approx cost (INR)	3,50,000

Laser land leveler

SOWING

Maize/multi-crop planters: Maize planter discharge consistent number of seeds and fertilizer across the field. Unlike seed-drill, the planter maintains needed plant-to plant distance, resulting in great output and preservation of pricey seeds.

Specifications of Multi crop planter	
No of rows	3-6
Row to row spacing	24 inch standard and adjustable
Fertilizer metering	Agitator and sliding orifice type
Seed dropping	Rotating disc with cells on its periphery
Approx cost (INR)	40,000-50,000

Multi-crop planter

Ridge planter:

Maize is particularly susceptible water logging. Drought also causes severe yield loss to the crop. Bed planting preserves the crop in harsh water situations like excess or shortage rainfall. During excess rainfall the furrow function as drainage route while it accumulates rain water during low rain occurrences. Ridge planters are commercially available which can accomplish bed making & sowing on the tip of the bed in a single operation. Ridge planting provides greater root growth, reduced logging, saving of irrigation water and also cut down operating expense. It can reduce down 24 and 90 %

cost and time, respectively when compared with traditional approach(Rajaiah, P. et al., 2020).

Specifications of Ridge planter	
No of rows	2-5
Row to row spacing	24 inch standard and adjustable
Fertilizer metering	Agitator and sliding orifice type
Seed dropping	Rotating disc with cells on its periphery
Field capacity (ha/day)	3.5

Ridge Planter

Zero till planter:

In traditional agriculture, one ploughing, 2-3 harrowing followed by planking is done for effective seedbed preparation and weed control. These 4-5 runs of tractors and tractor connected heavy tools, crush the soil particles influencing soil structure, and generate compaction issue which inhibit seedling emergence, root penetration, soil aeration and water flow. Further, these traditional tillage operation demands extra fuel, greater turn around duration and manpower raising expense of agriculture. Alternative to traditional tillage is no-till planting, in which planting is done in stubble of previous crop without any soil disturbance/tillage activity. This technique minimises capital expenditure in land preparation and intercultural activities. It is a feasible substitute to traditional and tillage-intensive agriculture. This

technique is quite prevalent in the U.S.A, Canada, Argentina and Australia. In India zero till maize planting has been introduced in coastal Andhra Pradesh in rice-maize system. This system saves fuel, tractor's working time and manpower allowing timely seeding of crops. If zero planting is paired with residue mulching, it alters hydro-thermal characteristics and protect the crop under severe circumstances(Nguyen, P. et al., 2023).

Specifications for Zero till maize planter	
Seed dropping	Rotating disc with cells on its periphery
Fertilizer metering	Agitator and sliding orifice type
No. Of rows	Available in 3-6 rows
Row to row spacing	24 inch standard (maximum) and adjustable
Furrow openers	Inverted 'T' type
Approx cost (INR)	45,000

Zero till planter

Pneumatic planter:

Uniform planting depth and accurate spacing from seed to seed ensures uniform germination and also helps in conserving of the pricey hybrid maize seed utilising the pneumatic planters in maize. This offer consistent crop establishment and crop stand which boost the maize yield up to 10-20%. These may be housed in custom hiring centers for maize planting.

Specifications of Pneumatic planter	
No. of rows	2,4, 6
Row to row spacing	12 inch minimum and adjustable
Fertilizer metering	Fluted roller
Seed metering	Vertical rotating disc pneumatic seed picking
Sowing depth	Adjustable
Furrow opener	Shovels for sowing in tilled/prepared field
Approx cost (INR)	4-6 lakhs

Pneumatic planter

Happy seeder:

Happy Seeder comprises of a straw management rotor for cutting the previous crop wastes and a zero till drill for seeding the following crop. Flail type straight blades are fitted on the straw management rotor which cuts (hits/shear) the standing stubbles/loose straw arriving in front of the sowing tine and clean each tine twice in one rotation of rotor for appropriate. The flails pushes the leftovers as surface considerably between the planted rows.

Specifications for Happy seeder	
Seeding metering	Fluted rollers type
Power source	45-50 hp tractor
Field capacity (ha/hr)	0.3-0.4
Cost (INR)	Approximate 1.3 lakh

Happy seeder

Wide bed planter:

This planter is used for broad bed making and planting of maize simultaneously in single operation. It can prepare two raised bed per pass. Two row of maize is sown on tip of each bed.

Specifications for Wide bed planter	
Seed metering	Fluted Roller / Rotating Disc with cells on its perifery
Fertilizer metering	Agitator and sliding orifice type
Power source	45 hp tractor
Cost (INR)	Approximate 1.3 lakh

Wide bed planter

FERTILIZER APPLICATION

Tractor mounted fertilizer broadcaster:

This equipment is used for uniform broadcasting of granular fertilizer. The broadcaster, mainly consists of a hopper and a spinning disc. The fertilizer from the hopper is made to fall on the spinning disc rotating at high speed, which in turn uniformly spreads the fertilizer.

Specifications for Fertilizer broadcaster	
Type	Tractor mounted
Hopper capacity	500 liter fertilizer
Fertilizer spreading mechanism	High speed rotating disc
Hitching	3 point linkage
Fertilizer spreading width	20-30 feet
Field capacity (ha/h)	2.5

Fertilizer broadcaster

Tractor driven three row fertilizer band placements cum earthing up machine: This machine can execute three jobs in one operation, which are as follows:

• Placement of fertilizer (60 to 250 kg/ha) along the row (50 to 100 mm away from the plant),

• Earthing up (can cover 10 cm height of stem) and

• Cutting of weeds. This equipment may save large quantity of fertilizer, time and labour over previous approach.

The field capacity of machine is 0.56 ha/h. The estimated cost of the machine is 50,000.

WEEDING

Cultivator:

Cultivators are common agricultural instruments used for intercultural operations/weeding after regulating tyne spacing. Mechanical weed management with tractor mounted implements can only be done during the early crop phases since restricted tractor and cultivator ground clearance harm the crop canopy during later development stages. Working depth should be modest to avoid plant roots injury. Self-propelled power weeder: It is a diesel engine driven weeder with 50 cm operating width. It can cover 1-1.2-hectare area every day. The weeder is appropriate for inter-culture operations and inter-row weeding of tapioca, cotton, sugarcane, maize, tomato and pulses with row spacing greater than 45 cm. Its tines may be changed to fit the row to row spacing of the crop and depth of operation. Attachments like sweep blades, ridger, trailer may also be mounted with the machine.

Specifications for Power weeder	
Working width (mm)	350-500
Power source	3 hp engine
Field capacity (ha/h)	Weeding- 0.06 Earthing up-0.14
Approx cost (INR)	80,000

Tractor mounted 3-row rotary weeder:

With one pass the weeder can clean three successive rows (1600 mm width). The rotary type weeder destroys the weed root and remove them from the soil. Additionally, this provides dust mulch for conservation of soil moisture and helps aerate the soil. It is appropriate for the broad row crops (45-90 cm) such as cotton and maize in which the tractor may be operated in

the rows without disrupting the crop zone. The width of inter-row rotary weeder may be varied according to the crop row spacing. To accomplish effective weeding with least crop damage, the crop height should be less than 55 cm(Saleh, A. and Suleiman, L, M., 2021).

Specifications for Rotary weeder	
Type	Rotary type
No. of rotary weeder units	3
No. of blades per flange	4
Row spacing (mm)	675-1165 (adjustable)
Field capacity (ha/h)	0.24
Operation efficiency (%)	83-87
Approx cost (INR)	60,000

Rotary weeder

PLANT PROTECTION

Air assisted horizontal sleeve boom sprayer:

Boom sprayer can spray larger area with negligible time. It works well in wide space row crops having enough row to row spacing for mobility of tractor. Crop planting needs to be done in rows keeping in view track width of the tractor. The clearance provided in the boom sprayer mounting frame was not sufficient for crop more than 45 cm height so these sprayers are suitable

for pre-emergence and early post emergence application of agro-chemicals. It can cover 1.12-1.25 area in an hour.

Specifications of Boom sprayer	
Dimension (m)	6.34´1.29´1.57
Tank capacity (liters)	400
Weight (kg)	150
Adjusted range of boom height (m)	0.3-1.26
Spacing between two nozzles (mm)	460
Spray swath (m)	10.2
Power requirement	35 hp tractor
Field capacity (ha/day)	8 (with 14 nozzles)
Approx cost (INR)	50,000

Boom sprayer

Self-propelled high clearance sprayer:

Self-propelled high clearance sprayer is particularly ideal for spraying on tall height crops like cotton and maize. It contains 18 nozzles at 67.5 cm

spacing. The track wheel is 1.35 m which implies two rows of 67.5 cm falls beneath the machine and machine wheel track on inter-row zone. Its boom width is 10.80 m and height is adjustable between 31.5 and 168.5 cm depending to the crop height. Fenders have been fitted in front of the drive wheels to deflect the crop branches away from the wheels for preventing mechanical damage. Its average capacity is1.8 ha/h and cost per spray is Sign of ₹ 485 /h.

Specifications of Self-propelled high clearance sprayer	
Ground clearance of machine (m)	1.2
No. of gears	4
Length of boom (m)	10.8
No. of nozzles	18
Nozzles spacing (cm)	67.5 (fixed)
Width of coverage (m)	10.8-13.5
Tank capacity (liters)	1000
Maximum field speed (km/h)	5
Power required	20 hp diesel engine
Approx cost (INR)	80,000

Self-Propelled high clearance sprayer

Q-5AC acoustic device for bird management:

Nearly 10 bird's species eat and destroy the corn cobs. The yield loss due to bird feeding is considerable and varies from 10 to 40 per cent in the case of maize crop. Hence, autonomous electrical sound generating gadget is invented by AINP on agricultural ornithology. The acoustic gadget keeps away depredatory birds from fields by making recorded noises. The gadget provides natural sound of bird predators and warning cry of problem birds. Thus the pest bird avoid the spread area. It is a weather resistant equipment and it required to install one foot above from crop canopy on a pole. Its estimated cost is ₹ 9,000 and one device may protect 4 acres of crops from bird damage.

HARVESTING

Shelf powered maize combine harvester: It is used for direct harvesting and threshing of maize crop. It features particularly designed cutting bar for maize. It features a collection mechanism to direct the stalks into the machine and snapping rollers to remove the ears from the stalks. It may be used for harvesting various cereal crops in one operation by altering the header. It can harvest one hectare in one hour.

Specifications of maize combine harvester	
Cutter bar width (m)	3.65
Cutting height (mm)	100-1000
No. of straw walker	5/7
Area of straw walker (m^2)	0.89
Row spacing (mm)	460-685
Type of threshing bar	Rasp bar
Power requirement	75-110 hp

Working capacity (ha/h)	1
Approx Cost (INR)	12-14 lakh

Fig: Combine harvester

THRESHING

Maize dehusker-sheller:

This dual-purpose machine is suitable for simultaneous removal of the cobs sheath along with separation of maize kernels from the cobs. It can save 95% shelling time and 60 % shelling cost as compared to traditional method.

Specification of Maize dehusker sheller	
Type of threshing drum	Spike tooth
Type of blower	axial flow
Moisture content of cob (%)	12-18
Cylinder speed (rpm)	670-750
Threshing capacity (q/h)	15-20
Threshing efficiency (%)	98-99.5
Cleaning efficiency (%)	90-95

Power requirement	26.25 kw
Approx cost (INR)	60,000

Maize dehusker and sheller

GRAIN DRYING

Mobile Batch dryer:

It is PTO or electricity driven, portable and long-lasting dryer. It can dry any type of grain and do not need pre-cleaning of grains. It is free of the risk of blockages or hot spots. It's drying rate ranges between 2-10 t/h depending on crop type, grain moisture content etc(Gbabo, A., Efomah, N, A. and Mohammed, I, G., 2017).

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