

Package of Machinery



Maize

Production and Post Production Management



ICAR-Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road, Bhopal-462 038 (M.P.) India

Technical bulletin
on
Package of Machinery for Production and Post
Production Management of Maize Crop

Under
The project
“Expansion of Activities of Biotech Kisan Hub in Eight
Aspirational Districts in Madhya Pradesh-Phase II”

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Package of Machinery for production and post production management of Maize Crop

Introduction

Maize is the third most important cereal crop in India after rice and wheat in terms of area and production. Maize is widely used as food, feed and fodder besides use as industrial raw material and also for bio-ethanol production. In recent past maize is gaining much popularity for silage and fodder purpose. Among cereals, maize has highest compound annual growth rate for area, production and productivity in last over two decades. The phenomenal increase in maize area and production has been commensurate with the growth in poultry and allied industry in the country as maize is the highest contributor in poultry and animal feed due to its high energy content. Growth of starch industry is also a contributor in fast progress of maize production in the country as maize starch has maximum use in this industry. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 % (782 mt) in the global grain production.

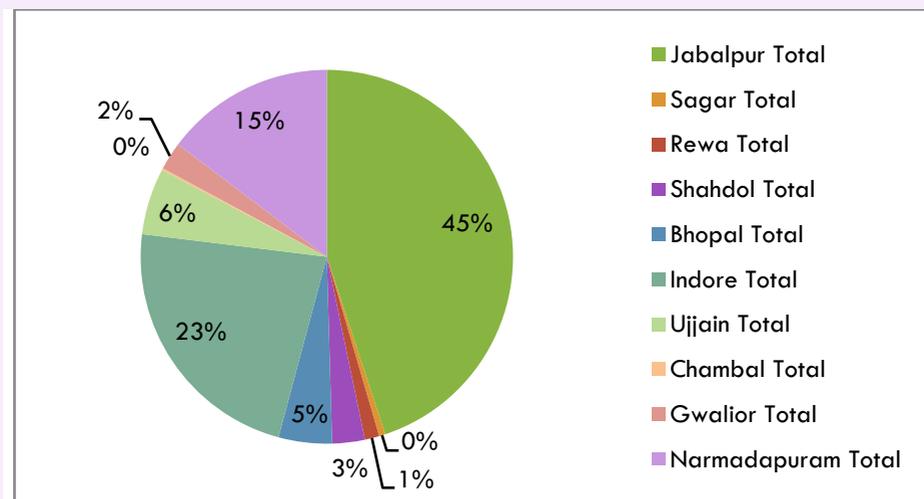


Fig. 1: Division wise Maize cultivation area of the Madhya Pradesh state

About Maize

Crop name	Maize		
Scientific name	<i>Zea mays</i> L.(Gramineae family)		
Cropping season	Kharif (June to October)		
	Rabi (November to February)		
Purposes	Grain, Fodder, Green Cobs, Sweet Corn, Baby Corn, Pop Corn		
Major growing states	Andhra Pradesh (20.9 %), Karnataka (16.5 %), Rajasthan (9.9 %), Maharashtra (9.1 %), Bihar (8.9 %), Uttar Pradesh (6.1 %), Madhya Pradesh (5.7 %), Himachal Pradesh (4.4 %)		
Major growing districts of Madhya Pradesh	Chhindwara, Seoni, Mandla, Guna, Vidisha, Narsinghpur, Betul, Rajgarh, Khandwa, Harda.		
Climate			
Temperature	Season	Kharif	Rabi
	Sowing	25°C to 30°C	21°C to 27°C
	Harvesting	30°C to 35°C	25°C to 30°C
Water requirement	500-800mm (kharif) 250-400mm (rabi)		
Popular varieties in India	Kharif- PMH 1, Prabhat, Kesri, PMH-2, JH 3459, Prakash, Megha, Panjab sathi 1, Pearl popcorn, FH-3211, JH-10655, HQPM-1Hybrid.		
Popular varieties in MP	JawaharMakka 8, JawaharMakka 12, JawaharMakka 216, JawaharMakka pop 11, PusaJawahar Hybrid Maize 1 (PJHM 1) (PML 93 X PML105), Jawahar Makka-215, Jawahar maize-218		
Plant protection	Major Pest- Stalk and steam borer, corn worm, pink borer, shoot bug, shoot fly, termites		
	Major Disease- Maydis leaf blight, post flowering		

	stalk rot, brown strip downy mildew, pythium stalk rot, turcicum leaf blight, bacterial stalk rot.			
Production in India	32.42 million MT (2021-22)			
Maize in M.P. state	Parameter	Productivity (Kg/ha)	Area (ha)	Production (MT)
	Total	1434282	4313998	3008

Health benefits of Maize

Maize has a lot of health benefits. The beta-complex vitamins are highly beneficial for the human health. They have a good role in maintenance of hairs, skins, heart and proper digestion. These are also good in rheumatism because these are helpful in moving the limbs and joints. The vitamins K, C and A along with carotenes have very positive effect on the improvement of immunity and health like proper functioning of thyroid glands. Maize or Corn silk has also potential benefits. These are used in many countries as to treat kidney problems, jaundice and fluids retentions. It also regulates the blood pressure and makes the body well. The fatty acids which are present in the maize are very helpful in maintaining the blood pressure, cholesterol and obesity. In maize oil, there is a good amount of vitamin E which has antioxidant activity which in body makes the immune system very well and responsive. Maize has also anti HIV activity compound name Galanthusnival is agglutinin (GNA) which is very useful in the HIV disease. Maize is believed as a well-treatment for HIV. Resistant starch in maize is also very well compound which is highly nutritive and its ingestion prevents the obesity and cholesterol level. It is also used in skin problem and cancers.

Mechanization of Maize crop

Agricultural mechanization implies the use of various power sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and draught animals, enhance the cropping intensity, precision in metering and placement of various crop inputs (seed, chemical, fertilizer, irrigation, water etc.) and reduce the losses at different stages of crop production. The end objective of farm mechanization is to enhance the overall productivity and production with the lowest cost of production. Use of commercially available and under development machinery by various research institute on sorghum may be able to form a package of machinery for various operation involved in the sorghum production. Variety of commercially available machinery for seed bed preparation, seeding, intercultural, plant protection, harvesting and threshing machinery are available. The package of machinery may vary from the power source available such as manual, bullock/animal operated, tractor/power operated as per the diverse scenario in Madhya Pradesh and at country level. Operation wise machinery and its application is summarized in below sections.

Operation wise machinery for maize crop

Seed bed preparation machinery

Tillage, in particular primary tillage, is the foundation of any crop production system and is the most expensive practice in the production any crop. It helps to create favorable environment to grow the plants. There are various types of tools and implements are available to perform the tillage or seed bed preparation.

	<p>Reversible Mould board (MB) plough</p> <p>This implement is used to turn sods up to 300 mm deep and is particularly effective on heavier soils. Turning the soil also has the advantage that weed seeds and unwanted crop residue can be buried deeply. MB ploughs are not recommended on sandy soils, because poor structure units which may exist can be destroyed, promoting wind erosion. Single bottom, two bottom, three bottom and five bottom ploughs are available in the market but right now reversible MB plough mostly used.</p> <p>Field capacity: 0.11-0.15 ha/h</p> <p>Cost, Rs.: 35000-50000</p> <p>Tractor suitable: 35-55 hp</p>
	<p>Disc plough</p> <p>The disc plough has a slicing action with the main advantage that better penetration is obtained under dry, hard conditions, with an additional advantage that wears is lower than moldboard plough. The implement is useful on hard, dry soils.</p> <p>Field capacity: 0.12-0.16 ha/h</p> <p>Cost, Rs.: 60000-90000/-</p> <p>Tractor suitable: 35-55 hp</p>
	<p>Chisel plough</p> <p>Chisel ploughs are used mainly to loose the soil to a limited depth of 250 mm. The best results are obtained if the soil is relatively dry, because the chisels break the soil, creating structural units. If conditions are too dry, however, big clods are formed, which restrict the plant development.</p> <p>Field capacity: 0.13-0.15 ha/h</p> <p>Cost, Rs.: 20000-30000</p> <p>Tractor suitable: 35-55 hp</p>

	<p>Rotavator</p> <p>Rotavator or rotary tiller is a versatile tractor implement to perform different soil functions such as mixing, pulverization, puddling & leveling at the same time. Under ideal conditions, on moist clay soils, this useful implement can prepare the seedbed in one operation.</p> <p>Field capacity: 0.2-0.21 ha/h Cost, Rs.: 80000-100000 Weight:400-600 kg Tractor suitable: 35-55 hp</p>
	<p>Cultivator</p> <p>Cultivator is an important agricultural implement used both as a primary tillage and secondary tillage. It is widely preferred by farmers for use in gardening, landscaping, and other farming operations. Spring loaded tines cultivator, Rigid tyne cultivator, duck foot cultivator are the types of cultivator generally used in India. Tine cultivators include a variety of hoeing implements, which are mainly used for controlling young weeds, but also for breaking surface crusts. These implements are only effective on moist soils. They are completely ineffective on dry, clay soils.</p> <p>Field capacity: 0.2-0.4 ha/h Cost, Rs.: 40000-50000 Tractor suitable: 35-50 hp</p>
	<p>Harrows</p> <p>A tractor harrow is used in agriculture to break up and smooth out the soil. In this way, it differs from the plough as plough used for deeper tillage. Farmers use tractor harrow on fields to smooth out the rough finish left by ploughing operations. The harrow implement breaks up clods and provides a more delicate finish, good tilth, or soil structure suitable for seedbed use.</p>

	<p>Harrows include a variety of implements. The tine harrow and disc harrow is primarily used to level the seedbed once it is in a fine condition.</p> <p>Field capacity: 0.18-0.22 ha/h</p> <p>Cost, Rs.: 90000-100000/-</p> <p>Tractor suitable: 35-55 hp</p>
	<p>Laser Land Leveler</p> <p>It consists of a laser transmitter, a laser receiver, an electrical control panel, a twin solenoid hydraulic control valve, two wheels and a leveling bucket. The laser transmitter transmits a laser beam, which is intercepted by the laser receiver mounted on the leveling bucket. The control panel mounted on the tractor interprets the signal from the receiver and opens or closes the hydraulic control valve, which raises or lowers the bucket. Some laser transmitters have the ability to operate over graded slopes ranging from 0.01% to 15% and apply dual controlled slope in the field.</p> <p>Tractor suitable: 55 hp or above</p> <p>Cost, Rs.: 3,50,000/-</p>

Sowing/planting Machinery

The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended row to row spacing, seed to seeds placing, seed rate and depth of seed placement vary from crop to crop and for different agro-climatic conditions to achieve optimum yields. Traditional sowing methods have following limitations; such as non-uniform distribution of seeds, poor control over depth of seed placement, high seed rate required, thinning required to maintain plant population, poor plant stand, weeding is a problem, lower yields etc. Therefore, use of seed drills and planters could be good option which facilitates line sowing and easy intercultural operations and well as mechanized intercultural as well as harvesting operations. The main function of seed drill and planters is to meter seeds

of different sizes and shapes and place the seed in the acceptable pattern of distribution in the field. Few machineries with their functions and performance are given below.

	<p>ICAR-CIAE Manually Operated Single Row Seed Cum Fertilizer Drill</p> <p>This Manual seed cum fertilizer drill is used for sowing of different seeds viz., wheat, sorghum, groundnut, cotton, castor, garlic, maize, cumin, soya bean, sunflower, paddy (dry land), all types of grains, cereals & pulses along with fertilizer. It is easily operated in both mode (Push and Pull type). The depth of sowing is also adjusted from 50.8-76.2 mm.</p> <p>Dimension- 1765mm x 613mm x 597mm</p> <p>Weight: 22 kg</p> <p>Cost, Rs.: 7,100/-</p> <p>Field efficiency:65-70%</p>
	<p>ICAR-CIAE Manually operated multi millet seed cum fertilizer drill (Inclined plate type)</p> <p>It is a manually operated light weight three row planter suitable for planting of small seeds such as millet crops, sorghum, bajra and vegetables seed etc. It saves the cost of seeds to the tune of 90% as compared to traditional method of broadcasting.</p> <p>Output capacity:0.10 ha/h</p> <p>Field efficiency: 65-68%</p> <p>Cost, Rs.: 12000/-</p>
	<p>ICAR-CIAE Manually operated multi millet seed cum fertilizer drill (vertical plate type)</p> <p>This implement is available with vertical plate type metering system. Planting with this machine saves seed, fertilizer and cost compared to drilling by traditional methods. It saves the seeds to the tune of 90% as compared to traditional method of broadcasting.</p> <p>Output capacity:0.10 ha/h</p> <p>Field efficiency: 65-68%</p>

	<p>Cost, Rs.: 11000/-</p> <p>ICAR-CIAE Animal drawn inclined plate type seed-cum-fertilizer planter</p> <p>It is an animal drawn implement suitable for planting sorghum, maize, and groundnut by changing suitable type of metering plates. Cell type rotors are used for metering the fertilizer and inclined plate is used for seed and which are driven by a chain and sprocket mechanism driven by the ground, wheel. It saves 86% labour, 58% operating time and 52-68% on cost of operation, compared to conventional method increase 20% in yield.</p> <p>Output capacity:0.12 ha/h</p> <p>Field efficiency: 65-70%</p> <p>Cost, Rs.: 17500/-</p>
	<p>ICAR-CIAE Animal drawn vertical plate type seed-cum-fertilizer planter</p> <p>This implement is a light weight unit with low ground clearance and suitable for planting of multi-crops such as millets, jute, carrot, grams etc and drills fertilizer simultaneously. There is a saving of 60-70% towards input and operational cost compared to traditional methods.</p> <p>Output capacity:0.12 ha/h</p> <p>Field efficiency:65-70%</p> <p>Cost, Rs.: 15000/-</p>
	<p>ICAR-CIAE Tractor Drawn Six-Row Planter with Fertilizer Drill for Millet- Multi- Crops (Inclined Plate Type)</p> <p>It is a light weight six row planter with fertilizer drill and available inclined plate seed metering system suitable for small and multi-crops seeds. There is a saving of 60-70% towards input and operation cost while using this equipment compared to traditional methods. Tractor suitable for operation 45 kW and above</p> <p>Output capacity:0.52 ha/h</p> <p>Field efficiency: 80-85%</p> <p>Cost, Rs.: 38000/-</p>

	<p>ICAR-CIAE Tractor Drawn Six-Row Planter with Fertilizer Drill for Millet- Multi- Crops (Vertical Plate Type)</p> <p>It is a light weight tractor operated six row planter with fertilizer drill and available in vertical plate type seed metering system. The implement has been developed with low ground clearance for effective sowing of millets and other multi crops. There is a saving of 60-70% towards input and operation cost while using this equipment compared to traditional methods.</p> <p>Output capacity:0.42 ha/h Field efficiency: 80-82% Cost, Rs.: 32000/-</p>
	<p>ICAR- CIAE Tractor drawn 9- row drum type pneumatic planter</p> <p>It can be used for planting various type of crops like cotton, groundnut, pigeon pea, soybean, green gram, black gram, maize etc. Multi seeds (hill dropping) can be planted at specific distance.</p> <p>Field capacity:0.3-0.7 ha/h Power Source: 35 hp or above Cost, Rs: 1-1.5 lakh</p>
	<p>Multi-crop planter (Ridge planter):</p> <p>During excess rainfall the furrow act as drainage channel while it stores rain water during low rain events. Ridge planters are commercially available which can do bed making & sowing on the tip of the bed in a single operation. Ridge planting ensure better root development, lesser logging, saving of irrigation water and also cut down operational cost. It can cut down 24 and 90 % cost and time, respectively when compared with conventional method.</p> <p>No of rows: 2-5 Field capacity: 3.5(ha/day)</p>

	<p>Wide bed planter</p> <p>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.</p> <p>Seed metering: Fluted Roller / Rotating Disc with cells on its periphery.</p> <p>Fertilizer metering: Agitator and sliding orifice type</p> <p>Power source: 45 hp tractor</p> <p>Cost, Rs.: Approximate 1.3 lakh</p>
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Some conservation agriculture (CA) and resource conservation (RC) machineries for maize crop

Conservation Agriculture (CA) is an approach to managing agro-ecosystem for improved and sustainable productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely:

1. Minimum mechanical soil disturbance
2. Permanent organic soil cover
3. Diversification of crop species grown in sequences or associations.

	<p>Mulcher-cum-Bed-Planter</p> <p>A zero-till bed planter-cum-residue mulcher has been developed for planting of maize and wheat seeds on beds under conservation agriculture. The machine can also form both broad as well as narrow beds of varying width from 200 mm to 1200 mm. It mulches maize residues left over after combine harvesting followed by planting. It works efficiently under the maize residue of 12 t/ha.</p> <p>Forward speed: 2.7 km/h</p> <p>Field capacity: 0.3 ha/h</p>
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Punch planter/Star wheel:

This machine is suitable for small and marginal farmer due to low cost and easy handling. Farmers also came with innovations of this type of machine to make CA more successful. It works under low residue load of up to 3 tonnes/ha.



Happy Seeder

The happy seeder technology offers a solution to the problem of direct drilling into heavy stubbles, enabling the stubble to be retained on the surface as mulch. The equipment is the combination of straw handling unit and sowing unit. It is used for sowing operation in combine-harvested field in a single pass while retaining the crop residue as surface mulch. The unit is compact, light weight and tractor mounted capable of managing rice stubbles and loose straw in a strip just in front of each furrow opener.

Field efficiency: 52.80 to 82.53 %

Field capacity: 0.28 to 0.416 ha/h

Cost, Rs. : 1.58-1.7 Lac

Power Source: 50 hp or Above



Zero till seed drill:

Zero tillage seed cum fertilizer drill

The main difference between No-till drill machine and conventional drill is that it has narrow shovels known as inverted T-type furrow openers instead of tyne type furrow openers. The main advantage of narrow shovels is lower draft requirement and easier penetration in the soil. The view of the commercially available tractor drawn zero till drill.

Field Capacity: 0.2-0.25 ha/h

Cost Rs.: 50000/-



Double disc coulters:

This is one of the second generation machines having double disc-coulters fitted in place of tynes to place the seed and fertilizer into the loose residues. The problem being faced with this machine is that being lightweight it fails to cut through the loose residues and the seed and fertilizer is dropped on the top of it, part of which reaches on the soil surface. For proper germination after seeding irrigation is required immediately. This machine may efficiently workup to a residue load of about 4 to 5 tonnes/ha.

Intercultural and weeding machinery

Weeds are the worst pests. They consume nutrients and harbor destructive insects. Management of weeds is an important component of production systems as elimination of weeds is expensive and hard to achieve. Weeding is the process of eliminating competition of unwanted plants to the regular crops so that crops can be grown profitably. The manual weeding is expensive and drudgeries also take about 20% of labor requirement. These operations are accomplished by means of many tools and equipment, such as hoes, cultivators, harrows, rotary hoes etc. Weeding and intercultural equipment are can be classified as manual, animal drawn, power tiller operated and tractor drawn. Few examples of the available tools and machinery with their performance parameters are given below.



Manual weeder

Manual weeder multi attachment tool is a manually operated for all farm operations like tilling of soil, making furrows and weeding. It has a light weight tyre for easy operations. All these three attachments can be easily attached and removed. The wheel hoe is a widely accepted weeding tool for weeding and inter-cultural in row crops.

Weight: 8 kg

Cost, Rs.: 3550

Field capacity: 0.01 ha/h



Self-propelled Rotary Weeder

It is a self-propelled engine operated power weeder for inter-cultural operation in horticulture and wider row crops like sorghum, maize etc. The depth of operation ranged from 40-70 mm. The machine can be operated at an average forward speed of 1.5 to 2.0 km/h and crop having average row width of 450 mm.

Field Capacity: 0.6 to 1.0 ha/day

Field Efficiency: 80-94 %

Power: 5-7 hp



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.

Hopper capacity: 500 L fertilizer

Fertilizer spreading width: 20-30 feet

Field capacity: 2.5(ha/h)



Tractor mounted 3-row rotary weeder

With single pass the weeder can clean three consecutive rows (1600 mm width). It is suitable for the wide row crops (45-90 cm) such as cotton and maize in which the tractor can be run in the rows without disturbing the crop zone. The width of inter-row rotary weeder can be change according to the crop row spacing. To achieve efficient weeding with least crop damage, the crop height should be less than 55 cm.

Field Capacity: 0.24 ha/h

Operation Efficiency: 83-87%

Cost, Rs.: 60,000/-

Plant protection machinery

Chemical application is an important aspect of the modern agriculture to save crop from insects, fungus, virus and other pest, as well as weeds. Weeds can be eradicated by effective cultivation, but pests and diseases have to be kept under control with chemical spray and powder application. Chemicals are now being used to kill weeds without damaging the crop in addition to the weeding tools. Chemicals are either sprayed in liquid form or applied as a dry powder. Sprayers and dusters are available for this purpose. Few useful machineries with their functions and performance are given below.



Manually Operated Knapsack sprayer

Knapsack sprayer consists of a pump and an air chamber installed in a 9 to 22.5 liters tank. The handle of the pump extending over the shoulder or under the arm of operator makes it possible to pump with one hand and spray with the other. It has a spray lance fitted with nozzle and has two straps for mounting the sprayer at the back of the operator.

Power required: one man

Cost, Rs.: 2500-4000

	<p>Power Knapsack Sprayer</p> <p>It consists of a frame on which a high density polyethylene tank, fuel tank, engine, delivery pipe, shock proof cushion and spray hose are mounted. This product is supplied with forced air cooled 4 Stroke petrol Engine. It is equipped with a brass metal pump and has the diaphragm of type carburetor. It is powerful and can maintain stable pressure. It adopts double cylinder pump, which enhances the operational efficiency.</p> <p>Field capacity:1.5ha/day Cost, Rs.:10000-12000</p>
	<p>Tractor Operated Boom Sprayer</p> <p>The sprayers essentially consist of a tank which is made of fiber glass or plastic, pump assembly, suction pipe with strainer, pressure gauge, pressure regulators, air chamber, delivery pipe, spray boom fitted with nozzles. These are hydraulic energy sprayers. They utilize PTO power of the tractor to operate the pump of the sprayer.</p> <p>Field capacity: 8 ha/day Power requirement: 35hp or above Cost, Rs.: 50000/-</p>
	<p>Self-propelled high clearance sprayer:</p> <p>Self-propelled high clearance sprayer is most suitable for spraying on tall stature crops like cotton and maize. It possesses 18 nozzles at 67.5 cm spacing. The track wheel is 1.35 m which means two rows of 67.5 cm comes under 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 according to the crop height. Fenders have been provided in front of the drive wheels to deflect the crop branches away from the wheels for reducing mechanical damage.</p> <p>Field capacity:1.8 ha/h Power required: 20hp diesel engine Cost, Rs.: 80,000/-</p>

Harvesting machinery

Harvesting is the process of collecting the mature crop from the field. It may consist of the action of cutting, picking, plucking, digging, or a combination of all these operations for removing the crop from under the ground or above the ground or detaching the useful parts such as, fruits, flowers or leaves from plants. In India, harvesting is traditionally done by hand using sickle. Because of limited size of land holdings, economic constraints and non-uniformity of field conditions, traditional harvesting is still in practice. Due to high labor demand at the time of harvesting, the operation continues for weeks together, resulting in over drying of crops in the field causing grain losses up to 5 - 15 per cent and may also results in total loss of crop due to untimely rains during harvesting. Some useful harvesting techniques for sorghum are given below.

	<p>Improved serrated sickle This Improved serrated sickle represents advancement in manual crop harvesting. It is a handheld cutting tool designed for harvesting crops such as cereals, grasses, and other vegetation. The term "serrated" indicates that the sickle blade is equipped with small, jagged teeth or edges. This feature enhances the efficiency of cutting specific types of plants, thereby reducing the effort required during operation. Field capacity: 0.018 ha/h Weight: 0.2 kg Cost, Rs.:120/-</p>
	<p>Vertical Conveyor Reaper It is an engine operated, walk behind type harvester suitable for harvesting and windrowing cereals and oilseed crops. The reaper consists of engine, power transmission box, pneumatic wheels, cutter bar, crop row dividers, conveyor belts with lugs, star wheels, operating controls and a sturdy frame. The engine power is transmitted to cutter bar and conveyor belts through belt pulleys. During forward motion of the reaper, crop row dividers divide the crop, which come in contact with cutter bar, where shearing of crop stems takes place. The cut crop</p>

	<p>is conveyed to one side of the machine by the conveyor belt fitted with lugs and is windrowed in the field. The crop is bundled manually and transported to threshing yard. There are no shattering losses due to vertical conveying of the crop.</p> <p>Power: 5-7 hp Length of Cutter bar: 1000 mm Cost, Rs:80,000-150000 /-</p>
	<p>Maize Harvester</p> <p>A corn harvester is a machine used on farms to harvest corn, stripping the stalks about one foot from the ground shooting the stalks through the header to the ground. The corn is stripped from its stalk and then moves through the header to the intake conveyor belt. A multipurpose machine such as a combine harvester reduces the number of people employed in harvesting; thereby reducing manpower, time and effort taken which consequently increases the overall productivity.</p> <p>Cost Rs.: 20-25 lakh Power requirement: 75-110 hp</p>
	<p>Self propelled maize combine harvester</p> <p>It is used for direct harvesting and threshing of maize crop. It has specially designed cutter bar for maize. It has a gathering unit to guide the stalks into the machine and snapping rolls to remove the ears from the stalks. It can be used for harvesting other cereal crops in one operation by changing the header. It can harvest one ha in an hour.</p> <p>Cutter bar width: 3650mm Cutting height: 100-1000mm No. of straw walker:5/7 Row spacing: 460-685mm Type of threshing bar: Rasp bar Power requirement: 75-110 hp Cost, Rs.:12-14 lakh</p>

Threshing Machines

Threshing is the process of loosening the edible part of cereal grain (or other crop) from the scaly, inedible chaff that surrounds it. It is the step in grain preparation after harvesting and before winnowing, which separates the loosened chaff from the grain. Threshing may be done by beating the grain using a manual tool on a threshing floor. Another traditional method of threshing is to make bullocks or donkeys walk on the grain at threshing yard. Few exemplary machineries with their functions and performance are given blow.

 A photograph of a small, octagonal, blue metal sheller. It is a simple, manually operated device. A corn cob is being processed, with yellow maize grains falling from the sheller. The sheller has a blue cylindrical body and a silver metal top.	<p>ICAR-CIAE Octagonal Tubular Maize Sheller</p> <p>It is a manually operated simple device to remove maize grains from the dehusked cobs. The sheller is of octagonal shape. The sheller consists of 4 mild steel fins tapered along their length; one edge of the fin is taper. About 15% saving in cardiac cost of workers per unit of output in comparison to the traditional practice.</p> <p>Working capacity:20-27 kg/h</p> <p>Weight: 0.22 kg.</p> <p>Cost Rs.:200</p>
 A photograph of a green and yellow lever-type maize sheller. It is a larger, manually operated device. A corn cob is being processed, with yellow maize grains falling into a collection chamber. The sheller has a green frame and a yellow collection chamber. A black handle is attached to the top.	<p>Lever type Maize Sheller</p> <p>It consisted of a handle, guiding rod, supporting rod, spring loaded ram, maize cob guiding cylinder, shelling blade, buffer, collection chamber, shutter and frame. The overall throughput capacity and shelling capacity was found to be 44.63 kg cobs/h and 33.90 kg seeds/h. It is suitable for remote areas where source of electricity not found.</p> <p>Shelling efficiency:96.34-99.45%</p> <p>Cost, Rs.:2000</p>



Rotary Maize Sheller

It is manually operated equipment consisting of a frame, a flywheel, a hopper and three shelling gears. With one hand a person operates the equipment whereas cobs are fed by the other hand one by one. The shelled cobs come out through the port on other side. About 32% saving in cardiac cost of workers per unit of output in comparison to the traditional practice.

Capacity : 73 kg/h

Cost: Rs. 6000/-



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.

Threshing capacity: 15-20(q/h)

Threshing efficiency: 98-99.5%

Cleaning efficiency: 90-95%

Power requirement: 35 hp

Cost, Rs.: 60,000



CIAE High capacity Multicrop thresher

It consists of a spike-tooth cylinder (700 mm diameter), three aspirator blowers, cleaning sieves and automatic feeding and bagging systems. The thresher is provided with accessories such as extra pulleys, concave, and sieves for threshing different crops. It is suitable for threshing wheat, maize, and sorghum grain, pigeon pea, soybean and sunflower crops.

Output Capacities: 1412, 2890, 1130, 1360, 950, 782, 553 kg/h

Power Source: 20 hp electric motor or 35 hp tractor pto.

Processing and value addition machinery for sorghum

Value addition is the enhancement of a product before it is offered to the consumers. Value-added products are the agricultural products that are modified to enhance the market value and/or shelf life and enhanced quality. The value-added products include pasta, muffins, cookies and other processed foods. Some prominent basic processing machinery described as following.



Mini Groundnut Decorticator-cum-Sunflower Thresher and Maize Sheller (3-in-1)

It is a small hand-operated device with a mild steel body. The ribbed threshing cylinder consists of rubber cushions to facilitate smooth shelling of the pods inside the shelling chamber. The pods are fed through a 500 g capacity hopper. When the handle is rotated, the pods get shelled inside the shelling chamber and both the shell and kernel fall through the sieve at the bottom of the shelling chamber to be separated manually. The equipment is provided with two separate inter-changeable attachments for maize shelling and sunflower threshing which can be fitted to the shaft at the far end of the shaft.

Prime mover	: Manual
Weight, kg	: 8
Man power	: 01
Suitability for crop	: Groundnut, sunflower, maize
Cost, Rs	: 2,000/-
Output capacity, kg/h	: 15 Groundnut) 12-15 (Maize/Sunflower)
Efficiency	: 97%
Cost of operation, Rs/kg	: 2.25/-



Multi Grain Mill

A 75 kg/h multi mill has been developed for multiple uses *viz.* dhal milling, grain pearling/polishing and dawning of coriander. The machine consists of an abrasive tapered roller, an aspirator, separation sieve box, mixer/conveyor, oil/water tank and a motor. The unit can be utilized for grading of grains and imparting oil/water pretreatment.

	Prime mover	:	2 hp Electric motor – single phase
	Weight, kg	:	220
	Man power	:	one
	Suitability for crop	:	Pigeon pea milling, wheat and maize pearling and coriander deawning / debearding
	Cost, Rs	:	50,000/-
	Output capacity, kg/h	:	75
	Efficiency	:	Pigeon pea milling: 76%, maize pearling: 91-93%, wheat pearling :93-96% ,coriander deawning : 82%
	Cost of operation, Rs/ton	:	1000/-for dhal milling and 70/- for deawning and pearling/polishing



Flaking Machine

It is an electric motor operated equipment to press and stretch processed grain into thin elongated flakes of soybean, sorghum, corn and bengal gram. It consists of three mild steel roller (knurled and chromium plated surface), main frame, hopper, stand, collecting tray and drive mechanism.

Power source	:	1 hp, single phase motor
Weight, kg	:	80
Cost of equipment, Rs.	:	20000/-
Labour requirement	:	50man-h/t
Output capacity, kg/h	:	20
Cost of operation, Rs/tonne	:	750/-



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.

Products of Maize

The production of value-added products from maize involves the processing of maize kernels into different forms that are more convenient and appealing to consumers. The value-added products can range from food items such as snack foods, breakfast cereals, and baking mixes to industrial products such as biodegradable plastics, adhesives, and biofuels. We will explore the potential value-added products of maize and ingredients used to create them.

<p style="text-align: center;">Pasta</p> 	<p style="text-align: center;">Muffins</p> 	<p style="text-align: center;">Biscuits</p> 
<p style="text-align: center;">Ingredients</p> <p>Maize flour-500 g Water-220 ml</p>	<p style="text-align: center;">Ingredients</p> <p>Maize Flour-200 gm Sugar-130 gm Oil-100 ml Milk Powder-70 gm Powdered sugar for decoration- 50 gm Baking Powder-7 gm Baking Soda- 7 gm</p>	<p style="text-align: center;">Ingredients</p> <p>Maize Flour-100 gm Butter-60 gm Baking Powder-2 gm Powder sugar-50 gm Milk-12 to 15 ml</p>
<p style="text-align: center;">Cookies</p> 	<p style="text-align: center;">Barfi</p> 	<p style="text-align: center;">Ghachak</p> 
<p style="text-align: center;">Ingredients</p> <p>Maize Flour-100 gm Butter-60 gm Baking Powder-2 gm Powder sugar-50 gm Milk-12 to 15ml</p>	<p style="text-align: center;">Ingredients</p> <p>Maize Flour-200 gm Ghee-100 gm Powder sugar-100 gm Dry fruits-25 gm</p>	<p style="text-align: center;">Ingredients</p> <p>Jaggery-150 gm Popcorn-20 gm Peanuts-20 gm Dry fruits-20 gm</p>

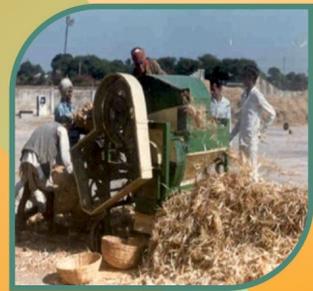
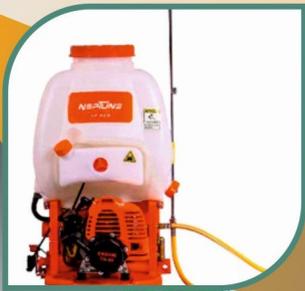
Table: Comparison of machinery used by farmer and machinery suggested for the aspirational districts of M.P.

Operation	Machinery used by farmer	Suggested Machinery
Tillage	Country plough, MB plough, Rotavator, cultivator	Reversible MB plough /Disc plough, Light weight rotary tiller/Disc Harrow
Sowing	Manual broadcasting, Seed drill, Bullock drawn Tifan	Tractor/ animal operated Seed cum fertilizer drill, Tractor Operated pneumatic planter, Ridge bed planter, Wide bed planter
Plant protection	Knapsack sprayer(battery operated)	Power pump (engine operated), Tractor operated Boom sprayers, Self-propelled high clearance sprayer
Intercultural	Manual khurpi or spade	Wheel hand hoe, Sweep cultivator, Self-propelled power weeder, Tractor mounted fertilizer broadcaster
Harvesting	Manual by use of sickle	Self-propelled Combine harvester (cutter bar type), Tractor mounted fodder harvester
Threshing/shelling	Traditional practices, Conventional low capacity thresher	Tubular maize sheller, Lever type maize sheller, Rotary maize sheller, CIAE multi-crop thresher, Maize dehusker-sheller

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