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MECHANIZATION IN MAIZE CULTIVATION

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Maize is the world's most widely grown cereal, producing 1148 million tonnes with an average productivity of 5.9 tonnes per hectare whereas in India and Odisha the productivity is around 2.8 to 3.6 and 2.5 to 3 tonnes per hectare respectively. Maize has one of the highest growth rates. The crop is rapidly spreading to non-traditional places such as peninsular, central, and eastern India. Due to its high market demand for food, feed, fodder, and industrial products, as well as its usage in bioethanol production, this crop is ideal for farmers looking to double their maize-based cropping system. Convergence agriculture has proven effective in maize-based cropping systems, leading to increased production and profitability. Currently, agriculture is less profitable due to labor shortages and rising input costs.Thus, the use of machineries for crop cultivation is much needed for sustainable production specially the crop like maize that is fast spreading in India.

The availability of labor in India's agriculture industry has decreased over the past few decades, primarily as a result of more job options in the manufacturing and service sectors. Many jobs related to crop production require the use of automated or semi-automated farm machinery due to the trends of falling agricultural labor and rising wages. Almost 80% of the maize farmed in India is grown in rain-fed regions, where timely completion of all agricultural tasks is dependent on the availability of rain. In order to plant more crops in a year, intensive cropping system especially in irrigated regions need to prepare the soil, seed, and harvest it quickly. Therefore, mechanization is highly desired in both irrigated and rain-fed corn.

Table 1: Machineries used for different field operation in maize cultivation

Operations	Implements/Machinery
Tillage and seed bed preparation	Mould Board plough, Disc plough, Cultivator, Disc harrow, Rotavator, and Levelers
Sowing/planting and fertilizer application	Seed-cum-fertilizer drill, Ridge planter, Wide bed planter, Multi-crop pneumatic planter, Zero-till seed drill, Happy seeder

Weeding/interculture/earthing up	Power weeder, Tractor mounted weeder/inter-cultivator, Tractor operated fertilizer band placement cum earthing up machine
Irrigation	Pumps, Drip Irrigation
Plant protection	Boom sprayer, Drone sprayer, Q-5 AC acoustic device for bird management
Harvesting and threshing	Combine harvester, Maize de-husker
Fodder Harvesting/Residual management	Fodder harvester, Silage packing machine, Shredder/Rotavator, Chaff cutter

Tillage and Land Preparatory Implements

Tillage is the mechanical manipulation of soil used to prepare the farm land for sowing or planting of different crops. Primary tillage implements cut and turn furrow slices to pulverize the seed bed, while secondary tillage implements crush the clods followed by smoothening and leveling the farm land by levelers.

- Mould board plough (fig.1) is a primary tillage implement used in stone free, non sticky soils while disc plough as a primary tillage implement used in stony, hard and dry soil where MB plough can't be administered. Both the implements work with 35 HP tractor having a field capacity of 2.4-3.2 ha/day and their approximate cost is about Rs.42,000-48,000.
- Cultivator is a secondary tillage implement used for preparation of seed bed and intercultural operations/weeding after adjusting tyne spacing while Disc harrow as a secondary tillage implement used to perform the harrowing operation. The approximate cost of both the implements ranges between Rs.30,000-48,000 and having a field capacity of 2.4-3.2 ha/day
- Rotavator (fig.1) carries out primary tillage as well as secondary tillage operations such as harrowing and leveling simultaneously. It prepares seed bed in one pass saving draft power, time, labor and cost as compared to conventional tillage. It reduces land preparation cost by Rs.1, 000-1,500 per ha as compared to traditional method. It is operated by 35-45 HP tractor having a field capacity of 2.0-2.4 ha/day. The approximate cost of the implement is Rs.1, 00,000-1, 20,000.
- Land leveling can be done by tractor drawn leveler and laser land leveler (fig.1) which provides precise land leveling and uniform moisture content. It is operated by 35-45 HP tractor and having a field capacity of 2.0-2.4 ha/day. The approximate cost of the implement is Rs.32, 000-36,000.

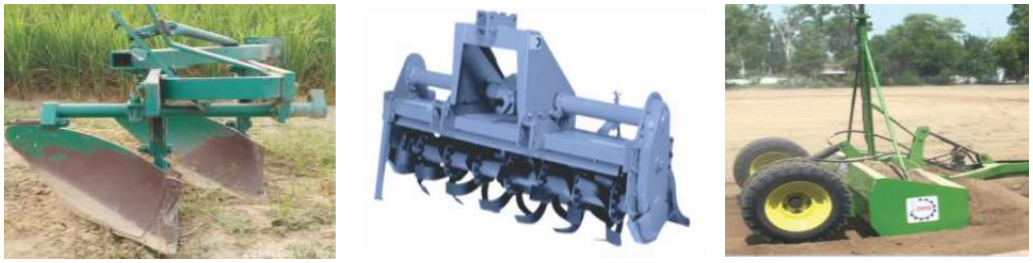

Fig 1: MB Plough, Rotavator, Laser land leveler

Sowing/planting Machine

Mechanical sowing results in better seed placement as compare to manual method and also maintains optimum plant population. Some commercially available maize seeding machines are discussed below.

- The seed-cum fertilizer drill (fig.2) comes with seed and fertilizer boxes, a seed metering mechanism, and a 9 tyne cultivator. It features a depth control system, adjustable row spacing, and a covering device for easy furrow closure. The field capacity of the machine is 3.2-4.0 ha/day with a 45 HP tractor as a prime mover and costs approximately Rs.75,000.
- The multi-crop pneumatic planter offers high seed spacing accuracy and a metering system for single seeds. It consolidates soil without pressure and prevents water stagnation. The field capacity of the machine is 3.2-4.0 ha/day and costs approximately Rs.6, 25,000. Despite its high cost, it maintains plant-to-plant distance, resulting in high yields and cost savings.
- Ridge planter which is used for bed planting is done by ridge planters (fig.2) to avoid significant yield loss of maize by water logging and drought condition. These machines operating with a 45 HP tractor, ensure better root development, reduce lodging, save irrigation water, and reduce operational costs, with a approximate cost of Rs.1, 00,000-1, 20,000. It is having a field capacity of 3.2-4.0 ha/day.

Fig 2: Seed cum fertilizer drill, Ridge planter, Zero-till drill

- Wide Bed Planter operating with a 45 HP tractor can simultaneously make broad beds for maize planting, with a field capacity of 2.4-3.2 ha/day, costing around Rs.1, 35,000.
- The Zero-till seed-cum fertilizer drill (fig.2), with a furrow opener and seed metering system, delivers seed and fertilizer in different depths in the furrow. It works with a 45 HP tractor and have a field capacity of 3.2-4.0 ha/day, costing approximately Rs.75, 000.
- The Happy seeder uses a straw management rotor and zero-till drill for crop sowing, using flail blades to cut and clean stubbles. It's field capacity 2.4-3.2 ha/day and costs between Rs.1,00,000-1, 20,000.

Weeding/intercultural Implements

Maize crop weeding can lead to significant yield reductions of 29 to 70 percent due to its wider row spacing and slow growth. Manual weeding, using khurpi is time-consuming and labor-intensive. During rainy seasons, manual weeding delays, causing significant yield loss. Mechanical weed control methods, such as burying, cutting, and uprooting are viable alternatives.

- Tractor operated three row fertilizer band placement cum earthing up machine can perform tasks such as placement of fertilizer along the row, earthing up and cutting of weeds. The field capacity of machine is 4.5 ha/day. The approximate cost of the machine is Rs.50, 000.
- The engine-operated power weeder (fig.7), with a 50 cm or more operational width, can cover 1-1.2 ha/day and is suitable for inter-culture and inter-row weeding of maize with over 45 cm row spacing.
- Tractor mounted weeder/inter-cultivator (operating tool as rotary/blades/tynes/sweeps) can clean two or more consecutive rows at a time, damaging weed roots and creating dust mulch for soil moisture conservation and aeration.The field capacity of the machine is about 2-4 ha/day and its approximate cost is Rs.45,000-60,000.

Irrigation

Maize, a rain-fed crop, is grown with irrigation during rabi season. Conventional methods like flooding or furrow operation require precise land leveling and water-guided channels, making them labor-intensive and less efficient.

- Utilization of electricity/diesel operated water lifting pumps reduces labor, time required to lift water and cover bigger crop area. It can be operated by 5HP engine or more. Pump having approximate capacity of 100-500 l/min and costing around Rs.25, 000-50,000
- Drip irrigation offers precise water application without these issues and allows simultaneous application of fertilizer, insecticide, and herbicide. Its approximate cost is Rs.1, 10,000-1, 50,000/ha.

Plant Protection

Manually-operated sprayer involves drudgery and needs more time to cover the field. Use of mechanical sprayers ensures timely plant protection and efficient use of agro-chemicals.

- The boom sprayer is suitable for pre-emergence and early post emergence application of agro-chemicals, covering 9-10 ha/day. It works well in wide space row crops with sufficient row spacing, and costs approximately Rs.1, 08,000.
- Agricultural spraying drone/drone sprayer (fig.3) use GPS and sensors to autonomously spray crops with precise amounts of fertilizers, pesticides, and water. Its tank capacity is 5-20 litres and field capacity is 8-20 ha/day. Agricultural drone generally have fixed wings can cost upto Rs.20, 00,000.
- Q-5 AC acoustic device for bird management: The All India Network Project on Agricultural Ornithology has designed an automatic electrical sound producing device to protect maize crops from bird damage. The device, costing approximately Rs.9,000 produces natural bird predator sounds and alarm calls, preventing pest birds from entering the broadcast area.

Harvesting and Threshing

Traditional maize harvesting, labor-intensive and time-consuming requires 80-110 man/ha of land. Mechanized harvesting using a combine harvester reduces costs and ensures timely crop harvesting, especially in bad weather conditions. Separation of grains from ear/cob is known as threshing. In case of maize, the word shelling is used instead of threshing. Shelling is the most important post-harvest operation in maize.

Fig 3: Agricultural Drone Sprayer

- **Self-propelled Maize Combine Harvester** is designed for direct maize harvesting and threshing, with a cutter bar, gathering unit, and snapping rolls. Its field capacity is about 8 ha/day and costs around Rs.30, 00,000.

- **Maize Dehusker cum Sheller** performs harvesting, shelling, and separation of grains from ear/cob simultaneously. In case harvesters are unavailable, manual harvesting is done and then dehusking and shelling is done using a dehusker cum sheller, saving 95% shelling time and 60% cost.The shelling capacity is about 16-20 q/day with an approximate cost of Rs.1, 50,000.

Fodder harvesting/Residue Incorporation

Maize is increasingly used as fodder, but traditional harvesting is labor-intensive. Commercial machines now perform harvesting, chopping, and trolley loading efficiently.

- **Tractor mounted fodder harvester** is suitable for fodder crops like maize, bajra, sorghum, berseem, and oats, with up to 80 plants/m^2 and 100-282 cm plant height. It can harvest 1.12 -1.26 m width in single pass, ultimately saves 90% labor and 75% operation cost.

- **Silage Packing Machine*:*** The machine can cut and crash the green fodder, load in the 50 kg air tight plastic bag and compress it. After this process, the bag can be sealed with thread and can be stored in open place for ensiling (process of silage making). These 50 kg capacity bags are easy to handle and transport. It is having capacity to pack 30 bags per hour.

- **Maize Shredder/Rotavator** cuts the remaining part of maize directly from the field which can increase soil organic matter and add nutrients like N, P, K etc. Its field capacity is 3-4 ha/day with a approximate cost of Rs.80, 000.

- **Chaff cutter** is needed to cut green plants into small pieces for efficient feeding. For this purpose manual (capacity-1.8-2.0q/h & cost around Rs.10, 000), electrical (capacity-25-100q/h & cost around Rs.50, 000) and tractor operated (capacity-52.8-76.3q/h & cost around Rs.4, 00,000) chaff cutters are commercially available.

Conclusion

Maize cultivation using agricultural machineries boosts efficiency, productivity and profitability while reducing drudgery, labor cost, and environmental impact. By embracing machinery in maize cultivation farmers can optimize their operations, drive business growth, and contribute to a more agricultural industry by which the goal of doubling the farmer's income by 2050 can be achieved.

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