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20. Farm Mechanization

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Abstract:

Agricultural mechanization plays an important role in the production and productivity of crops. It ensures timeliness of operation as well as reduces drudgery involved in agricultural operations. Farm power availability in Indian agriculture had reached to 2.24 kW/ha in 2016-17 with a major contribution from tractors, diesel engines, electric motors, draught animal, human power, combine harvesters, and power tillers as 1.324, 0.460, 0.193, 0.130, 0.091, 0.021, 0.018 kW/ha respectively. Mechanization levels in different crops varied differently, it was 63, 45, 40, 34, 34, 26, 26 and 24 % for wheat, rice, maize, pulses, oilseeds, sorghum, cotton and sugarcane respectively. Mechanization in wheat is higher compared to other crops whereas it is lower for cotton and sugarcane. Mechanization level also varies with different operations in different crops.

Seed bed preparation is highly mechanized invariably for all crops whereas weeding/interculture/plant protection are the least mechanized operations. This chapter deals with the status of mechanization, different machineries for mechanization, constraints in mechanization and future prospects of mechanization in Indian agriculture.

Keywords:

Crop, Production, Mechanization, Farm, level.

20.1 Introduction:

Agriculture contributes 14% to the Gross Domestic Product in India; and 50% population is dependent on agriculture. Agricultural production has increased five times from a mere 50 million tonnes in 1950-51 to 285 million tonnes in 2018-19, whereas productivity increased four times from 522 kg/ha in 1950-51 to 2129 kg/ha in 2016-17(Anonymous, 2018). Since the time of green revolution, farm mechanization played an important role in the crop production system. As a result, farm power availability has been increased from 0.293 kW/ha during 1971-72 to 2.24 kW/ha during 2016-17.

In the overall farm power availability contribution of tractor (1.324 kW/ha) is maximum followed by diesel engines (0.460 kW/ha), electric motor (0.193kW/ha), draught animal (0.130 kW/ha), human power (0.019 kW/Ha), combine harvester (0.021 kW/ha) and power tillers (0.018 kW/ha) (Mehta *et al.*, 2019). The overall farm mechanization level in India revolves around 40% which is lower than other developed countries viz., USA (95%), Western Europe (95%), Russia (80 %), Brazil (75%) and China (57%) (Mehta *et*

al., 2019). India is the largest manufacturer of tractor in the world and produces around 8 lakhs of tractors annually. It had exported around 80 thousand tractors in the year 2019-20 to different countries (Anonymous, 2021).

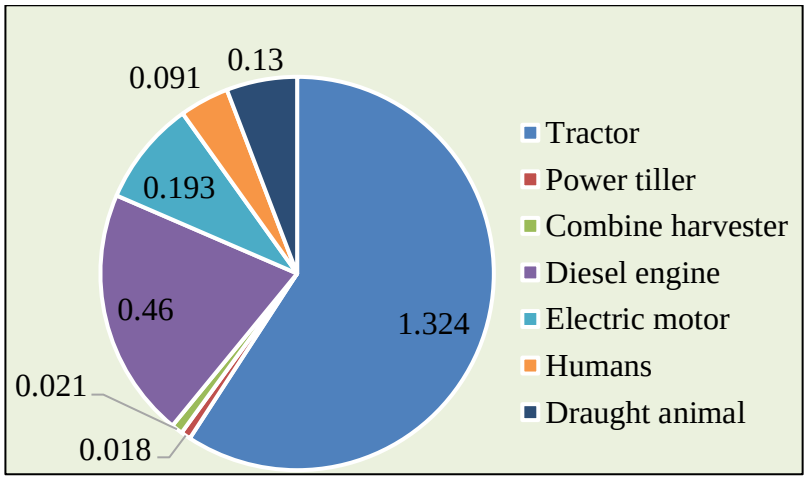

Figure 20.1: Farm power availability (kW/ha) in India (Mehta *et al*., 2019)

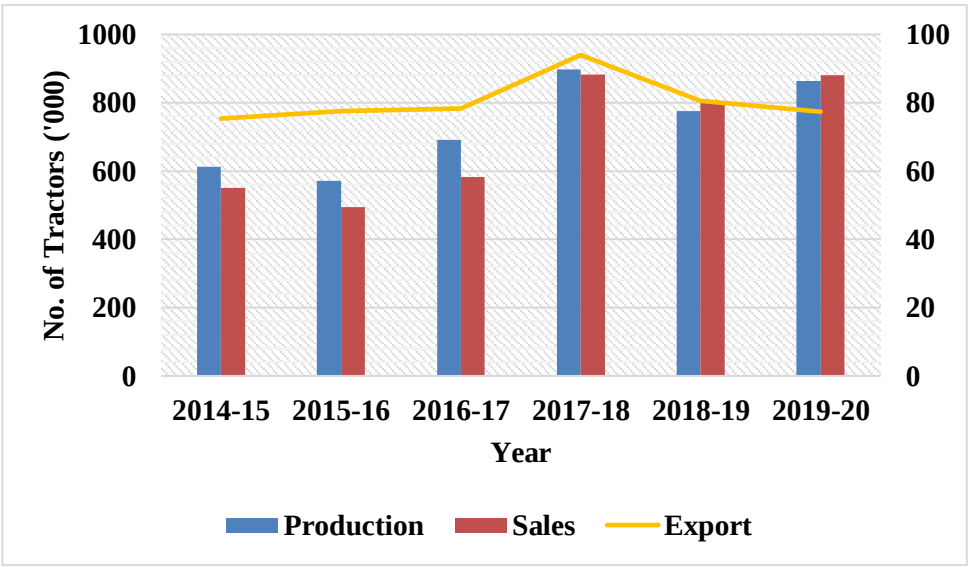

Figure 20.2: Trend of year wise production, sales and export of tractors in India (Source: tma.in)

The level of farm mechanization is different for different crops and it varies with the particular operation. Overall mechanization levels for different field crops, namely rice, wheat, maize, sorghum, pulses, oilseeds, cotton, and sugarcane stand at 45, 63, 40, 26, 34, 34, 26, 24%, respectively. The level of mechanization in pulses, oilseeds, cotton and sugarcane is at lower side compared to wheat (63%), rice (45%) and maize (40%) (Mehta *et al*., 2019).

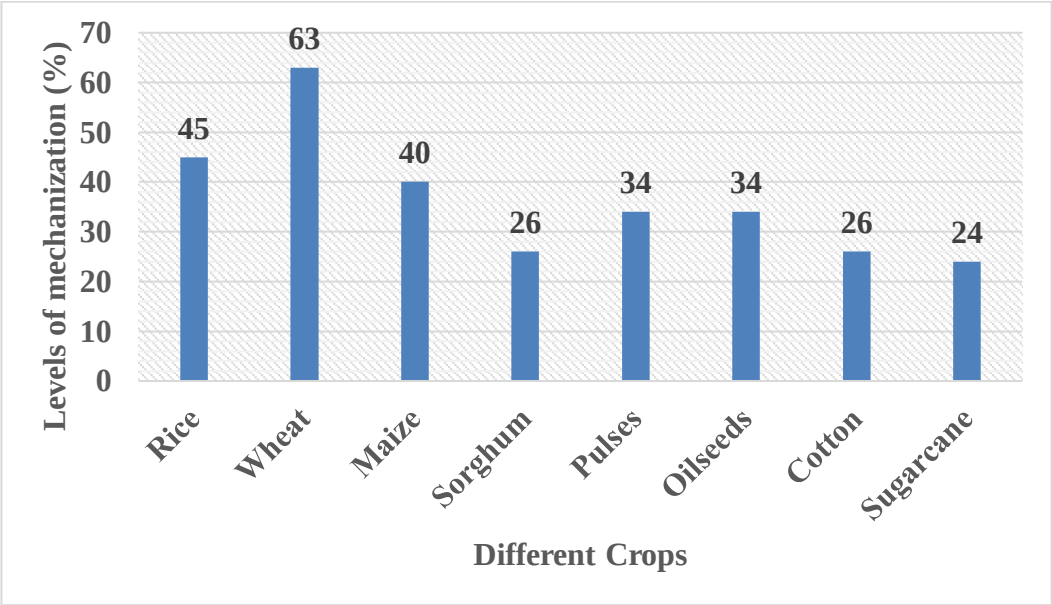

Figure 20.3: Overall Mechanization Level (%) In Different Crops

Mechanization level in different crop also varies with the particular operation. In cereals (rice and wheat) mechanization level is very high (70% for seed-bed preparation, 20-60% for sowing/planting/ transplanting, 30-50% for weeding/ intercultural/ plant protection, and 60-70% for harvesting/threshing operations).

It is found that seedbed preparation is the highest mechanized operation in different crops, while weeding followed by harvesting and threshing are the least.

20.2 Mechanized Production of Crops:

The use of improved agricultural machineries and mechanized power has increased among Indian farmers in recent past. The main reason behind is non-availability of human labour for agriculture and high operational cost of animal and human energy in comparison to mechanical power. Based on purpose agricultural machineries can be used to perform following operations:

A. Seed bed preparation
B. Seeding and transplanting
C. Interculture and weed control
D. Plant protection
E. Harvesting
F. Threshing, cleaning and grading

Brief descriptions of machineries developed in recent past which can find its application in crop production system are given below:

20.2.1 Seed Bed Preparation Machineries:

A. Indigenous Plough: Animal drawn indigenous plough is the most commonly used implement for field preparation in India. It is also known as wooden or country plough. In addition to ploughing the same implement can be used for line sowing of seeds with seed metering attachment. This versatile implement is being used for interculture and harvesting of root crops. Neck yokes are common to harness animal power for the country plough.

Figure 20.4: Indigenous Plough

B. Mould Board Plough: The mould board plough is one of the oldest agricultural implements and an improvement over indigenous plough. It is used in the area of sufficient rainfall and the weed growth is heavy and needs to be turned under for complete decay. This plough is also useful in turning the green manure crop and for mixing of compost, farmyard manure and lime with the soil. With small and marginal farmers mostly animal power is used to draw the plough. In case rich farmers, tractor drawn mould board plough is directly attached by three-point hitch. During operation it completely covers the trash residue and also helps in mixing a portion of the surface residue with the top soil.

Figure 20.5: Mould Board Plough

C. Disc Plough: A disc plough cuts the furrow and turns it when pulled forward and is especially useful in hard, dry, trashy, stony and stumpy field conditions. It is most useful in soils where both scouring and moisture conservation are problems.

Due to high force requirement, it is operated by tractor power. The tractor drawn disc plough has two or three concave steel discs. A furrow wheel is provided to control depth of cut. The plough is attached with three-point hitch and raising and lowering of implement is done by hydraulic. Disc plough prevents the formation of hardpan.

Figure 20.6: Disc Plough

D. Disc Harrow: There is a very wide range of harrows to conduct secondary field operation after primary tillage. Disc harrow is most commonly used implement and has widely been used. It is used for cutting and covering the soil effectively. It also pulverizes the soil and leaves a surface mulch and compacts the subsurface. Heavy duty disc harrow is used to destroy weeds, to cut and mix up stubbles. It is also used as primary tillage equipment in orchards and open fields. Depending upon number of gangs and their relative positions the disc harrow can be single action, double action or offset disc harrows.

Figure 20.7: Disc Harrow

E. Cultivator: A cultivator is used to stir the surface soil to a shallow depth in between the rows of the young plants for destroying the young weeds and promoting plant growth. This is also used to control the weeds by stirring the soil on the seedbed before planting. The other uses of cultivator are opening the land, preparing the seedbed and sowing the seeds and fertilizer. Seeds and fertilizers are placed in the field by fitting suitable attachment to the cultivator.

Under present mechanized farming, cultivator has become the most popularly used tractor drawn primary tillage implement. Considering the versatility of the implement animal drawn cultivator have also been developed by reducing number of shovels.

Figure 20.8: Cultivator

F. Leveler and Clod Crusher: The indigenous implement used to level the field is called *patella* or *sohag.* It is a flat piece of log dragged over the clods by bullocks. The driver stands on the log to add weight to it. In UP the improved patella, called 'Singh Patela', is quite popular.

It has a series of pointed hooks to crush the clods and to collect the weeds. In tractor ploughed fields, the same is attached behind the cultivators.

Figure 20.9: Leveler and Clod Crusher

G. Bund Former: For soil conservation and holding irrigation moisture, it is necessary to make temporary low-level bunds of 18 to 22 cm height, which lasts for one agricultural season. They either wash away or obliterated by subsequent ploughing and cultivation. For forming such bunds an implement called bund former has been developed. It consists of two concave blades joined across in a conversing manner. In operation, it collects soil at wider front and deposit soil as bund behind it. However, at present mostly this operation is performed manually with the help of spade.

Figure 20.10: Bund Former

20.2.2 Seed Planting and Fertilizer Application Equipment's:

A. Manually Operated Seed Drill: A wide variety of crops are grown in the country, each having its own sowing requirements for best growth. The seed rate, the spacing of hills in a line, spacing between the lines, depth of placement and compaction are some factors which need careful consideration. When the seed drill is pushed forward, the furrow openers open the furrow and seeds are dropped into the soil and covered by the soil.

Figure 20.11: Manually Operated Seed Drill

B. Animal Drawn Seed Drill: A three to five row seed drill having a working width of about 1m is an ideal size for animal draft. As the animal drawn seed drills have a greater number of rows, the sowing operation is done quickly before soil moisture gets depleted.

Figure 20.12: Animal Drawn Seed Drill

C. Tractor Drawn Seed Drill: Tractor drawn seed drills may have 9 to 11 furrow openers attached to tractor body with the help of three-point link. Depth of planting is controlled by means of hydraulic. Usually, tractor drawn seed drills are attached with fertilizer metering and placing device, the fertilizer is applied simultaneously along with seeds. Number of furrow openers and spacing between the rows can be altered according to the crop requirement.

Figure 20.13: Tractor Drawn Seed Drill

D. Animal / tractor drawn Planter: Planters are used to maintain row to row as well as plant to plant distance. Inclined plate seed metering mechanism is used for pigeonpea and other pulse crops. It consists of seed / fertilizer boxes, depth control wheel, shoe type furrow opener and chain and sprocket drive system. Fertilizer is metered with the help of fluted roller. Raised bed planter is also available where sowing is done on the raised bed. It is particularly suitable for Kharif crops where excess rain is a problem like pigeonpea crops. Other crops can also be shown using raised bed planter.

Figure 20.14: Animal / Tractor Drawn Planter

E. Pneumatic Planter: A six-row pneumatic planter requires 35 hp or above tractors. The equipment plants the seed at predetermined row and plant spacing. It is suitable for planting small size seeds like pigeonpea, moong, urd and lentil. The planter has aspirated blower, disc with cell type metering plate, individual hopper, furrow opener, PTO driven shaft, ground wheel etc.

Figure 20.15: Pneumatic Planter

F. Zero till Seed Drill: Zero till seed-cum-ferti drill has been developed mainly for sowing wheat immediately after harvest of paddy crop. The paddy field is relatively free from insect and weeds due to long duration of standing water in the field. Therefore, no field preparation is required to sow the seeds in such fields. It is a tractor drawn implement having 9 or 11 furrow openers. It consists of inverted-T type furrow opener for opening a fine slit in the soil. This implement reduces cost of production by avoiding operation of field preparation. The drill can suitably be used for pulse crops especially for conservation agriculture.

Figure 20.16: Zero till Seed Drill

20.2.3 Interculture Implements:

A. Hand Implements: Most of the interculture in India is done with the Khurpi, which is a sharp-edged triangular sickle shaped blade. Sometimes weeding is done with the small spade, hoe or mummuty. Most of these tools have small handles and the user has to sit on his heels or bend his back while weeding.

Figure 20.17: Hand Implements

B. Wheel Hoe: Weeding is an important agricultural operation which increases crops yield without much additional investment. Effective and timely weed control results into higher crop yield. But this is a time-consuming cumbersome process. To reduce drudgery wheel hoes have been developed. The mechanical weed control using wheel hoe is more effective and economical.

Figure 20.18: Wheel Hoe

C. Three tined Hand Hoe: The three tined hand cultivator is pulling type weeder suitable for upland row crops. 4 – 5 times higher output over Khurpi can be achieved with this weeder.

Figure 20.19: Three tined Hand Hoe

D. Push Type Hand Weeder: The push type hand weeder is simple in construction and is suitable for weeding in low land rice transplanted in rows. It is available in different sizes to meet the various row spacing. This weeder has two spiked wheels or rotors, which rotates on a supporting frame. The skid forming the front end, controls depth for the rotors

E. Grubber Weeder: It is a simple and light in weight, manually operated equipment for weeding and interculture in upland row crops in black soil. It consists of long handle, ferrule, three times and sweep type blades. The operator uses pull force to break the soil crust and uproot the weeds.

Figure 20.20: Grubber Weeder

F. Peg Type Dryland Weeder: It is manually operated equipment for weeding and interculture in row crops like groundnut, sunflower, soybean and sorghum. It consists of a handle, adjustable V-blade and peg holding roller. The top soil of crust is broken by roller while the weeds uprooting and soil mulching are done by the blade through push and pull action of the unit.

Figure 20.21: Peg Type Dryland Weeder

G. Twin Wheel Hoe Weeder: It is a manually operated equipment for weeding and interculture in upland row crops in black soil region. It consists of twin wheels, frame, V-blade with tine, U – clamp, scrapper and handle. Weed cutting and uprooting are done through push and pull action of the unit.

Figure 20.22: Twin Wheel Hoe Weeder

20.2.4 Spraying and Dusting Equipment's:

A. Hand Compression Sprayer: The hand compression sprayer is suitable for spraying crops like paddy, groundnut, vegetables, cotton, potato, tobacco etc. It is available in different sizes (4-to-13-liter capacity).

Figure 20.23: Hand Compression Sprayer

B. Foot Sprayer: It is commonly used in plantation crops. It consists of pump, spray lance with nozzle, control valves, suction and delivery hoses, strainer and frame for foot paddle.

Figure 20.24: Foot Sprayer

C. Knapsack Sprayer: It consists of 15 o 20 liters tank made of galvanized iron or high-density polythene. The tank is generally kidney shape so that it could easily be carried out at the back. Adjustable shoulder straps are provided for proper holding. Right- or left-hand levers are provided for pumping. Agitators are provided for through mixing of chemicals.

Figure 20.25: Knapsack Sprayer

D. Compression Sprayer: It consists of a cylindrical container of about 15 to 20 liters capacity. The container is made of brass and act as pressure vessel. It is filled to its 2/3rd capacity. The remaining space is used for compressed air to pressurize the solution. A reciprocating air charge pump is used for compressing the air to about 4 kg/cm^2. Pressure gauge or spring-loaded safety valves may be provided to release excessive pressure.

E. Mist Blower-Cum-Duster: This is a power operated sprayer-cum-duster. It is used to cover large areas with small quantity of chemicals. The frequent filling up and continuous pumping is required in hand compression sprayers, is avoided by use of this machine.

Figure 20.26: Mist Blower-Cum-Duster

F. Power Sprayer: The power sprayer may be stationary engine or PTO operated tractor mounted type. The stationary engine driven power sprayers are small in size and are mounted on trolleys with pneumatic wheels, for transportation. Hydraulic type power sprayers are more commonly used. It has a tank capacity of about 100 to 500 litters. A positive displacement pump is provided with sufficient discharge and pressure range to meet varying requirements of spraying job. These pumps are operated by tractor PTO.

Figure 20.27: Power Sprayer

20.2.5 Harvesting Equipment's:

A. Serrated Sickle: This is a hand operated equipment having serrated blade fixed in wooden handle. The unit predominantly applies the friction and shear actions on the stem of plant for cutting. The cutting force drastically reduces when compared with traditional sickle, which uses impact principle. Operator's safety and comfort has been taken into account by providing appropriate size of raised wooden handle.

B. Self-Propelled Reaper: It is a 6 hp diesel engine driven walking type reaper where crop cutting and conveying mechanism mounted on the front of the unit. It consists of handle, engine, cutter bar, crop row divider (4 nos.), star wheel, conveyor belt and lugged wheel.

The unit has successfully used for harvest of cereals and oilseed; however, this machine is yet to be tested for pulse crops. Two gear boxes, one for lugged wheels and other for cutter are used.

C. Power tiller Operated Soybean Reaper: It is a 8 – 10 hp power tiller front mounted reaper consists of cutter bar, reel, platform, gauge roller, hitch plate, power transmission system, dog clutch and main frame.

D. Tractor Mounted Reaper Windrower: Timeliness of operation in case of crop harvesting is of prime importance since much has been invested in the crop and risk is high. Presently used sickle harvesting is time consuming and laborious. This also increases utility of tractors for this very important field operation. the machine is mounted on the front of tractor and power is taken from PTO.

E. Vertical Conveyor Reaper: It is a 35 hp or above tractor front mounted reaper to harvest rice and wheat crop. It consists of cutter bar, conveying system, row divider (7 Nos.), telescopic / universal shaft, lifting side-rods, gear box and mounting bracket. Tractor PTO is used to drive the cutter bar and conveying system.

Figure 20.28: Harvesting Equipment's

20.2.6 Threshing Equipment:

A. Multi-crop Thresher: This has been developed to cater to the needs of farmers to thresh common crops replacing existing single crop threshers. This is suitable for threshing of wheat, maize, rice, gram, Pigeonpea, soybean, mustard, safflower, linseed etc.

Operated by 5 hp three phase electric motor and consists of feeding tray, spike tooth cylinder, concave, top cover, aspirator blower and sieve shaker. The unit is supplied with two top covers, three concaves and three sieves and a set of belts and pulleys to achieve variable speed (7 – 21 m/s).

Figure 20.29: Threshing Equipment

B. Semi-axial Flow Multi-crop Thresher: It threshes the crop by moving it axially over spike tooth cylinder and predominantly using intra crop friction for grain separation besides impact force. The thresher is suitable to thresh crops like wheat, soybean, sorghum, maize, pigeonpea, rice, sunflower and safflower. Operated by 7.5 hp three phase electric motor and consists of feeding chute, spike tooth cylinder, concave, semi-circular aspirator blower, sieve shaker and pneumatic transport wheel. The unit is supplied with two top covers, three concaves, three sieves and set of belts and pulleys to achieve variable cylinder speed (10 - 20 m/s).

C. High-Capacity Multi-crop Thresher: Developed to suit large holding farmers and custom hiring. It is suitable to thresh crops like wheat, maize, sorghum, gram, soybean, Pigeonpea and sunflower. Operated by 20 hp, three phase electric motor or 35 hp tractor PTO. It consists of hopper with automatic feeding, spike tooth cylinder, three aspirator blower, concave, shaker unit, bagging unit, hitch system and pneumatic transport wheel. The unit is supplied with concave sieves and set of belts and pulleys to achieve variable cylinder speed (8 – 14.6 m/s).

20.3 Conclusions:

Mechanization plays an important role in the crop cultivation system. It reduces the drudgery involved in different operations and ensures timeliness and improves crop productivity. Though tractors, and tractor-operated machineries are costly they can be used by small and marginal farmers in custom hiring mode. Adoption of farm machineries has shown to increase efficient utilization of agricultural inputs in terms of productivity. Machines are not quite frequently used in farming of pulse, cotton, sugarcane and oilseed crops as most of these machineries have been developed and adopted for cereal crops.

It is high time to develop and introduce machines for production of less mechanized crops like pulses, oilseeds, sugarcane, and cotton. Therefore, it is the need of hour to make these machineries available on custom hiring basis. Only after observing the utility of these machines acceptance for mechanized farming will increase among farmers. Mechanized crop production is also essential to make the produce cost competitive in international market in the existing global trade scenario.

20.4 References:

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