



## **Lesson 1&2. Farm Mechanization: Introduction, objectives and level of mechanization in Punjab and India**

### **SOURCES OF FARM POWER AND MECHANIZATION**

Various types of agricultural operations performed on a farm can be broadly classified as:

1. Tractive work such as seed bed preparation, cultivation, harvesting and transportation, and
2. Stationary work like silage cutting, feed grinding, threshing, winnowing and lifting of irrigation water.

These operations are performed by different sources of power namely, human, animal, stationary engine, tractor, power tiller, electricity, solar and wind. For doing these operations different types of power available is classified as:

- Human power
- Animal power
- Mechanical power
- Electrical power
- Wind power

**HUMAN POWER:** The indications are that the decline in number of labourers employed for agriculture is likely to increase in future resulting a greater investment in labour saving devices and mechanical power.

**Labour (Human Energy) on Farms:** Labour is one of the most important sources of farm power in regions where traditional system of agriculture is practiced. On small farms, high proportion of labour is supplied by the farmer and his family. Only to meet the peak and permanent labour requirements, the hired labourers are employed.

On small farm having very little spare capital to buy appropriate type of hand tools and animal drawn equipment, both labour use **efficiency** and **productivity** are very low. Labour use efficiency can be improved by engaging labour in a group where sequence of operations



demands teamwork for effective output. In the absence of the team, single man would waste other energies, which might result into higher cost of operation. For example, a power thresher operation always demands a team effort for efficient utilization of expensive resources i.e., thresher, cleaner, the prime mover, etc.

**ANIMAL POWER:** Animal power is the most important source of power on the farm all over the world particularly in developing countries. It is estimated that nearly 80 per cent of the total draft power used in agriculture throughout the world is still provided by animals. Different animal sources are:

- Bullocks- can pull of about 15% of its weight
- Buffaloes
- Camels
- Horses
- Donkeys-can pull 80 % of its weight for short period and 10-15% of its weight for sustainable period.
- mules
- and elephants

The average force a bullock can exert is nearly equal to one tenth of its body weight. But for a very short period, it can exert many more times the average force. Generally a medium size bullock can develop between 0.50 to 0.75 hp.

### **MECHANICAL POWER**

The third important source of farm power is mechanical power that is available through tractors and stationary engines. The engine is a highly efficient device for converting fuel into useful work. The efficiency of diesel engine varies between 32 and 38 per cent, whereas that of the petrol engine in the range of 25 and 32 per cent. In recent years, diesel engines and tractors have gained considerable popularity in agricultural operations. Small pumping sets within 3 to 10 hp range are very much in demand. Likewise, engines of low to medium speed developing about 14 to 20 hp are successfully used for flourmills, oil expellers etc. Diesel engines of the larger size are used on tractors. Diesel engines are the main source of power in agriculture. The basic reason for their preference is the **economy** in operation.



## **ELECTRICAL POWER**

Now-a-days electricity has become a very important source of power on farms in various countries. It is steadily becoming more and more available with the increase of various river valley projects and thermal stations. The largest use of electric power in the rural areas is for irrigation and domestic water supply. Besides this, the use of electric power in dairy industry, cold storage, fruit processing and cattle feed grinding has tremendously increased.

## **WIND POWER**

The availability of wind power for farm work is quite limited. Where the wind velocity is more than 32 km/h, wind mills can be used for lifting water. The most important reason of its low use is its uncertainty. Thus the average capacity of a wind mill would be about 0.50 hp. It is one of the cheapest sources of farm power available.

## **MECHANIZATION**

**AGRICULTURAL MECHANIZATION** involves the design, manufacture, distribution, use and servicing of all types of agricultural tools, equipment and machines. It includes three main power sources: human, animal and mechanical with special emphasis on mechanical (tractive power).

**FARM MECHANIZATION:** is technically equivalent to agricultural mechanization but refers to only those activities normally occurring inside the boundaries of the farm unit or at the farm unit level (example: village, community, co-operatives etc).

**TRACTORIZATION:** refers to the application of any size tractor to activities associated with agriculture.

**MOTORIZATION:** refers to the application of all types of mechanical motors or engines, regardless of energy source, to activities related to agriculture.

**AGRICULTURAL IMPLEMENTS:** are devices attached to, pulled behind, pushed, or otherwise used with human, animal or mechanical power source to carry out an agricultural operation.

**AGRICULTURAL MACHINERY:** is a general term used to describe tractors, combines, implements, machines and any other device more sophisticated than hand tools which are animal or mechanically powered.



**AGRICULTURAL EQUIPMENT:** generally refers to stationary mechanical devices such as irrigation pump-set.

### **SCOPE OF MECHANIZATION**

It is quite true that the farmers of developing countries have the **lowest earnings per capita** because of the **low yield per hectare** they get from their **land holdings**. One of the few important means of **increasing farm production per hectare is to mechanize it**. Mechanization may have to be done at various levels. Broadly, it can be done in three different ways:

- I. By **introducing the improved agricultural implements** on small size holdings to be operated by bullocks
- II. By **using the small tractors, tractor-drawn machines and power tillers** on medium holdings to supplement existing sources.
- III. By **using the large size tractors and machines** on the remaining holdings to supplement animal power source.

**As a matter of fact, the progress of the country should be mainly judged on the basis of degree of farm mechanization (production per worker and the horsepower under his command per unit area).**

Large amount of labour or draft power, which can be replaced through machines, provides a strong incentive to mechanize.

From the energy application point of view, the Indian agriculture is in the transition from:

**Stage 1 (human power) and stage 2 (animal power) to**

**Stage 3 and 4 (power tiller or four wheel tractor).**

### **FARM MECHANIZATION:**

Farm mechanization is the application of engineering and technology in agricultural operations, to do a job in a better way to improve productivity. This includes development application and management of all mechanical aids for field production, water control, material handling, storing and processing. Mechanical aids include hand tools, animal drawn equipment, power tillers, tractors, engines, electric motors, processing and hauling equipment.



### **SCOPE OF FARM MECHANIZATION:**

There is a good scope of farm mechanization in India due to the following factors:

- 1) Improved irrigation facility in the country.
- 2) Introduction of high yielding varieties of seeds.
- 3) Introduction of high dose of fertilizers and pesticides for different crops.
- 4) Introduction of new crops in different parts of the country.
- 5) Multiple cropping system and intensive cultivation followed in different parts of the country.

### **SOME OTHER FACTORS WHICH ARE RESPONSIBLE TO ENCOURAGE FARM MECHANIZATION ARE:**

i) Population of the country is increasing at the rate of about 2.2% per year. Steps have to be taken to arrange food and fibre for such large population by adopting intensive farming in the country. Intensive farming requires machines on the farm.

ii) In multiple cropping programme, where high yielding variety of seeds are used, all farm operations are required to be completed in limited time with economy and efficiency. This is possible with the help of mechanization.

iii) Farm mechanization removes drudgery of labour to a great extent. A farmer has to walk about 66 km on foot while ploughing 1 ha land once by bullocks with a country plough having 15 cm furrow width.

iv) A large number of females and children work on farm. So, with mechanization females can work at home and children go to school.

v) The proper utilization of basic inputs like water, seeds and fertilizers will be possible with proper equipment.

**vi) There are certain operations which are rather difficult to be performed by animal power or human labour such as:**

- a) Deep ploughing in case of deep rooted crops.
- b) Killing the pernicious weeds by deep tillage operations.



- c) Levelling of uneven land.
- d) Land reclamation.
- e) Application of insecticides during epidemic seasons. These operations need heavy mechanical equipment.

#### **BENEFITS OF FARM MECHANIZATION:**

There are various benefits of farm mechanization:

- 1) Timeliness of operation
- 2) Precision of operation
- 3) Improvement of work environment
- 4) Enhancement of safety
- 5) Reduction of drudgery of labour
- 6) Reduction of loss of crops and food products
- 7) Increased productivity of land
- 8) Increased economic return to farmers
- 9) Improved dignity of farmers
- 10) Progress and prosperity in rural areas

#### **PRESENT STATUS OF FARM MECHANIZATION:**

Present status of farm mechanization is quite appreciating. We have:

- a) Improved manual tools.
- b) Improved animal drawn implements.
- c) Tractor operated implements.
- d) Custom hiring units on the farm.
- e) Other stationary equipments like threshers, irrigation pumps, sprayers, dusters etc.



## **LIMITING FACTORS IN FARM MECHANIZATION:**

There are various limitations in adopting farm mechanization:

- 1) Small and fragmented land holdings.
- 2) Less investing capacity of farmers.
- 3) Agricultural labour is easily available.
- 4) Adequate draught animals are available in the country.
- 5) Lack of availability of suitable farm machines for different operations.
- 6) Lack of repair and servicing facilities for machines.
- 7) Lack of trained man power.
- 8) Lack of co-ordination between research organization and manufacturers.
- 9) High cost of machines.
- 10) Inadequate quality control of machines.

India has made impressive strides in the field of agriculture by enhancing agricultural production from a mere 51 m-tons in 1950-51 to 258 m-tons by 2011-2012. This has been achieved through the adoption of biological, chemical and mechanical inputs and by creating/promoting required infrastructure and facilities in rural areas. Appropriate Govt. policies such as consolidation of holdings, land levelling, rural roads, and establishment of grain markets, rural electrification, adequate credit and assured minimum support price have helped in this phenomenal increase in agricultural production and productivity. India's well orchestrated Green Revolution has done the nation proud. Beginning the mid sixties, India has witnessed many revolutions which have put our agrarian economy on a sound footing. These include Green Revolution, white revolution, blue revolution & grey revolution. The last named revolution is synonymous with machinery revolution. However, the Indian green revolution is gradually fading. The yields have reached a plateau. The country is now in search of a rainbow or evergreen revolution.

Indian agriculture is plagued with many problems such as low productivity in rainfed areas, decline in soil fertility, receding water tables, change in ecology due to monoculture and indiscriminate use of resources, increasing environmental pollution, staggering losses of perishables (30-40 %), absence of



scientific post harvest infrastructures, inadequacy of energy for production and post harvest agriculture, low exports, due to low quality and high cost of production, as well as non-conformance to global quality assurance and management norms. The WTO regime has created an urgency to bring about a paradigm shift in Indian agriculture and mindsets of all concerned. Ecologically sustainable agriculture by adopting conservation farming together with diversification of agriculture in problem areas, greater private investment and setting up chains of agro-processing centres in the rural areas are the new focus of Indian Agriculture. The country has about 60 million tonnes of wheat and paddy in the central food reserve and to avoid further complications and wastage, urgent steps need to be undertaken to promote exports and provide food to nearly 40% of the population which does not have economic access to food, even though the country has plenty of it in the reserve.

In the sixties and early seventies debates were often held by the policy makers, economists, sociologists, engineers and all those concerned with agricultural modernization regarding relevance of agricultural mechanization in a labour abundant economy. Literature is replete with studies commissioned by the Planning Commission through National Council of Applied Economic Research (NCAER), SAU's and other bodies to find out the impact of agricultural mechanization on agricultural productivity, cropping intensity, labour employment and returns to the farmers. These studies conclusively proved that adoption of tractors & farm mechanization led to significant increase in cropping intensity, increase in production & productivity and reduction in the cost of production. For certain operations like harvesting, use of machines did displace the labour but taking into account direct labour on the farm, indirect labour employed for manufacturer, repair, maintenance and subsidiary labour, farm mechanization led to higher employment generation. Timeliness of operations, precision, better quality of operations, accurate placement, uniform distribution, reduction in losses, better quality of produce, reduced cost of production, reduction in drudgery to human beings and animals and enhancing the dignity of labour are the major advantages offered by farm mechanization. It is now agreed that introduction of tractors & machines has also helped to check migration of educated youth, skilled and unskilled man power from the rural to urban areas.

Notwithstanding the wide agro ecological diversity, variation in soil types, climate, precipitation, irrigation intensity, cropping systems, land topography and industrial infrastructure, India has done remarkably well in mechanization of Agriculture. We have evolved a unique model by way of selective mechanization where in we have utilized both the animate and inanimate





sources of farm power namely, human labour, draft animals, tractors, diesel engines and electric motors, The country's farmers presently employ over 205 million agricultural labourers, 63 million pairs of draft animals, 3.0 million four wheel tractors, 110000 power tillers and over 18 million irrigation pumps, One of the commonly used indicators to express the level of mechanization of agriculture in a state/country is the availability of farm power per unit area (kW/ha). For India, it stands at 1.12 kW/ha and that for the most mechanized state of Punjab, at 2.96 kW/ha, followed by 2.33 kW/ha for Haryana, 2 kW/ha for Tamil Nadu and 1.48 kW/ha for UP. Table 1, gives the power availability, irrigation intensity, cropping intensity and yield for different states in India, which clearly demonstrates that states with higher power availability per ha also have higher yields per hectare.

FAO publishes a Year Book each year which gives the number of tractors and harvesters per 1000 ha for all countries and continents. For India, the number of tractors available as of now is 14 tractors /1000 ha as against 82 tractors per 1000 ha for the state of Punjab. Indeed, Punjab occupies a place of pride in the development and introduction of farm mechanization technology in India. The beginning was made with the use of stationary power sources (engines and electric motors for pumps, tube wells and threshers) in the late fifties followed by mobile power sources like tractors and combines for a wide range of field operations from land preparation to crop harvesting. India's first power thresher was innovated in Punjab in 1957, so also the animal and tractor operated seed drills, potato planters and diggers, sunflower thresher, seed planters, sugarcane planter, strip till drill, high clearance sprayer, straw combine, various types of weeders, cleaners, graders & vegetable seed extracting machines. Mechanization of a crop or operation always begins from Punjab and spreads first to the adjoining states and later to every nook & corner of India. The role of Agricultural engineers, manufacturers & farmers in mechanizing agriculture is commendable.

**Table 1: Power availability, cropping intensity, percent irrigated area, fertilizer consumption and grain yield for different states in India.**

State	Annual rainfall (mm)	% Irrigated area	Power (kW/ha)	Fertilizer (kg/ha)	Cropping intensity	Grain equivalent yield (ton/ha)
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Jammu & Kashmir	617	40.0	0.71	69.8	1.48	2.01
Himachal Pradesh	494	13.1	1.61	50.9	1.71	2.40
Punjab	555	93.7	2.96	299.5	1.80	5.26
Uttar Pradesh	837	64.7	1.48	150.6	1.49	3.58
Haryana	494	78.6	2.33	202.5	1.68	3.63
Rajasthan	421	29.3	0.53	39.2	1.20	0.93
Assam	1449	27.9	0.56	18.2	1.42	1.61
Bihar	1024	44.3	0.82	93.5	1.38	1.91
West Bengal	1355	24.7	1.21	158.9	1.65	3.11
Madhya Pradesh	1021	25.2	0.71	42.2	1.24	1.38
Gujrat	609	31.1	0.90	81.1	1.13	1.08
Orissa	1123	28.6	0.48	37.7	1.38	1.23
Maharashtra	920	13.4	0.78	76.6	1.24	1.28
Andhra Pradesh	594	40.8	1.18	158.9	1.21	1.83

Karnataka	802	24.9	0.80	90.2	1.15	1.58
Tamil Nadu	950	53.6	2.00	135.4	1.21	2.81
Kerala	1927	19.3	0.86	90.5	1.36	1.45
Total	880	38.3	1.02	97.6	1.32	1.96

**Source: Singh, G., 2001, Relationship between mechanization and agricultural production in various parts of India, AMA: 32(2), 68-76.**

One can better appreciate the Indian farm mechanization scenario by looking at the extent of mechanization of various crop production operations such as seed bed preparation, sowing & planting, weed & pest control harvesting, threshing & post harvest operations. According to the estimates prepared by Ministry of Agriculture, tillage is mechanized to the extent of 37%, sowing and planting 63%, threshing 20%, irrigation 54%, plant protection 43% and harvesting 2%. Hence there is ample scope for further mechanization of Indian agriculture.

India is today the largest tractor producing nation of the world with an installed capacity of over 4.79 lakh tractors per year. As many as 2.2 to 2.5 lakh tractors are manufactured and sold in the country every year. Apart from 15 tractor manufacturing firms, there are about 3500 farm machinery manufacturers, over two dozen colleges and departments of agricultural engineering, one Central Institute of Agricultural Engineering at Bhopal, One Central Institute of Post Harvest Engineering and Technology at Ludhiana and four Farm Machinery Training and Testing Institutes located in different parts of the country. All these agencies are engaged in R&D, testing and evaluation as well as commercialization of various types of equipment.

#### **BOTTLENECKS IN INDIAN FARM MECHANIZATION SYSTEM**

- Low annual use of tractors (only 500-600 hrs/year against recommended 1000 hrs/yr).
- Non availability of matching equipment.
- Cumbersome and energy inefficient designs.



- Poor reliability, frequent breakdowns and high repair and maintenance cost.
- Low quality.
- Use of ungraded materials, absence of inter-changeability of components.
- Inadequate R&D, Testing & Training facilities and inadequate Research funding.
- Inadequate user education.
- Lack of standardization.
- Non-availability of relevant literature like operator's manual, parts catalogues etc.

#### **PRIORITY AREAS FOR INDIAN AGRICULTURAL MECHANIZATION**

- Intensification of R & D to introduce energy efficient machines for relatively un-mechanized crops such as cotton, sugarcane, oil seeds, pulses, vegetables & fruits. Use reverse engineering and enforce close collaboration with farm machinery manufacturers. Assist Indian manufacturers in seeking collaboration with well known foreign firms wherever desired engineering technologies are not available.
- Intensify research in the area of tractor design engineering due to their extensive use in Indian farming. India is now the largest tractor manufacturer in the world. TMA needs to be involved in this task.
- Farm machinery management research to find out use patterns, annual usage, breakdown frequencies, repair & maintenance cost and above all reliability.
- Research on safety, comfort, exhaust emissions and health hazards in the use of mechanical power sources and machines needs to be expedited.
- Emphasis be laid on conservation farming and energy saving/energy efficient tools and machines.
- An area of utmost importance from environmental point of view is proper utilization of about 540 million tonnes of crop residues available



in India. Punjab alone has 10 million tonnes paddy straw which is mostly burnt. Burning needs to be banned. Appropriate machines for incorporation of residues into the soil, for mulching, for collection, handling & transport for briquetting, gasification, power generation, and/or allied usage is a priority area in the field of mechanization.

- Research on alternate engine /tractor fuels including bio-diesel, ethanol, producer gas need to be intensified.
- Greater emphasis be laid on design and manufacture of high capacity and precision machines for multi farm use, for corporate/contract farming as well as for custom hiring through Agri. Business Centres being promoted by Govt. of India for the benefit of rural youths.
- Equipment for post harvest transport, bulk handling, cleaning grading drying milling packaging and storage are urgently required. These could be imported wherever non-existent. Next revolution in agriculture must be ushered in the area of efficient food processing & agro industries to transform the rural areas & utilize the surpluses. Mechanization packages will be crucial to ensure success of contract/corporate farming.
- Mandi mechanization with a view to introduce bulk handling of grains is an urgent need.
- Mechanization of hill-agriculture (20% total cultivated area), horticulture and floriculture, forage production and handling equipment, forestry mechanization, and efficient transport equipment are some important areas.
- Women-friendly tools and gadgets need to be evolved by modifying the existing ones and designing the new tools to reduce drudgery to women workers.
- Mechanization of experimental plots is an important area requiring urgent attention. A mission mode project under the NATP has recently been sanctioned in this area.
- Nearly two-third of the cultivated area is rainfed. Farm power available in these areas is barely 0.3 kW/ha. Hence, mechanization of these areas should be under taken on priority basis. Large horse power tractors and suitable equipment for conservation of soil moisture, seed bed preparation, seeding/planting, harvesting etc., are required.



- The benefits of farm mechanization have so far remained confined to mainly wheat-based cropping systems. These need to be expanded to all cropping systems including horticulture.
- The present credit policy based on land mortgage is not favourable to small farmers to own mechanical prime movers. It excludes them from the benefits of farm mechanization and supplementing their incomes through hiring out their spare operational capacity. Instead of land mortgage, viability and hypothecation of the machinery may be better criteria.
- There being a positive relationship between power availability and agricultural productivity, power constraint should be removed. An annual growth rate of 4% over 1996 base in power supply to raise it from 1kW/ha to 2kW/ha by 2020 will be adequate to maintain a growth rate of 3% or more in agricultural production. This is based on “power-production relation” studies in India and abroad. The additional power will be supplied by tractors, power tillers, self-propelled machines, engines and electric motors.
- For precision farming, precision equipment for planting and plant protection are required.
- Increasing emphasis on Integrated Pest management and Organic farming would require use of efficient cultivation machinery for weeding and hoeing. Research in this area would be necessary to evolve optimum planting geometry and practices.
- Under the WTO regime with liberalization of markets foreign countries might take advantage of dumping their machinery in India, especially such equipment as sugar-cane harvesters, paddy transplanters, potato combines, cotton pickers, horticultural machinery, sprayers unless required equipment are expeditiously developed indigenously and have cost and quality competitiveness. Joint projects by R&D organizations and Indian firms would be desirable.

## **SUGGESTIONS FOR FURTHER IMPROVEMENT**

1. No Farm Machinery research/development project should be initiated without conducting a market survey to assess the client needs and perceptions.



2. Greater industry-institution collaboration by undertaking joint research projects and use of reverse engineering would be helpful for speedy development and commercialization of new equipment.
3. Computer Aided Design (CAD) must be used for optimum design, cost reduction and reliability. All R&D organizations must have a CAD facility with latest design packages. Train R&D engineers to develop proficiency in computer aided design.
4. R&D engineers must ensure compatibility of their designs with BIS/ISO standards, norms and practices.
5. Standardization of critical components to ensure quality, durability and inter changeability is essential.
6. Up gradation of manufacturing technology to upgrade quality and reduce the cost.
7. It is under stood that a proposal is afoot to establish a Farm Mechanization Institute under the auspices of the Ministry of Agriculture and Co-operation. This institute will intensify research on different aspects of Farm Mechanization including techno-socio-economic aspects with a view to develop a long range Farm Mechanization Policy. A Draft Agricultural Mechanization Policy has already been evolved and it awaits approval of the government. Since bulk of tractor and farm machinery manufacturers are located in the northern states of India, it might be desirable to locate such an apex institution in the Punjab, as this state in spite of being one of the most mechanised states in the country, has just one ICAR institute, whereas her neighbouring states have 2 to 3 ICAR/central institutes.

To sum up, it may be concluded that farm mechanization is a dynamic technology. It evolves with changes in agriculture in a region/state/country. With diversification of agriculture and adoption of frontier technologies with a view to have eco-friendly sustainable agriculture with globally competitive outputs, cutting edge farm mechanization technologies will need to be developed and introduced expeditiously. Reduction in cost and up-gradation of quality are the twin goals to be achieved. Farm mechanization technology being capital intensive, all farm mechanization R&D projects must be demand-driven and reverse engineering approach must be followed. Up-gradation of manufacturing capabilities, use of computer-aided design and close co-



operation with industry through joint projects will help improve the quality and reliability of farm equipment. Conformance to global standards and norms will be necessary. In coming years, higher horse power tractors and high capacity machinery will be required to meet the needs of export oriented agriculture, corporate farming, custom hiring and multi-farm use. Human engineering applications to ensure safety, comfort and compatibility in respect of noise levels and exhaust emissions will be necessary. The future of farm mechanization in India is bright. However, we will have to intensify research funding and efforts in frontier areas as outlined in this chapter.

Farm Power is an essential input in agriculture for timely field operations for increasing production and productivity of land. Farm power is used for operating different types of machinery like tillage, planting, plant protection, harvesting and threshing machinery and other stationary jobs like operating irrigation equipment, threshers/ shellers / cleaners/ graders, etc.

### **SOURCES OF FARM POWER**

There are different sources of farm power available in India which are classified as

1. Human power
2. Animal power
3. Mechanical power (Tractors + Power tillers + Oil engines)
4. Electrical power
5. Renewable energy (Biogas + Solar energy + Wind energy)

## **HUMAN POWER**

Human power is the main source for operating small implements and tools at the farm. Stationary work like chaff cutting, lifting, water, threshing, winnowing etc are also done by manual labour. An average man can develop maximum power of about 0.1 hp for doing farm work.



**Paddy Nursery collection**



**Nursery transport**



**Paddy transplanting**





**weeding**



**weeding**



**Winnowing**

## ANIMAL POWER

Power developed by an average pair of bullocks about 1 hp for usual farm work. Bullocks are employed for all types farm work in all seasons. Besides bullocks, other animals like camels, buffaloes, horses, donkeys, mules and elephants are also used at some places. The average force a draft animal can exert is nearly one-tenth of its body weight.



**Ploughing a land**



**Ploughing a land**



**Bullock cart**



**Persian wheel- water lifting**

## MECHANICAL POWER

Broadly speaking, mechanical power includes stationary oil engines, tractors, power tillers and self propelled combines. Internal combustion engine is a good device for converting liquid fuel into useful work (mechanical work). These engines are two types

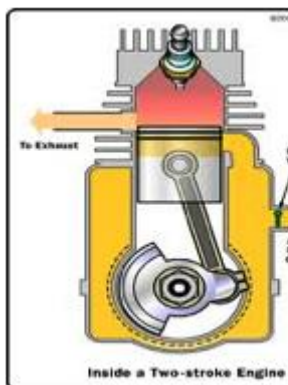
1. Spark ignition engines (Petrol or Kerosene engine)
2. Compression ignition engines (Diesel engines)

The thermal efficiency of diesel engine varies from 32 to 38 per cent whereas that of petrol engine varies from 25 to 32 per cent.

In modern days, almost all the tractors and power tillers are operated by diesel engines. Diesel engines are used for operating irrigation pumps, flour mills, oil ghanis, cotton gins, chaff cutter, sugarcane crusher, threshers, winnowers etc.



Two stroke engine



Two stroke engine ( SI engine)



Eighteen cylinder two stroke engine



Four stroke Engine + Pump



Thresher Thresher



Different types of tractors



Tractor with dozer blade



Power tiller



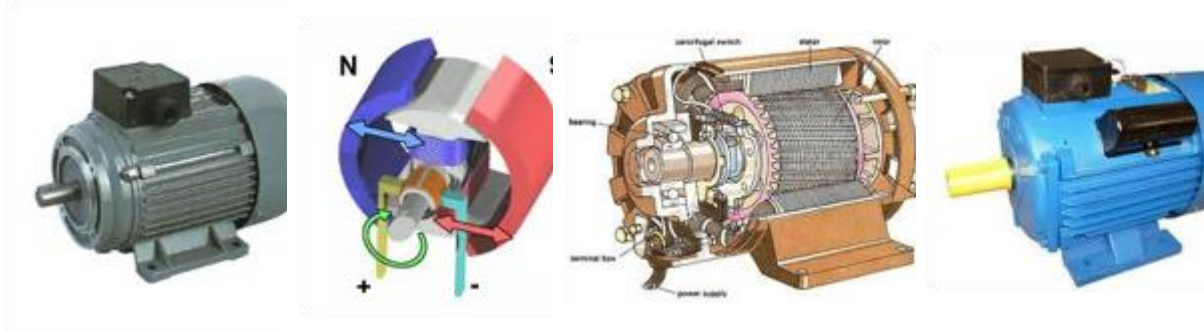
Power tillers



ELECTRICAL POWER



Electrical power is used mostly in the form of electrical motors on the farms. Motor is a very useful machine for farmers. It is clean, quiet and smooth running. Its maintenance and operation needs less attention and care. The operating cost remains almost constant throughout its life. Electrical power is used for water pumping, dairy industry, cold storage, farm product processing, fruit industry and many similar things.



Electric motors

Electric motors

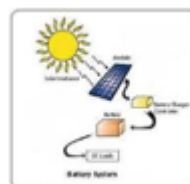
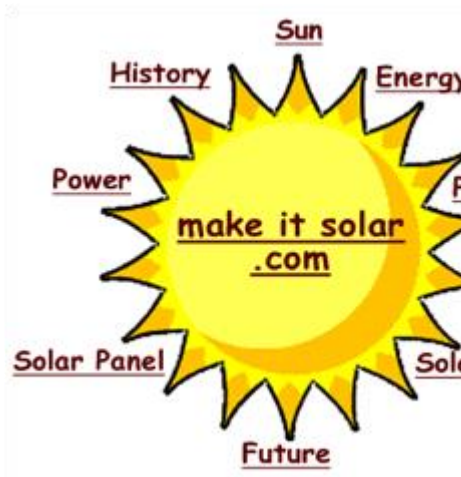


Electric motor + pump Chaff cutter

Chaff cutter – motor driven

## RENEWABLE ENERGY

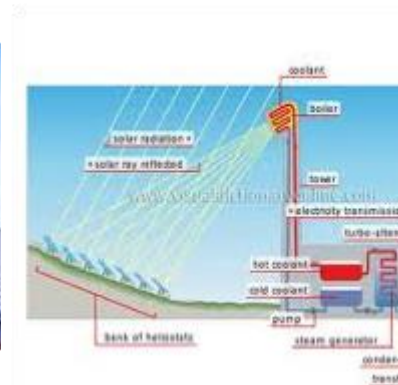
It is the energy mainly obtained from renewable sources of energy like sun, wind, biomass etc. Biogas energy, wind energy and solar energy are used in agriculture and domestic purposes with suitable devices. Renewable energy can be used for lighting, cooking, water heating, space heating, water distillation, food processing, water pumping, and electric generation. This type of energy is inexhaustible in nature.







## Different applications of solar energy

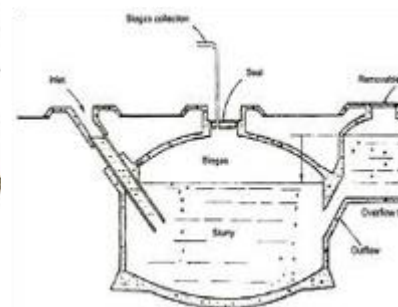


Solar electric panel Solar electric panel

Grid connected solar energy



Wind Farms



Biogas plants

### Usage of renewable energy sources

**Solar energy-** Solar dryers, lantern, cooker, solar still, solar refrigeration, solar lighting etc

**Wind energy-** Water pumping, electricity generation etc.

**Biomass energy-** Gasifiers to produce producer gas, pyrolysis to produce liquid fuels, Biogas etc

**Tidal energy –** electricity generation

**Geothermal energy-** Heat and electricity production

### MERITS AND DEMERITS DIFFERENT FARM POWER SOUECES

Merit		Demerit	
<b>Human Power</b>			
1. Easily available.		1. Costliest power compared to all other forms of power.	
2. Used for all types of work.		2. Very low efficiency.	
		3. Requires full maintenance when not in use.	
		4. Affected by weather condition and seasons.	
<b>Animal Power</b>			
1. Easily available.		1. Not very efficient.	
2. Used for all types of work.		2. Seasons and weather affect the efficiency.	
3. Low initial investment.		3. Cannot work at a stretch.	
4. Supplies manures to the field and fuels to farmers.		4. Requires full maintenance when not in use.	
5. Lives on farm products.		5. Creates unhealthy and dirty atmosphere near the residence.	
		6. Very slow in doing work.	
<b>Mechanical Power</b>			
1. Efficiency is high.		1. Initial capital investment high.	
2. Not affected by weather.		2. Fuel is costly.	
3. Cannot run at a stretch.		3. Repairs and maintenance needs technical knowledge.	
4. Requires less space.			
5. Cheaper form of power.			
<b>Electrical Power</b>			
1. Very cheap form of power.		1. Initial capital investment high.	
2. High efficiency.		2. Requires good amount of technical knowledge.	
3. Can work at a stretch.		3. If handled carelessly, it causes great danger.	
4. Maintenance and operating cost is very low.			
5. Not affected by seasons.			

### Concept of Farm Mechanization

The main concept of farm mechanization is to apply the principles of engineering and technology to do the agricultural operations in a better way to increase crop yield. This includes the development, application and management of all mechanical aids for field operation, water control, material handling, storage and processing. Mechanical aids include hand tools, animal drawn implements, power tillers, tractors, engines, electric motors, grain processing and hauling equipments.

### SCOPE OF FARM MECHANIZATION

Improved irrigation facilities, introduction of high yielding varieties. use of higher doses of fertilizers and pesticides have increased the scope for greater farm mechanization. Farm mechanization helps for proper utilization of basic inputs like water, seed and fertilizer, optimum placement of the seed and fertilizer, ploughing, removal of weeds, leveling of uneven land and land reclamation. If machines are used farmer and his animals are relieved of hard work. With the support of machines farmer can do his job better and quicker. He will get more leisure and



devote his time to other works. He can earn better living.

### **BENEFITS OF FARM MECHANIZATION**

1. Timeliness of operation
2. Precision of operation
3. Improvement of work environment.
4. Enhancement of safety
5. Reduction of drudgery of labour
6. Reduction of loss of crops and food products
7. Increased productivity of land
8. Increased economic return to farmer
9. Improved dignity of farmer
10. Progress and prosperity in rural areas

### **CONSTRAINTS IN FARM MECHANISATION (LIMITING FACTORS IN FARM MECHANIZATION)**

1. Small land holdings
2. Less investing capacity of farmers
3. Adequate availability of draft animals
4. Lack of suitable farm machine for different operations
5. Lack of repair and servicing facilities for machines
6. Lack of trained man power
7. Lack of coordination between research organization and manufacturer
8. High cost of machines
9. Inadequate quality control of machine

### **QUESTIONS**

1. The cheapest source of energy is -----
2. Power available from a farm labour is -----hp
3. Solar energy is a ----- energy
4. State the merits and demerits of different sources of energy used in farm