OLABISI ONABANJO UNIVERSITY

AGRICULTURAL ENGINEERING DEPARTMENT

AEG 501 AGRICULTURAL MACHINERY 1 (3 Units)

Lecture Note 1

Course Outline

- Short review of the development of mechanization in various branches of agriculture.
- Principles of construction, design, operation and adjustment of machines and implements for primary and secondary tillage, as well as land leveling and earth moving.
- Analysis of forces acting on the plough.
- Selecting of tillage implement suitable for various Nigerian conditions.
- Instrumentation and Measurement of Field parameters.

Note developed by Engr. Babalola Ayoola A.

1.0 Introduction

Agricultural mechanization embraces the use of tools, implements, and machines for a wide range of farm operations from land preparation to planting, harvesting, on-farm processing, storage, and marketing of products.

1.1 What is of Agricultural Mechanization?

To *mechanize* means to use machines to accomplish tasks or operations. A machine may be as simple as a wedge or an inclined plane, or as complex as an airplane. Agricultural mechanization, therefore, is the use of any machine to accomplish a task or operation involved in agricultural production. It is clear from this definition that agriculture anywhere has always been mechanized, employing a combination of different sources of power: human, animal and mechanical/engine, giving rise to three broad levels of agricultural mechanization technology classified as *hand-tool technology* (HTT), *draft-animal technology* (DAT) and *mechanical-power* or *engine-power technology* (EPT). However, recent improvements in energy sources and utilization has allowed more energy sources to be explored for agricultural use They include

Wind power

Water power

Solar Power

Electric Power

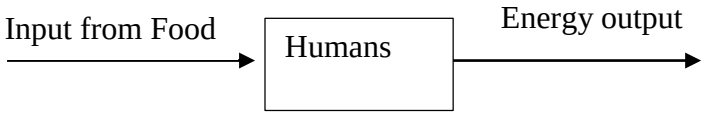
1.1.1 Hand Power Technology

Hand-tool technology is the most basic level of agricultural mechanization, where a human being is the power source, using simple tools and implements such as hoes, machetes, sickles, wooden diggers, etc. A farmer using hand-tool technology can

cultivate only about one hectare of land. He cannot do more than that because of certain scientifically established facts.

1.1.1.1 Power Production and Consumption by Humans

As a source of power, the human being operates essentially like a heat engine, with built-in overload controls or regulators.



Chemical energy input in the form of food is converted into energy output, some of which is useful for doing work. On the average, a healthy person in temperate climates consumes energy at a sustainable rate of only about 300 W, while in tropical climates, as a result of heat stress the rate is reduced to only about 250 W. Many tasks for agricultural production can be performed only at higher rates of energy consumption, however, as shown in Table 1.1. Some actual manual work rates for certain field operations are presented in Table 1.2.

Table 1.1. Human Power Consumption for Various Farming Activities

Activity	Gross power consumed (Watts)
Clearing bush and scrub	400–600
Felling trees	600
Hoeing	300–500
Ridging, deep digging	400–1000
Planting	200–300
Plowing with animal draft	350–550
Driving single axle tractors	350–650
Driving 4-wheel tractor	150–350
Driving car on farm	150

Source: mainly from Dumin and Passmore, 1967, Energy, work and leisure. Heineman as given by Inns (1992).

Table 1.2. Some Field Operation Rates by Farmers Using Hand-Tools

Operation	Average manual work rate (man days/ha)*	
Land clearing	32.6	(20.1–47.8)
Ridging for cassava	43.8	(29.7–64.5)
Mound making for yams	57.8	(35–93)
Cassava planting	28.3	
Yam planting	17.3	
Weeding root crops	36.7	(22.3–77.6)
Weeding general	40.0	
Cassava harvesting	28.5	
Yam harvesting	32.0	

* Range values in parenthesis [1].

Source: Odigboh

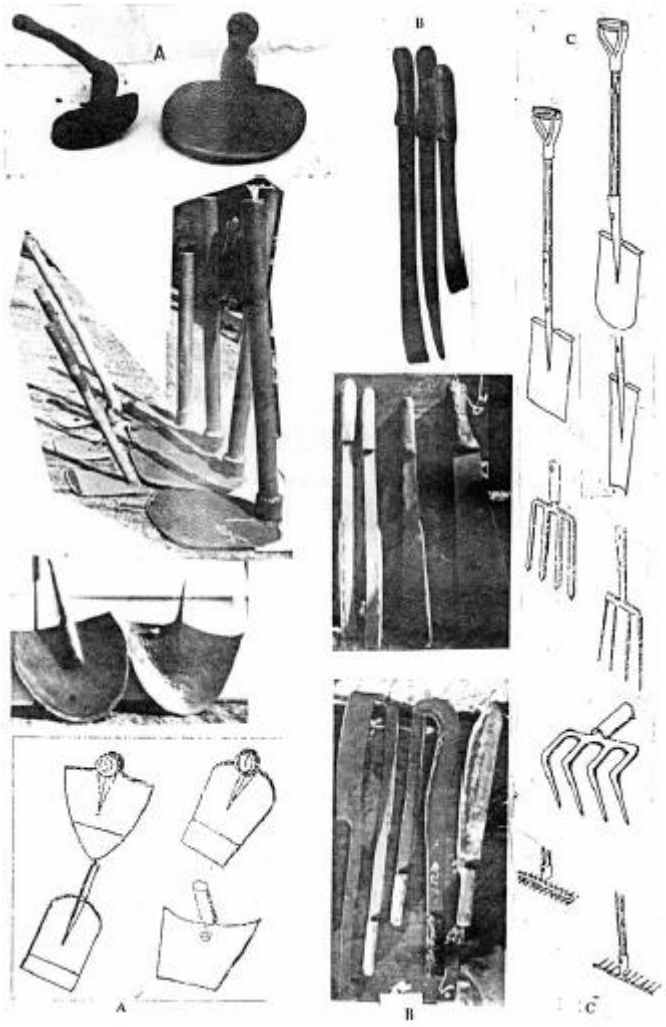
The fact that many primary agricultural production operations demand higher rates of energy than the maximum sustainable rate of energy consumption by humans necessitates rest periods in manual work. The rest period required can be estimated using the formula

$$T_R = 60(1 - \frac{250}{P}) \qquad 1$$

$T_{R=}$ Rest period in Minutes/hour of work

P = Actual rate of Energy Consumption in Watts

Examples of some hand powered tools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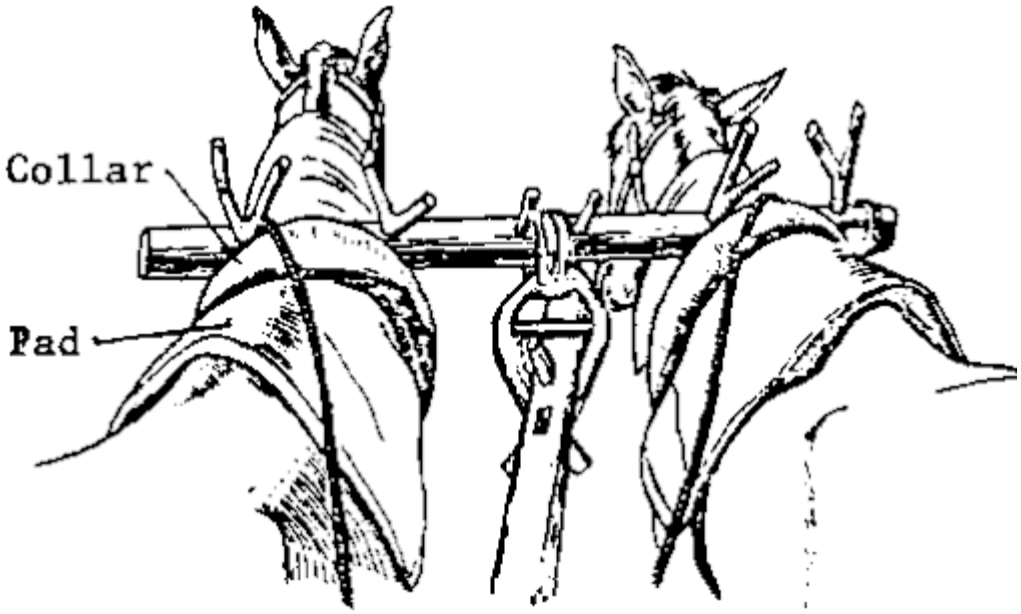
1.1.2 Draft Animal Power

Animal Power is still used in several countries and may be derived from oxen, buffalo, donkeys, camels, or horses. Such power may be used for both stationary and mobile operations.

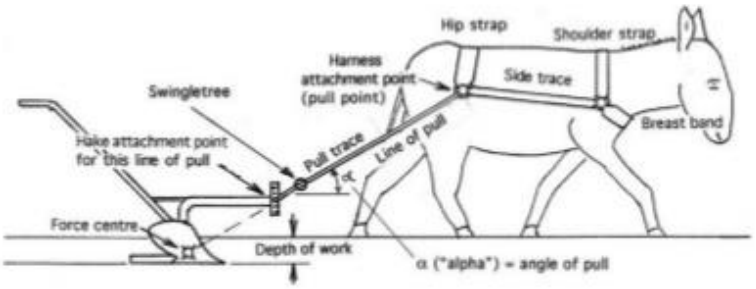
Special harnesses and yokes are used to hitch various equipment to the animal. Animals generally have the capacity to be overloaded for short periods of time and they provide good traction (grip) even in difficult conditions. Animals can also pull loads that are many times heavier than they can carry.



Harness

A Donkey can pull about 80% of his weight for short period and about 10-15% of its weight for sustained periods.

Draft Animal Power



- The force system acting on a draft animal. Increasing the angle of pull (α) will reduce the implement draft.
- The angle of pull (α) should be 30 degree.

The Power Output from animals is dependent on

- The food intake
- Breed of animal
- Training Given

1.1.3 Engine Power Technology

Engine power technology is the highest level of mechanization commonly used in agriculture today. It takes many forms: a wide range of tractor sizes which are used as mobile power for field operations and transport, and as stationary power for many different machines, engines or motors using petrol, diesel fuel or electricity to power threshers, mills, irrigation pumps, grinders and other stationary machines, aircraft for distributing crop protection materials and fertilizers, and self-propelled machines for production, harvesting and handling a wide variety of crops

1.1.4 Solar Power

Nigeria receives about 490W/m^2/day of solar radiation. Hence, there is plenty of of potential for the development of solar energy Solar Energy can be used for processing fruits and vegetables and from general drying of crops. Another relevant application is in the use of solar powered pumps.

The sun's rays are received in a collector and transmitted to a heat engine which converts the solar energy into mechanical power to run a water or irrigation pump

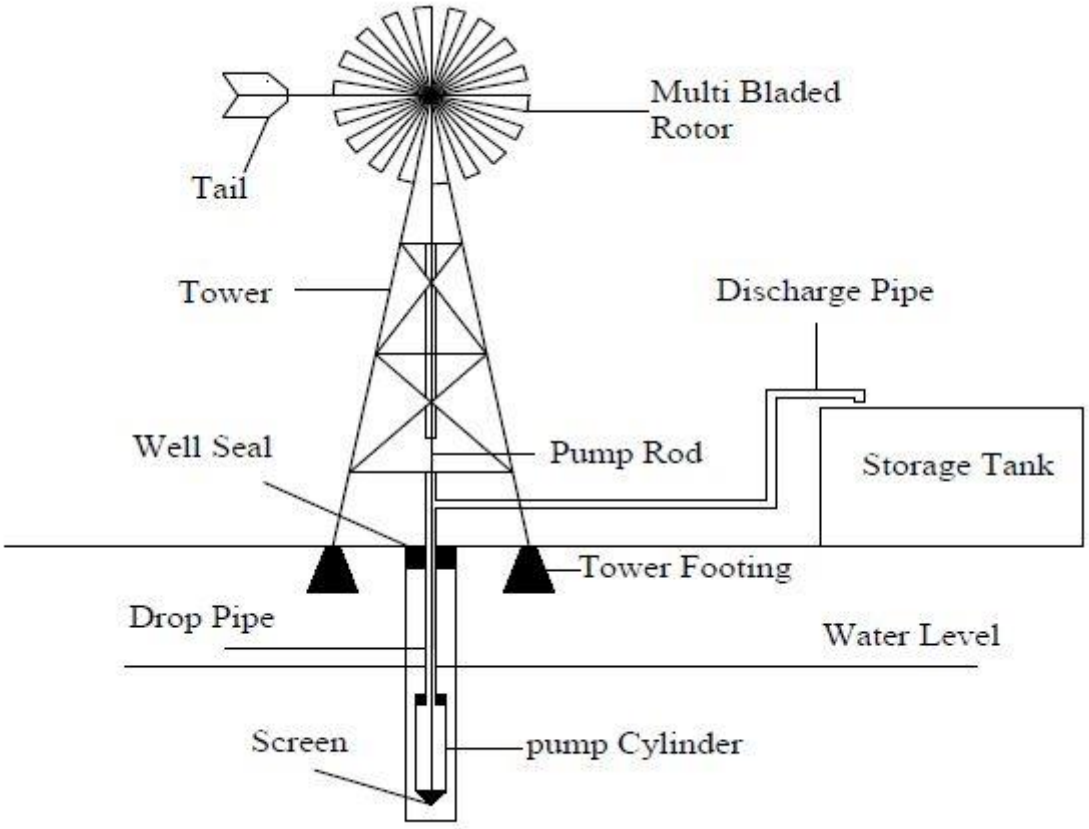
The advantages of Solar Power include

- Maintenance free Operation
- No fuelling requirement
- No waste that could cause environmental pollution

Solar Powered Irrigation Pump

1.1.5 Wind Power

Wind power has been successfully used for raising water. The natural breeze or wind is used to turn the blades if a windmill which in turn operates a pump to lift water. Wind power has also been sued to generate electricity for use on the farm.



The wind turbine shown gives an output of 180l/h from a depth of about 10m

1.1.6 Electric Power

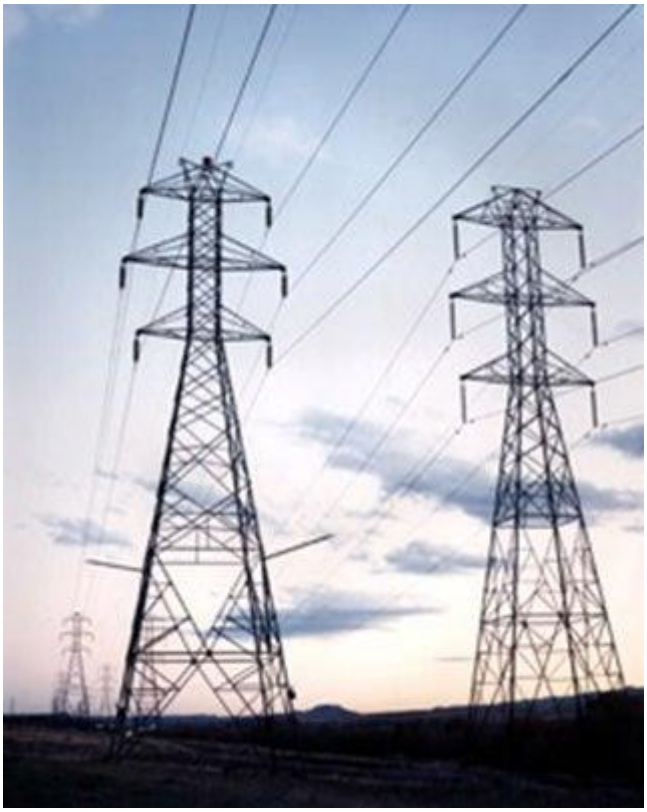
Electricity is useful for a number of operations. Electricity is useful fr

Heating for poultry sheds

Refrigeration

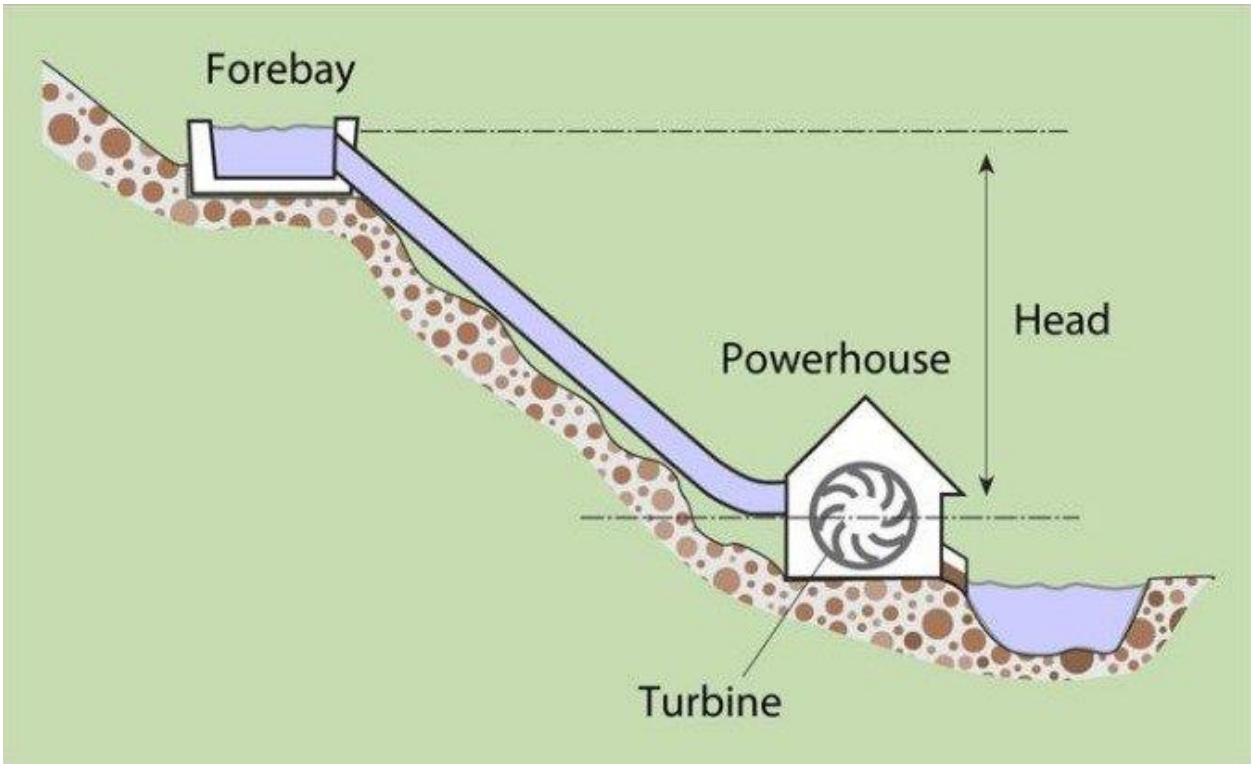
Water supply

All stationary operations such shelling, grinding, and drying of crops



1.1.7 Water Power

The Energy available from falling water can be harnessed to run a few farm operation such as feed grinding, or to operate a generating plant to provide electricity.



Example of a micro hydropower station

1.1.8 Electricity Power

Electricity is used for a number of operations on the farm and they include

Heating of poultry sheds and drying facilities

Refrigeration and Air-conditioning

Water Supply

Practically all stationary operations such as shelling, grinding, milling and drying of crops. The most important use of electricity is in driving electric motors which convert electric power into mechanical power to run different machines.

Summary

Levels of Agricultural Mechanization is in three stages: Hand Tool, Animal Drat ad Engine Powered Technology. Others include Solar, Wind, Water, Electricity have also made great relevance in agricultural mechanization.

References

Agricultural Mechanization and the Smallholder Farmers in Nigeria NIGERIA STRATEGY SUPPORT PROGRAM Policy Note No. 22 Hiroyuki Takeshima and Sheu Salau available online at http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/15313/filename/15314.pdf