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Chapter 6

Implements and methods for the preparation of agricultural soil

Dryland agriculture as practised in the semi-arid region of Northeast Brazil, is mainly undertaken using a hand hoe for preparing the soils and to open up holes to receive the seed when the soil is sufficiently moist. In this case, there is no conventional soil preparation (ploughing). The soil is only disturbed superficially by hoeing to eliminate the weeds and to reduce moisture loss due to evaporation.

Another practice is to broadcast bean seeds (*Phaseolus vulgaris L.*) in the regions where rainfall is strongly influenced by the Atlantic Ocean and characterized by regular rainfall. The crop seeds are hand broadcast along alleys that have been opened up previously in the native vegetation, grasses and bushes and which, after the seeding operation, will be cut down to give room for the crop. This constitutes a cultivation system without any previous soil preparation, where the native vegetation springs back to recover alongside the crop. After the harvest, the land will stay fallow for two or three years. This system is ecologically sound and forms part of the programme of the Government of Pernambuco State. It is called "Mata Viva" (living shrub) and has the objective of protecting the soil from erosion in the mountainous regions receiving abundant rainfall, thus conserving the soils and the natural resources of the environment.

In the Northern and North-eastern part of Brazil, the farming system, particularly the soil preparation for seeding, differs from that practised in other parts of the country due to the rains being more intensive. In the temperate regions with moderate rainfall, the crop is planted in the bottom of the furrow where there is more moisture available in the soil. This would also be ideal for the tropical region but because of the rainfall characteristics showing high intensity over short periods, this is not possible. The solution is to sow on the ridges (Kepner *et al.*, 1972).

Despite the well-known techniques of conservation agriculture to protect the soil, today in Brazil shifting agriculture is still practised. It is a primitive method to cultivate the soil which consists in cutting down the forest and then burning it to facilitate planting the crops. The area is then abandoned once it becomes unproductive and from there, the farmer leaves to look for new areas which have not yet been exploited. This type of "slash and burn" agriculture is common in the Northern (Amazonian) region and is known as migratory agriculture (Kitamura, 1982).

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OBJECTIVES OF SOIL PREPARATION

The objectives of soil preparation are based on the following principles (Mazuchowski and Derpsch, 1984):

- elimination of undesirable plants, reducing competition with the established crop;
- achievement of favourable conditions for sowing or for placing vegetative material into the soil, so allowing germination, emergence and good plant development;
- maintenance over the long term of fertility and productivity, preserving the soil organic matter and avoiding erosion;
- elimination of hard pans or compacted layers to increase water infiltration through the soil whilst avoiding erosion;
- incorporation and mixing of lime, fertilizers or agro-chemical products into the soil;
- incorporation of organic and agricultural residues;
- land levelling to facilitate better quality of work with machinery during sowing and up to the time of harvest.

The option chosen concerning the type of soil preparation depends on many factors and for each situation, particular decisions must be made at farm level. Each operation also involves particular time commitments depending upon the power source to be used, be this manual labour or animal traction (Table 10).

TABLE 10
Work rates per unit area needed to carry out a selection of agricultural tasks on the farm

Implements and tools used on the farm (animal traction and hand-operated)	Time required (hours/hectare)
Plough (animal traction)	20
Tined harrow (animal traction)	6
Disc harrow (animal traction)	4
One-row planter for beans (animal traction)	10
Bean planter (hand planter) "matraca"	16
One-row maize planter (animal traction)	6
Maize planter (hand planter) "matraca"	8
One-row rice planter (animal traction)	11
Rice seeder (hand seeder) "matraca"	18
"Planet" type seed-drill (animal traction)	8
"Planet" type cultivator (animal traction) + hand hoe	40
Hand hoe (for weeding)	80
Manual harvest of maize (40 sacks)	60
Manual harvest of beans (15 sacks)	80
Manual harvest of rice, reaping with a small hand sickle (35 sacks)	64
Manual threshing of beans with a wooden flail (15 sacks)	30
Manual threshing of rice with a wooden threshing table (35 sacks)	35

- When calculating the number of hours needed to prepare a hectare of land with mechanical power or animal traction, the parameters of working width, forward speed and total width of the working area must be considered. Equation (1) may be used to calculate the time needed for manoeuvres (Tm).

$$Tm = \frac{\frac{L}{l} \times t}{3\,600} \times f \qquad \text{(Equation 1)}$$

where:
Tm = time lost in manoeuvres (h/ha);
L = width of the area (m);
t = time needed for one turning (seconds)
l = working width of the implement (m)
f = factor $\left(\frac{100}{L}\right)$

- The effective time (h/ha) is calculated on the basis of Equation (2)

$$Te = \frac{10}{1 \times V} \qquad \text{(Equation 2)}$$

where:
Te = effective time (h/ha);
l = working width of the implement (m);
V = forward speed of the implement (km/h).

- The operational time (h/ha) is the sum of (Tm + Te) according to Equation (3).

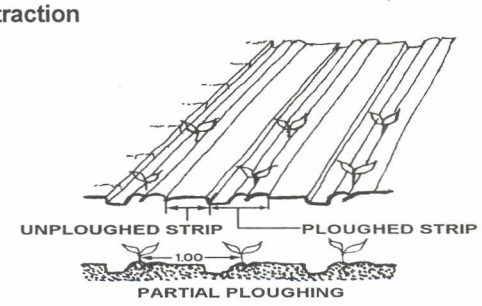
$$To = Tm + Te \qquad \text{(Equation 3)}$$

where:
To = operational time (h/ha);
Tm = time lost in manoeuvres (h/ha);
Te = effective working time (h/ha).

IMPLEMENTS FOR SOIL PREPARATION

- Animal drawn ploughs (mouldboards) are the most commonly used implements, together with tractor operated mouldboard or disc ploughs, although the working efficiency depends more on selection of the method of soil preparation than on selection of the type of implement (Figure 7). Ploughing in strips or bands is a method by which no more than 50 percent of the total land area is tilled. The unploughed part between two strips is used for rainwater collection and for redirecting the water towards the area being cropped

FIGURE 7
Method of ploughing in strips with animal traction



(Anjos *et al.*, 1988). Figure 8 shows the type of lifting share used, which is the same as that employed for harvesting groundnuts. Another method is to use a tractor-mounted reversible disc plough for strip ploughing the land for watermelon production under dryland conditions.

- Harrows are implements used to complete the work accomplished with the plough, breaking down the clods and levelling the soil after ploughing. They can be drawn by draught animals or operated with tractors. Some heavier models are often used as a soil preparation implement to replace the plough and operated by a tractor, but their continuous use tends to degrade the soil causing a compacted plough pan. The harrow components which disturb the soil are the tines (either rigid or flexible) or the discs (straight or serrated).

- Cultivators are used to scarify the soil surface with the objective of controlling weeds and improving the soil physical conditions (Figure 9). This hoeing operation may be considered as a type of minimum tillage when it is undertaken as a cultural operation either before sowing or after plant emergence.

- Ridgers are designed to open up furrows in the soil (Figure 10), either to serve as water channels, to orient or to mark out the crop rows for fertilizer distribution, or as a tillage operation to control weeds. It is quite possible to couple ridgers to seed-drills in order to simultaneously plant the seed and open up furrows for subsequent irrigation (Franz and Alonço, 1986).

- Seed-drills are single-purpose implements. The combined seed-drill/fertilizer applicator is a multipurpose tool for placing chosen amounts of seed and fertilizer at a predetermined depth and in a single operation. The animal powered and tractor-operated models distribute the

FIGURE 8
Groundnut lifting share used for ploughing in strips or bands

FIGURE 9
System for weeding (hoeing) with animal traction

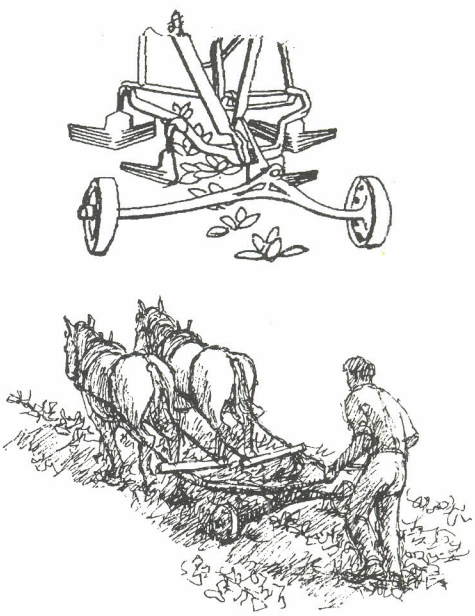
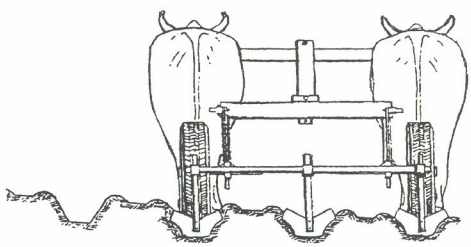


FIGURE 10
Ridging with animal traction



seeds and fertilizers in lines to make up the rows. The fertilizer applicator is located so as to apply the fertilizer parallel to and beneath the seed so that it does not affect the seed germination.

- Manual planters are tools used for planting into holes punched in the soil. They can be single-purpose for the distribution of seeds only or multipurpose for the placing of both seeds and fertilizers in a single operation (Figure 11). The fertilizer is placed in the hole to one side and lower than the seed itself. This avoids damaging the seed during the germination process. There are some specific models designed for particular crops, such as the planter for non-delinted cotton seed, planters for groundnut seed (which is very sensitive to mechanical damage), together with special accessories for sowing small graminaceous seed such as buffalo grass (*Cenchrus ciliaris L.*) (Anjos *et al.*, 1983) or for direct planting through stubble or other vegetative cover material (Almeida, 1993).

FIGURE 11
Manual planter for non-delinted cotton seed