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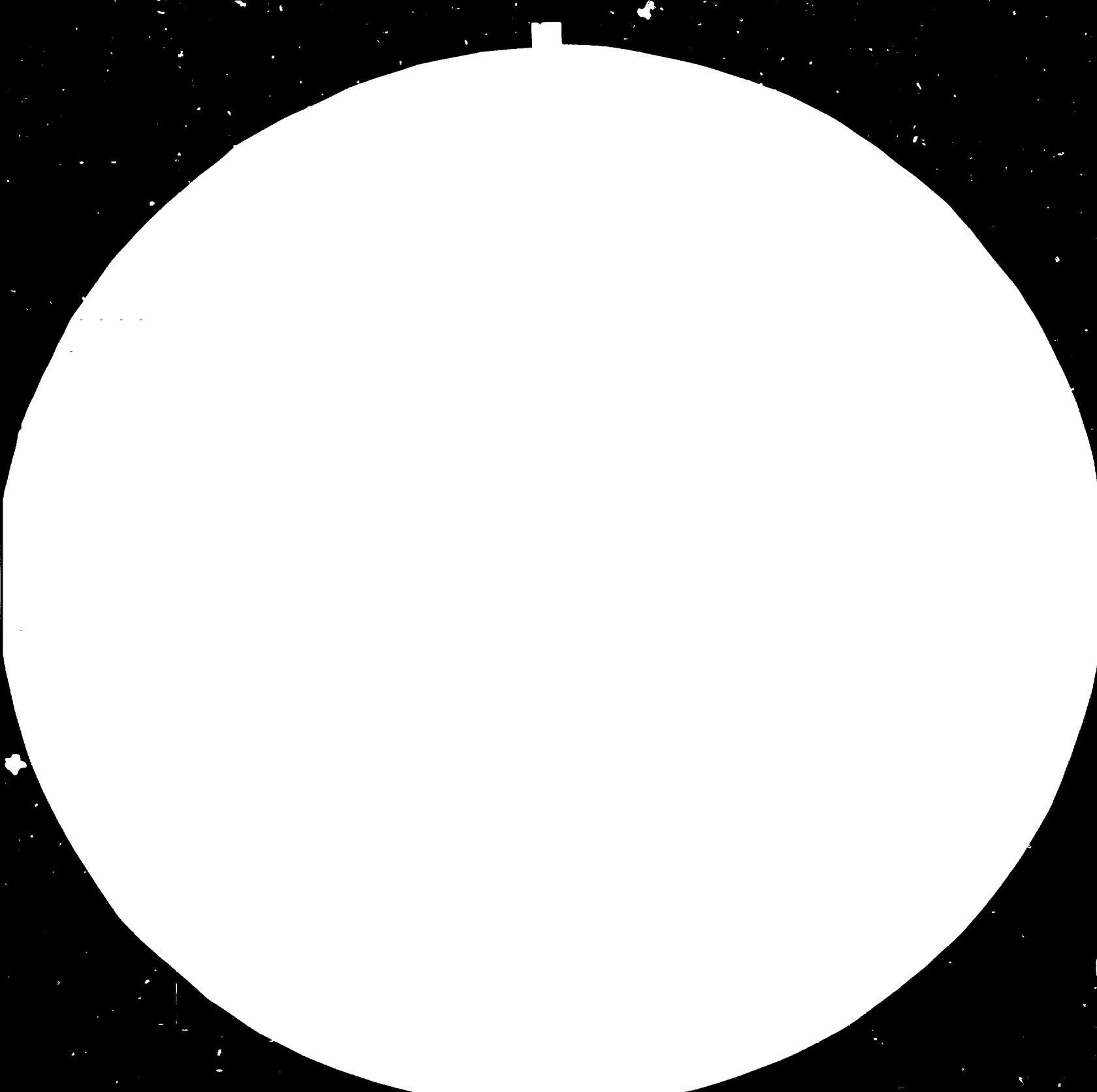

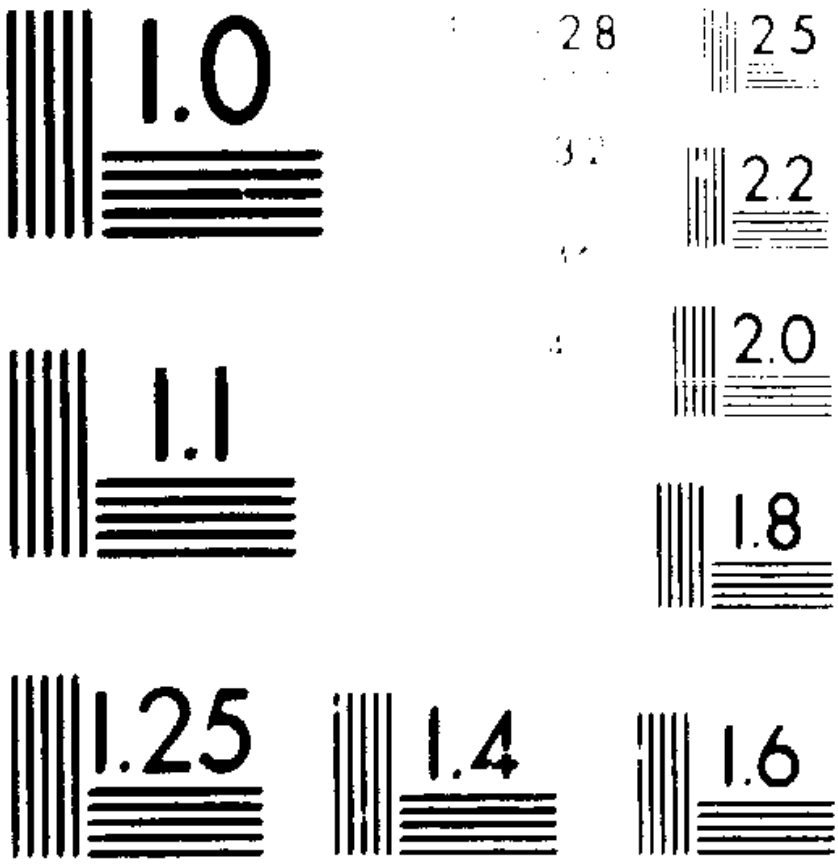

ANIMAL DRAWN AGRICULTURAL IMPLEMENTS.

- The Indian Experience.

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for

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CONTENTS

1	Introduction	1-1
2	The Indian Experience	2-1
	2.1 Indigenous Animal Drawn Implements	2-1
	2.2 Improved Agriculture Implements	2-11
	2.3 Manufacture of Agriculture Implements	2-26
	2.4 Raw Materials	2-28
	2.5 Government Policy	2-28
3	Structure of Production	3-1
4	Lessons from the Indian Experience	4-1
	4.1 Productivity	4-1
	4.2 Government Support	4-2
	4.3 Employment	4-6
	4.4 The Scale of Production	4-7

Annexures

List of Tables

2.1	Weight, Draft and the Furrow Size of the Different 'Desi' Ploughs	2-3
2.2	Draft and Furrow Size of Mould Board Ploughs	2-17
3.1	Product No. 1 - Chisel Plough	3-11
3.2	Product No. 2 - Helical Blade Puddler	3-12
3.3	Product No. 3 - West Land Leveller	3-13
3.4	Machinery and Equipment	3-14
3.5	Alternate Product Volume	3-16
3.6	Annual Sales	3-17
3.7	Working Capital	3-18
4.1	Indigenous and Improved Implements - Some Comparisons	4-1

List of Annexures

I Suggested Improved Implements

II Agencies Engaged in Research and Production of Improved Agricultural Implements

O:

1 Introduction

1 Introduction

Agricultural mechanisation has tended to be thought of mainly in term of tractorisation, to the extent that it tends to become a "monolithic technical model. This model derives from the constraints of industrial production, from the influence exerted by major firms which dominate the agriculture mechanisation market".

However, the structure of agricultural production differs widely between countries. Differing production operations and agricultural structures require the combined use of a totality of mechanical goods of different technological content. The most suitable forms of mechanisation depend not only on the agricultural system but are also affected by the state of industry and the economic and social systems. There has to be a compatibility between the products required by the agricultural sector and the products offered to it.

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1 UNIDO - Agricultural Machinery and Implements (Preliminary Study), March 1978.

Agricultural mechanisation is applied to a series of production operations, the most important being the clearing, development and cultivation of new land, irrigation, actual work of cultivation, transport, storage of production and farm activities. The production operations require a variety of tools ranging from simple hand tools, simple hand-or animal-drawn mechines, fairly sophisticated tractors and towed machines to specialised self powered machinery. Mechanisable forms of agriculture are limited in developing countries by reason of existing production structures, geographical constraints, agrarian structures, the relative cost of capital and labour and the solvency of farmers.

95 per cent of the peasantry in developing countries use either hand tools or animal power. To reduce drudgery and raise productivity animal drawn implements are the basic step towards agricultural mechanisation. They are the most appropriate in the bulk of agriculture in developing countries for being the most affordable and easy to use and maintain. They are also the most appropriate in terms of the capacity of the developing countries to produce indigenously.

The begining of mechanisation of Indian agriculture was made by the use of improved hand tools and improved animal drawn implements. Particular stress was laid on these in the first three five-years Plans and slowly more sophisticated implements were introduced from the Fourth Plan onwards.

India's approach was basically to see what the farmer was traditionally using and then to introduce improvements which would not mean a major change in the concepts and structure of existing farm practices, but would

a) raise productivity and increase output for a given amount of animal horse-power;

b) be easily understood, accepted and adopted by farmers;

c) be within the buying power of the bulk of farmers;

d) be produced with indigenous materials as far as possible.

2 The Indian Experience

2 The Indian Experience

2.1 Indigenous Animal Drawn Implements

India has a wide variety of agricultural implements in use all over the country. Before efforts were made to introduce improved/foreign implements, it was necessary that a comprehensive survey of existing agricultural implements in use be made. A country-wide survey of agricultural implements in use was carried out in 1954-57 by the Indian Council for Agricultural Research (ICAR)[1].

The survey listed around 140 types of hand and animal drawn implements widely used in India. Indigenous animal drawn implements most commonly in use being:

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1 Indian Council for Agricultural Research : Indigenous Agricultural Implements of India, All India Survey, 1960.

1 Wooden plough
2 Peg-tooth harrow
3 Spike tooth harrow
4 Blade harrow
5 Wetland harrow
6 Clod crusher
7 Leveller
8 Sowing device attachment to wooden plough
9 Hoes for interculture
10 Puddlers
11 Threshing roller
12 Bullock cart

These were almost entirely manufactured by village artisans. They vary in terms of design detail in different parts of the country, depending on the soil and climatic conditions of the area.

Ploughs: A plough is the primary implement used all over India. The 'desi' (indigenous) ploughs have almost a common design consisting of a shoe, a body, a handle and a beam. They differ mostly in size, depending upon the type of the soil and the size of the bullocks or buffaloes used in the particular area. The heaviest ploughs are found

in the black-cotton soil areas of India. The 'desi' plough is almost like a Western-style cultivator, both in design and action. All indigenous ploughs are almost similar in design, but vary considerably in size and weight to suit the prevailing soil types, ploughing conditions and the weights and heights of the draft animals in the locality. There are about 35 types of indigenous ploughs. The working draft varies from 27 to 143 kg. Table 2.1 gives an idea of the size and the draft of the 'desi' ploughs used in different stages. Their price ranges between US $ 15 - $ 30.

Table 2.1 - Weight, Draft and the Furrow Size of the Different 'Desi' Ploughs

Ploughs	Weight (kg.)	Length of Beam (m)	Average Draught (Kg.)	Horse Power Expended	Average size of furrow (cm)	
					Width	Depth
Bareilly	10.88	2.66	28.57	0.40	17.78	10.16
Pusa (Bihar)	15.42	2.50	27.66	0.43	25.40	17.78
Angul(Orissa)	10.88	2.15	47.17	0.73	27.94	15.42
Sabour (Bengal)	19.95	2.87	100.24	1.35	30.40	20.32
Patna	15.87	2.71	54.43	0.81	27.94	20.32
Kerala	23.58	3.32	134.26	1.87	30.40	20.32
Dohad (Bombay)	13.15	2.84	158.75	2.67	22.86	22.86
Coimbatore	37.00	3.53	328.00	1.71	27.94	22.00
Indore	57.00	3.15	403.50	1.71	22.00	26.00

The 'desi' plough makes a V-shaped furrow and, unlike a mould-board plough, does not turn over the soil. It is mostly made of hard-wood, e.g. 'babool' or 'kikar' (Acaica nilotica). The depth of ploughing is usually from 10 to 20 cm and the width from 13 to 18 cm. There are minor variations in design, weight, the length of the beam, et .

Most of the 'desi' ploughs are light in weight and can be carried either on the yoke of the bullocks, or on the shoulders by the farmers. The depth of the plough can be adjusted with a wedge provided in the body of the plough by adjusting the yoke either forward or backward on the beam. In Andhra Pradesh, a simple triangular plate is fixed in front of the body of the plough so that ridges and furrows can be made. This is an ingenious device to convert the 'desi' plough into a ridger. Since the 'desi' plough acts like a cultivator, repeated ploughings and cross ploughings are necessary to secure a good tilth. These ploughs are also used for making shallow furrows for depositing seeds, for intercultivation between the rows of crops and to harvest crops such as potatoes,

It can thus be seen that the 'desi' plough is a multi-purpose implement difficult to be replaced, unless more efficient multi-purpose improved implements are designed.

Harrows and Cultivators: It is mainly used as a secondary tillage implement to supplement the work of a plough for preparing the seed bed for crops and for covering the seeds after sowing. The object of harrowing is to obtain proper tilth of soil. The blade harrow and the toothed harrows are the most common, the former in clay soils and the latter in lighter or gravelly soils.

These are called 'bakhars' or 'guntakas'. Bakhar is a very common implement used in the Deccan. It is one of the best implements for primary tillage. The farmers use it for preparing the land and for sowing the seed. It consists of a steel blade of about 45 to 90 cm in length and 8 cm in width. It can cultivate the land to a depth of 9 to 10 cm. Even the dryland tillage is done with this implement by adding a wedge to it. If the soil is very dry, a man stands on the

implement to give it the weight. It can cover 0.8 to 1.6 hectares in a day because of its greater width The Lanka 'bakhar' used in the Vidarbha area has a blade even up to 1.5 m in length and is used after a few monsoon showers to kill young germinated weeds. The implement is worked cross-wise in the fields to achieve a better tilth. This is a very useful implement and costs only US $ 3 to 5.

The 'keni' or levelling 'karaha' consists of a flat blade 1 to 5 m long, with a vertical handle and two rings in the front for yoking the bullocks with ropes. This is probably the commonest implement used in soil conservation for making bunds and levelling the land. It costs US $ 10.

The indigenous implement for levelling, called 'patela' or 'sohaga', a flat log 1.8 to 2 m long which is dragged over the clods by bullocks. The driver usually stands on the log to put weight on it and hold it down. It costs US $ 5.

A land-leveller or 'jandra' is also used in some tracts. It consists of a plank of wood, about 1 to 1.5 m long, 12 cm and 2.5 cm thick. In those areas where bamboo is readily available, a ladder-shaped leveller made of bamboo is used. It costs US $ 3.

Puddlers: In paddy cultivation puddlers are used for levelling under water, they are very simplistic, are made of wood by the village craftsman and cost US $ 5-7 and are able to cover 1 acre a day with two bullocks and one man.

Sowing Devices: Many seed-sowing devices are attached to implements such as the 'desi' plough. They are commonly called 'nari' plough, 'tifan', 'argada' and other multi-type implements that are used in the Deccan. Tube or tubes are fixed to these implements and on the top of these a seeding-bowl, in which the seed is dropped, is fixed. The seeding-bowl has a number of holes in it. The construction of the holes is ingenious, with the result that the seed is dropped fairly evenly into the tubes and goes down to the tynes. There are several variations of this implement and the price ranges between US $

15-30. In some areas, which area considered backward agriculturally, broadcasting or the sowing of seed at random on the cultivated field is still prevalent but the majority of farmers now follow the practice of sowing in line and drilling the seed. Sowing in lines ensures the proper distribution and placing of seed, resulting in the uniform spacing of the plants, with a concomitant reduction inthe seed-rate. It helps the seed to germinate regularly, ensuring a better stand of the crop and also facilities interculture with bullock spearted hoes, thus reducing the cost of cultivation.

Interculture Implements: Most of the interculture in India is done with a hand tool called 'khurpi', which consists of a sharpedged triangular or sickle-shaped blade. Sometimes, weeding is done with a 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.

For hoeing line-sown crops with bullock power a light 'desi' plough is used in northern India. In the area between the Narmada river the Krishna river,

multitined bullock-operated hoes are used. They are known as 'doura' (Gunti), 'douri', 'dundia', and 'dulari'. These are the miniature forms of 'bakhars'. They cost US $ 8 - 15. When the plants are small, multi-tined hoes fixed to a single wooden body are also used in Andhra Pradesh and Northern Karnataka. The draft of these hoes is very light and sometimes two to four of them are pulled by one pair of bullocks. In the dry farming areas of Maharashtra, a 'doura' with a split blade is used.

Harvesting Implements: So far, the harvesting operation has not yielded to any mechanised tool. Almost universally the sickle is used for harvesting crops in India even though efforts have been made to introduce reapers, mowers, and even combined harvesting and threshers.

Threshing Implements: Threshing in the case of paddy, if the area is small, is done mostly by beating the harvested plants with sticks. In the case of other crops, it is done by treading the crop

with a team of animals. Animal drawn stone rollers, about 90 cm in length and 30 to 60 cm in diameter have also been used in many areas. They cost US $ 30-50.

Transport: The bullock cart is the most common form of transport used by Indian farmers.

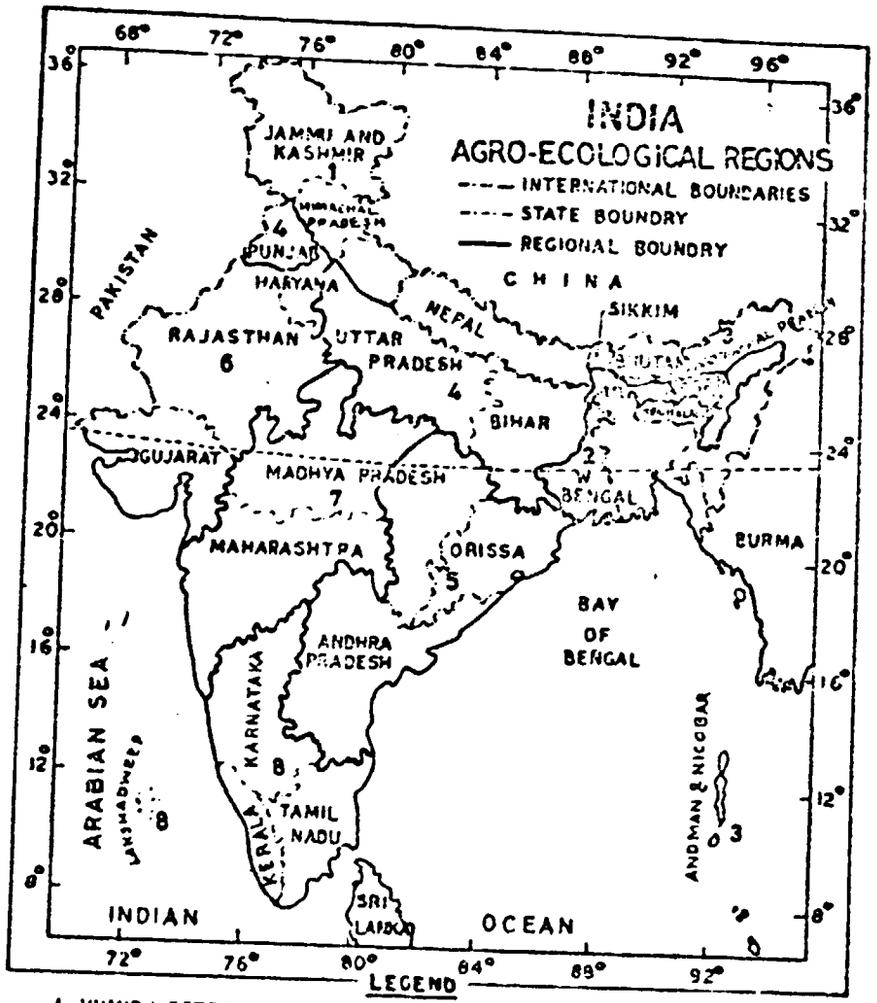
India has been divided into eight agro-ecological regions based on agriculture, ecological, climatic and soil conditions. These regions are:

1 Humid Western Himalayan Region
2 Humid Bengal-Assam Basin Region
3 Humid Eastern Himalayan Region and Bay Islands
4 Sub-Humid Sutlej - Ganga Alluvial Plains
5 Arid Western Plains
6 Semi-Arid Lava Plateaus and Central Highlands
7 Humid to Semi-Arid Western Ghats and Karnatka Plateau

These are shown in Figure 2.1.

As a result of entensive research a number of improved animal drawn implements have been successfully developed and introduced. These have been designed

Figure 2.1 - Agro-Ecological Regions



SOURCE - *Progress report on* AGRICULTURAL RESEARCH & EDUCATION OF ICAR SEPT, 1977

to improve effeciency of the operation and to reduce expenditure of time and animal power. The most commonly used improved implements are listed in Annexure I. They are classified by the agro-regions noted above.

2.2 Improved Agriculture Implements

Improved animal drawn agricultural implements have been developed for the following operations:

1 Seed bed preparation
2 Sowing
3 Inter-culture, weeding, earthing
4 Harvesting
5 Irrigation
6 Post Harvest Operation
7 Transport

The survey[1] undertaken by ICAR broughtout a

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1 Ibid - Page 2-1.

number of important points for the development and improvement of agricultural implements:

1 Reduction in Types: Although there is a very large range of implements in use and they differ considerably in detail, the basic types are comparatively few, and their number should be reduced for standardisation purposes.

2 Standardisation: There is no standardisation of shapes and sizes of parts. Research in improvement of implements must work towards standardisation of shapes, sizes and components, so that they can be manufactured on a mass scale so as to be readily available to the cultivators.

3 Simplicity of Construction: The implements should be simple in construction sothat they canbe operated by illiterate farmers, and be manufactured/repaired by village artisans.

4 Reasonable Cost: The prices of implements should be within the reach of the ordinary farmer. There must be a balance between cost and effeciency.

5 Weight Reduction: The implements should be light, so that they can be transported from the village to the field and the draft of the implements should be suitable for the types of animals that are used in particular areas.

6 Use of Local Materials: In designing the implements, local materials should be used as far as possible.

7 Superior Design: Promising types of foreign implements should be tried out under various soil and climatic conditions in different regions of the country with a view to evolving successful designs incorporating the desirable features of the foreign and indigenous implements which are useful.

8 Ease of Repair: The implements should be capable of being repaired by the farmer with the help of the local village artisans.

The purpose of the improvement would be to increase the efficiency and ease of operation of the implements, so as to increase the output from the

use of a given amount of animal energy and raise productivity of labour and land.

To achieve this effectively the Indian Council of Agricultural Research (ICAP) has established one research-cum-training centre in each state of the country. The object is to improve the indigenous implements, to design new implements and to test them in the field upto the prototype level. After the implements have been proved tobe useful, the prototype can be given to the manufactures both in the public as well as the private sectors.

The following improved implements have been most successfully introduced:

1 Seedbed preparation

a Mould board plough
b Disc harrow 6 disc
c Patela harrow
d Paddy puddler
e Clod crusher
f Peg tooth harrow
g Land leveller
h Bund former
i Buck scraper
j Levelling board

2 Sowing

a Seed-cum-fertiliser drill
b Seeding and fertiliser attachment for indigenous plough
c Maize planter
d Potato planter
e Sugarcane planter
f Groundnut planter
g Jute seed drill

3 Inter-culture, Weeding, Earthing

a 3-5 tined cultivator
b Ridger
c Improved bakhar (narrow)

4 Irrigation

a Animal drawn duplex pump
b Persian wheel

5 Harvesting

a Potato digger
b Groundnut digger
c Reaper

6 Post Harvest Operations

a Chaff cutter
b Sugarcane crusher
c Olpad thresher

7 Transport

a Improved bullock cart

Figures 2.2 and 2.3 show some of the improved annual drawn agricultural implements.

Ploughs: A mouldboard plough consists of a share and a mouldboard of steel. This is probably one of the first implements to be introduced into India from foreign countries. It differs in action from the 'desi' plough in ploughing a square furrow and in inverting the soil either completely or partially, depending on the curvature given to the mouldboard. For a proper functioning of the mouldboard ploughs, the provision of an adequate vertical and horizontal suction to the share tip is necessary. In the case of long-beam ploughs, the beam and the handle are made of wood, whereas in the case of a short-beam plough, the complete implement is made of metal. Where it is necessary to have a one-way ploughing, the turnwrest type of ploughs are used. It is being adopted where green-

Figure 2.2 - Some Improved Agricultural Implements

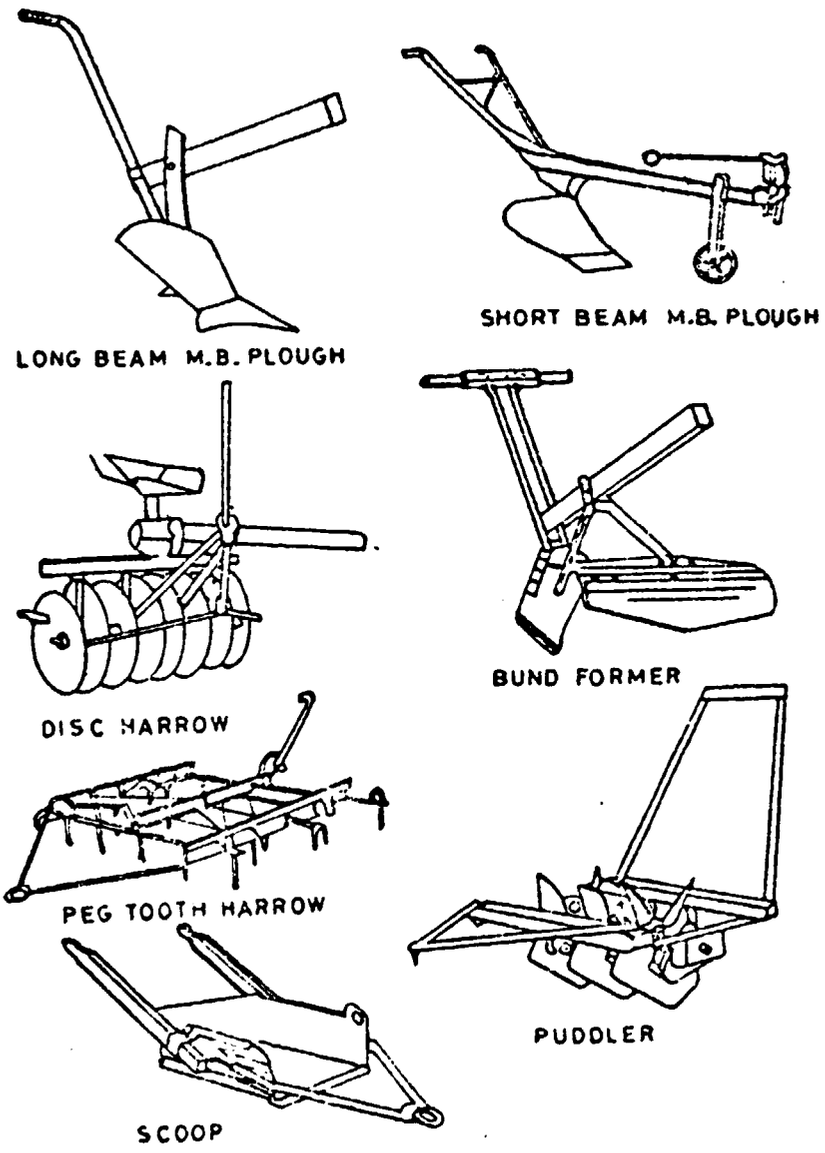
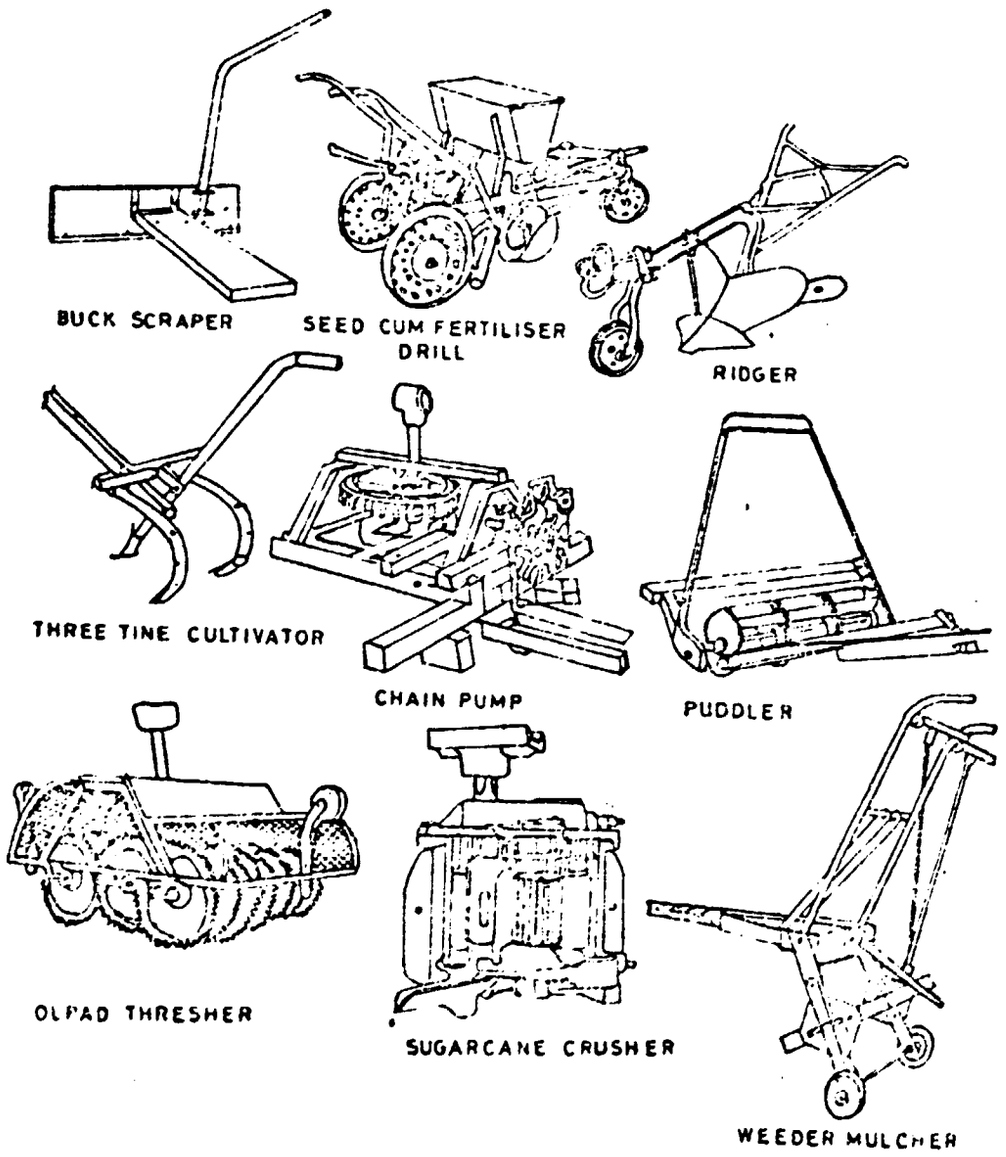


Figure 2.3 - Some Improved Agricultural Implements



manuring crops or surface vegetation have to be buried to hasten decomposition. Heavy mouldboard ploughs require sturdier animals, and sometimes two or three pairs of bullocks are used. They are also employed for the eradication of deep-rooted weeds. The turnwrest type of mouldboard ploughs are very efficient. For lighter ploughing, the beam-type ploughs are used. The shares of the lighter ploughs should be made of steel instead of cast iron. The mouldboard plough in common use cuts furrow slices varying from 12 to 23 cm in width. Typical figures in respect of their relative performances are given below:

Table 2.2 - Draft and Furrow Size of Mould Board Ploughs

Width of the plough (cm)	17.78	16.31 (nominal)	10.41 (nominal)
Width of the furrow cut (cm)	17.78	13.34 to 16.31	9.16 to 10.43
Depth of the cut (cm)	12.70	12.70	12.70
Draught in dry sandy loam at Delhi (kg.)	123.37	127.00	118.00
Draught per square inch of furrow cross-section	0.562	0.632	0.913
Speed of bullocks (km)	3	1.673	1.737

Ridger Ploughs: These ploughs have double mould-boards. There are three sizes - the light, the medium and the heavy. The heavy ones are used for the cultivation of sugarcane and the lighter ones for the cultivation of vegetables and other crops. Some of the improved ridger ploughs have an arrangement for adjusting the width of the furrow by changing the distance between the two mouldboards. For vegetables orchards, and for farmers who grow sugarcane, potatoes, etc. the possession of the ridger is a must.

Improved 'bakhars' and 'guntkas' have also been, lately, manufactured. The improvements relate to the changing of the blades, the adjustment of the depth and the attachments that may be needed in the case of these harrows. The length of the blade is from 61 to 152 cm and, therefore, this implement can cover quite a large area in a day. Steel 'bakhars' and 'guntkars' are nowadays mass-manufactured in India. Their prices range from US $4 -5.5.

Some of the harrows used in foreign countries, e.g. the spike-tooth harrow, peg-tooth harrow, the spring-tooth harrow, and disc harrows have also been

introduced. Out of all these harrows, the disc harrows have proved to be very popular.

The improved 'bata' or 'batela' is now mass-manufactured and has become quite popular. It is called 'Singh Patela'. It is provided with a series of pointed hooks made of 10 mm to 15 mm rods of mild steel. These hooks help to crush the clods and to collect the weeds. This implement costs US $ 10-15 depending on the length of the wooden blade and the number of steel rods used.

Bund Formers: For soil conservation, sometimes it is necessary to make temporary low-level bunds, 18 to 22 cm high. These bunds last for one agricultural season. They either get washed away or are obliterated by subsequent ploughing and cultivation. For forming such bunds an implement, called bund-former was originally developed at the Tamil Nadu Agricultural University, Coimbatore. The implement consist of two concave blades, 90 to 150 cm long and 10 to 15 cm wide, joined across conversly. This implement is to be

worked in a well-ploughed and harrowed field just for collecting the soil and not for digging it. Its job is to collect the soil at the wider front and deposit it in the form of a ridge or a low bund behind. There are three sizes of bund-formers with blades 9 and 12 cm long. Recently, a bigger bund-former (called 'sara-making' machine) has also been designed. A wooden bund-former that would cost less than US $ 2.00 has been prepared at the Agricultural Workshop at Nilokheri (Haryana). Its blades are made of 'babool' wood and its construction is so simple that the implement can be easily made by village carpenter. If the wood is made available by the farmer, the implement would cost less than US $ 1.00.

Seed Sowing Devices: Quite a large number of improved seed-drills, both automatic and hand-operated, have been designed. Among the hand-operated ones, a copy of the wooden 'tifan' has been made in Uttar Pradesh. It is made of mild

steel with an arrangement for changing the distance between the tynes. The price of such a seed drill is US $ 4.

Several improved seed drills have been developed ranging from the simple single row seed drill which costs US $ 18 to the multicrop seed drill which costs US $ 60. Efforts have been made to combine the simultaneous feeding of fertiliser with the dropping of the seed. The Ganga seed-cum-fertiliser drill is a multicrop drill which costs around US $ 40 and can be manufactured by the village artisan.

Specialised drills have been developed for planting certain crops like maize, potato, sugarcane, groundnut and jute. These cost between US $ 90-150.

The seed-drills need a lot of skill in operation. It is necessary, particularly in respect of automatic seed-drills, to calibrate them before sowing, so as to know the exact seed-rate that it will drop. The seed-drills, are to be calibrated separately for each type of crop because of the differences in the shape, size and weight of the seeds of different crops.

Similarly, in the case of the automatic seed-drills proper care has to be exercised in choosing the soil-working parts, such as the tyne. If the soil is hard, strong straight tynes with sharp edges in front should be selected. If the soil is soft, the disc shovels may be preferred. Some other important factors which a designer of a seed-drill and its user have to keep in mind are the covering of the seeds, the pressing of the soil slightly over the seeds, the transport facilities for these drills, etc.

Harvesting Implements: Animal drawn harvesting implements have also been developed. A reaper consisting of one reciprocating type cutter bar, swath divider, platform for holding the harvested crops, gear box, pitman wheel and land wheel has been developed at the Punjab Agricultural University. It is used for wheat, rice and barley and its sale price is US $ 310.

There is a simple potato digger which costs US $ 9. It consists of a 540 mm wide curved blade with lifter rods attached to it at the rear. It loosens

the soil. The loose material passes over the lifter rods leaving potatoes on the field. A groundnut-cum-potato digger which has two attachments costs around US $ 95.

Threshing Implements: No other thresher has become so popular as the 'Olpad Thresher', which consists of 14 to 21 serrated discs fixed on a rectangular wooden frame in three lines. A seat is provided for the driver and also a guard. The implement is pulled by a pair of bullocks and worked on the harvested material which is spread thickly on the threshing-floor. Threshing with this thresher is not only cheaper but is also quicker and more efficient than treading by bullocks and by using other methods.

Other Implements: With the growing of improved varieties of cane, a three-roller cast-iron crusher operated either by bullock power or by engine power has been put into the market. It has greater crushing efficiency and, therefore,

farmers are either buying such crushers or taking them on rent during the season.

Another set of implements and machinery used for preparing the land for irrigation consists of a float, a drag, and a leveller. The float consists of a rectangular wooden frame to which cross plates are fixed. The last cross plate is inclined in the direction of the movement of the float. The float is mostly used where the land has already been levelled fairly well and where it is necessary to level it further in order that the irrigation water flows over the land uniformly and does not accumulate in depressions. A drag is an implement which throws the soil in one direction, making the channels flat-bottomed. The leveller is similar to the 'keni', but is longer for the uniform levelling of seedbeds.

One of the major difficulties of the farmers is the raising of water from the wells, tanks or canals to irrigate the fields. Since time immemorial, various indigenous devices have been used for lifting water, the simplest ones being a dhenkli, a Persian-wheel, a mhot, a pikota, and dons.

The Persian wheels, or rahats, are extremely common in Northern India, Uttar Pradesh, Rajasthan, Punjab and Northern Maharashtra. Wherever the water level is between 4.5 and 9 meters below the ground level, they are popular. A Persian-wheel consists of an endless chain and mild steel flats to which are fixed galvanized-iron buckets. The endless chain rotates on a large cage wheel. The axle of the cage wheel is geared with a pinion to the big gear, which is rotated by a pair of bullocks or a camel walking in a circular track. The modern Persian-wheels are fitted with ball-bearings, and several improved types have been produced. Mention may be made of 'Mayadas' double Persian-wheel which has found some favour in Uttar Pradesh. The average draft of a Persian wheel working up to a depth of about 4 meters comes to 59 Kg. and that working up to a depth of 7.3 m is 86.1 Kg. The discharge ranges from 8200 to 22700 litres per hour and the effieiency ranges from 34 to 44 per cent.

The improved bullock cart is another very important improvement in this field. It is the

main form of transport in all agricultural and village operations and its improvement has meant a lot of saving in terms of time and animal power.

The population of manual and animal drawn agricultural implements (indigenous and improved) in India in 1977 is estimated[1] as follows:

Implement	Nos. (In 000)
Ploughs	
- Wooden	40,766
- Iron	6,258
Blade Harrow or Bhakar or Guntuka	11,497
Wet Land Puddler	2,056
Earth Levellers & Scrapers	8,728
Seed Drills	4,822
Maize Shallers	226
Bullock Carts	12,742
Sugarcane Crushers (Animal Drawn)	673

2.3 Manufacture of Agriculture Implements

The manufacture of indigenous agricultural implements in India has traditionally been the work of

1 Directorate of Economics and Statistics, Ministry of Agriculture - 12th Linestock Census 1977.

village artisans. Even though today there are a large number of organised units and government agencies involved in manufacturing implements, the village blacksmiths still continue to play an important role in the fabrication and repair of a wide range of simple implements, both indigenous and improved. The bulk of the farmers depend on the village blacksmiths for repair services because of easy accessability and cheap service.

Today small scale industries and village artisans together contribute a major portion of the production of improved agricultural implements in the country. In 1971 there were 97 small scale units registered[1] who were engaged in the manufacture of improved agricultural implements. In addition there is a much larger number of unregistered small units. Production of animal drawn agricultural implements is reserved for the small scale sector.

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1 The term 'registered' means that they are registered with the State Director of Industries, and have a maximum investment of US $ 200,000 in plant and machinery.

The 97 registered factories had an invested capital of US $ 12 million, an annual output of US $ 20 million and a value added of US $ 5 million in 1971. This is, however, only a small part of the total output of agricultural implements as the majority is still produced in the household and tiny sector, by village artisans. In 1981, there were about 150 registered units producing agricultural implements of all types.

2.4 Raw Materials

The main raw materials used in the manufacture of animal drawn implements are:

1. Wood - usually the ones locally available
2. Mild steel - usually scrap steel
3. Carbon steel
4. High carbon steel
5. Cast iron
6. Stone

2.5 Government Policy

The basic objective of government policy in this field has been to raise productivity of land

and agricultural labour by improving the efficiency of implements used. Though there has been an introduction of power driven implements in Indian agriculture, animal drawn implements are still the most fruitful area for affecting improvements as they are accessable to the majority of farmers.

There are several government sponsored agencies engaged in research into improvement and development of agricultural implements. These range from agricultural universities to institutes of agricultural engineering. The apex body is the Indian Council for Agricultural Research. The important ones are listed in Annexure II.

As a large number of implements are still manufactured, and almost all are maintained, by the village blacksmiths and carpenters, the government has established 40 agricultural wings attached to rural extension - training centres for training the sons of blacksmiths and carpenters in repairing and maintaining improved agricultural implements.

The trained artisans are also given loans for purchasing improved tools which they can use in the villages.

An agro-industries corporation has been established in each state, with the financial assistance of the Central Ministry of Agriculture. In five states, namely, Haryana, Tamil Nadu, Uttar Pradesh, Maharashtra and Rajasthan, factories to manufacture agricultural implements have been established under these corporations, in the public sector.

The government has also undertaken the standardisation of improved agricultural implements, so that their main parts may be inter-changed and repairs can be facilitated.

Government sponsored institutes are also responsible for testing newly designed implements and, once they have proved successful and been manufactured, introducing them to the farmers on a large scale

3 Structure of Production

3 Structure of Production

As stated earlier, traditionally the manufacture of agricultural implements has been undertaken at the village level. The village blacksmith and the village carpenter between them have been able to put together the simple implements needed by the farmers for tillage and sowing. These artisans though lacking in tools were certainly not deficient in skills and the manufacture of agricultural implements of the traditional type was possible by procuring a few pieces of steel and a small number of fasteners from nearby towns. The bulk of indigenous agricultural implements are still manufactured at this level.

With the introduction of improved implements, the structure of production changed. Most of these implements involved a welded construction, at other places wooden grips were fixed to the steel frame with bolts and nuts. The village artisans, though familiar with fastners, did not have the means of drilling holes, particularly, in the thicker steel sections. Welding was often not possible as most villages have no electricity. The village artisans adjusted himself to the new situation in two ways. First,

the implement designs were modified so as to replace welded joints by overlapping joints secured with traditional fastners and by evolving some new hand operated tools suitable for carrying out the operations now required.

The main source of supply of the improved tools is, however, the small sector with units located mainly in small towns, frequently at block headquarters. These units are also technologically simple and have the advantage of low capital investment. Simple machines like power operated drills and shapers enables them to form components quickly and efficiently and the availability of electricity also enables them to undertake welding and thus fabricate the implements with greater ease. The location of these units in urban areas also provided them with an infrastructural support in the sense that timber, nuts, bolts, rivets and common steel sections, such as rounds and flats, are generally available with local dealers. This makes for easier and often cheaper procurement of raw materials.

Thus, there are two levels at which the production of improved agricultural implements is carried out. At the village level production has the advantage of use of local

timber which leads to reduced costs. Overheads are low and there is no expenditure on electricity, etc. Even though wages are lower, labour costs tend to be higher than in the organised sector as most of the work has to be done manually. The existence of this sector is vital to the village economy as not only does it supply the traditional implements suited to local conditions but is also responsible for the maintenance and repair of improved implements which may have been produced in the organised sector.

The organised small scale sector has advantages of better technology and higher volume of production. This means cheaper purchase of raw material. The use of welding sets also reduce costs and allows for improvements in design. The quality is better due to superior machining facilities. These units, however, have to be located in small towns which have skilled artisans capable of handling the machines, easy access to bought out components, as well as enough entrepreneurship to set up a unit for the manufacture of engineering products.

In India the production of agricultural implements in the organised sector is exclusively reserved for the

small scale sector. In the broader prospective it has to be considered whether the setting up a larger manufacturing facility with substantially greater capital investment would or would not play a role in either making better implements or reducing their cost of production. The Indian experience appears to point in the opposite direction. Even the improved agricultural implements do not present the sort of engineering problems which need sophisticated machinery. Neither does mass production appear to offer any particular advantage for non-power driven simple implements, whether conventional or improved, as they vary from region to region depending upon soil, cropping and climatic conditions.

To sustain a viable small scale sector, it is necessary that training facilities for artisans, credit for the purchase of equipment and raw materials are available. Above all, it is necessary to inculcate a sense of entrepreneurship before it would be possible to produce the implements efficiently and in adequate quantity.

As the village artisan is crucial to the successful use of improved implements, the inputs of training and credit are also required at this level to support the production at the higher level.

As noted in chapter 2, a fairly comprehensive range of improved agricultural implements have been developed in India. For illustrative purposes, three implements which are in common use and which can be manufactured at both the industry levels described above, have been selected. The profile of a typical manufacturing unit has been described for the manufacture of these three implements at the village level and at the level of an organised small industrial unit.

The three implements selected are:

1 Chisel plough;

2 Helical Blade Puddler; and

3 Wet Land Leveller.

Chisel Plough

The chisel plough consists of a curved chisel like tyne of 390 mm radius of curvature and 30 mm thick. It is rigidly held in a frame which is provided with a handle and a shaft pole fixture. It rips its way through the soil with the narrow chisel edge. As the soil is broken by slicing, it is not inverted or pulverized. The hard layer

of soil just below the regular ploughing depth is broken up and the rain water infiltrates down.

Specifications

Power source	:	Animal
Overall length	:	1150 mm (without beam)
Overall width	:	350 mm
Overall height	:	1175 mm
Total weight	:	45 kg.
Width of ploughing	:	40 mm
Depth of ploughing	:	300 mm
Suitability for soil	:	Clay soil
Actual field capacity	:	0.2 ha/hr (900 mm row spacing)
Draft	:	120 kg.
Power requirement	:	A pair of bullocks
Labour requirement	:	One person to operate the plough.

Figure 3.1 presents a schematic drawing of the Chisel Plough.

Helical Blade Puddler

Five numbers of helical blades made of mild steel are fixed in a skew shape and mounted on a wooden frame

having wooden bearings such that the blades rotate freely. A handle and a pole shaft are provided. Due to the helical shape of the blade, there will be a continuous contact between the blades and the soil which gives a uniform load on the neck of the bullocks. Thereby the conventional undersirable intermitant load is avoided. After ploughing the land with a country plough, the implement can be used to puddle the soil. It operates at a depth of 8-10 cm. The helical geometry facilities better churning and slicing of the soil as required for puddling purposes.

Specifications

Power source	:	Animal
Overall length	:	3500 mm
Overall width	:	725 mm
Overall height	:	400 mm
Total weight	:	45 kg.
Depth of puddling	:	100 mm
Suitability for Crop	:	Rice
Actual Output	:	0.075 ha/hr.
Draft	:	50 kg.
Power requirement	:	A pair of bullocks
Labour requirement	:	One person to operate the puddler

Figure 3.2 presents a schematic drawing of the Helical Blade Puddler.

Wet Land Leveller

The wet land leveller consists of a 2750 mm long, 300 mm wide and 30 mm thick wooden plank and two smaller wooden wings of 700 mm length, 150 mm height and 30 mm thickness attached at the end of the plank to carry the excess puddled soil forward. The unit is pulled by a pair of bullocks and has arrangements for an operator to stand on it during the operation. The implement is very useful for levelling the puddled field for efficient water management practices required in high yielding paddy varieties.

Specifications

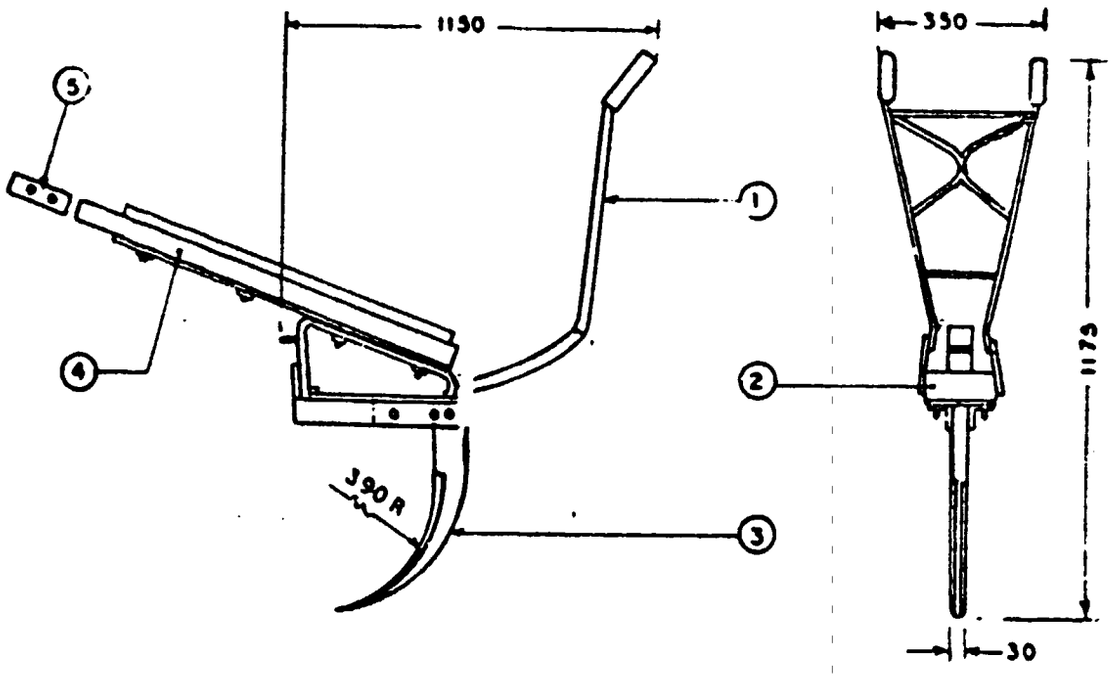
Power source	:	Animal
Overall length	:	2750 mm
Overall width	:	700 mm
Overall height	:	150 mm
Total weight	:	33 kg.
Width of coverage	:	2750 mm
Suitability of crop	:	Rice

Draft	:	110 kg.
Suitability of soil	:	Puddled soil
Actual field capacity	:	0.55 ha/hour
Power requirement	:	A pair of bullocks
Labour requirement	:	One person to operate the leveller.

Figure 3.3 presents a schematic drawing of the Wet Land Leveller.

The profiles of the manufacturing units presented at the two industry levels assume that the same unit will be producing all the three implements. This assumption is made for purely illustrative purposes. In fact, the unit may manufacture only a single implement or sometimes more than three. For example, the village artisans usually tends to manufacture, in addition to the improved implements, the whole range of the traditional implements of his area and is also engaged in the repair and maintenance of all the implements in his village. Similarly, the small scale industrial units may specialise in the production of only one of the improved agricultural implements. The product mix depends on the area they serve and whether the implements are fairly standardised or very greatly in detail from area to area.

Figure 3.1 - Chisel Plough



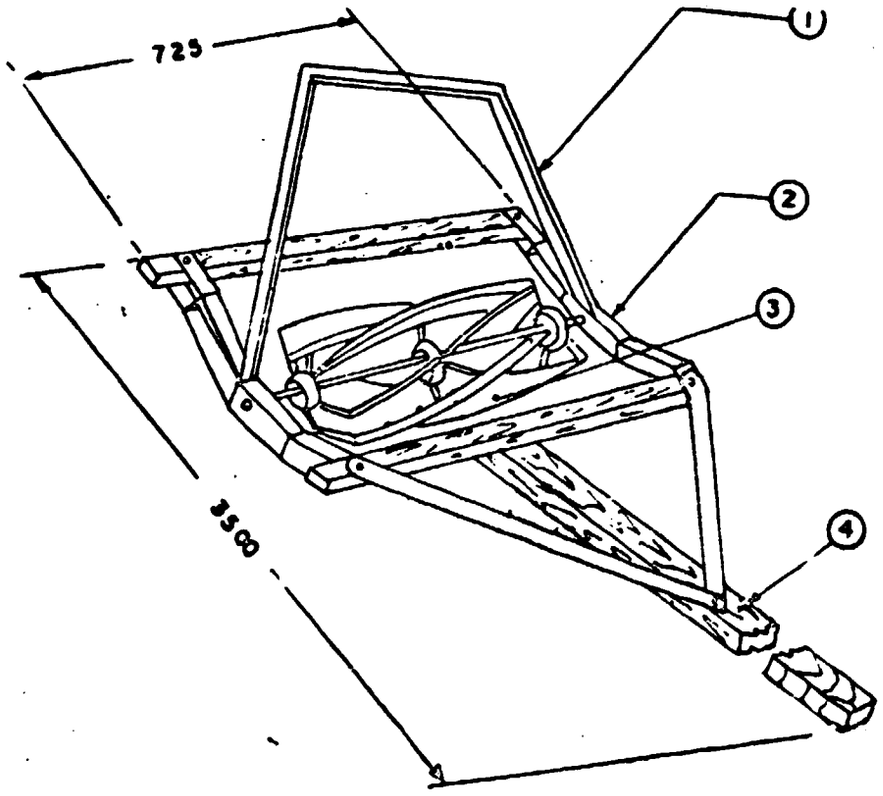
ELEVATION

REAR VIEW

(1) HANDLE
(2) FRAME
(3) CURVED CHISEL
(4) WOODEN BEAM
(5) HOLES FOR HITCHING

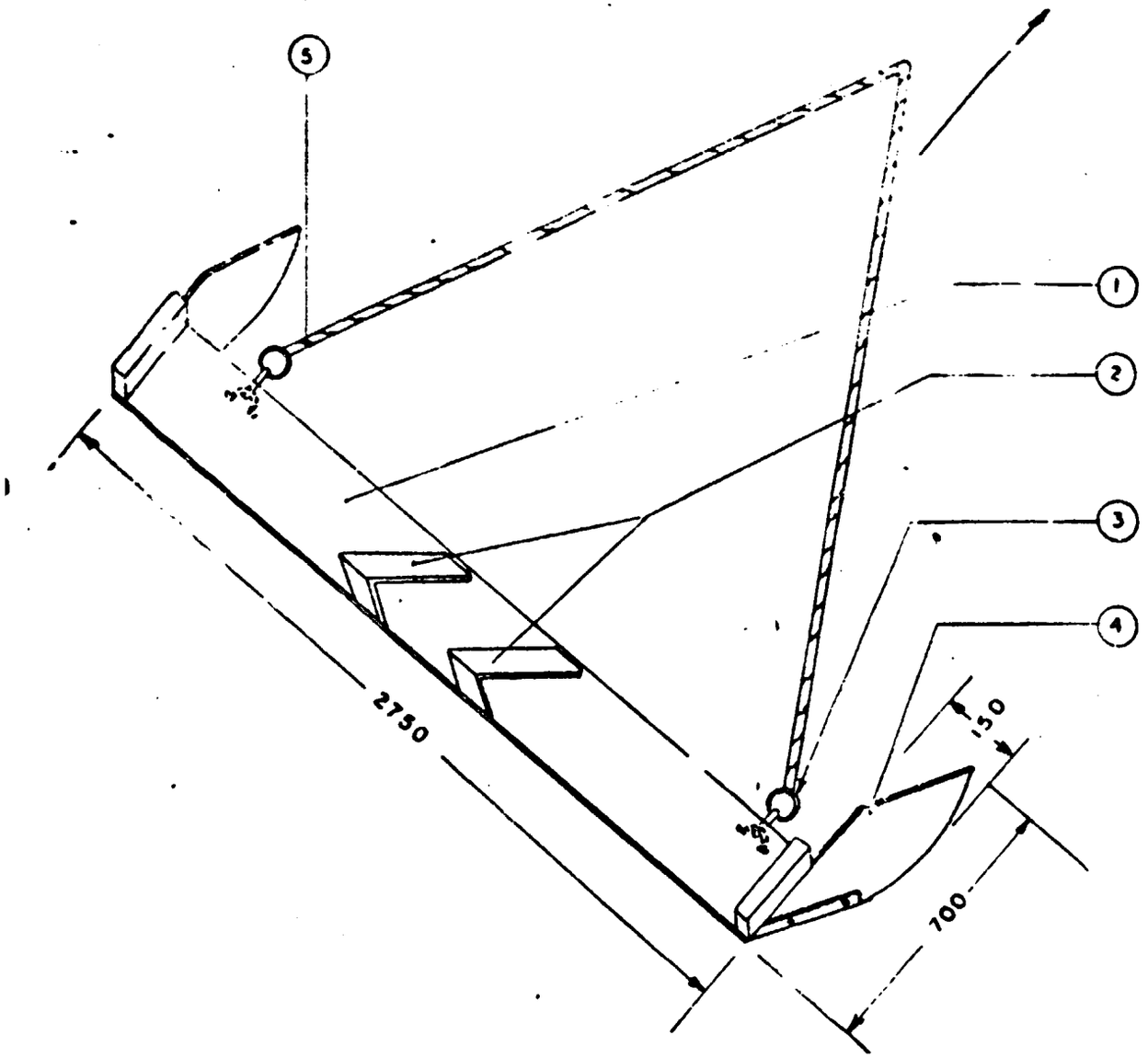
ALL DIMENSIONS IN mm

Figure 3.2 - Helical Blade Puddler



(1) HANDLE
(2) WOODEN FRAME
(3) HELICAL BLADE
(4) POLE SHAFT
ALL DIMENSIONS IN mm

Figure 3.3 - Wet Land Leveller



(1) WOODEN PLANK
(2) STAND FOR OPERATOR
(3) HOOK
(4) WOODEN WINGS
(5) HITCHING ROPE
ALL DIMENSIONS IN mm

Tables 3.1, 3.2 and 3.3 present the materials specifications of the three implements. Table 3.4 gives an outline of the capital investment required by the two levels of manufacturing units. It does not account for fixed capital investment in land and buildings. At the village level (Industry Level I) the manufacturing unit producing these three implements would require a capital investment of around US $ 80 in machinery and equipment while the small industrial unit (Industry Level II) would require a capital investment of US $ 24,000 in machinery and equipment. (Details of the machinery and equipment required at both the industry levels are given in Table 3.5).

The working capital requirements are estimated at US $ 250 for Industry Level I (village level) and US $ 27,000 for Industry Level II (small scale sector). These estimates are based on the currently prevalent price for these implements and the annual production levels described in Table 3.6.

Table 3.1 - Product No.1 - Chisel Plough

1 Product Specification

Product	Specifications
Chisel plough	Weight 45 kgs., single tyne, braced steel frame with wooden hitching beam.

2 Material Specification

Major Implement Components	Specifications	Shape/ Size	Remarks
Implement handle	Mild steel (SAE 1010)	Flat	Readily available at nearest town.
Main frame	Wood	Scantling	Local wood to be used.
Curved chisel	Carbon steel (SAE 1070)	Round bar	Available at nearest major city.
Wooden beam	Wood	Sleeper	Suitable local wood
Rivets	Mild steel	Bought out as standard	Available at nearest major city.
Nuts and bolts	Mild steel	Bought out as standard	Available at nearest major city.

Table 3.2 - Product No.2 - Helical Blade Puddler

1 Product Specifications

Product	Specifications
Helical Blade Puddler	Weight 45 kgs. five helical blades, mounted on wooden frame, A handle and pole shaft.

2 Material Specifications

Major Implement Components	Specifications	Shape/ Size	Remarks
Implement handle	Mild steel	Flat	Readily available at nearest town
Wooden frame	Wood	Scantling	Local wood to be used.
Helical blade	Mild steel	Flat	Available at nearest major city.
Pole shafts	Wood	Sleeper	Local wood to be used
Wooden Bearings	Wood	Round	Hard wood to be used
Nuts and bolts	Mild steel	Bought out as standard	Available at nearest major city.

Table 3.3 - Product No.3 - Nest Land Leveller

1 Product Specification

Product	Specifications
Nest Land Leveller	Weight 33 kgs., a thick wooden plank and two smaller wooden wings attached at the end of plank.

2 Material Specifications

Major Implement Components	Specifications	Shape/ Size	Remarks
Main wooden plank	Wood	Plank	Suitable local hard wood to be used.
Wooden wings	Wood	Plank	Suitable hard wood to be used available locally.
Stand for operators	Wood	Plank	Local wood to be used
Hook	Mild steel	Round bar	Available at nearest town.
Hitching rope	Jute	-	Available at nearest town.
Bolts and nuts	Mild steel	Bought out	Available at nearest major city
Nails	Mild steel	Bought out	Available at nearest town.

Table 3.4 - Machinery and Equipment

Industry Level I			Industry Level II		
Description	No.	Estimated Cost (US $)	Description	No.	Estimated Cost (US $)
Black Smithy Shop			**Machine Shop**		
1. Anvil	29		1. Centre Lathe Pulley driver with accessories for screw cutting.	2	1,765
2. Hammer Heavy	4				
3. Hammer Light	2				
4. Fuller-set	21				
5. Heart-Earthern	6		2. Pillar type Drilling machine with twist drills	3	880
6. Bellows	18				
Carpentary Shop			3. Grinding machine double headed	3	1,200
1. Awl	6		4. Shaper	1	2,000
2. Hatchet	4				
3. Saw-large	9		5. Hack Saw, reciprocating type.	2	590
4. Saw-small	3				
5. Planes	4				
6. Chisel-set	5		6. Arc Welding Equipment, transformer type.	2	880
7. Hammer	2				
8. Wood drill & bow	4				
9. Drill bits-set	2		7. Guages & Tools	12	175
10. Honing Stone	1				
Total	80				

Industry Level I			Industry Level II		
Description	No.	Estimated Costs (US $)	Description	No.	Estimated Cost (US $)
			Smith Shop		
			8. Anvil	6	60
			9. Smith's hearth with motorised blower.	3	175
			10. Water quenching tank	3	25
			11. Hammer set	5	25
			12. Fuller set	5	25
			13. Misc Smiths tools, tongs etc.	3	25
			14. Chain & Pulley	2	175
			Carpentery Shop		
			15. Mechanical band saw	1	885
			16. Cross cut saw	1	885
			17. Portable drilling machine with drill bits	3	175
			18. Planers, in sizes set	5	60
			19. Awl	4	30
			20. Hatchet	4	30
			21. Hammers Set	4	30
			22. Chisel Set	4	30
			23. Honing Stone	2	6
			24. Paint and related equipment	1	200
			25. Miscellaneous		2,900
			Total		24,000

Table 3.5 - Alternate Product Volume.

Product	Industry Level I village Sector	Industry Level II Small Scale Sector
Chisel Plough	100	2000
Helical Blade Puddler	50	1000
Wet Land Leveller	75	1500

Table 3.6 - Annual Sales

Product	Industry Level I			Industry Level II		
	Unit Selling Price (U.S.$)	Annual Production (Unit)	Annual Sales (U.S.$)	Unit Selling Price (U.S.$)	Annual Production (Unit)	Annual Sales (U.S.$)
1. Chisel Ploughs	60	100	6,000	60	2000	120,000
2. Helical Blade Puddler	60	50	3,000	60	1000	60,000
3. Wetland Leveller	20	75	1,500	20	1500	30,000
Total			10,500			210,000

Table 3.7 - Working Capital

Item	Industry Level I (U.S.) (for 15 days)	Industry Level II (U.S.) (for 2 months)
Raw Material Cost	250	14,000
Over head cost	-	7,000
Labour Cost	-	6,000
Total	250	27,000

4 Lessons from the Indian Experience

4 Lessons from the Indian Experience

4.1 Productivity

The use of improved agricultural tools and equipment contributes directly to increased production through timely operations, better quality of work, precision in application of inputs, increasing cropping intensity and reducing post harvest losses. The following table gives some comparisions highlighting the relative productivity of comparable traditional and improvec animal drawn implements.

Table 4.1 - Indigenous and Improved Implements - Some Comparisons

	Price US $	Work Capacity Hectares/day	Operating Cost US $
Desi Plough	15	0.3	8.00/hectares
Mould Board Plough	9	0.5	10.00/hectares
Chisel Plough	31	1.6	1.00/hectares
Harrow	25	0.4-0.8	3.00/hectares
Disc Harrow	50	1.6	1.50/hectares
Seed Drill	30	0.3	3.6/hectares
Cup-feed Seed Drill	105	1.0-1.5	3.50/hectares
Ganga Seed-cum-Fertiliser Drill	40	0.5	3.00/hectares
Levellers (Paddy)	12	0.5	
Wet Land Leveller	10	4.5	9.3 /hectares
Pedal Operated Thresher		75 kg.	2.00/100 kg.
Olpad Thresher	38	500 kg.	1.50/100 kg.

Mechanisation of agriculture faces two major constraints in India - the low purchasing power of the bulk of farmers and and their inability to accept, operate, maintain and repair sophisticated equipment. Mechanisation that replaces manpower on a large scale is not always desirable. Improvements in tools and equipment that assist labour in raising productivity of land by making possible timely operations are preferable in the medium term. In view of these constraints India has successfully taken up the task of improvement of traditional implements which can be operated manually or with the use of animal power (side by side with development and introduction of power driven machinery). It has been possible to introduce them into Indian agriculture on a much wider basis than power driven machinery, the use of which is still fairly limited. This is because they are cheaper and can be more easily understood and repaired at the village level.

4.2 Government Support

Another lesson that emerges from India's

experience in this field is that industrial research and development tends to be divorced from the needs of the agricultural sector. "The industrial system produces a range of tools and machines, the coherence of which results from that of the industry; the agricultural system calls for a range of tools and machines the coherence of which, is not, a prior, identical"[1].

Thus, all the research in development of more efficient agricultural implements have been supported by the government. There has been a conscious effort on the part of the government to set up research, engineering and training institutions in this field. Once the initial research and development has been done the private sector may be able and willing to take up manufacturing. This too once the implement has proved its acceptability by the farmers and is expected to have a market.

The bulk of the work on the development of improved implements is done at engineering colleges

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1 UNIDO - ibid Page 1-1

attached to agricultural universities and specialised agricultural engineering and research institutes set up and financed by the Central and State Governments. Annexure II lists some of the important ones in this field. The agricultural colleges undertake research education and extension.

Some of the state governments, with the financial assistance of the Central Ministry of Agriculture have also set up agro-industries corporation for the manufacture of agricultural implements. These corporation run training institutions and workshops in rural areas. These are meant to train artisans and mechanics in manufacture, maintenance and repairs of improved implements.

The agro-industries corporations have also taken up the manufacture of improved agricultural implements which have been successfully tested.

Extension work in introducing improved implements to the farmers is perhaps the most crucial function. Extension work is done at several different levels. The agricultural universities have their own extension departments and they also run demonstration frame. They have regular fairs to which farmers of the surrounding areas come to learn about new improved agricultural practices.

Under the Intensive Agricultural District Programme extension work is carried out by the District Agricultural Officer. At the block level there are Agricultural Extension Officers. At the village level are the village-level workers known as 'gram sewaks'.

At another level are voluntary agencies which undertake extension at the village level.

The Indian experience has been that the system suffers from bureaucratic rigidities.

The most successful extension work has been done at the village level by volunatary agencies, which have proved more successful due to their flexibility.

The Indian experience also highlights the role of the government in provision of credit both at the level of manufacturing and purchase of the implements. The bulk of the rural economy being very short of capital the activity has to be sustained by credit. Credit is made available to the artisan for purchase of tools and working capital to the farmer for the purchase of the implements and to the small scale industrial unit for capital investment.

4.3 Employment

Although the bulk of the traditional implements are still manufactured by the village artisan, to the extent these are being replaced by improved agricultural implements there is an impact on the employment of the village artisan.

Improved implements are manufactured in the organised sector and the manufacturing units tend to be in the urban areas. Due to this trend there has been a serious displacement of village artisans in many areas.

The organisation of manufacturing should be such as to be able to involve the displaced artisan in the new level of activity. The manufacturing activity should be accessible to the village artisan side by side with the training workshops.

Instead of centralising manufacturing activity at the state level the system should aim at dispersed manufacturing at block level workshops with the agro-industries corporation co-ordinating the activity at the state level.

4.4 The Scale of Production

Agricultural implements are made at the level of the village artisan and in organised small industrial units. Though improved agricultural

implements are mainly being produced at the level of organised small industrial units, the two are complementary. The village artisan is crucial to sustain the market for these implements as he undertakes the functions of maintenance and repair.

Large scale production at the level of the agro-industries corporations has shown no advantage over the small scale units. Variations in design requirements for different regions mean a very varied product mix for large scale production. Again, at the level of the village and use on the farm it is the village artisan who has to support them. Large scale production has been more relevant in the manufacture of power driven agricultural implements and machinery. For simple animal drawn implements the small scale production unit has been the most appropriate.

A N N E X U R E S

Annexure I

SUGGESTED IMPROVED IMPLEMENTS

Region 1 - Humid Western Himalayan Region

Area : Jammu & Kashmir, Himachal Pradesh & Northern Uttar Pradesh.

Climate: Hot to sub-humid tropical in southern tracts & cold arid in the northern mountains.

Annual Rainfall: 8-350 cm.

Important soil types - Mountain meadow and sub-mountain meadow soil.

Important crops-Wheat, maize, rice, barley, potato and orchard crops.

Operation	Implements
Seedbed preparation	1. Mould board plough, 10-15 cm.
	2. Disc harrow, 6 disc.
	3. Patela harrow.
	4. Peg tooth harrow.
	5. Land leveller.

Operation	Implements
Sowing	1. Seed-cum-fertiliser drill, 2-3 row.
	2. Sowing and fertiliser attachement over desi plough.
	3. Maize planter
	4. Semi-automatic potato plant
Interculture, Weeding Earthing	1. 3-5 tined cultivator.
	2. Ridger, 30-40 cm
Irrigation	1. Persian wheel
	2. Animal drawn duplex pump.
Harvesting	1. Potato digger.
Threshing	1. Olpad thresher.
Post Harvest Equipment	1. Chaff cutter.
Transport	1. Improved bullock cart with brakes.

Region 2 - Humid Bengal Assam Region

Area : Bengal, Assam.

Climate: Hot humid monsoonal.

Annual Rainfall: 220-400 cm.

Important soil types: Alluvial, red, brown hill and coastal.

Important crops: Rice, jute, tea, maize, wheat, castor, rapseed, mustard, potato, vegetable crops.

Operation	Implements
Seedbed preparation	1. Mould Board plough, 10-15 cm.
	2. Disc harrow 6 disc.
	3. Patela harrow.
	4. Puddler, 50-70 cm size.
	5. Peg tooth harrow.
	6. Land leveller.
Sowing	1. Seed-cum-fertiliser drill, 2-3 row.
	2. Sowing & fertiliser attachment over desi plough.
	3. Maize planter.
	4. Jute seed drill.

Operation	Implements
Interculture, Weeding, Earthing	1. Three tined cultivator. 2. Ridger.
Irrigation	1. Duplex pump.
Post harvest operations	1. Chaff cutter 2. Potato grader
Transport	1. Improved bullock cart.

Region 3 - Humid Eastern Himalayan Region & Bay Islands

Area : Arunachal Pradesh, Nagaland, Meghalaya, Manipur, Tripura, Mizoram, Sikkim, Andaman & Nicobar Islands.

Climate : Hot humid monsoonal type.

Annual Rainfall: 200-400 cm.

Important soil types: Brown hill, red loamy, red and yellow, alluvial & laterite.

Important crops: Rice, maize, small millets, potato, oilseeds. Terrace farming is common.

Operation	Implements
Seedbed preparation	1. Mould board plough. 2. Disc harrow, 6 disc. 3. Patela horrow. 4. Puddler, 50-70 cm.
Sowing	1. Seed-cum-fertiliser drill, 2-3 row. 2. Seeding attachment for desi plough. 3. Maize planter. 4. Potato planter.

Operation	Implements
Interculture, Weeding, Earthing	1. Three tined cultivator. 2. Five tined cultivator. 3. Ridger.
Harvesting	1. Potato digger.
Post harvest operations	1. Chaff cutter.
Transport	1. Improved bullock cart.

Region 4 - Sub-Humid, Sutlej-Ganga Alluvial Plain

Area : Punjab, Haryana, UP and Bihar.

Climate : Extreme climates. Hot summer and cold winter.

Rainfall : 30-200 cm.

Important soil types: Calcarious sierozem, redish chestnut and alluvial soils.

Important crops: Wheat, rice, maize, potato, sorghum, mustard, pulses, millets, sugarcane and vegetable crops.

Operation	Implements
Seedbed preparation	1. Mould board plough 15-20 cm.
	2. Disc harrow 6 disc.
	3. Harrow patela.
	4. Clod crusher.
	5. Paddy puddler 70 cm.
	6. Bund former.
	7. Buck scraper.
	8. Wooden float/levelling board.

Operation	Implements
Sowing	1. Seed-cum-fertiliser drill 3-5 row.
	2. Seeding attachment for desi plough
	3. Maize planter.
	4. Potato planter.
	5. Sugarcane planter.
	6. Groundnut planter.
Interculture, Weeding, Earthing	1. 3-5 tined cultivator
	2. Ridger.
	3. Improved bakhar.
Irrigation	1. Persian wheel
	2. Duplex pump.
Harvesting	1. Potato digger
	2. Groundnut digger.
Threshing	1. Olpad thresher.
Post Harvest Operations	1. Chaff cutter.
	2. Sugarcane crusher.
Transport	1. Improved bullock cart.

Region 5 - Sub-Humid Eastern and South Eastern Uplands

Area : Orissa, Eastern M.P., Andhra Pradesh.

Climate : Tropical monsoonal and sub-humid to humid.

Annual Rainfall : 100-180 cm.

Important soil types: Mixed black, red and yellow, red sandy, laterite black, riverine alluvial and coastal sandy alluvial.

Important crops: Rice in high rainfall area.
Sorghum in drylands.
Groundnut, cotton, mustard, linseed, pigeon pea, coarse millet and sugarcane.

Operation	Implements
Seedbed preparation	1. Mould board plough, 15cm
	2. Disc Harrow, 6 disc.
	3. Harrow patela.
	4. Paddy puddler, 70 cm.
	5. Bund former.
	6. Buck scraper.
	7. Clod crusher.
	8. Wooden float/levelling board.

Operation	Implements
Sowing	1. Seed-cum-fertiliser drill, 2-3 row. 2. Seeding attachment for desi plough. 3. Groundnut/cotton planter.
Interculture, Weeding, Earthing	1. 3-5 tined cultivator. 2. Ridger. 3. Improved bakhar.
Irrigation	1. Duplex pump
Harvesting	1. Groundnut digger.
Post harvest operations	1. Chaff cutter 2. Sugarcane crusher.
Transport	1. Improved bullock cart.

Region 6 - Arid Western Plain

Area : Rajasthan and Gujarat

Climate : Arid with extremes of temperature

Annual Rainfall : 10-65 cm

Important Soil Types : Alluvial, grey brown alluvial, black, desert and alkaline.

Important Crops : Pearl millet and sorghum in desertic tracts.

Others : Wheat, pulses, maize, cotton, millets, rice, groundnut, sugarcane oilseeds.

Operations	Implements
Seedbed preparation	1 Mould board plough, 15 cm
	2 Disc harrow, 6 disc.
	3 Harrow patela
	4 Bund former
	5 Buck scraper
	6 Clod crusher
Sowing	1 Seed-cumfertiliser drill, 2-3 row
	2 Seeding attachment for desi plough
	3 Maize planter
	4 Groundnut planter
	5 Cotton planter
	6 Sugarcane planter (in lighter soil)

Operations	Implements
Interculture, weeding, earthing	1 3-5 tined cultivator 2 Ridger 3 Improved bakhar
Irrigation	1 Persian wheel 2 Duplex pump
Harvesting	1 Groundnut digger
Post harvest operation	1 Chaff cutter 2 Sugarcane crusher
Transport	1 Improved bullock cart

Region 7 - Semi Arid Lava Plateaus and Central Highlands

Area : Madhya Pradesh, Maharashtra, Goa, Damen & Diu

Climate : Semi-arid with extremes of temperature

Annual Rainfall : 70-750 cm

Important Soil Types : Alluvial black and lateritic, mixed red and black and yellowish brown

Important Crops : Millets, maize, wheat, rice, oilseeds, cotton pulses and sugarcane.

Operations		Implements
Seedbed preparation	1	Improved bakhar
	2	Mould board plough, 15 cm
	3	Disc harrow, 6 disc.
	4	Harrow patela
	5	Bund former
	6	Buck scraper
	7	Clod crusher
Sowing	1	Seed-cum-fertiliser drill 2-3 row
	2	Seeding attachment for desi plough
	3	Maize planter
	4	Cotton planter
	5	Groundnut planter

Operations	Implements
Interculture, weeding, earthing	1 3-5 tined cultivator 2 Improved bakhar 3 Ridger
Irrigation	1 Persian wheel
Harvesting	1 Groundnut digger
Post Harvest Operation	1 Chaff cutter 2 Sugarcane crusher
Transport	1 Improved bullock cart

Region 3 - Humid to Semi Arid Western Ghats and Karnataka Plateau

Area : Tropical.

Annual Rainfall: 60-300 cm.

Important soil types: Black, red lateritic and alluvial.

Important crops: Rice sugarcane and garden crops in irrigated areas. Sorghum, finger millets, pulses, cotton and pulses in dry farming areas.

Operation	Implements
Seedbed preparation	1. Improved bakhar.
	2. Mould board plough, 15 cm.
	3. Disc harrow, 6 disc.
	4. Harrow patela.
	5. Bund former.
	6. Buck scraper.
	7. Clod crusher.
	8. Paddy puddler.
	9. Wooden float/levelling board.

Operation	Implements
Sowing	1. Seed-cum-fertilizer drill, 2-3 row.
	2. Seeding attachment to desi plough.
	3. Maize planter.
	4. Cotton planter.
	5. Groundnut planter.
Interculture, Weeding, Earthing	1. 3-5, tined cultivator.
	2. Improved bakhar.
	3. Ridger.
	4. Sweep.
Harvesting	1. Groundnut digger.
Post Harvest Operation	1. Chaff cutter.
	2. Sugarcane crusher.
Transport	1. Improved bullock cart.

Annexure II

Agencies engaged in Research and Production of Improved Agricultural Implements

1. College of Agricultural Engineering
   Tamil Nadu Agricultural University
   Coimbatore, India.

2. Central Institute of Agricultural Engineering
   Bhopal, India.

3. International Crop Research Institute for
   Semi-Arid Tropics,
   Hyderabad, India.

4. College of Technology
   G.B. Pant University of Agriculture and Technology
   Pantnagar, India.

5. Central Rice Research Institute
   Cuttack, India.

6. Indian Grasslands and Fodder Research Institute
   Jhansi, India.

7. Indian Institute of Sugarcane Research
   Lucknow, India.

8. Indian Agricultural Research Institute
   New Delhi, India.

9. Haryana Agricultural University
Hisser, India.

10. Jute Agricultural Research Institute
Barrackpore, India.

11. College of Agriculture
Mahatama Phule Krishi Vidyapeeth
Pune, India.

12. College of Agricultural Engineering
Punjab Agricultural University
Ludhiana, India.

13. Central Plantation Crops Research Institute
Kasaragod, India.

14. Agricultural Research Institute
Andhra Pradesh Agricultural University
Hyderabad, India.

15. M/s Water Development Society
Moula Ali
Hyderabad, India.

16. M/s Vicon Limited
35/5 Langford Road
Bangalore, India.

17. M/s Government Implement Factory
Satya Nagar,
Bhubaneswar - 75100
Orrissa, India.

18. R.N. Mahapatra
62 Surya Nagar
Bhubaneswar, India.

19. M/s Small Scale Industries
Rudrapur (U.P.)
India.

20. M/s M.P. State Agro Industries Corporation, Ltd.,
T.T. Nagar
Bhopal, India.

21. M/s Hema Engineering Industries
26, R.K. Nagar
Koundangalayam,
Coimbatore, India.

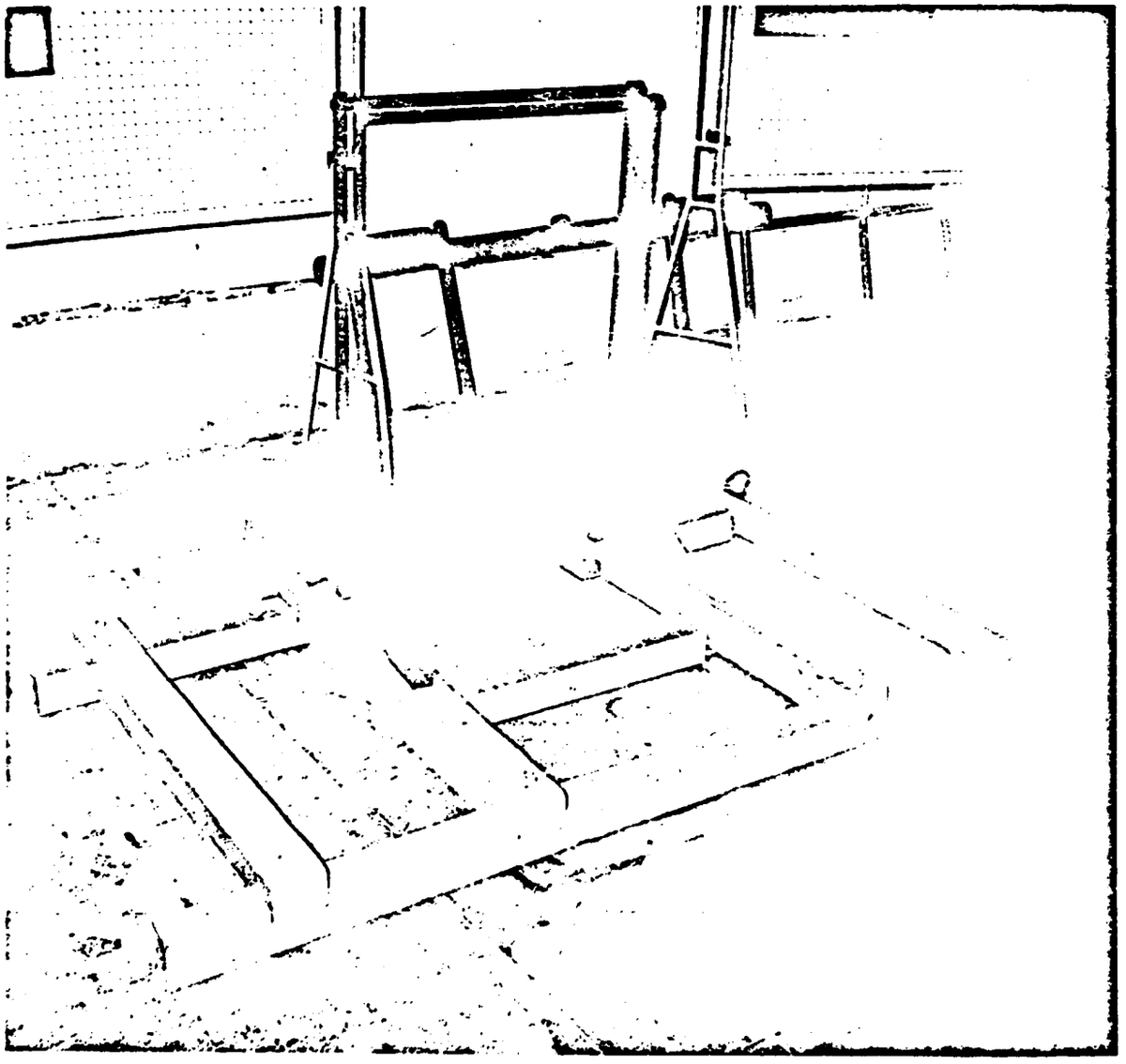
22. M/s Diwana Industries
7/8 Guruwar Peth
Puna, India.

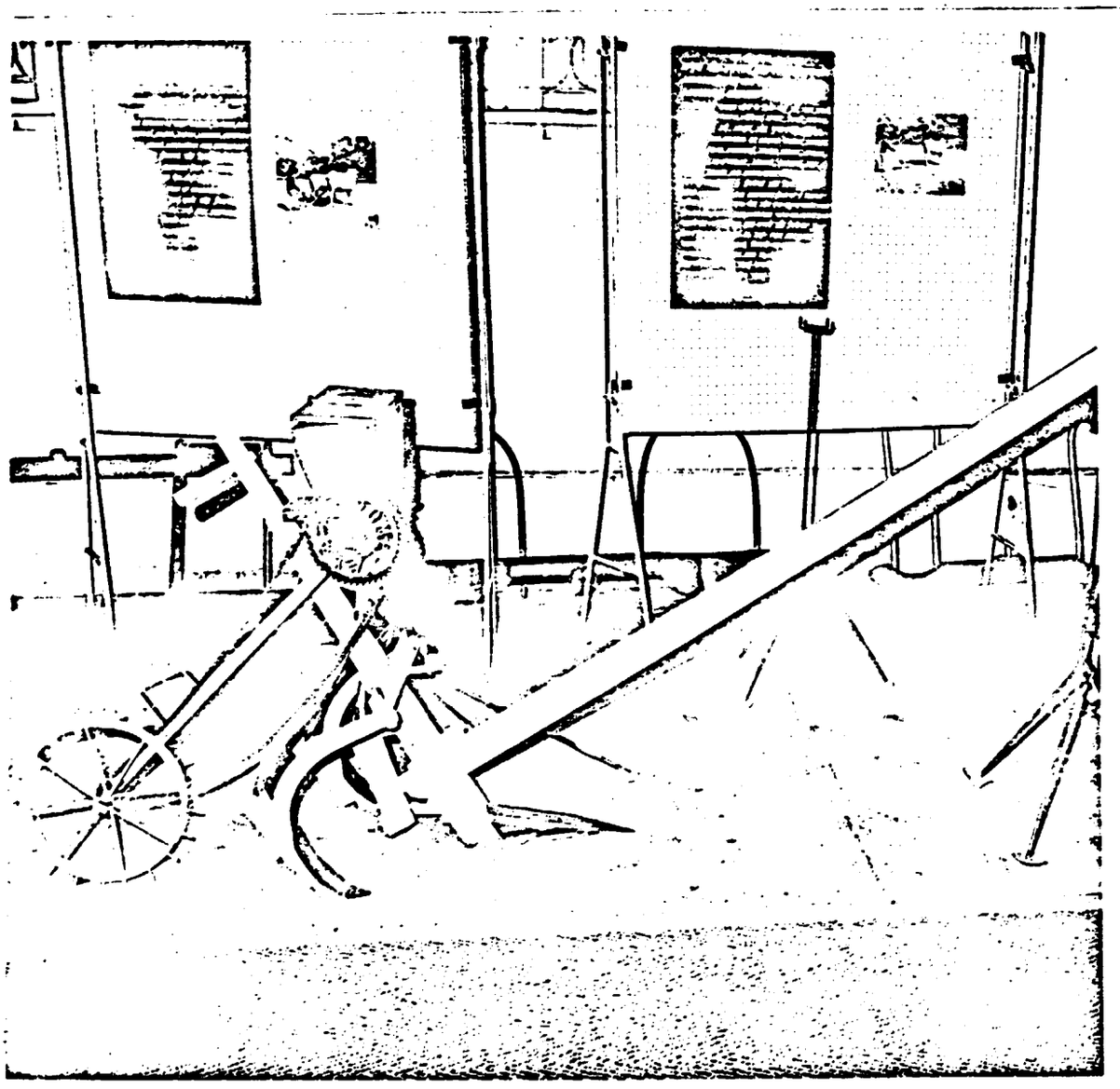
23. M/s Saumitra Fabricators
Phaltan, India,

24. M/s Steel Engineering Corporation
Lohari Marg,
Saharanpur, India,

25. M/s U.P. Agro Industries Corporation
22, Vidhan Sabha Marg,
Lucknow, India.

26. M/s Precision Tools
10-A Industrial estate
Ludhiana,
Punjab, India.





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