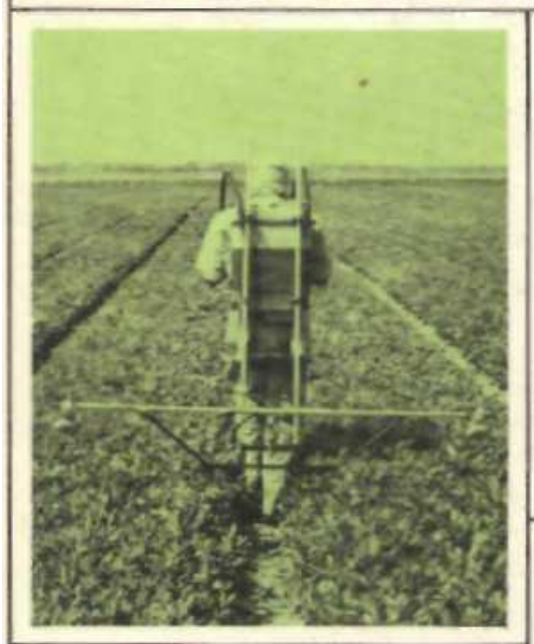
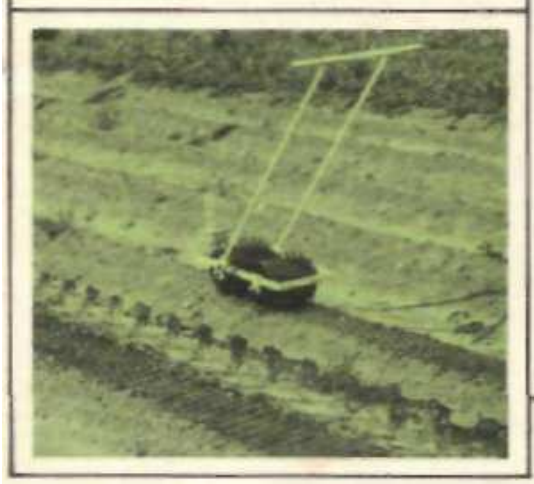
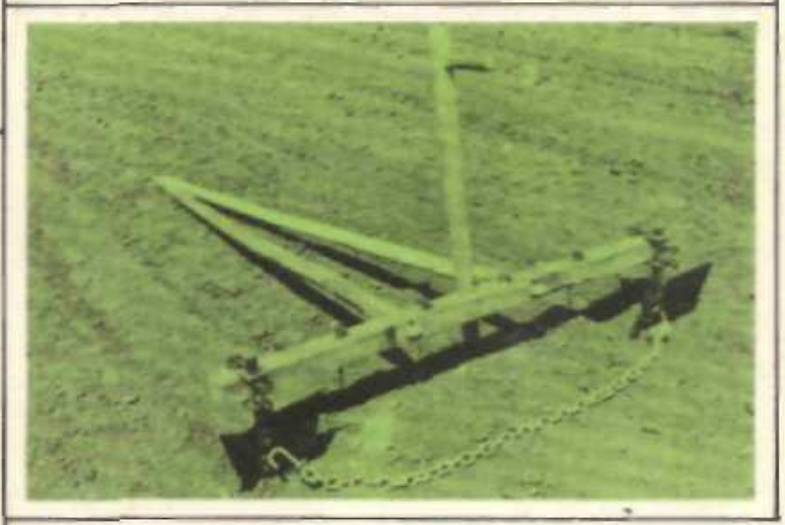
New Implements for Crop Production in the Semi-Arid Tropics







Information Bulletin no. 27

International Crops Research Institute for the Semi-Arid Tropics

Abstract

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A suite of simple bullock-drawn implements has been developed at ICRISAT to form broadbeds and furrows and to carry out subsequent field operations easily. Agribar II, an improved version of the Agribar fitted with a four-row planter, can sow various crops and perform tillage operations. Simple implements based on a T-bar have been developed for making broadbeds, applying fertilizer, sowing, and interrow cultivation. A crust breaker was developed to enhance seedling emergence through the surface crust. A spinning-disc knapsack sprayer and a groundnut digger have also been developed to meet specific requirements of farmers who grow groundnut in the semi-arid tropics.

Résumé

Référence : Awadhwal, N.K. et Smith, G.D. 1989. **Nouveaux matériels agricoles conçus pour les zones tropicales semi-arides.** Bulletin d'information n° 27. Patancheru, A.P. 502 324, Inde : International Crops Research Institute for the Semi-Arid Tropics.

L'ICRISAT a mis au point une gamme d'outils à traction bovine pour la préparation des planches larges et sillons et la réalisation facile des opérations au champ. L'Agribar II, un modèle amélioré de l'Agribar, équipé d'un semoir à quatre rangs, permet de semer différentes cultures et d'effectuer le labour. Des outils simples comprennant des instruments aratoires, des épandeurs, des semoirs et des cultivateurs interlignes ont été conçus. Un dispositif pour briser l'encroûtement du sol a été produit afin de faciliter l'émergence des cultures. L'ICRISAT a aussi créé un pulvérisateur centrifuge à dos et une souleveuse pour la récolte de l'arachide destinés aux paysans des zones tropicales semi-arides.

New Implements for Crop Production in the Semi-Arid Tropics

N.K. Awadhwal and G.D. Smith

ICRISAT

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Introduction

ICRISAT has developed farm machinery that can increase crop yields in the semi-arid tropics (SAT) by making better use of human resources and animal traction. Many of the cultural practices tested and developed at ICRISAT are based on a broadbed-and-furrow (BBF) system. A range of simple bullock-drawn implements is now available to enable farmers to easily form a BBF system and to carry out subsequent field operations. Implements have been developed to facilitate specific tasks such as digging groundnut in hard soil, where blade-type diggers cannot penetrate to the desired depth, spraying of chemicals on short crops (groundnut, chickpea, etc.), and breaking soil crusts to improve seedling emergence.

Figure 1. Sowing with a mechanical planter, and fertilizer application with a low-cost hand-metering device attached to an Agribar II.

Agribar II

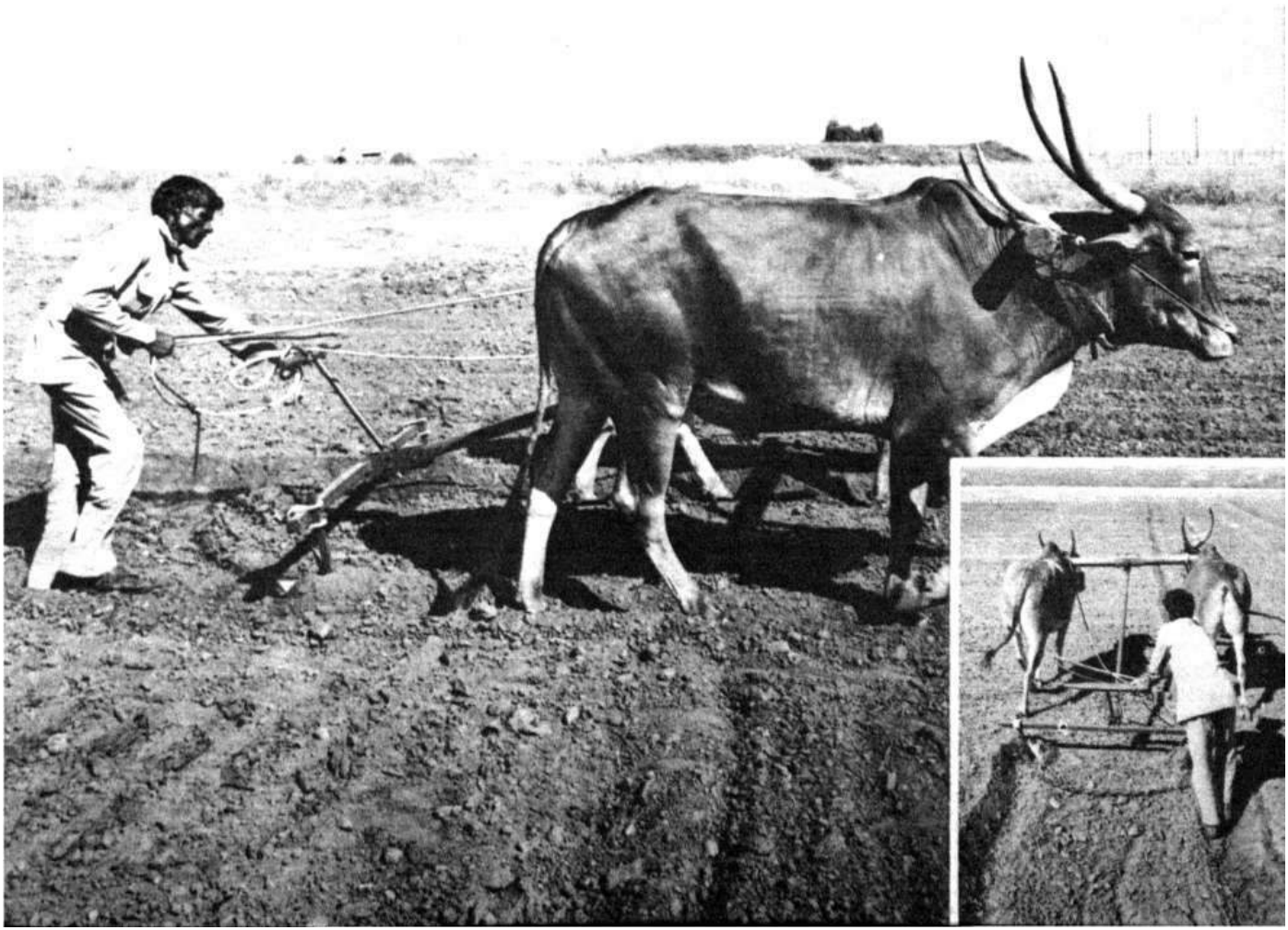
This is an improved version of the Agribar. It is lighter, its toolbar is easier to lift, and it can be fitted with a four-row mechanical planter. The overall mass is about 85 kg and it travels on solid rubber wheels (300-mm diameter) supported on ball bearings. For primary tillage it can be fitted with a disc or a moldboard plow. The wheel track is adjustable so that the right wheel can be moved to the inside of the frame to keep the plow in line with the beam. For preparation of seedbeds, it can be fitted with a blade harrow or duckfoot sweeps; for shaping broadbeds, ridgers and a chain are used. A wide range of crops (groundnut, chickpea, pigeonpea, maize, sorghum, pearl millet, and safflower) can be sown at desired spacings if a planter with appropriate seed-metering plates is used (Fig. 1). Interrow cultivation can be carried out with duckfoot sweeps (Fig. 2) and blade harrows. Fertilizer can be applied in a band either separately or during planting with the help of a low-cost hand-metering device. The working capacity of the implements depends on many factors, such as width of the implement, speed of operation, skill of the operator, size of the field, and condition of the field. A 15-cm plow pulled by a pair of bullocks walking at 3 km h^{-1} would cover aproximately 0.2 ha in a 6-h day. However, a 150-cm cultivator pulled at the same speed would cover about 2 ha in a 6-h day. All the operations described above can normally be done using a medium-sized pair of bullocks (300 kg each).

Simple Implements for Cropping on the Broadbed-and-Furrow System

Farmers do not normally have access to implements suitable for making broadbeds and furrows or for subsequent operations on them. Wheeled tool carriers are ideal for this purpose (Awadhwal et al. 1987), but are too expensive for many farmers. ICRISAT, therefore, developed a set of simple, low-draft implements that are easy and economical to make so that the farmers can readily adopt BBF-based systems on light-textured soils. The design is simple enough for the implements to be fabricated in small workshops with locally available material. The central component common to all of these implements is a "T-bar" made from either iron or wood (Figs. 3 and 4). The iron T-bar consists of a square toolbar, formed by joining

Figure 2. Interrow cultivation with duckfoot sweeps fitted on an Agribar II.

Figure 3. A broadbed former on an iron T-bar.



two angle-irons (40 x 40 x 6 mm, 1.7 m long), and a drawpole made of iron pipe (50 mm diameter). The wooden T-bar consists of a wooden plank (70 x 100 mm, 1.7 m long) and two beams. Standard C-clamps are used to attach implements to the iron T-bar, whereas specially designed clamps are used for attaching tools to the wooden T-bar. This allows farmers to carry out a range of operations using the implements described below.

Broadbed former. Two ridgers are attached to the T-bar at a spacing of 1.5 m. The ridgers make two 30-cm parallel furrows on each side of a 1.2-m broadbed. A chain can be attached behind the ridgers to smooth the top of the broadbed (Figs 3 and 4).

Broadbed former with fertilizer application attachment. Four furrow openers and a wooden divider bowl, for manual metering of fertilizer, are attached to the T-bar of the broadbed former. This enables broadbeds to be formed, rows to be made, and fertilizer applied, simultaneously in one operation. If fertilizer is already mixed

Figure 4. A broadbed former on a wooden T-bar.

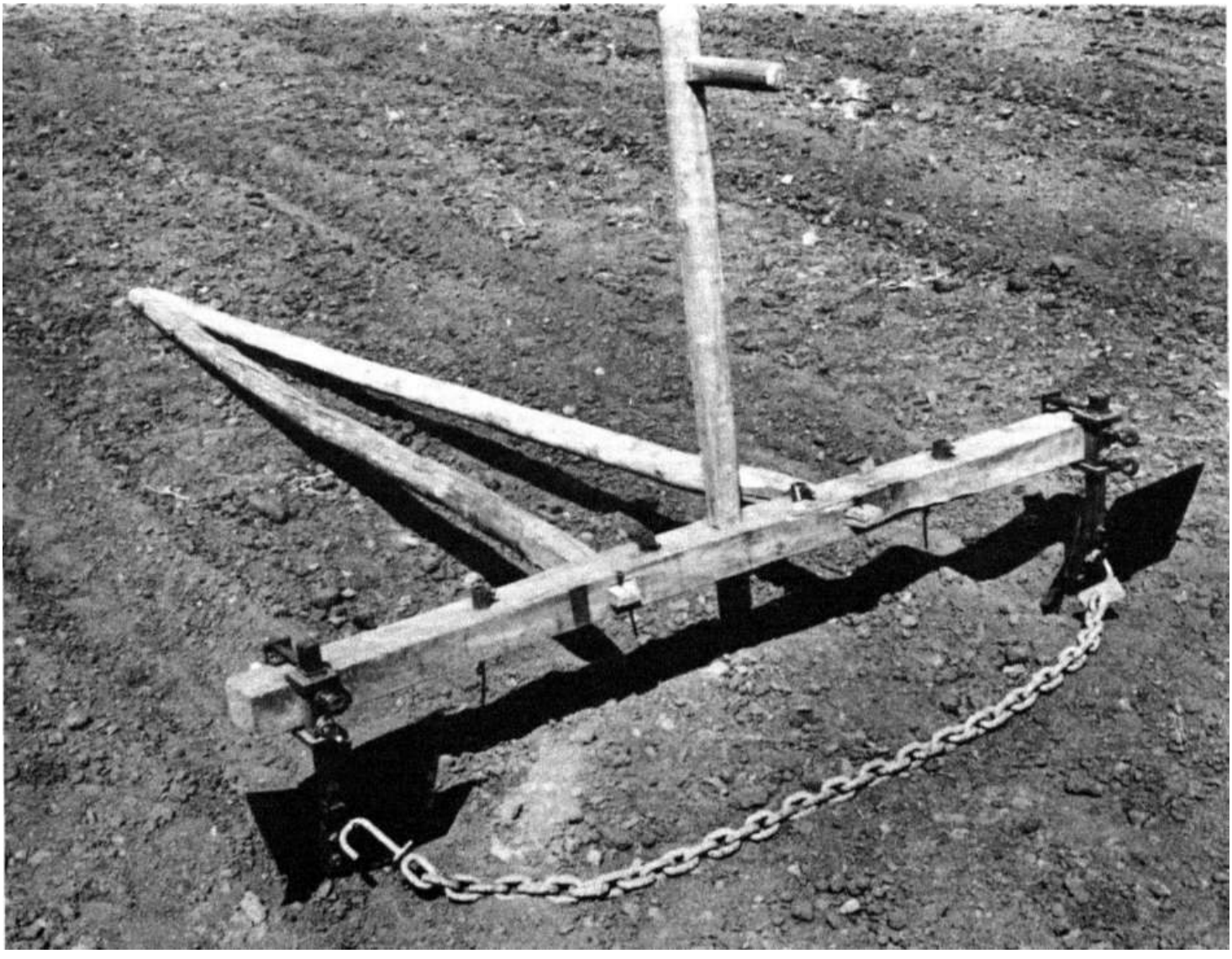


Figure 5. A broadbed former with a hand-metering device for fertilizer application.

into the soil, and seeds are to be dibbled manually, this implement can be used for making broadbeds and marking the rows (Fig. 5).

Seed planter. A four-row planter developed for groundnut is mounted on the T-bar, along with a pair of wheels and four furrow openers. The planter consists of a seedbox containing four seed metering plates, a ground wheel-drive, and a frame to support this whole unit on the T-bar. The drive wheel can be lifted during transport. Press wheels are attached to the furrow openers to compact the seeded rows (Fig. 6). However, for sowing in dry soil a chain attached to shanks of the T-bar wheels can be used in place of press wheels to cover the sown rows.

If the cost of the planter is a constraint, then a low-cost hand-metering device can be attached on the T-bar in place of the planter for sowing small-seeded crops such as sorghum and pearl millet.

However, use of the hand-metering device is not recommended for sowing large-seeded crops such as groundnut, maize, etc.

Interrow weeding attachment. Three duckfoot sweeps are attached to the T-bar of the broadbed former, and used for interrow weeding. The sweeps cultivate the interrow zone in the crop while the ridgers remove weeds from the furrows and deepen them (Fig. 7).

The average field capacity of each of the implements on the T-bar is about 0.2 ha h^{-1}

Figure* 6. *A four-row planter attached to an iron T-bar.

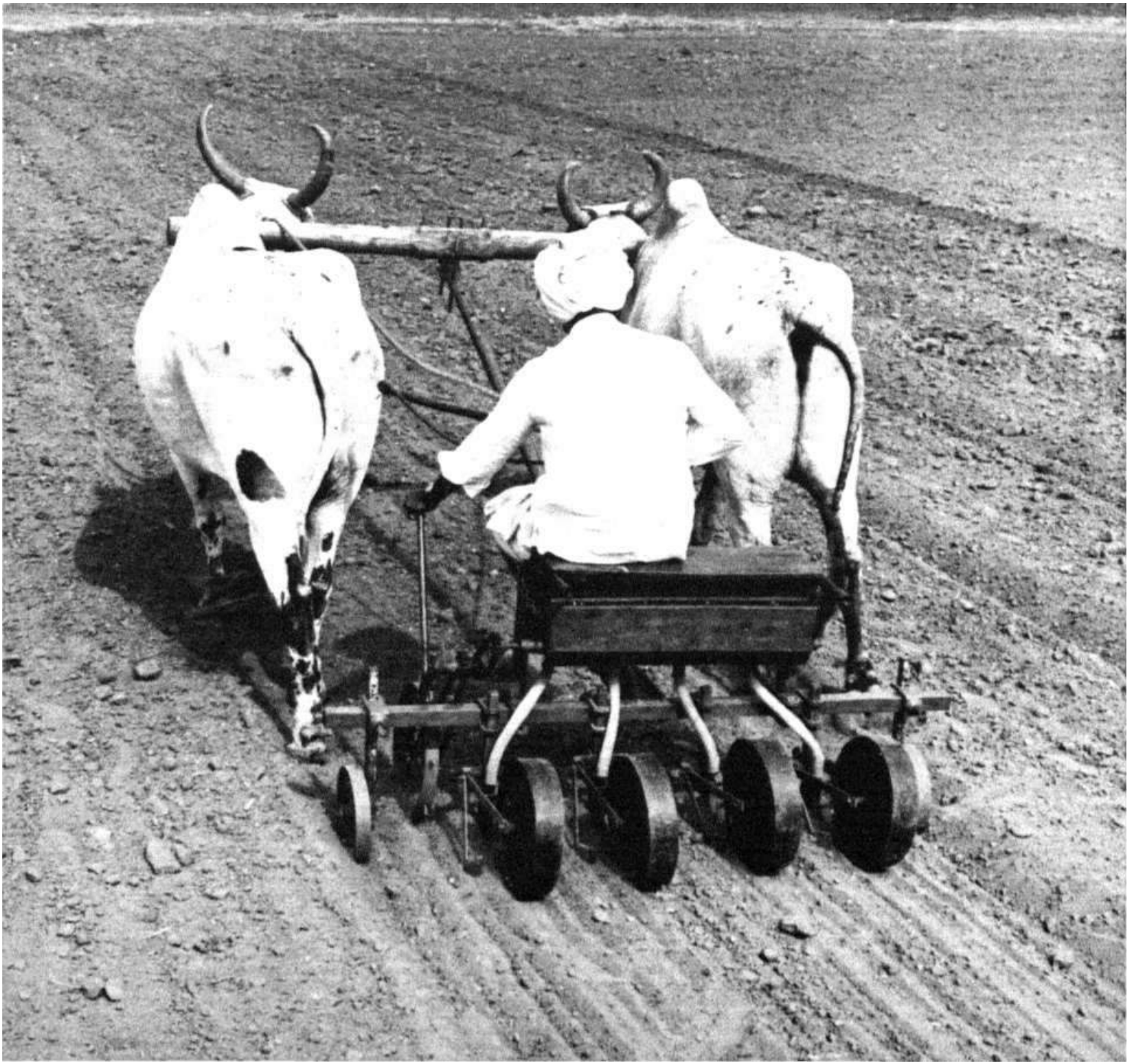


Figure 7. Interrow weeding attachment on a broadbed former.

Crust Breaker

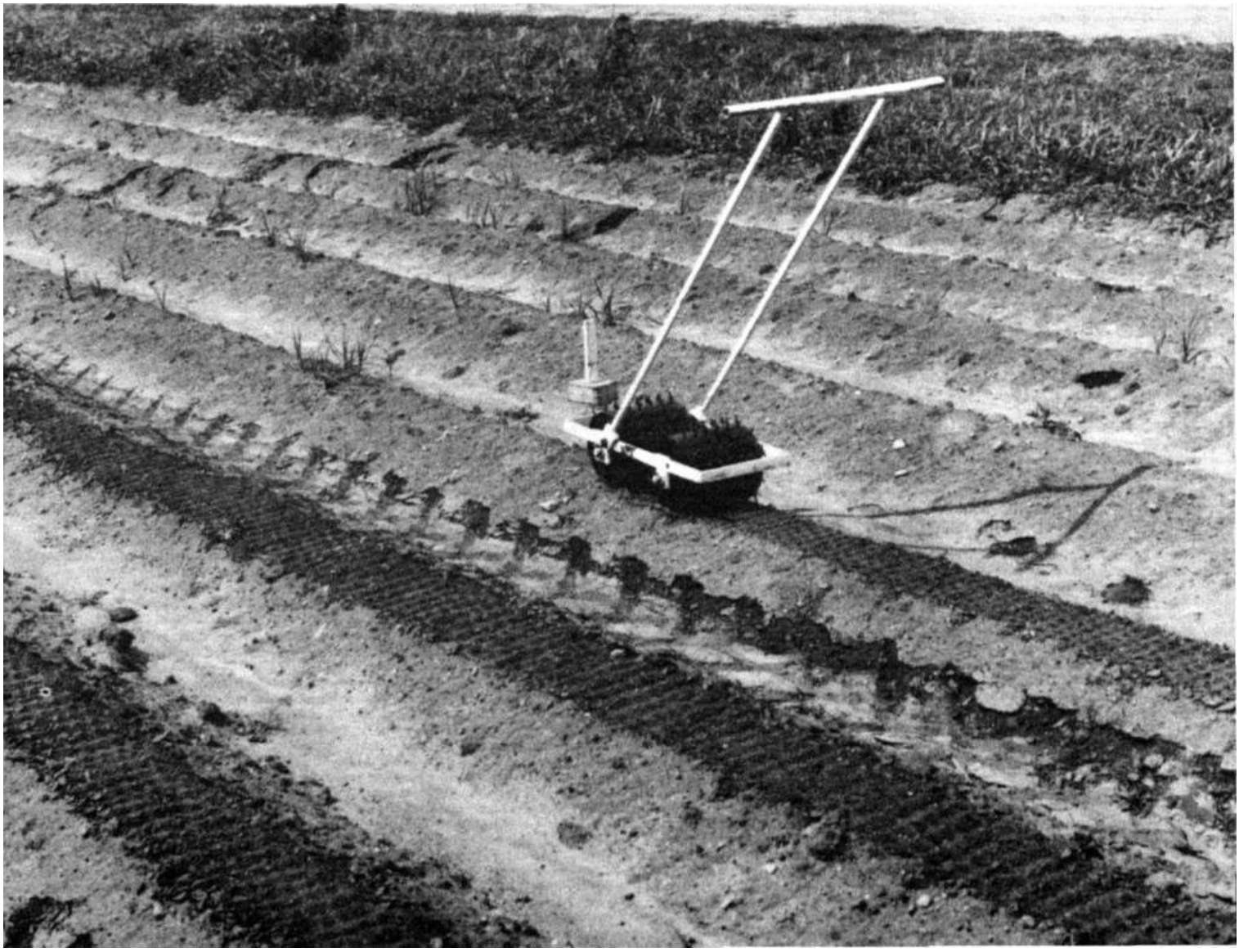
The poor emergence of seedlings through a soil crust is common in sandy and loamy soils of the arid and semi-arid regions. To ensure good emergence of seedlings when crusts have formed, the soil surface must be wetted frequently or mechanically broken. Breaking the crust with a hand tool, such as a sickle, can require 200 man-hours per hectare (Awadhwal 1988).

In 1983, ICRISAT developed a single-row crust breaker with a tandem roller that broke soil crusts over seeded rows. This imple-

ment was manually operated (Fig. 8). It covered a 15-cm strip and was suitable for crust-breaking operations on ridges and on flat land (ICRISAT 1983). A manually operated crust breaker was also developed to cover two rows in one pass (Fig. 9). It consists of two inclined-roller units attached to a 1-m frame. The rollers are inclined at an angle to the direction of travel and the spacing between the rollers can be adjusted to match the row spacings. Multiple units of either the inclined-roller or tandem-roller crust breakers can be attached to a toolbar pulled by a pair of oxen or a small tractor (Awadhwal and Thierstein 1983).

An animal-drawn crust breaker with a pair of inclined rollers covering a 1-m wide strip has now been developed (Fig. 10). In field tests on an Alfisol at ICRISAT Center, this implement broke the crust completely and damaged less than 1% of the crop seedlings. After the crust was broken, the emergence of pearl millet and sorghum seedlings increased to levels equivalent to those in non-crusted soils. However, breaking the crust may also encourage the

Figure 8. Single-row crust breaker with tandem rollers.



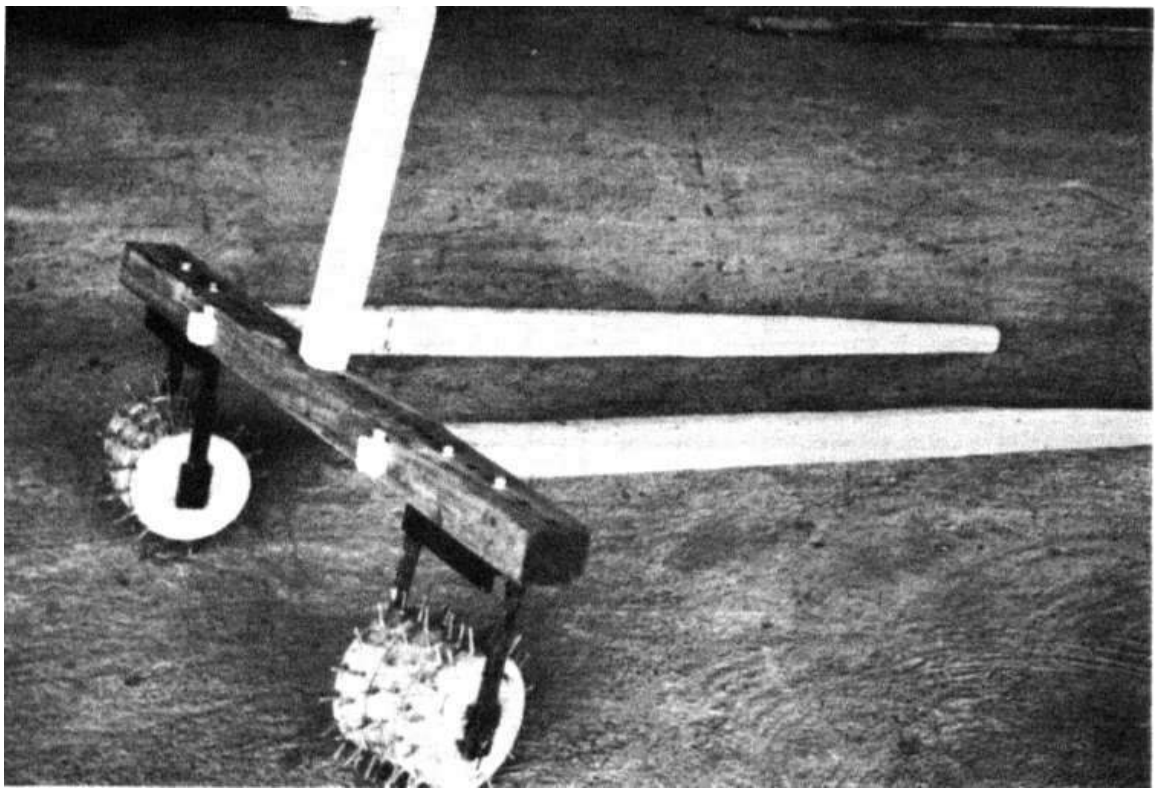
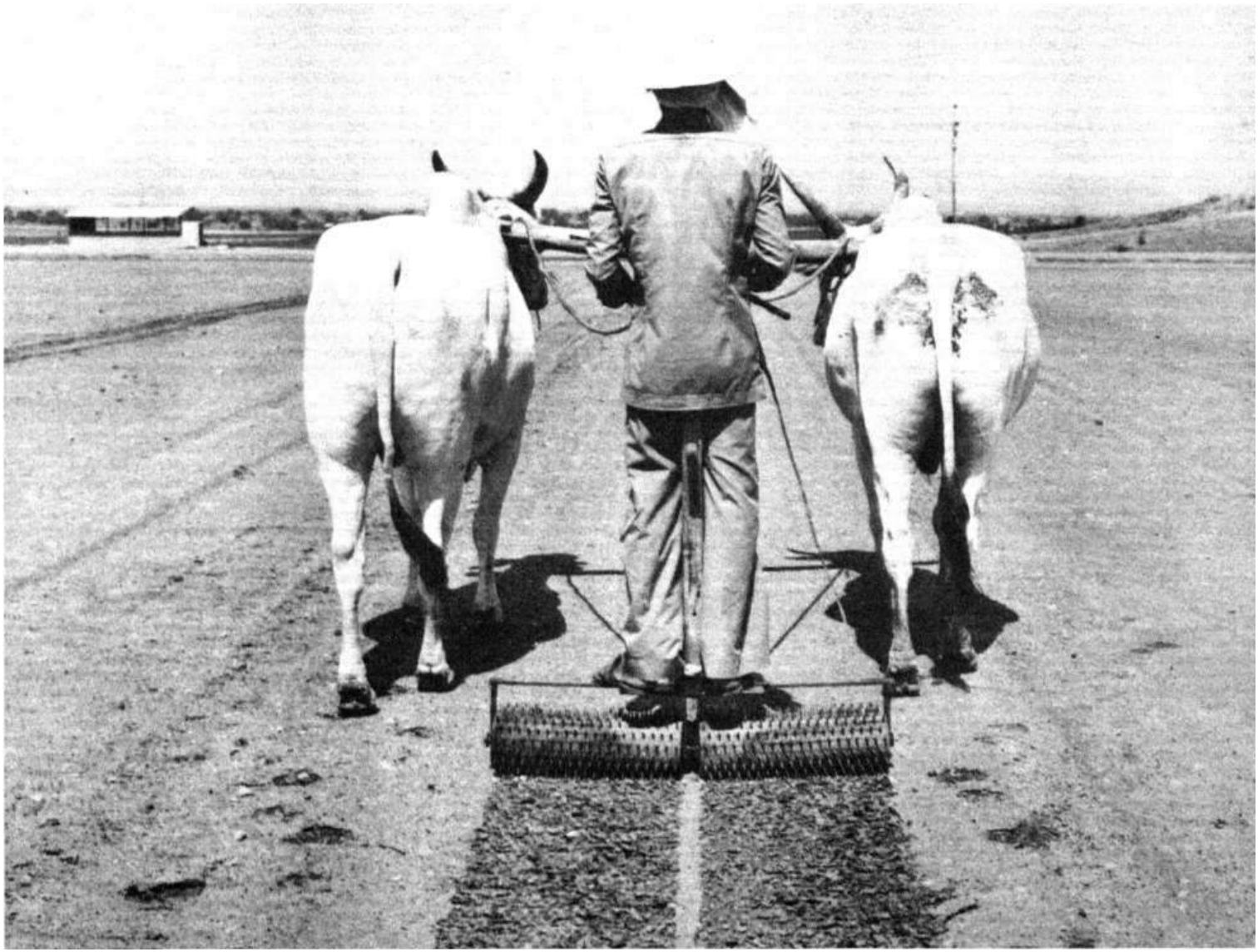


Figure 9. A two-row crust breaker with inclined rollers.

Figure 10. An animal-drawn crust breaker with inclined rollers.

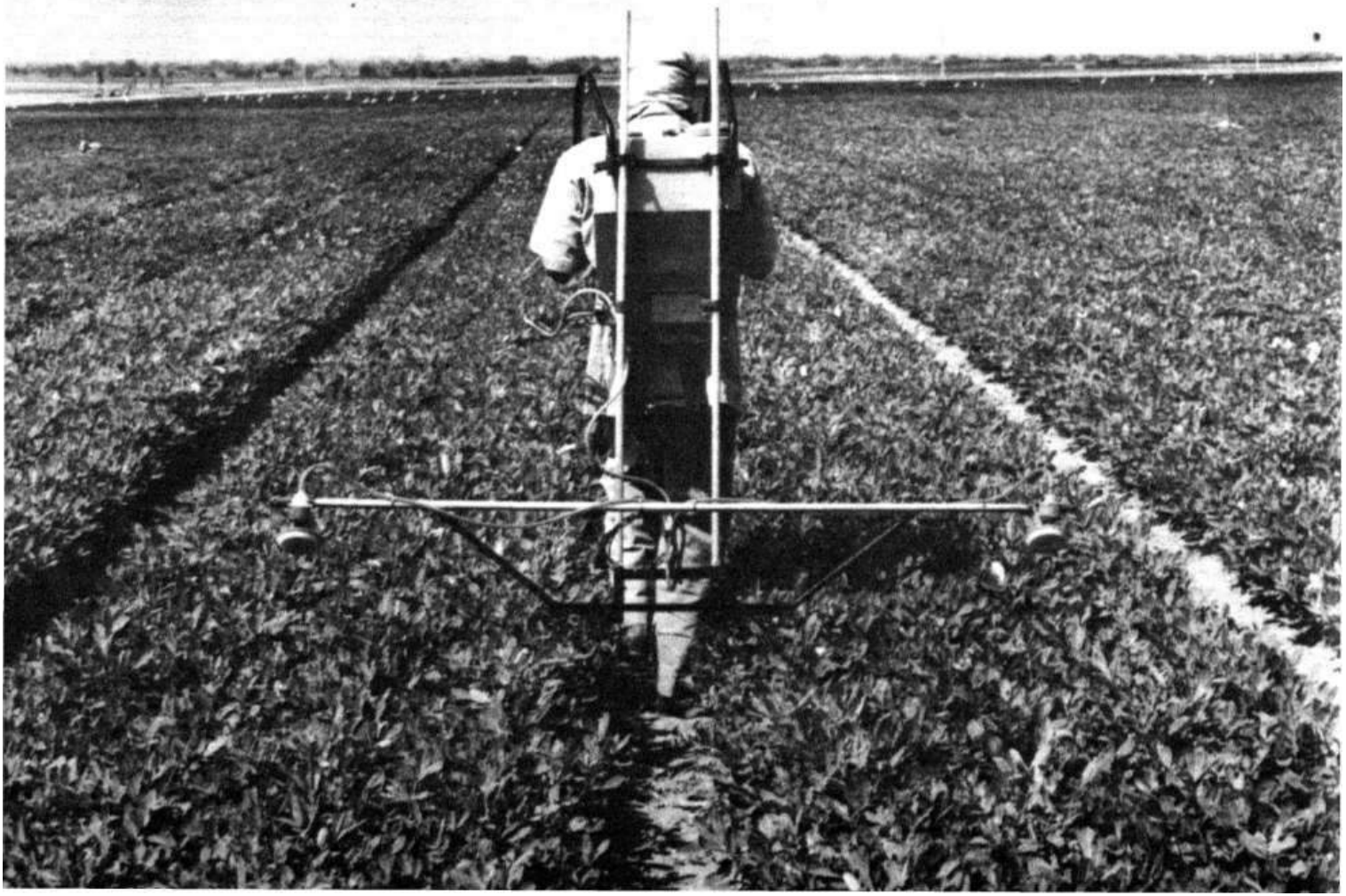


emergence of weeds. The implement can cover 1 ha in about 3 h. The wider unit has advantages where seeds are not sown in straight lines (ICRISAT 1987).

Spinning-Disc Knapsack Sprayer

A twin spinning-disc knapsack sprayer for short crops such as groundnut, chickpea, and mung bean, developed at ICRISAT, combines features of the conventional knapsack sprayer and the hand-held spinning-disc controlled droplet applicator (CDA) (Figs 11 and

Figure 11. A twin spinning-disc knapsack sprayer for groundnut and other short crops.



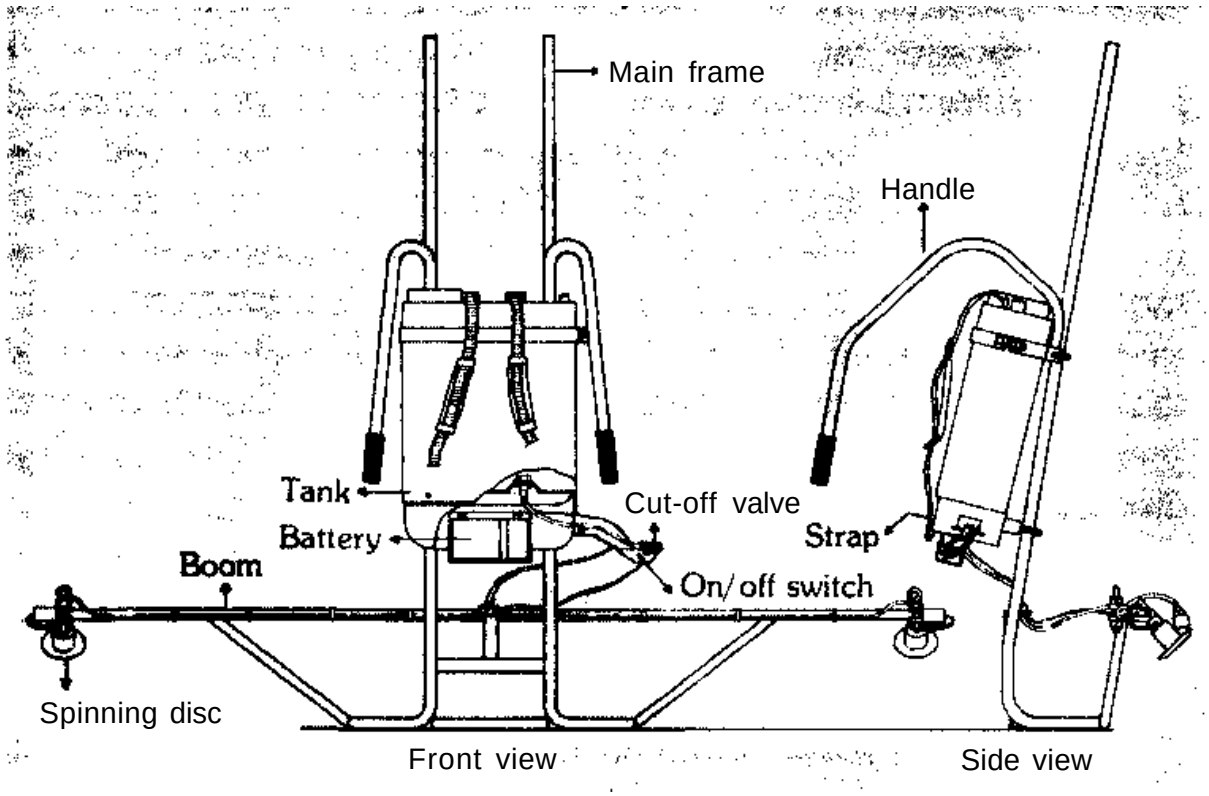


Figure 12. Sketch of the twin spinning-disc knapsack sprayer.

12). It consists of a 10-L chemical tank fitted to a tubular frame. Two spinning-disc applicators, mounted on a boom, are energized by a 6-V rechargeable battery, placed under the chemical tank. The sprayer is carried on the back of the operator and the position of the boom can be adjusted to suit various crop heights. The empty sprayer weighs approximately 9 kg.

Field trials conducted to evaluate the performance of the spinning-disc knapsack sprayer for the application of wettable powder and emulsifiable concentrate formulations on groundnut, chickpea, and mung bean crops, indicated that it performed as well as the conventional hydraulic knapsack sprayer in controlling leaf spot, leaf miner, thrips, and jassids. The spinning-disc knapsack sprayer covered a 3-m swath, requiring only 15 L of water and taking about 1.5 h to spray 1 ha, whereas the conventional knapsack sprayer required more than 400 L of water and 20 man-hours to spray the same area (ICRISAT 1988).

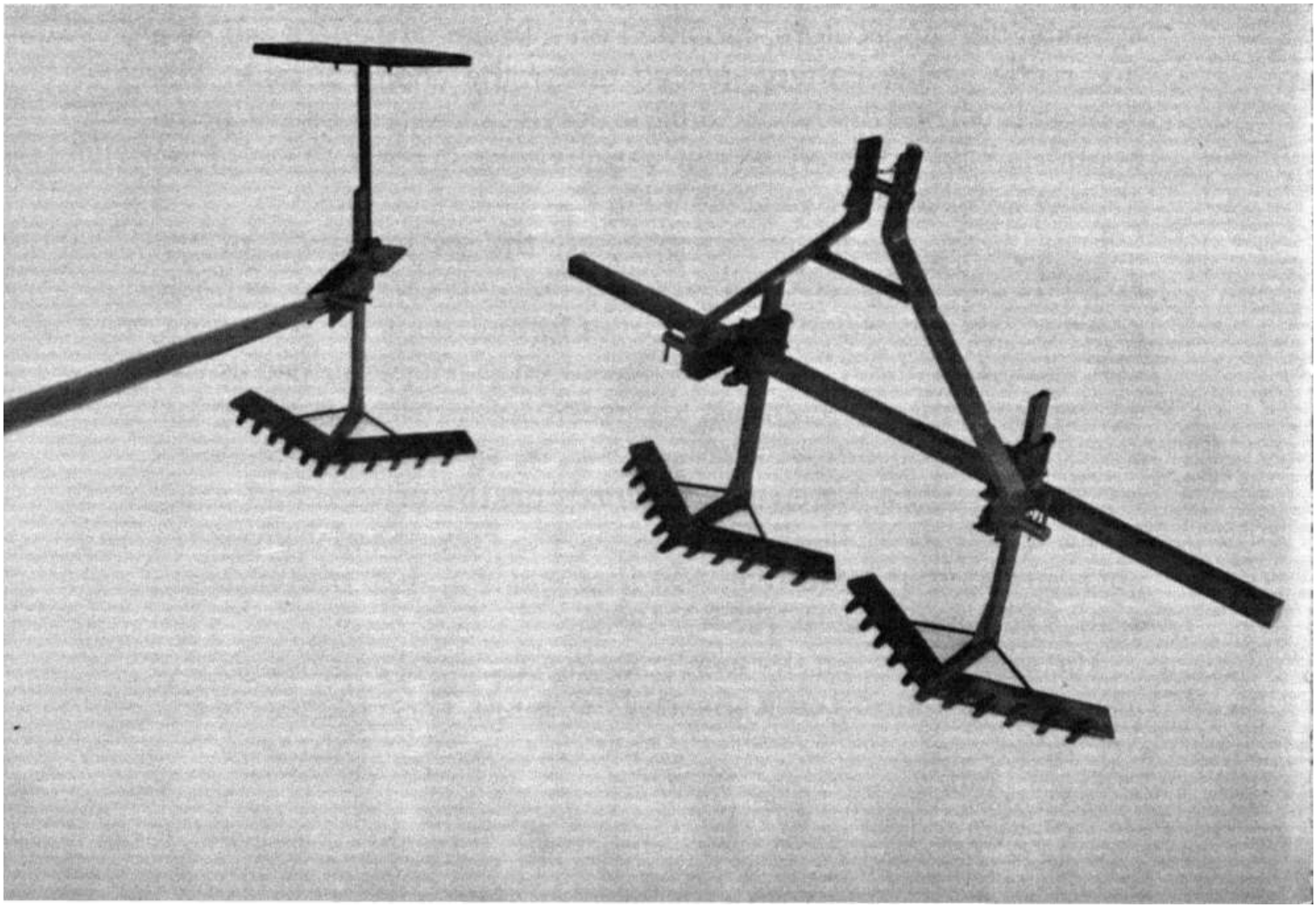
The spray boom on the twin spinning-disc sprayer is designed to allow the operator to walk ahead of the spray. This reduces the risk

to the operator from exposure to chemicals, which is less than that occurring when a portable single spinning-disc sprayer is used. The risk of exposure can be further reduced if a polythelene sheet is suspended from the sprayer frame or is worn as an apron to protect the legs of the operator. In addition, the operator must follow the rules for safe handling of agricultural chemicals, i.e., wear protective clothing, including a face mask and gloves when handling and mixing the concentrated pesticides. Spraying should be done only when there is little or no wind, and the operator should walk in such a way that the wind is always at least 30° across his path. Even with these precautions, very toxic chemicals must not be used in the spinning-disc sprayers (Awadhwal and Takenaga: in press).

Groundnut Digger

Groundnut in hard soil cannot be easily harvested manually and the existing lifting implements, mainly blade types, cannot penetrate to

Figure ***13. A groundnut digger for hard soils.***



the desired depth and do not work satisfactorily. Therefore, a new type of digger has been developed. The digger bottom has two shares inclined at 120° to each other. It has chisel points for proper penetration into hard soil (Fig. 13). A single digger attached to a draw-pole can be pulled by a pair of bullocks and two or more diggers can be pulled behind a tractor. A single digger covers a 60-cm strip or one row and has an average field capacity of about 0.04 ha^{-1}; it requires about 100 kg pull. Field tests showed that in a dry and hard Alfisol, where a blade-type digger failed to penetrate to the desired depth and left more than 25% of pods in the soil, the new digger worked well (ICRISAT 1989). It undercuts the main roots and leaves the plants as they are. They can then be lifted manually, and pods can be easily separated from the soil. The harvesting losses in the trial were about 5%, comparable to losses incurred during manual lifting of groundnut in moist soil.

Additional Information

For further information, contact manufacturers directly. Names and addresses of firms manufacturing these implements are listed on the back cover. There may be other suppliers of whom ICRISAT is not aware. This listing should not be taken as an endorsement by ICRISAT. ICRISAT is not in any way responsible for the quality of manufacture. Parties interested in manufacturing these implements may send their requests for engineering drawings to the Director, Resource Management Program, ICRISAT, giving details of the workshop facilities and technical manpower available with them.

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ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1987. Pages 289-292 in Annual Report 1986. Patancheru, A.P. 502324, India: ICRISAT.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1988. Pages 312-314 *in* Annual Report 1987. Patancheru, A.P. 502 324, India: ICRISAT.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1989. Pages 181-183 *in* Annual Report 1988. Patancheru, A.P. 502 324, India: ICRISAT.

Suppliers of these implements discussed here and known to ICRISAT in August 1989.

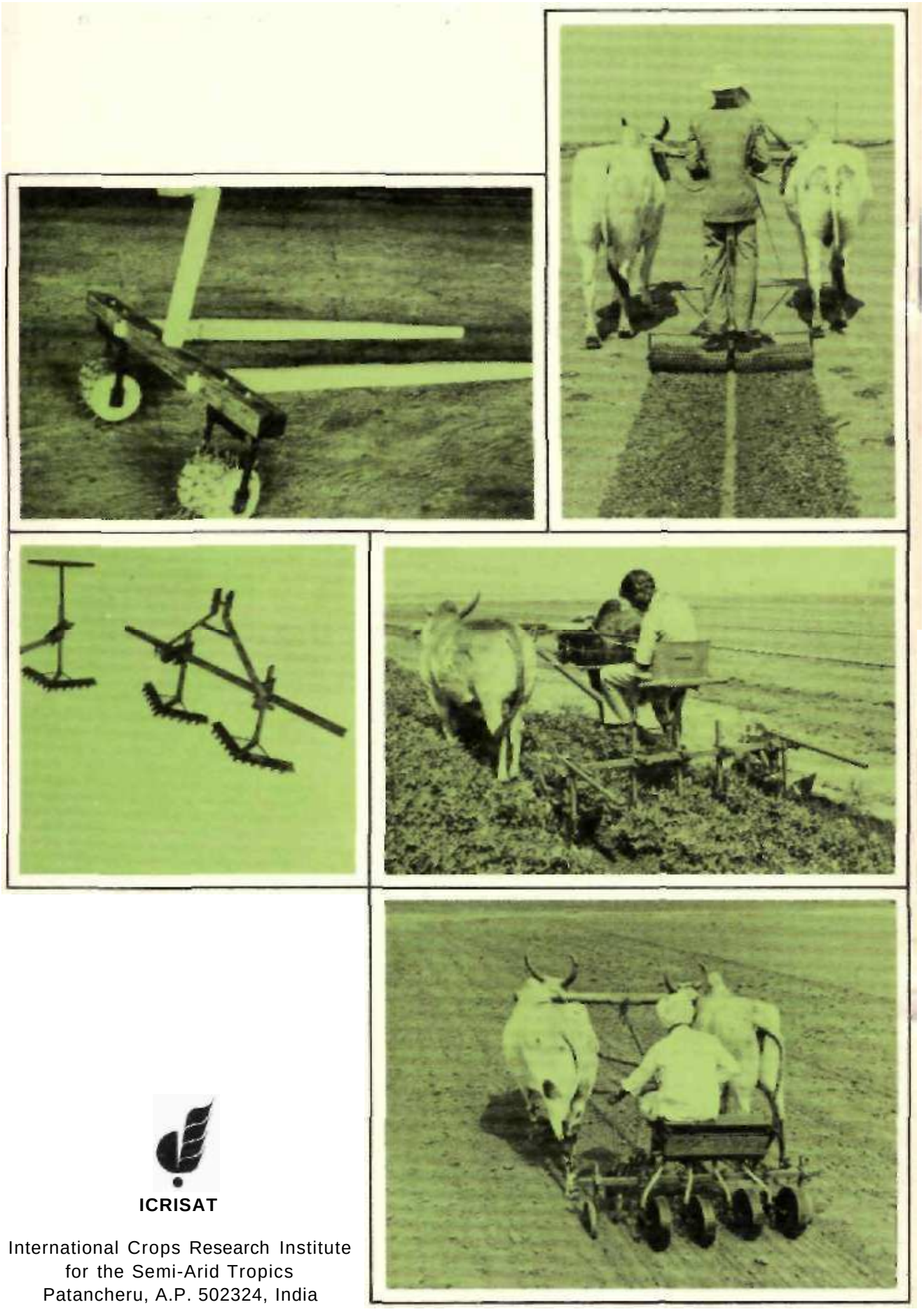
A.P. State Agro Industries
Development Corporation Ltd
Agro Bhawan 10-2-3, A.C. Guards
Hyderabad 500 004, India

Balaji Industrial and Agricultural Castings
4-3-140 Hill Street,
P O Box 1634
Secunderabad 500 003, India

Kale Krishi Udyog
31/2/2 Hinge Khurd
Vithalwadi, Sinnagad Road
Pune 411 051, India

K.V. Agro Industries
A-15, APIE, Balanagar
Hyderabad 500 037, India

Mekins Agro Products Private Ltd
6-3-866/A
Begumpet, Greenlands
Hyderabad 500 016, India



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