

De nouveaux outils pour les petits agriculteurs des zones tropicales semi-arides

Une série d'outils adaptés aux besoins des agriculteurs des zones tropicales semi-arides a été mise au point par l'ICRISAT en particulier Agribar II qui est utilisé pour divers types de travaux aratoires et peut être équipé d'une planteuse à quatre rangs. De simples barres supports en forme de T tirées par des bœufs servent à creuser de larges sillons, épandre les engrais, semer et cultiver en interlignes. Trois types de herbes brise-mottes ont été mis au point afin de favoriser la levée des jeunes pousses à travers la croute du sol. Un pulvérisateur à dos à double disque rotatif a été mis au point pour les cultures à croissance lente. Un soc à pointes facilitant la pénétration permet de déterrer les arachides dans les sols durs. Un cultivateur muni d'un semoir tiré par un âne a été conçu pour semer le millet et le sorgho en terrain montagneux et sarcler en interlignes dans les sols légers.

Nuevos aperos para los pequeños agricultores de las zonas tropicales semiáridas

Entre una serie de aperos apropiados para los agricultores de las zonas tropicales semiáridas puestos a punto en el ICRISAT figura el Agribar II que se utiliza en diversas operaciones de labranza y que se puede equipar con una sembradora de cuatro filas. Está basado en una barra en T sencilla y se han perfeccionado aperos tirados por bueyes para hacer surcos anchos, aplicar fertilizantes y sembrar y efectuar cultivo interlineas. Se prepararon tres modelos distintos de arado a fin de favorecer el nacimiento de las semillas a través de la costra del suelo. Para los cultivos que alcanzan poca altura se puso a punto un pulverizador de mochila de disco rotativo doble. Se fabricó una arrancadora de mani para suelo duro con puntas en cinco que facilitan la penetración. También se preparó un cultivador-sembradora tirado por un asno para la siembra del mijo y el sorgo en las colinas y para la escarda interlineas en suelos con textura ligera.

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New implements for small farmers of the semi-arid tropics

A range of implements have been developed at ICRISAT for farmers in the semi-arid tropics. They include Agribar II, used for various tillage operations and which can be fitted with a four-row planter, and simple T-bar bullock-drawn implements for making broadbeds, applying fertilizer, sowing and interrow cultivation, three different models of crust-breaker, covering one row, two rows and a metre-wide strip, to enhance the emergence of seedlings through the soil crust, a twin spinning-disc knapsack-sprayer for low-growing crops, a groundnut digger for hard soil, with chisel points to assist penetration, and a donkey-drawn cultivator-cum-seeder for sowing pearl millet and sorghum in hills and for interrow weeding on light-textured soils.

The objective of developing these agricultural implements has been to enhance the efficiency of farm inputs and operations while paying special attention to the better use of human resources and animal traction, a major source of power in the semi-arid tropics. The broadbed-and-furrow (BBF) system has been successfully tested to increase crop production in the semi-arid tropics (Virmani, Willey and Reddy, 1981). Farmers normally do not have access to implements suitable for making broadbeds and furrows, nor for subsequent operations. Wheeled tool carriers are ideal for this purpose (Awadhwai, Takenaga and Bansal, 1987) but are too expensive for many farmers. A range of simple bullock-drawn implements was developed to enable farmers to form a BBF system easily and to carry out subsequent field operations. Tools have also been developed to facilitate specific tasks such as breaking soil crusts to improve seedling emergence, spraying chemicals on short crops (for example, groundnut and chickpea), and digging groundnut in hard soil where blade-type diggers cannot penetrate to the desired depth. A donkey-drawn, low-cost implement suitable for farmers in the African semi-arid tropics was also developed for sowing and speedy weeding operations on light-textured soils.

AGRIBAR-II

This is an improved version of the Agribar. It is lighter, its tool bar is easier to lift and it can be fitted with a four-row mechanical planter. It can be fitted with a plough for primary tillage and with a blade harrow or duckfoot sweeps for preparation of seed-beds. 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 spacing if appropriate seed-metering plates are used with the planter (Fig. 1). Fertilizer can be applied in a band, either separately or during planting, with the help of a low-cost hand-metering device. Interrow cultivation can be carried out with duckfoot sweeps and blade harrows. A 15 cm plough, pulled by a pair of medium-sized bullocks (300 kg each) would cover about 0.2 ha in a six-hour day. However, a 150 cm cultivator would cover about 2 ha in a day.

T-BAR BULLOCK-DRAWN IMPLEMENTS

The central component common to these implements is a T-bar made from either iron or wood. 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. A range of operations can be carried out using the implements described below.

Broadbed former. Two ridgers are attached to the T-bar with adjustable spacing up to 1.5 m. The ridgers make two 30 cm parallel furrows on each side of a broadbed. A chain is attached behind the ridgers to smooth the top of the broadbed (Fig. 2).

Broadbed former with fertilizer 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 and rows to be made and fertilizer to be applied all in one operation (Fig. 3).

Planter. A four-row planter, developed for groundnut, is mounted on the T-bar along with four furrow openers and a pair of wheels to control the depth of seed placement and facilitate transport of the implement. Press wheels are attached to the furrow openers to compact the seeded rows (Fig. 4). However, for sowing in dry soil a chain can be used in place of press wheels to cover the sown rows. A low-cost hand metering device can be attached to 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 and maize.

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. 5).

These implements can be operated using a pair of medium-sized bullocks (300 kg each). Field tests indicate



Sowing with a mechanical planter and fertilizer applicator.

A low-cost hand metering device is attached to an Agribar II

Semis à la planteuse mécanique avec applicateur d'engrais. Un dispositif de dosage manuel bon marché est monté sur un Agribar II

Siembra con una sembradora mecánica y un aplicador de fertilizantes. Se ha acoplado a un Agribar II un alimentador manual de bajo costo



Broadbed former on a wooden T-bar

Herse servant à creuser de larges sillons (sur barre de bois en T)

Arado para surcos anchos (en una barra en T de madera)



Broadbed former with hand metering device for fertilizer application

Herse munie d'un dispositif de dosage manuel pour l'épandage d'engrais

Arado para surcos anchos con un alimentador manual para la aplicación de fertilizantes



Four-row planter attached to an iron T-bar

Planteuse à quatre rangs montée sur une barre de fer en T
Sembradora de cuatro líneas acoplada a una barra en T de hierro

that the average field capacity of each implement is about 0.25 ha per hour and the draught required is in the range of 50 to 70 kg.

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. Soil crust must be wetted frequently or mechanically broken to promote the emergence of seedlings. Breaking the crust with a hand-tool such as a sickle can require 200 work hours per hectare (Awadhwai, 1988).

A manually operated single-row crust-breaker with tandem rollers was developed to break soil crusts over seeded rows. It covers a 15 cm strip and is suitable for crust-breaking operations on ridges and on flat land. A manually operated crust-breaker was also developed to cover two rows in one operation. It consists of two inclined roller units. Spacing between the rollers could be adjusted to match the row spacings. Multiple units of either the inclined or tandem roller crust-breakers can be attached to a tool bar pulled by a pair of oxen or a small tractor (Awadhwai and Thierstein, 1983). An animal-drawn crust-breaker with a pair of inclined rollers covering a metre-wide strip has also been developed (Fig. 6). It can cover 1 ha in about three hours. In field tests these implements broke the crust completely, damaged less than 1 percent of the crop seedlings and enhanced the emergence of pearl millet and sorghum seedlings to levels achievable under non-crusting conditions.

SPINNING-DISK KNAPSACK-SPRAYER

A twin spinning-disc knapsack-sprayer for short crops such as groundnut, chickpea and mung bean combines features of the conventional knapsack-sprayer and the hand-held spinning-disc ULV applicator (Fig. 7). It consists of a 10 l chemical tank fitted to a tubular frame. Two spinning-disc applicators, placed on a boom, are energized by a 6 V rechargeable battery, mounted 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 for the application of pesticides on groundnut, chickpea and mung bean indicated that the spinning-disc knapsack-sprayer performed as well as the conventional knapsack-sprayer. It covered a 3 m swath, required only 15 l of water and about 90 minutes to spray 1 ha, whereas the conventional knapsack-sprayer required more than 400 l of water and 20 work hours to spray the same area (Awadhwai *et al.*, 1990a).

The sprayer is designed to allow the operator to walk ahead of the spray, which reduces the risk of the operator's exposure to chemicals compared with a portable single spinning-disc sprayer. The risk of exposure can be further reduced if a polythene 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



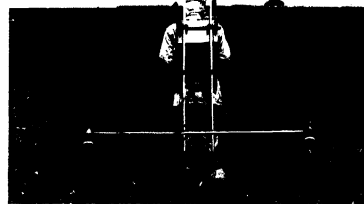
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Interrow weeding attachment on a broadbed former
Dispositif de désherbage en interlignes monté sur une herse
Dispositivo acoplado a un arado de surcos anchos para la escarda interlignes



6
Crust-breaker: (A) animal-drawn crust-breaker with inclined rollers; (B) manual single-row crust-breaker; (C) multiple units of crust-breaker with a tandem-roller attached to an animal-drawn tool bar

Herse brise-mottes: (A) à traction animale munie de rouleaux inclinés; (B) manuelle à un seul rouleau; (C) à plusieurs rouleaux montés sur une barre porte-outils à traction animale

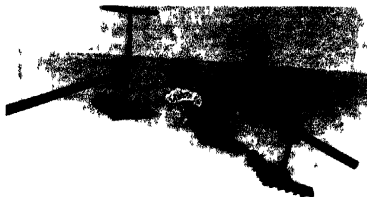
Arado para romper la corteza: (A) arado para romper la corteza de tracción animal con rodillos inclinados; (B) arado manual de una sola línea para romper la corteza; (C) unidades múltiples de arado para romper la corteza con rodillo doble acoplado a una barra porta-aperos de tracción animal



7
Twin spinning-disc knapsack-sprayer for groundnut and other short crops

Pulvérisateur à dos à double disque rotatif utilisé pour les arachides et les autres plantes de petite taille

Pulverizador de mochila de disco rotativo doble para el mani y otras cultivos de poca altura



Groundnut digger for hard soils
Soc pour déterrer les arachides en sol dur
Arrancadora de mani para suelos duros



Donkey-drawn cultivator
Cultivateur tiré par un âne
Cultivador tirado por un asno



Donkey-drawn two-row hill-seeder
Semoir à deux rangs tiré par un âne, pour cultures en terrain
Sembradora a golpes de dos filas tirada por un asno

for safe handling of agricultural chemicals including the wearing of protective clothing such as a face mask and gloves when handling and mixing the concentrated pesticides. Spraying should be done only when there is little wind and the operator should walk in such a way that the wind blows at an angle of at least 30° across his path (Awadhwal and Takenaga 1989).

GROUNDNUT DIGGER

Groundnut grown in hard soil is not easy to harvest manually and the existing lifting implements, mainly blade types, cannot penetrate to the desired depth and do not work satisfactorily. For these reasons a new type of digger was developed. The digger bottom has two shares inclined toward each other at 120° and there are chisel points for penetration into hard soil (Fig. 8). A single digger attached to a draw pole can be pulled by a pair of bullocks and two or more diggers can be pulled by a tractor. A single digger covers a 60 cm strip or two rows and has an average field capacity of about 0.04 ha per hour. It requires about 100 kg pull. Field tests showed that in a dry and hard Alfisol where a blade digger failed to penetrate to the desired depth and left more than 25 percent of pods in the soil, the new digger worked well. The harvesting losses were about 5 percent, comparable to losses incurred during manual lifting of groundnut in moist soil (Awadhwal and Smith 1989).

DONKEY-DRAWN CULTIVATOR-CUM-SEEDER

A low cost cultivator cum seeder to be pulled by a donkey was designed and made in Mali. Its construction is simple and it can be made with local materials. It consists of a wooden mainframe on which three duckfoot tines or the seeder attachment (furrow openers or seed hopper) and a gauge wheel are attached with the help of specially designed clamps. The position of the duckfoot tines or furrow openers and the wheel can be adjusted with respect to the frame which helps in controlling the depth of cultivation or seeding and facilitates transport of the implement. It can be hitched to a donkey with the harness used for donkey carts (Awadhwal *et al.* 1990b).

The seeder attachment consists of a seed hopper and gravity fed seed metering device of the stationary-opening type. The size of the metering hole controls the seeding rate and can be selected according to the size and quality of seed. A shutter is provided at the bottom of the hopper to halt the dropping of seeds when desired. A manually operated agitator is also provided in the seed-box to maintain a steady flow of seeds through the metering device. The furrow-openers have a trap and release mechanism that keeps the bottom end of the furrow-opener closed. Seeds dropped from the hopper pass through plastic tubes and accumulate in the furrow-opener. Actuation of the release mechanism allows the seeds to fall in hills. The actuator is a lever attached to the gauge wheel and operates twice for each complete turn of the wheel.

The donkey-drawn cultivator was tested for interrow

weeding in pearl millet and maize crops. Its draught requirement on a sandy soil was about 32 kg for a 45 cm strip and its field capacity was about 0.1 ha per hour. The two-row seeder was successfully tested for sowing pearl millet and sorghum in hills. The average spacing between two consecutive hills in each row was 42 cm and the number of seeds per hill was 15 and five for pearl millet and sorghum respectively. Spacing between rows is adjustable up to 90 cm.

CONCLUSIONS

Agribar II is a simple, lightweight and versatile tool carrier with wheels that can perform all the field operations required to adopt improved crop production practices in the semi-arid tropics.

The T-bar implements constitute a simple and affordable option for farmers adopting the BBI system and the improved cultural crop production practices that accompany it.

The spinning disc knapsack sprayer requires less water, labour and time for spraying than other conventional equipment and is especially suited to low-growing crops. The groundnut digger allows successful harvesting in difficult and hard soil conditions where existing blade implements fail, while the donkey-drawn cultivator-cum-seeder is a simple and low-cost implement which is suitable for light soils and can perform fast and timely seeding and weeding operations, thereby helping to increase crop production in the African semi-arid tropics.

An important consideration is that the design of these implements is simple so they can be constructed in small workshops with locally available materials.

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