REPORT ON

FARM EQUIPMENT DEVELOPMENT PROJECT
DAUDAWA, N.C.S. NIGERIA

November 1971 – December 1973

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The appearance of this report by Mr. John Boyd on the work of the Farm Equipment Development Project at Daudawa in the North-Central State of Nigeria is a matter of profound satisfaction to the Intermediate Technology Development Group Ltd. which sponsored the project. As Chairman of the Agricultural Panel of I.T.D.G. which provided remote supervision of the work, it is my privilege to write an introductory foreword.

Among recent publications by I.T.D.G. is a report by Mr. Robert Mann on the use of farm-level surveys for the identification of technological bottlenecks in African agriculture. Mr. Boyd's report is the logical sequel to that of Mr. Mann, since it is concerned with the design, development, production and use of farm equipment at technological levels appropriate to the needs of communities with problems revealed by survey-work of the type advocated by Mr. Mann.

The work described by Mr. Boyd is of special interest in that all the equipment he describes is suitable for manufacture by village blacksmiths and artisans. The I.T.D.G. range of leaflets published in support of this and other reports covers four of the individual items mentioned by Mr. Boyd. In each case the leaflet gives a list of materials required to construct the particular piece of equipment so facilitating its manufacture and introduction to regions new to its use.

H. S. DARLING

15th August 1974
Information already available was co-ordinated to provide an outline of the pattern of agriculture in the project area. Weeding was identified as a labour bottleneck limiting crop production on farms employing animal draught for land preparation. Improvement in methods of weed control was made the primary objective of the project.

Implements were developed for applying liquid and granular herbicides, for mechanical weeding, for harvesting groundnuts and for processing kenaf. Single ox harness for light draught work was introduced into the area. The more promising machines were demonstrated and tried out by local farmers. Four mechanical weeders, a groundnut lifter and single ox harness were found to be suitable for use in the northern states of Nigeria at the present time.

All items were designed for local construction from easily available materials, using simple equipment. Prototypes were built at the project workshop, but additional machines for farmer testing were commissioned from local entrepreneurs as a step towards initiating local manufacture.

Manufacturing instructions for the successful machines were drawn up in a form suitable for publication in different languages and for interpretation by non-engineers.

INTRODUCTION

The Daudawa project shared the general objective of all the farm machinery development projects run by the Intermediate Technology Development Group (IT), which is to study the pattern of local agriculture, assess which labour bottlenecks limit production and introduce appropriate machinery to alleviate these bottlenecks.

Work towards the Daudawa project occupied the period November 1971 to December 1973. The period March 1972 to November 1973 was spent at the Ministry of Agriculture and Natural Resources Farm Centre at Daudawa, North Central State, Nigeria.

A short preliminary study undertaken in the United Kingdom was funded through a scholarship from the Agricultural Engineers' Association. The remainder of the work was funded by IT. Housing and workshop facilities were provided by the North Central State government. Running expenses for the project Land Rover, access to workshop and library facilities and assistance with farm trials of machinery were provided by the Institute for Agricultural Research (IAR) at Ahmadu Bello University, Zaria.
There was insufficient time for a full survey to be carried out in the Daudawa area. During the preliminary study undertaken in the UK papers published by the Rural Economy Research Unit (RERU) at IAR were examined. RERU had made surveys in villages chosen to be typical of the north of Nigeria and information from a study of three villages in the Zaria area had been tabulated by Norman (1970a). This data was plotted, together with rainfall distribution, using the calendar/histogram approach suggested by Mann (1971). This presentation gives a summary of the whole farming system on a single page, allows labour peaks to be easily identified and shows which farming activities contribute to the labour peaks. Additional tabulated information on the characteristics of a typical family farm in the Zaria area was found in another paper by Norman (1970b).

Norman's studies indicated that the peak usage of labour occurred during June and July and was largely expended on weeding. Research stations and commercial organisations in the UK concerned with weed control were therefore visited in order to obtain information on weed control techniques which might be of use in the project area.

During March and April, 1972, the Project Officer and the IT Agricultural Projects Leader toured the Daudawa area and held discussions with leading farmers, local extension staff and research staff at IAR before drawing up a detailed work programme for the project.

The project area around Daudawa differs from Norman's survey area in having a large number of farmers who use draught cattle and tend to farm more land than those who rely on hand labour. There is also a settlement scheme at Daudawa, where the farmers each have between six and sixteen hectares in a compact block. All of these settlement farmers own draught cattle. The Farm Centre at Daudawa is the base for a Tractor Hiring Unit which carries out primary cultivations for farmers at subsidised rates. At present the farmers who use draught cattle or hire tractors for land preparation are still weeding by hand hoe. It was reasoned that the speeding up of land preparation (relative to the hand work done in Norman's survey area) would probably tend to emphasise the weeding bottleneck.

The only animal drawn field implement in general use is the Emcot ridging plough, which is not particularly effective for weeding, although it does kill some weeds during the 'earthing up' operation. The more versatile Ariana and Unibar animal drawn toolbar systems, which are capable of performing a wide range of farming operations, including inter-row weeding, have not proved popular with farmers in the Daudawa area, who believe the Emcot ridger is better suited to their soil type.

The major crops grown in the area are millet, sorghum, groundnuts, cowpeas and cotton. Most upland crops are grown on ridges at 75 cm. - 90 cm. spacing, this system being used by hand farmers as well as mechanised farmers. The earliest crop, millet, is planted by hand farmers in the previous year's furrows and the old ridges are later split over the growing
crop. Farmers who use draught cattle or hire tractors make new ridges on top of which they plant millet. Other crops are generally planted on top of the ridges by both hand farmers and mechanised farmers. Flat cultivation is used for upland rice and for most crops grown on the low lying *fadama* land.

Intercropping is widely practised in the area. The crop patterns used are systematic rather than random, but cropping on any one ridge is normally mixed and alternate row or strip cropping systems, which are more compatible with mechanisation, are rarely found.

At the end of the tour of the Daudawa area the following work priorities were drawn up (Mann, 1972):

(a) To develop improved techniques aimed at reducing the labour peak at the time of weeding and to assess the economy and acceptance of such techniques at farmer level.

(b) As found necessary along with the objective stated in (a), to broaden the field of development to include improved means of farm transport, crop harvesting, water lifting, etc., for the rural farming communities.
Characteristics of a typical traditional family-farm in the Zaria area, April 1966 to March 1967

<table>
<thead>
<tr>
<th>LAND</th>
<th>Variable specification</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Size of farm in acres (number of fields)</td>
<td>9.1 (6.4)</td>
<td></td>
</tr>
<tr>
<td>Land tenure: per cent of acres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inherited or a gift</td>
<td>75.4</td>
<td></td>
</tr>
<tr>
<td>Less secure types of tenure</td>
<td>24.7</td>
<td></td>
</tr>
<tr>
<td>Farm composition, total acres (acres fallow)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gona or upland</td>
<td>8.1 (1.6)</td>
<td></td>
</tr>
<tr>
<td>Fadama or lowland</td>
<td>1.0 (0.2)</td>
<td></td>
</tr>
<tr>
<td>Percentage of cultivated areas devoted to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sole crops</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>Crop mixtures</td>
<td>76.7</td>
<td></td>
</tr>
<tr>
<td>Per cent of adjusted cultivated acres in:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cereals</td>
<td>50.2</td>
<td></td>
</tr>
<tr>
<td>Grain legumes</td>
<td>24.2</td>
<td></td>
</tr>
<tr>
<td>Starchy roots and tubers</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>4.6</td>
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</tr>
<tr>
<td>Sugar cane</td>
<td>7.3</td>
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<tr>
<td>Non-food</td>
<td>7.3</td>
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<table>
<thead>
<tr>
<th>LABOUR</th>
<th>Variable specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Average family size</td>
<td>8.4</td>
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</tr>
<tr>
<td>Work on family farm: total man-hours</td>
<td>1753.3</td>
<td></td>
</tr>
<tr>
<td>Per cent composition:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family</td>
<td>84.7</td>
<td></td>
</tr>
<tr>
<td>Hired</td>
<td>15.3</td>
<td></td>
</tr>
<tr>
<td>Per cent by period:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June-July</td>
<td>25.8</td>
<td></td>
</tr>
<tr>
<td>February-March</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>Work per male adult per annum:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours per day worked</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Days worked on family farm</td>
<td>141.1</td>
<td></td>
</tr>
<tr>
<td>Days in off-farm occupations</td>
<td>82.8</td>
<td></td>
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over/
CAPITAL

Value of durable capital, April, 1966
(in shillings) 156.4

Imputed expenditure on capital goods, April, 1966 to March, 1967:

| Durable | 41.6 |
| Non-durable (per cent purchased) |  |
| Seed | 140.3 (17.1) |
| Fertilizer | 8.2 (18.5) |

CASH EXPENSES

Total in shillings (per cent spent on hired labour) 254.8 (58.0)

INCOME

Gross farm income in shillings
From crops (per cent sold) 1882.1 (40.5)
From livestock 27.5
Costs of production 327.7
Net farm income 1581.9
Off-farm income 505.0
Total income 2086.9

Source: Norman (1970b)

1 Defined as those people eating from one pot.
2 For example, pledge, loans, etc.
3 In calculating the adjusted acreage, each crop in a mixture was allocated an acreage by dividing the acreage of the crop mixture by the number of crops in the mixture.
**DEVELOPMENT OF FARM MACHINERY**

A. **HERBICIDE APPLICATION EQUIPMENT**

**Peristaltic Pump Sprayer**

A simple, wheeled, hand pushed herbicide sprayer was constructed using the principles of the Plant Protection Ltd. 'Polyrow' sprayer. The peristaltic pump of this machine is cheap, has no valves, has no metal parts in contact with the liquid and can be reversed to provide a 'suck back' effect and prevent dripping from the spray nozzle. It supplies liquid to a floodjet nozzle at a pressure low enough to eliminate spray drift almost completely. The sprayer was passed to IAR, where possibilities for its application in vegetable growing are being studied.

**Granule applicators**

The IAR Agronomy Department requested development of an applicator for fertilizer granules into which herbicide had been incorporated, the granules to be spread in a 15 cm. wide band on top of the ridges to control weeds in the crop rows while the inter-rows were mechanically weeded.

A Planet Junior hand pushed seeder was modified to spread a band of granules by replacing its seed tube with a fan shaped outlet.

A similar Planet Junior-based applicator was fitted to an Ariana toolbar and a simple direct drive from a spiked wheel was used to replace the original bevel gears and shaft drive to the metering mechanism. Standard Ariana soil moving components were added to enable a ridge to be built and granules to be applied, either on the surface or incorporated into the soil, simultaneously.

A simpler, more robust applicator with a larger hopper capacity was built from locally available mild steel sheet, water pipe and reinforcing rod, using normal hand tools and welding equipment, and fitted to an Ariana toolbar. It was found to be capable of spreading superphosphate granules in a 15 cm. wide band at rates between 10 kg. and 500 kg. per total hectare on the 75 cm. spaced rows used in the Daudawa area.

The granule applicators were passed to IAR for use in experiments.
B. MECHANICAL WEEDING EQUIPMENT

Rotary Hoes

Information on weeding implements already known to be satisfactory under local conditions was sought and it was found that the Agricultural Estates Manager of IAR made considerable use of a tractor mounted, ground driven rotary hoe. This machine could safely weed closer to a crop than sweep cultivators, had low draught, would roll over any stones, stumps or other obstructions and could be set to maintain the profile of the ridges during the weeding operation. Although often used at high speeds, the machine could still work well at speeds as low as 2 k.p.h. These qualities made the rotary hoe principle attractive as the basis for an animal drawn weeding implement.

A prototype rotary hoe was constructed for use with an Ariana toolbar. The machine was demonstrated to farmers during September, 1972, and their response was favourable. It was found that the machine was virtually self cleaning and worked well in a wide range of soil moisture conditions. Setting of the machine to weed both sides of one ridge at a time made it effective even when the crop rows were far from parallel. The Ariana mounted rotary hoe was used successfully for weeding crops up to 30 cm. high, governed by the clearance under the toolbar frame, and was suitable for all weeding of groundnuts and for early weeding of taller growing crops.

An assembly for weeding two 75 cm. - 90 cm. spaced ridges was set up using the Ariana toolbar with its rear frame extension. This was only suitable for weeding crops planted on parallel ridges. The same assembly was able to align pairs of ridges which were previously only approximately parallel and could thus be used before planting to align pairs of ridges for subsequent two row weeding operations.

To overcome the main limitation of the Ariana mounted rotary hoe a special high clearance frame was designed, allowing crops up to 75 cm. high to be weeded. Four examples of this high clearance rotary hoe were commissioned from a local blacksmith/welder (price $28 each) and tested by farmers on the Daudawa Settlement during the 1973 season. Most farmers were pleased with the work done and found that the machines were easy to handle. The testing is reported in more detail in pages 14 - 16.

Further testing and development of the high clearance rotary hoe were carried out on the project experimental plot in 1973. The machine was used for weeding millet, sorghum, maize, groundnuts and cotton, all planted on 75 cm. spaced ridges. In general it was most effective when the weeds were small and in soft soil conditions. It could be used in wet soil and cotton was successfully weeded when there was water standing in the furrows. It was least successful in very hard soil conditions, when penetration was poor. Penetration into hard soils could not have been improved without rendering the design unsuitable for manufacture by local blacksmith/welders.
Although no formal durability testing was possible it appeared that the mild steel tines would be acceptable in this application. The tines were cut from rods using bolt cutters and after the machines had been used over 10 ha. the marks of the bolt cutters were still clearly visible. This suggests that the rate of wear would be very slow on farms in the 6 ha. - 16 ha. size range as found in the Daudawa Settlement.

Three modifications to the high clearance rotary hoe were tried out:

(i) Adjustable angle rotors to suit different ridge profiles were used successfully on test plots, but were less robust than the fixed angle versions tried out by farmers and were less suitable for manufacture by local blacksmith/welders. Farmers would probably do better to try to make uniform ridges and use a machine with fixed angle rotors.

(ii) Small spider wheels running very close to the crop and in front of the main rotor gangs enabled a greater proportion of the field to be mechanically weeded, but caused considerable crop damage unless the crop rows were straight and the machine handled very carefully. This modification is probably not suitable for farmers' use at present, but should be reconsidered if mechanical planting is introduced.

(iii) Sheet metal shields prevented soil moved by the rotors from smothering very young crop plants. The shields were removed later in the season, allowing soil to be built up round the base of the crop. This modification would be suitable for use by farmers.

In an attempt to produce a very cheap, multi-purpose weeding implement, simple lightweight rotary hoe gangs were built with frames enabling them to be used in three configurations:

(i) As a hand pushed weeder for ridge planted crops, using the light draught characteristics of the rotary hoe with the wheeled push hoe principle.

(ii) As a single animal draught inter-row weeder for ridge planted crops.

(iii) As a tandem-rotor, hand pushed rice weeder.

None of these applications of the lightweight rotary hoe was very successful under field conditions at Daudawa. On ridge planted fields the clods and stones often prevented the small diameter rotors from turning freely. On the Daudawa rice fields the soil moisture content was too variable for this type of weeder to be used effectively.
IDC Emcot Weeding Attachment

The weeding attachment designed at the Industrial Development Centre in Zaria for use with the Emcot ridger consist of a frame which is attached to the Emcot beam and carries two weeding tines, set in front of the Emcot mouldboards. Modifications to the frame were made to simplify manufacture without affecting the functioning of the attachment. Four examples of the modified attachment were commissioned from a local blacksmith (price £10.50) and tested by Daudawa Settlement farmers during 1973. The weeding performance was good where the farmers had made uniformly spaced, parallel ridges. The farm testing is reported in more detail in pages 14 - 16.

The Emcot ridger with weeding attachment was easy to control if the Emcot depth wheel was used, but Daudawa farmers do not normally use the wheel and were adamant in their refusal to use it during the trials. Without the wheel the front of the Emcot beam tended to swing from side to side and the weeding tines swung with it, causing crop damage. This damage was reduced in a modification where the tines were set further back on the implement, but this was still not as satisfactory as using the wheel.

Dahomey Emcot Weeding Attachment

A very cheap and simple attachment to the mouldboards of a ridging plough, designed and used with success for weeding in the north west area of Dahomey, was constructed and tested. It was found to function well only in the sandiest fields in the Daudawa area. For the 1973 season three pairs of Emcot mouldboards with these weeding attachments were commissioned from a local blacksmith (price £7.50 per set) and sent for testing to Kafin Soli, an agricultural station 150 km. north of Daudawa. It was reported that the attachments worked well and seemed to be suitable for that soil type, which is sandier than that of Daudawa and similar to that of the north west of Dahomey.

Bedder Sweep Tine

A bedder sweep weeding tine, similar to that described by Willcocks (1969) for digging up weeds from the furrow and smothering those on the ridge side, was constructed, fitted to a Unibar toolbar and tested. It was not effective at Daudawa, where most weed growth occurs on the ridge sides, furrow bottom weeds being killed by waterlogging or smothered by soil washed down from the ridges. It would probably be more effective in lower rainfall areas, where more weed growth would occur in the furrows.

Emcot Dry Season Cultivator Attachment

The IAR Agronomy Department requested work on a cultivator to loosen soil to a depth of 15 cm. during the dry season. It was hoped that this would:

(a) cause the soil to dry out sufficiently to kill perennial grass weeds.
permit the first rains to enter the soil profile rather than run off, facilitating subsequent ridge splitting.

A low-rake-angle chisel tine was bolted onto an Emcot ridger beam in place of the standard ridging body to form an ard-like implement. With this implement a pair of cattle was able to cultivate during the middle of the dry season (January) to a depth of 15 cm. To simplify attachment of the chisel tine, clamps were devised for it and for the standard Emcot ridging body to enable either to be fitted to the Emcot beam in a few seconds after removing one locating pin.

Dry season cultivation was demonstrated to Daudawa Settlement farmers, who acknowledged the potential value of the operation, but felt it would not be worth keeping their cattle fed well throughout the dry season in order to do this work.

**Expandable Cultivator**

A lightweight cultivator suitable for construction by local blacksmiths was built and demonstrated and farmers liked the machine, which was very effective for weeding between parallel rows and easier to handle than the Emcot with IDC weeding attachment. The cultivator was designed as a cheap weeding implement for local manufacture rather than as a direct replacement for the all-metal, lever adjustment cultivators formerly imported into Nigeria, which were strong enough for ridge breaking as well as weeding. The cost of materials to make the IT cultivator was approximately N 6 and it was thought that a selling price of N 12 to N 15 would be reasonable. However, local blacksmiths recalled that the imported machines had been sold at N 30 each and would not make the IT design for less. The wooden frame of the IT cultivator could only be expected to last a few seasons and it would be very difficult to justify a price as high as N 30.

**Rotary Rice Weeder**

A tandem rotor, hand pushed implement of the type used in the Far East was built and tested with both spike toothed rotors and backward-curved-tine rotors. It was very effective over small areas with uniform soil moisture content, but not suitable for the Daudawa rice fields with their non-level surfaces where the soil was dry in some places and flooded in others. The implement should be suitable for properly levelled paddies or for fields of irrigated wheat, which in the north of Nigeria is grown in a similar manner to paddy rice.
C. CROP HARVESTING AND PROCESSING EQUIPMENT

Groundnut Lifter

All the groundnut lifters available - IDC Emcot Groundnut Lifter Attachment, Ariana, Unibar, Ring Blade Lifter, Offset Beam Toolbar (Stokes, 1963) - were field tested during 1972. The most effective and convenient lifter for use under Daudawa conditions was the Unibar. It was observed that a complete machine, similar in form to the Unibar as set for groundnut lifting, could be made more easily and cheaply than the IDC Emcot attachment and would be more convenient for the farmer. It would be suitable for a farmer who already possessed an Emcot ridger and did not wish to buy one of the imported toolbars. A machine was built and tested and found to function well. Farmers' response to the IT lifter during demonstrations held in 1972 was favourable.

Five examples of the IT Groundnut Lifter were commissioned from a local blacksmith (price N 9.50 each) for farmer testing during 1973. Unfortunately the testing was on a much smaller scale than had been planned because fewer groundnuts than usual were planted on account of the late rains and many of the crops which were planted were destroyed by monkeys. The limited trials which were conducted confirmed the 1972 observations that the machine worked well so long as the crop was not overgrown with weeds.

Kenaf Ribboner

A prototype hand turned ribboner was built to function in the same way as the large, powered machines developed and used in the Caribbean area. The kenaf stalks were gripped between a pair of small diameter, low speed rolls and allowed to move slowly between a pair of large diameter, high speed, fluted rolls, which stripped the fibres from the unwanted pith. The chain drives and bearings for the rolls were made from bicycle components.

The ribboner worked well when used with small diameter (less than 1.5 cm.) kenaf stalks, but was difficult to turn when used with larger diameter stalks. The output of cleaned ribbons was not very much greater than that obtainable by hand stripping and it would probably not be worth while proceeding with development of the ribboner as a hand turned machine. A similar machine powered by a petrol engine of 3 kw. and using motor cycle rather than pedal cycle components for the chain drives and bearings would have a much greater output and might be suitable for a large farm or co-operative.
D. MISCELLANEOUS EQUIPMENT

Flap Valve Pump

It was considered that the NIAE Flap Valve Pump, said to be capable of high output at low lifts and virtually unblockable, might be a suitable replacement for the shaduf, which is currently used for irrigating the fadama land. This work was taken over by IAR, where a pump has been built and tested.

Single Ox Yoke

A very cheap and simple yoke of the type developed in Dahomey was made to enable a farmer to use his cattle singly for light draught work such as weeding. One of the most experienced Daudawa Settlement farmers, who has well trained cattle, used the yoke for weeding during the latter part of the 1973 season and found little difficulty in training his cattle to work singly.

Emcot Wheel Clamp

The performance of the IDC Emcot Weeding Attachment was impaired because Daudawa farmers did not use the Emcot depth wheel. It was suspected that this was partly because fitting and adjusting the wheel was a tedious job for which a well-fitting spanner was necessary. A simple clamp was made so that the depth wheel could be fitted and adjusted quickly without using a spanner.
The objective of the trials was to find out whether the machines developed during 1972 were acceptable to farmers. The implements considered to be in a suitable state of development were the modified IDC Emcot Weeding Attachment and the IT High Clearance Rotary Hoe. Four examples of each were commissioned from local entrepreneurs and issued to farmers on the Daudawa Settlement. The farmers used the machines under guidance during the 1973 season. Their opinions of the machines' weeding performance and acceptability were recorded as answers to a questionnaire drawn up by the IAR Rural Sociology Section.

To obtain a quantitative indication of the labour saving potential of the machines, the farmers' labour inputs for weeding on measured plots were recorded by a member of IAR staff and compared with the labour inputs on five other Daudawa Settlement farms where the only animal drawn implements in use were Emcot ridgers. The farmers were all selected in consultation with the IAR Rural Sociology Section and the Daudawa village head.

On each farm a plot of 0.5 - 1.0 ha., to be planted with either millet or sorghum, was selected. Farmers were asked to prepare the land in their usual way and use the IT machines for weeding. The farmers were each given two bags of fertilizer as an incentive to co-operate in the trials.

Under the existing system the farmers' operations are normally:

(i) Land preparation by direct splitting of previous year's ridges with Emcot ridger.

(ii) Hand planting.

(iii) Weeding with hand hoe.

(iv) Thinning.

(v) Fertilizer application.

(vi) Re-ridging with Emcot mouldboards at narrow setting to avoid smothering the young crop.

(vii) Weeding with hand hoe.

(viii) Re-ridging with Emcot mouldboards at wide setting to build soil around the base of the crop.

There is some variation in the sequence of operations and in the number of hand weeding and re-ridging operations carried out.

In the trials with mechanical weeders the hand weeding operations were replaced by machine weeding of the inter-rows plus hand weeding of the tops of the ridges.

Detailed results of the trials are given in Appendix III. In general the farmers found that the machines were easy to use and saved labour for weeding. The farmers' enthusiasm...
for the machines was in fact much greater than the labour input results would appear to warrant, the average saving in total labour for weeding being only 18%. Not too much reliance should be placed on the figures for labour inputs because there are many possible causes of variability in results from a mechanical weeding trial. Some of these are:

(i) Numbers of weeds and weed seeds present at start of trial.
(ii) Effectiveness of land preparation in killing seedbed weeds.
(iii) Species of weeds present.
(iv) Soil type.
(v) Soil moisture content at time of weeding.
(vi) Weather conditions immediately after weeding.
(vii) Setting of machines.
(viii) Size of weeds at time of weeding.
(ix) Location of weeds relative to crop plants - depends partly on extent of crop cover, which in turn is affected by crop variety, spacing and fertilizer treatment.

Reliable experimental results can only be expected where some of the above factors can be controlled.

Part of the enthusiasm for the machines was probably due to the farmers' desire to please when answering the questionnaire. However, the farmers definitely began to appreciate the machines more and make better use of them as the season progressed and numerical results might be expected to favour the machines more after one or two seasons use. The IDC Emcot Weeding Attachment requires parallel ridges for efficient working, but most farmers in the Daudawa area do not at present make their ridges exactly parallel. Thus at the beginning of the trials the farmers said, "This machine is not very useful because it does not suit our ridges." By the end of the season they had realized the potential of the attachment and were saying, "This machine could be very useful to us - we shall try to make our ridges parallel next year."

The exceptionally dry conditions at the beginning of the 1973 season influenced farmers' willingness and ability to co-operate in the weeding trials. The work cattle were underfed and weak and the number of days when the soil was soft enough for ridge splitting was limited. Farmers therefore had to conserve the strength of their cattle for land preparation and did not want to give them the extra work of weeding. In the early part of the season the farmers had planted only small areas of crops and when the soil was too hard for ridge splitting they had plenty of time for hand weeding. Farmers who were willing to use the machines would only do so when the ground was too hard for the essential work of ridge splitting in preparation for later planted crops. This had a greater detrimental effect on the performance of the rotary hoe, which does not work well in hard conditions, than that of the IDC
attachment, which can work fairly well in hard soil.

Several farmers said they wished to buy the implements they had been using during the trials. However, IAR hopes to conduct further trials in 1974 and the machines were therefore left with the farmers. Additional machines were commissioned from the local blacksmiths to enable the Daudawa trials to be held on a larger scale in 1974 and to enable the Extension Research Liaison Service of IAR to test the machines in different locations throughout the northern states of Nigeria.
A. DESIGNING FOR LOCAL/ MANUFACTURE

The machines produced by the project were designed for manufacture in Nigeria at one of two levels of technology:

(i) Village blacksmith

There are very many skilled blacksmiths working in rural areas in the northern states of Nigeria. Most of them make only traditional hand tools, but some make parts for the Emcot ridger and a few make complete ridgers. These blacksmiths could make the IDC and Dahomey Emcot Weeding Attachments, IT Expandable Cultivator, IT Groundnut Lifter and Single Ox Yoke.

(ii) Blacksmith/welder

A number of blacksmiths have been trained at the Industrial Development Centre in Zaria and have received government loans to purchase welding and drilling equipment and small hand tools. These blacksmith/welders could make the same items as the village blacksmiths and also the IT Rotary Hoe, IT Emcot Dry Season Cultivator Attachment, IT Rice Weeder and IT Emcot Wheel Clamp. With some further technical training, but using the same equipment, they could make the Peristaltic Pump Sprayer and IT Granule Applicator.

Where possible machines have been designed for construction from reinforcing rod and water pipe, because these builders' materials are much cheaper and more readily available in the rural areas than flat bars, angle iron or other engineering materials. Timber was used for some components where function would not be impaired by the warping which is common with locally available timbers. Most soil engaging components were forged from used motor vehicle spring leaves. Machines were designed to use standard lengths of steel and timber where possible to reduce wastage to a minimum.

B. INITIATION OF LOCAL MANUFACTURE

Before any new farm implement can be brought into use on a large scale it is necessary to:

(i) create a demand, by making farmers aware of the machine's existence.

(ii) ensure that the demand can be met by the manufacturing facilities.
Some machines developed in the past at IAR were made in small numbers for demonstration to farmers. It appears that in some cases the farmers liked the machines, but lost interest when nobody could tell them the source or price of the machines. Local blacksmiths, who might have been able to produce such machines, were probably not invited to the demonstrations.

The IDC machines were designed for local manufacture and local blacksmiths were trained to make them at IDC. However, at least in the Daudawa area, the IDC trained blacksmiths have not sold any such machines to farmers. It seems that these blacksmiths did not know how to promote sales of new designs. Farmers were unaware of the existence of such new designs and so could not ask for them to be made.

A number of examples of each of the more promising machines developed by the project during 1972 was required for farmer testing during 1973. It was desirable that this repetitive work should be farmed out to allow the project to concentrate on further development work. It was felt that repetition of past failures to get new machines into use on farms might be avoided simply by commissioning the project's test machines from entrepreneurs who worked in the rural areas and were already in contact with the farmers. The entrepreneurs would learn how to make the implements without suffering loss of income by going away for a training course. If the farmers liked the machines they could be told the source and price.

Initial demonstrations and promotion of the designs would take place under the project's testing programme.

This policy was put into effect and examples of the IDC and Dahaney Emcot Weeding Attachments, IT Groundnut Lifter, IT High Clearance Rotary Hoe and single ox yoke were made locally for the project.

One highly skilled village blacksmith using traditional equipment and one IDC trained blacksmith/welder were involved. Both were quick to appreciate the essential features of a design and were left to make their own modifications to minor parts (e.g., handles) to suit the materials most easily available. At the end of 1973 the village blacksmith received approval from the government for his application for a loan and he will shortly obtain additional equipment.

This method of initiating local manufacture appears to be a suitable one for any similar project working in an area where there are already plenty of skilled local craftsmen.
The drawing up of designs in a form suitable for dissemination throughout the developing world was considered an essential part of the project. It was envisaged that the designs might be useful to:

(a) Large agricultural machinery factories.

(b) Engineering departments of universities and large research stations.

(c) Small research and advisory centres without specialist engineering staff.

(d) Small rural workshops.

Categories (a) and (b) would be able to interpret manufacturing instructions in any form. Organisations in category (c) would be likely to have a handyman/agriculturalist who could interpret engineering drawings if these were supplemented by notes and by perspective and 'exploded' diagrams. Category (d) would probably need to work from patterns produced by one of the other categories.

Detailed manufacturing instructions for the successful machines have been drawn up in a form intended for use by category (c). Drawings of the less successful machines have been made in less detail because these would probably be used mainly as a source of information and ideas by designers in categories (a) and (b).

To simplify production of the designs in various languages, the written instructions were placed on separate sheets from the drawings. The drawings bear only dimensions and letters for reference to the written instructions, which can be translated into any language. The drawings have been made on A4 size sheets because these are more convenient than larger sheets for handling in a workshop, for printing and photocopying and for mailing.
A. REPAIR WORK FOR FARMERS

Many farmers said that the most helpful thing the project could do would be to repair their broken existing equipment. There was not sufficient time for much of this work and it was decided that the project would not accept any work which could have been done by repairmen in the local town, but would help farmers if no other repair facilities were available to them. In practice, the only such repairs accepted were the manufacture of lathe-turned bushes for an ox cart wheel and a few specialised welding jobs. This work was done free of charge. A good deal of repair work was refused because it could be done at several workshops in the local town.

If sufficient manpower were available in another project it would be worth considering providing repair facilities because this would be an excellent way of making contact with and gaining the confidence of the farmers.

B. BUSINESS MANAGEMENT TRAINING FOR LOCAL MANUFACTURERS

As was noted in the I.D.C. report 'Blacksmith Entrepreneurs and their Capabilities', the limitation to growth of these businesses is likely to be lack of management training rather than lack of technical skills. Several examples were noticed during the project's contact with local manufacturers.

Even items for which there is a steady demand, such as ox drawn ridgers, are normally only built to order and hence materials have to be purchased in very small quantities at high prices.

The blacksmiths' ability to bargain effectively for raw materials with local suppliers is limited because they seldom know the true value of the materials, although price lists are available from the distributors in Kaduna and Kano.

The Blacksmiths sometimes borrow at ridiculously high interest rates by accepting reduced prices in return for partial payment in advance. For example, one blacksmith preferred to make machines for the project for N 45 with a N 25 advance rather than for N 50 with payment on delivery. The order took one week to complete, hence the blacksmith reduced his price by N 5 in order to borrow N 25 for one week – an interest rate of 20% per week or 1300% per year.

Blacksmiths who build copies of the factory-made Emcot ridger also copy the blue colour paint and thus help to advertise the factory product, whereas they could be advertising their own work if they used a different colour paint.

Any future project should consider offering some type of business management training to local entrepreneurs.
Observations made over two seasons with the Daudawa farmers suggest that some of the most important factors contributing to the weeding bottleneck are:

1. **Inefficient land preparation**

   The normal method of land preparation on ox powered farms at Daudawa is direct splitting of the previous year's ridges with the Emcot ridger. The Emcot mouldboards are shaped to give soil inversion and all weeds can be covered if the implement is correctly used. Farmers often fail to cover many of the seedbed weeds for two reasons:

   a. The Emcot only does a good job of ridge splitting if the share is sharp, but farmers tend not to replace the share until it is almost completely worn away. A locally made share costs N 1.50 and lasts for about 10 ha.

   b. The farmers' cattle are often weak and not capable of pulling the Emcot when set to move sufficient soil to cover all the weeds. When cattle are weak they cannot work many hours per day and are unable to take advantage of times when the soil is soft, hence they often have to work in difficult soil conditions. There are three main reasons for weakness of the cattle:

      1. **Poor feeding**

         Many cattle are turned out to graze during the dry season with very little supplementary feeding. They are weakest when first brought in for land preparation, though this is the period of hardest work for them. The situation could be eased by encouraging more conservation of cattle food for use in the dry season or by encouraging profitable dry season use of the cattle (e.g. pulling carts or cultivating the irrigated fadama land) which could justify their being better fed.

      2. **Sickness**

         The present high incidence of sickness in cattle is probably due as much to poor feeding as to lack of veterinary treatment.

      3. **Size of cattle**

         Farmers can often be seen using draught cattle which are very small. It appears that many farmers are in fact combining the use of draught cattle with a beef fattening enterprise. Cattle are bought and trained while they are cheap, young, small and amenable to handling.
They are worked for two to four years during which time they grow to their full size. They are then sold at a profit for slaughter and replaced with young animals. This practice means that the farmers spend a lot of time working with under-sized, under-trained cattle.

(ii) Delay between land preparation and planting

This delay, which is difficult to avoid when the farmer has a large area of land and land preparation proceeds slowly, allows weeds to re-establish and largely nullifies the weed control effect of the land preparation.

(iii) Late application of fertilizers

Most farmers ignore the recommendation to apply part of their fertilizer in the seed bed and do not spread either farmyard or artificial manures until the time of thinning, when cereal crops are 15 cm. to 20 cm. high. The result is that the crop cover which could suppress weed growth is slow to develop.

When asked why they apply fertilizers so late the farmers answer that:

(a) the crop might fail and they do not want to risk the fertilizer until they are sure of getting a crop.

(b) they do not want to waste fertilizer on those plants which are going to be removed during thinning.

There is truth in both of these arguments, although a crop which was given a good start in life by having fertilizer available from germination time would be less likely to fail later.

(iv) Late weeding

Farmers usually wait until there is a heavy growth of weeds before starting to tackle the problem, although research in many countries has indicated that better yields can be obtained using less labour if two timely weedings are carried out rather than one late weeding.

(v) Slow growing crop varieties

Many local crop varieties grow slowly in the early stages and hence may not compete with weeds as effectively as faster growing varieties which could soon shade out many of the weeds.

What is clear from the foregoing is that the proven existence of a weeding bottleneck does not necessarily mean that research must be aimed directly towards
mechanical or chemical weeding techniques. An indirect approach, such as work on conservation of fodder for draught cattle, development of equipment for use with cattle during the dry season or development of more competitive crop varieties may be just as rewarding in terms of alleviating the weeding bottleneck.

A very small number of farms in the Daudawa area appear to have hardly any weed problem. These are owned by farmers who kill seedbed weeds by using strong cattle to pull well maintained ridging ploughs, apply F.Y.M. and at least some of their artificial fertilizers in the seedbed, plant crops before weeds have had time to re-establish themselves, plant improved varieties obtained from their agricultural extension officers and do their hand weeding while the weeds are still small. Their crops grow quickly and often need only one hand weeding because the plants are soon tall and robust enough to permit complete weed control by earthing up with the Emcot ridger. These farms serve as a demonstration of the tremendous improvements which could be achieved by applying properly the existing knowledge and using the equipment which the farmer already possesses.

REFERENCES

1. Industrial Development Centre "Blacksmith entrepreneurs and their capabilities." IDC, Zaria.


3. Mann, R.D. (1972) "ITDG Farm Equipment Development Project - work programme." ITDG.


## SUMMARY OF PROJECT EXPENDITURE

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(Total approx. £625 Sterling)
APPENDIX II. HISTORY OF THE DAUDAWA SETTLEMENT

Overprint from: Ministry of Agriculture Northern Region Newsletter No. 37 September 1961, pp. 1 and 2.

FIELD SERVICES DIVISION, DAUDAWA GOVERNMENT MIXED FARMING SETTLEMENT, SOUTHERN KATSINA

Daudawa Government Settlement was initiated by the Empire Cotton Growing Corporation in 1926 to promote cotton production. Farm holdings of 15 acres were laid out and reliable farm labourers were settled on them on condition that each settler would cultivate a minimum of 8 acres of cotton for sale to R.C.G.C. Green manuring was advocated as the means of maintaining soil fertility. Green manuring, however, was a failure and the E.C.G.C. then provided the settlers with ploughs and cattle. The settlers thus became mixed farmers.

In 1941 the department of Agriculture took over the E.C.G.C. Estate at Daudawa and settlers' outstanding debts were transferred to Katsina N.A. mixed farming advances account.

Extension of this scheme was envisaged towards the end of the war by the Department of Agriculture, partly with the object of resettling ex-servicemen. A plan was drawn up in 1944 for 100 settlers each on a 15-acre holding. Experimental semi-permanent cattle pens were constructed for some farmers. The scope of the scheme was enlarged from the promotion of cotton production to the establishment of model mixed farmers applying improved techniques in all aspects of agriculture as advised by the Agricultural Department.

Settlement of farmers took place gradually and as the scheme developed it was found necessary to enter into an agreement with each settler. This agreement gave the settler the right of occupancy of the land on condition that he agreed to take the advice of the officers of the Agricultural Department with regard to sound farming techniques and practices. Settlers had also to abide by the rules governing the settlement. Failure to observe these rules rendered the settlers liable to eviction.

Cooperative marketing of settlers' produce was introduced in 1945 and this, together with general supervision of farmers, necessitated the posting of a full time senior officer. A thrift and loan cooperative society was also formed later. A social centre, a school and a dispensary were built in 1947; a new village was laid out with a market and a hall. Water supply was provided by wells built by the government. Pipe borne water was made available to those settlers living near to the Government Farm Centre. The scheme made good progress and proposals for expansion were put up. This met with opposition on the grounds that one small area was already receiving too much attention and money at the expense of other places, and Government refused to provide funds for extension. This was a big setback to the settlement which gradually began to decline.

Vigorous attempts were made in 1953 and in the following years to revive the good work done before and to reorganise farming on the settlement on sound lines. Poor farmers were ejected and their land was taken up by better farmers who wanted to expand. Thus the number of settlers decreased to the present number of forty-eight operating on approximately 1000 acres.
Eleven of the forty-eight farmers occupy 30 acres each; the rest each have acreages ranging from 15 to 25 acres. Crops grown are guineacorn, cotton and groundnuts and a small acreage of millet (interplanted with guineacorn) is grown by some farmers. Cotton is the main economic crop and large acreages are grown. Recently more and more groundnuts have been cultivated for an early cash return. A two course crop rotation (cotton followed by guineacorn and groundnuts in the same year) is common. The settlers are also being encouraged to grow fruit trees in their compounds. Although these farmers are settled on Government land they are administered in exactly the same way as mixed farmers in the Districts and are set up with advances from the N.A. mixed farming fund, to which they make annual repayments until the loans are fully repaid.

An Advisory Committee now meets monthly to discuss progress and problems on the settlement. Five members are selected by the settlers themselves to put their views to the extension staff of the Ministry of Agriculture who sit on the committee to advise on problems as they arise.

Mallam Abdulkadir Daudawa
APPENDIX III. TRIALS OF MECHANICAL WEEDERS ON DAUDAWA SETTLEMENT FARMS

A. QUESTIONNAIRE USED IN TRIALS

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP, DAUDAWA
INSTITUTE FOR AGRICULTURAL RESEARCH, SAMARU

ITDG/IAR/Instruc 1

Project on mechanical weed control

During the year 1972, several mechanical tools were developed in Daudawa by ITDG with a view to alleviate the burden of weeding for farmers during the busy months of June and July. Two of these tools are now ready to be tested by farmers and from their experiences it is hoped to ascertain the acceptability and usefulness under realistic conditions.

In Daudawa settlement scheme a number of farmers have been asked to cooperate with ITDG in the sense that they would use the experimental equipment on their farms after which they will be questioned on a number of aspects.

Four farmers will experiment with the Rotary Cultivator and four farmers will use the EMCOT with a special attachment. There is a remaining group of about 6 farmers which will use their own EMCOT. They function as control farmers.

The experiments will be undertaken on stretches of land of approx. two acres. These pieces of land have been demarcated with pegs. The farmers have agreed that at least on these selected pieces of land they would use the experimental equipment.

One crucial facet of the survey is the handweeding that is to be done after the mechanical weeding. It is anticipated that for the various tools the periods needed for supplementary weeding will be different. Consequently, the time needed for each experimental field to weed supplementary by hand will be determined as exactly as possible. In order to do this an enumerator will be stationed in the field for a period of three weeks. In that period he will have frequent, if possible daily contact with both experimental farmers and control farmers.

As much as possible recordings of periods spent in the field ought to be made in the field. Where this is not possible, the enumerator should make every possible effort to visit each farmer in the project (experimental and control farmer) at least once during every two days.

The survey consists of a number of separate questionnaires:

ITDG/IAR/F 1 and F 2 contain questions about the farmer, his family and his history. They can be filled in at any time during the stay of the enumerator in the survey area.

ITDG/IAR/IT 1 contains questions about the test plot. These should be recorded as soon as possible after arrival. Where the answers to some questions can only be given after certain operations, the enumerator should go back to the farmer as soon as the answers can be supplied.

ITDG/IAR/OI 1 contains questions concerning the actual operations on the test plot. It is in particular this set of recordings which make the presence of the enumerator during the survey period essential. Preferably each farmer should be visited at the moment that he works in the field. All operations in the test plot should be recorded, including those that are done by mechanical means.
ITDG/IAR/ATT 1, 2, 3 and 4: These contain questions about the farmer's experience with the equipment and his opinions about it. Preferably these answers should be recorded as soon as possible after the use of the experimental mechanical equipment. Ideal situation would be in which the enumerator could interview the farmer immediately after the trial. As it is impossible to anticipate all the problems and feelings that the farmer may have, it is hoped that the enumerator will show a lot of personal initiative to elicit answers and in conducting the interview. On page Att 4 there is sufficient room to record any comments over and above the ones taken care of in the formal questionnaire.

ITDG/IAR/Instruc 2

Detailed instructions where considered necessary. The abbreviation S.E. will be used to indicate the "self-explanatory" characteristic of the question.

ITDG/IAR/F 1 and 2

1, 2, 3, 4, 5, 6. S.E.

7. This refers to any training that aimed at making the man more proficient in a particular field. This can include agricultural training but also training for car mechanic, messenger, etc. As a number of farmers have been in the Army, whichever training they underwent there should also be recorded.

8. S.E.

9. Some farmers work in a family unit consisting of themselves, their wife(s) and unmarried children. Others, however, have a work unit called gandu in which at least two married males with their respective families are working together. These other males may be sons, brothers or other relatives. Also record the relationship between the farmer in the experiment and the man who is working with him in the gandu.

10. The four following questions are aiming at finding the total population of the workunit of the experimental farmer. Where possible and if the farmer is cooperative, a full family questionnaire should be filled in.

14, 15, 16, 17, 18, 19, 20, 21, 22. S.E.

23. In this and the following two questions the word normal and regularly refer to habits. Some farmers may apply takin zamani just whenever they have some money. If they don't have money they will forget about the takin zamani. Others can no longer farm without applying fertilizer and will make every possible effort to get fertilizer.

ITDG/IAR/IT 1

1. S.E.

2. S.E. Under point c is meant the EMCOT that the farmer should have as part of his own farm inventory. We have been told and have checked that all of the farmers have an EMCOT and cattle to use with it. These farmers will—as is anticipated—use their EMCOT on their fields as they would do anyhow, irrespective of the presence of the ITDG or survey team.

3. The fields are somewhat regular in shape and there should not be any difficulty in measuring. In case of difficulties please contact either Mr. Boyd or Mr. Ogborn.

4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14. S.E.
15. As in this year the rains have been somewhat late, it could be that the farmers or some of them have to adjust themselves to the new conditions. It is possible that the farmer has decided to plant different crops on the field because he now has to do everything in a shorter growing period. It is also thinkable that some weeding will be left out which otherwise would have been done.

ITDG/IAR/Instruc 3

ITDG/IAR/OT 1

1, 2. S.E.

Table: Date: S.E.
Operation: Here a short description ought to be given of the type of work being undertaken (e.g.: weeding or ridging or weeding and ridging, etc.).
Type of tool: State here whether the operation was done mechanically, with handhoe or otherwise. State which mechanical equipment was used.
Duration: As much as possible here should be recorded the length of time that the particular operation was done. So for instance one can record: from 07.00 a.m. till 9.30 p.m.

3. It is quite possible that the farmer after having weeded the test plot with the experimental tool will continue working with the experimental tool on the rest of his land.

There are several possibilities here:

1) On the day that he is weeding the experimental plot, he will continue with the experimental tool on the rest of his land, but he will not on any other day use the experimental tool, although he is allowed.

2) On the day of the experiment he will continue working with the experimental tool and he will also work with the experimental tool on other days.

3) He will only work with the experimental tool on the test plot. As soon as he has done this he will go over to his own EMCOT.

After having filled in on page ITDG/IAR OT 1 yes or no, put a figure next to that answer according to the key here above.

4. Unforeseen circumstances may prevent the farmer from doing the things that we would like him to do. Please comment as much as possible.

ITDG/IAR/ATT 1, 2, 3 and 4

1, 2. S.E.

3. Should be asked from all the farmers
4. Should be asked from all the farmers.

Between 4 and 5. Enumerator, IT IS ESSENTIAL TO TELL THE FARMER THE CONTENT OF THE MESSAGE AS WE HAVE TO DEPEND VERY MUCH ON HIS PERSONAL OPINION. THERE ARE NO SUCH THINGS AS "GOOD" ANSWERS. ANY ANSWER THAT HE GIVES IS VALUABLE. THE FARMER DOES NOT NEED TO EXPECT ANY UNPLEASANT CONSEQUENCES FROM WHICHEVER ANSWER he SUPPLIES.

5, 6, 7, 8 and 10. See for additional space to record information page ITDG/IAR/ATT 4. Where the sign * has been put, please be extra careful.

11, 12, 13, 14, 15. S.E.
16. Even though a farmer may like the thing in general, he may wish to comment on certain aspects that may be corrected from the technical point of view. Similarly, although a farmer may not like the thing at all, there may be certain aspects of the tool and its performance that he likes.

17. S.E.

18. S.E. Fill in here the price of the Rotary Cultivator if you are talking to a farmer who has used that tool, and the price of the attachment to the EMCOT if the farmer has used that.

ITDG/IAR/Instruc 4

ITDG/IAR/ATT 3

1. For each of the possibilities ask the farmer whether that possibility is applicable to himself. Later on in the season, we will follow up this question with some more.

2. S.E.

IAR/SAMARU/MAY 1973
J.B. B.J.B.

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP, DAUDA
INSTITUTE FOR AGRICULTURAL RESEARCH, SAMARU

Mechanical Weed control Project, Daudawa, June 1973

Date of interview: ............... Name of interviewer: ............... Place of interview: ............... 

1. What is your name? .....................

2. How old are you? ............. years of age

3. In which place were you born? Village: ............... State: ............... 

4. Have you ever attended primary school. Yes / No *

If yes, for how many years? ............. years

5. Have you ever attended Koranic school? Yes / No *

If yes, for how many years? ............. years

6. Have you ever followed a training to learn how to read and write? (Yaki da jahilci) Yes / No *

If yes, where: ............. and when: .............

7. Have you had any other training for whichever capability? Yes / No *

If yes, what type of training: .............

where: ............. and when: .............

8. Have you, apart from being a farmer in the settlement scheme, any other occupation?

In the wet season:

1) .....................

2) .....................

In the dry season:

1) .....................

2) .....................
9. In your farm, are you at present (in this year) working on your own or is some other person, married, working with you in your gandu? 
On his own/with others in his gandu *

If somebody is working in his gandu, what is the relationship between you and that other person(s): 1) . . . . . . . . . . . . . . . . .
2) . . . . . . . . . . . . . . . . . . .

10. How many wives do you at present have? . . . . . .

11. How many adult married males are working in your gandu? . . . . .

12. How many wives are there in your gandu apart from your own? . . . .

13. How many unmarried children are there in your gandu both of yourself and of the other married males in your gandu? . . . .

**Enumerator:** For the answers to these questions some probing has to be done. If the farmer is cooperative and prepared to spend the time, please fill in the separate family questionnaire attached.

14. Now some questions about yourself before you came here and when you became a settler here:

When did you become a settler in this settlement scheme? . . . . . .

15. What was your occupation before you became a settler in Daudawa? . . . .

16. Did you before you came to Daudawa as settler, have any experience as a farmer? 
Yes / No *

If yes, where: . . . . . . . . . . . . . . . . . . . .

17. Before you came to Daudawa, did you ever see farmers using a plow with cattle? (garman shanu) 
Yes / No *

If yes, where: . . . . . . . . . . . . . . . . . . . .

18. Did you, before you came to Daudawa, ever use a garman shanu yourself? 
Yes / No *

If yes, where: . . . . . . . . . . . . . . . . . . . .

Was that your own garman shanu? Yes / No

Was the cattle that you used with the garma, your own? Yes / No

19. How soon after you entered the settlement scheme in Daudawa, did you obtain an garman shanu (EMCOT)? 
Immediately after becoming settler/ Years later

20. Have you cattle of your own now? Yes / No

If yes, have you just about two cattle to work with the garman shanu, or do you have a larger herd? 
Just two / Larger herd / Only one / None

21. How many acres of land do you have within the settlement scheme? . . .

22. Have you any land outside the settlement scheme? Yes / No *

If yes, how many acres: . . . . . . . . and where: . . . . . . . . . . . . . . . . . . .

* Whenever this sign appears, there is a follow-up to the answer given.
23. Do you regularly each year use the EMCOT that you have?  Yes / No *
   If yes, for which operations do you normally use the EMCOT?
   1) ................................
   2) ................................
   3) ................................
   4) ................................

   If No, why don't you use your EMCOT regularly?

24. Do you regularly each year apply takin zamani on your farm?

25. Do you regularly each year wash your seeds with medicine before you plant?  Yes / No

26. Do you normally work with the members of your gandu/family ONLY, or do you normally hire labourers for certain periods in the year?
   Family labour or gandu labour only / Hired labour.

Information about the test plot.

1. What is the name of the farmer cultivating the test plot?  .................

2. Is the farmer using on his test plot a) a rotary cultivator?
   b) EMCOT and attachment
   c) EMCOT (control farmer)

3. How big is the test plot: ........ x ........ yards = ........ sq. yards
   (Measure the sides with a tape)

4. What type of soil is the test plot? Ja / Baki / Fari / Other: .............

5. How would the farmer classify the quality of the soil?
   Very good / Good / Reasonable / Not so good / Poor / Very poor

6. What was grown on the test plot last year (1972): 1) .................
   2) .................
   3) .................

6. Was any takin zamani applied last year?  Yes / No

7. Was any cattle manure applied last year?  Yes / No

8. In the dry season that just ended, did any cattle wander over the field for some time?  Yes / No

9. Was any operation undertaken with a tractor last year?  Yes / No *
   If yes, which operation?  .................

10. Was any operation undertaken with the EMCOT last year?  Yes / No *
    If yes, which operation?  .................
11. In this year (1973), which operations were undertaken before planting and with which tool?

with tractor: ridgebreaking / ridgemaking / others . . . . . . . . .
with EMCOT: ridgebreaking / ridgemaking / others . . . . . . . . .
otherwise: ridgebreaking / ridgemaking / others . . . . . . . . .

12. When was the field planted in this year and with which crop(s)?

<table>
<thead>
<tr>
<th>Date of planting</th>
<th>Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) . . . . . . .</td>
<td>. . .</td>
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<tr>
<td>2) . . . . . . .</td>
<td>. . .</td>
</tr>
<tr>
<td>3) . . . . . . .</td>
<td>. . .</td>
</tr>
</tbody>
</table>

13. Does the farmer at this moment (at the time of the interview) intend to plant more crops in the test plot than have been planted so far?

Yes / No * If yes, which crops? . . . . . . . . . . . . . . . . . . . .

14. Has in this year any takin zamani been applied? Yes / No

any cattle manure? Yes / No
any takin gida? Yes / No
any other manure? Yes / No . . . . . . . . . . . . . . . . . . . . .

15. Has the farmer because of the late rains in this year, been forced to alter some of his original plans that he had for the test plot?

(Please probe whether the farmer would have planted other things in the field and whether he would have done different operations if the rains had not been so late)

ITDG/IAR/OT 1

Operations on Test Plot

1. Name of the farmer: . . . . . . . . . . . . . . . . .

2. Type of farmer: using rotary cultivator / EMCOT and attach / Control EMCOT only

Except where otherwise stated, the following information has to be recorded for the test plot only.

<table>
<thead>
<tr>
<th>Date</th>
<th>Operation</th>
<th>Type of tool</th>
<th>Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
3. For those farmers who have used either the rotary cultivator or the EMCOT with attachment on the test plot:

Did the farmer after having finished the test plot, also use the new tools on the rest of his farm? Yes / No Number . . . . (see instruction)

4. There may have been special reasons why the farmer, despite his commitment may not have been able to use the experimental tools or even his own EMCOT. It is also possible that he has no time at all to weed. In that case, please give the exact reason why the farmer has not done what he ought to have done.

In the above information, we are particularly interested in knowing the time involved in handweeding after the mechanical weeding. Whether the farmer uses the improved tools or the traditional EMCOT, in all cases it is assumed that he has to do additional handweeding. It may be that the differential periods devoted to handweeding are crucial in the farmer's appreciation of the usefulness of the new tools. IT IS THEREFORE OF THE UTMOST IMPORTANCE THAT THE ENUMERATOR MAKES EVERY POSSIBLE EFFORT TO RECORD ALL THE HANDWEEDING THAT HAS BEEN DONE ON THE TESTPLOT AFTER THE MECHANICAL WEEDING.

ITDG/iar/h: T 1

Performance of experimental tools and Perception of usefulness by the farmer

1. What is the name of the farmer? . . . . . . . . . . . . . . . . . . . . . . . . . .

2. What type of experimental tool does he use? Rot. cult. / EMCOT & attach. /

(In the following, whenever mention is made of either Rot. Cult or EMCOT & attach. the enumerator should use that expression that is applicable to the farmer whom he is interviewing.)

3. The Rot. Cult has been developed in Daudawa about a year ago. It has also been demonstrated during a visit of an agricultural officer to Daudawa as well as on the farm in front of Mr. Boyd's house.

Before we showed the equipment to you during the meeting in Daudawa that was held in April:

Had you ever seen the Rot. Cult? Yes / No
Had you experimented with it? Yes / No
Had you seen other farmers use it? Yes / No

4. The attachment to the EMCOT has also been shown to the farmers. Before we showed the equipment to you during the meeting in Daudawa

Had you ever seen it ? Yes / No
Had you experimented with it ? Yes / No
Had you seen other farmers use it ? Yes / No
ENUMERATOR : PLEASE, BEFORE ASKING QUESTIONS, TELL THE FARMER THE FOLLOWING:

Now that you have used the experimental equipment we would like to ask you a few questions about your experiences with it and your feelings about it. I must stress that we hope that on the basis of your information, we will be able to improve the tools according to your wishes. We would therefore appreciate if you would be as frank as possible in your judgment of the usefulness to you of this particular tool that you have tested out on your farm. If you like it very much, please say so; if you like it not so much, please say so; if you don't like it at all, please say so. And if possible, give us the reasons why you don't like it so much or not at all.

Now, some questions:

5. You first had to learn about how to use the new tool. Do you think it was:
   - very difficult / a bit difficult / not difficult / very easy to learn how to operate and adjust the tool? *

6. How easy or difficult was it for the animals to get used to the equipment?
   - very difficult / a bit difficult / not difficult / very easy

7. Once you started using it in the field, how difficult or easy was it to make the tool do what it was meant for?
   - very difficult / a bit difficult / not difficult / very easy

8. Could you get the width of the tools properly adjusted to the widths of the ridges? Yes / No
   How difficult or easy was it to do that?
   - very difficult / a bit difficult / not difficult / very easy *

9. Did you have to adjust the tools? : frequently / sometimes / never after the first time

10. How difficult was it to keep the tool and the animals in the proper direction?
    - very difficult / a bit difficult / not difficult / very easy *
    Did you experience any special drag out of the direction that you wanted to go?
    Yes / No

11. In your opinion, how well or poorly does the equipment weed the weeds?
    - excellently / good / reasonably well / poorly

12. Is there any damage done to the crops by the equipment? Yes / No *
    If yes, how much?: very much / much / somewhat / very small

13. As this is a new tool to you, one can imagine that you would get tired after the use of the equipment. How tired were you actually after having used it on the test plot?
    - very tired / a bit tired / not tired

* Whenever the sign (*) appears, the enumerator should ask the farmer the reason for "very difficult" or "a bit difficult" of a particular activity. The answers can be recorded on a separate sheet attached to this questionnaire.
14. We would now like to compare the usefulness of this experimental tool with the EMCOT that you are used to.

Which of the two tools (EMCOT on the one hand, and Rot. Cult/EMCOT and attach. on the other hand) :

a) is easier to operate?  
EMCOT  
Rot.Cult / EMCOT +

b) is quicker in the job?  
EMCOT  
Rot.Cult / EMCOT +

c) is easier to adjust?  
EMCOT  
Rot.Cult / EMCOT +

d) IS CLEANING (weeding) the field better?  
EMCOT  
Rot.Cult / EMCOT +

e) is easier for the animals?  
EMCOT  
Rot.Cult / EMCOT +

f) tires you down quicker?  
EMCOT  
Rot.Cult / EMCOT +

15. Looking at the new equipment in its general performance, taking into account all the things that we discussed, could you tell me how much you like or dislike the equipment?

Like it very much / like it much / somewhat / not very much / not at all *

16. Even though you like it / although you don't like it, there may be a few things : that you would like to see corrected / that you appreciate of the thing.

Which things would you like to see corrected?
1) . . . . . . . . . . . . . . . . . . . . .
2) . . . . . . . . . . . . . . . . . . . .
3) . . . . . . . . . . . . . . . . . . . .

Which things do you like in particular?
1) . . . . . . . . . . . . . . . . . . . .
2) . . . . . . . . . . . . . . . . . . . .
3) . . . . . . . . . . . . . . . . . . . .

17. Suppose you have a friend in a neighbouring village. He has heard that you have used a new modern technique in your field, and he comes to ask you what you think of this new thing.

What would you tell to your friend in this case? Would you recommend it to your friend or would you tell him that he better wait because it is not all that good.

18. There are three more questions to ask.

The machine that you have used will cost approx. Naira . . . . (£ . . . .

Will you please tell me whether you consider that :

About the correct price for what you get for it?  
A bit too expensive for what you get for it?  
Far too expensive for what you get for it?
I am going to tell you a number of possible answers on the question whether you like the equipment or not. There will also be some reasons for not liking it. Could you please tell me which of the following answers and reasons is most applicable to you and which ones are not.

1) I like the thing very much and I would buy one immediately if I had the money. Applicable/Not applicable

2) I like the thing very much but as I have already an EMCOT I do not see a reason for buying this one. Applicable/Not applicable

3) I like the thing very much but it is not that much better than the EMCOT to justify buying the thing. Applicable/Not applicable

4) I don't think the thing is all that much better than the EMCOT that I have already. Applicable/Not applicable

5) The EMCOT will do just as good a job as this new thing. Applicable/Not applicable

6) I don't like the thing, it wears me down quickly. Applicable/Not applicable

7) I don't like the thing, it does not do a better job than the EMCOT. Applicable/Not applicable

8) I don't like the thing, the animals have problems. Applicable/Not applicable

2. A question about the weeding by hand after having weeded mechanically:

I presume that after having weeded with your EMCOT, you need to do a bit of handweeding? I am right in thinking that? Yes / No *

If No: Enumerator, please find out what is going on on the farm after mechanical weeding. If he does not handweed after mechanical weeding (in normal years after the use of the EMCOT) what is the reason of that:

Mechanical weeding does a good enough job?
He has no time to go back for handweeding?
Any other reason: PLEASE DISCUSS PROPERLY WITH THE FARMER.

If Yes: Even after the use of the Rot. Cult/EMCOT +, you will have needed to do some handweeding.

Was the time needed for handweeding in your opinion (on the test plot) approx.

the same?
very much more?
a little more?
very much less?
a little less?

than you think you would have had to do if you had used your own EMCOT instead of the experimental equipment that you now used.
Question 5. If the farmer mentions that it was very difficult or a bit difficult, ask him the reasons why and which difficulties he experienced.

Questions 6, 7, 8, and 10. The same as above.

B. **PRELIMINARY ANALYSIS OF RESULTS**

The traditional system of cultivation as reported by farmers is as follows:

1) clearing land
2) making ridges (huda, EMCOT or hand, ridgesplitting)
3) planting
4) handweeding
5) thinning
6) application of fertilizer
7) reridging (fiyaki = to diminish the ridge)
8) handweeding with *fragana*, normally left till close to the end of the rains.
9) upridging (increasing the ridge = Hayi)
10) third ridging (if there is much rain)
11) harvest.

The information that has been obtained is basically consisting of information concerning weeding operations. Reridging and *fiyaki* are a sort of weeding and have been included.

The following activities in this report have been recorded:

**Rotary Cultivator Farmers**

<table>
<thead>
<tr>
<th>Order of Activity</th>
<th>011 Activity</th>
<th>041 Activity</th>
<th>031 Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rotary cultivator</td>
<td>1st Rotary cultiv.</td>
<td>1st Rotary cultivator</td>
</tr>
<tr>
<td>2</td>
<td>1st Handweeding</td>
<td>1st Handweeding</td>
<td>Handweeding</td>
</tr>
<tr>
<td>3</td>
<td>2nd Handweeding</td>
<td>Ridging (fiyaki)</td>
<td>Fiyaki</td>
</tr>
<tr>
<td>4</td>
<td>Fiyaki (EMCOT)</td>
<td>* 2nd Rotary cultiv.</td>
<td></td>
</tr>
</tbody>
</table>

* application of manure or modern fertilizer.
EMCOT plus Attachment Farmers

<table>
<thead>
<tr>
<th></th>
<th>O52</th>
<th>O62</th>
<th>O82</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EMCOT (+) weedng</td>
<td>1) 1st Handweeding</td>
<td>1) Handweeding + EMCOT</td>
</tr>
<tr>
<td>2</td>
<td>Handweeding</td>
<td>2) EMCOT weedng</td>
<td>2) 2nd Handweeding</td>
</tr>
<tr>
<td>3</td>
<td>1st Fiyaki + some handweeding</td>
<td>3) 2nd Handweeding</td>
<td>3) * Fiyaki</td>
</tr>
<tr>
<td>4</td>
<td>* 2nd Fiyaki</td>
<td>4) 3rd Handweeding</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5) * Fiyaki</td>
</tr>
</tbody>
</table>

Control Farmers

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<thead>
<tr>
<th></th>
<th>O93</th>
<th>133</th>
<th>O72</th>
<th>123</th>
<th>O103</th>
<th>O113</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Handweeding</td>
<td>Handweeding</td>
<td>Handweeding</td>
<td>Handweeding</td>
<td>Handweeding</td>
<td>Handweeding</td>
</tr>
<tr>
<td>2)</td>
<td>Fiyaki</td>
<td>* Fiyaki</td>
<td>Handweeding</td>
<td>Weeding with *Handweeding</td>
<td>*Thinning (-HN)</td>
<td>Fiyaki</td>
</tr>
</tbody>
</table>

With the help of the figures on the page of Performance per acre, one could derive a picture of an average farm.

PERFORMANCE PER ACRE

The following calculations are based on complete fields that have been treated in a particular way. The figures are derived from original data of hours and minutes spent to finish an operation and are expressed in decimal measurements per acre. Figures in brackets indicate the identification number of the farmer.

Rotary Cultivator

<table>
<thead>
<tr>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.04</td>
<td>(O11)</td>
<td>4.11</td>
<td>(O62)</td>
<td>5.78</td>
<td>(O52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.02</td>
<td>(O41)</td>
<td>4.50</td>
<td>(O82)</td>
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</tr>
<tr>
<td>5.04 (2nd time)</td>
<td>(O41)</td>
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<tr>
<td>3.97</td>
<td>(O31)</td>
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<tr>
<td>3.25 (2nd time)</td>
<td>(O31)</td>
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<tr>
<td>20.32 Average =</td>
<td>4.06</td>
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1st Handweeding after R.C.

<table>
<thead>
<tr>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.95</td>
<td>(O11)</td>
<td>21.07</td>
<td>(O52)</td>
<td>13.31</td>
<td>(O62)</td>
<td>17.90</td>
<td>(O31) (calculated)</td>
</tr>
<tr>
<td>10.07</td>
<td>(O41)</td>
<td>17.80</td>
<td>(O82)</td>
<td></td>
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<tr>
<td>17.90</td>
<td>(O31)</td>
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</tr>
<tr>
<td>43.92 Average =</td>
<td>14.64</td>
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</tbody>
</table>

1st Handweeding after EMCOT plus

<table>
<thead>
<tr>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.07</td>
<td>(O52)</td>
<td>13.31</td>
<td>(O62)</td>
<td>17.80</td>
<td>(O82)</td>
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<tr>
<td>52.18 Average =</td>
<td>17.39</td>
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<td></td>
</tr>
</tbody>
</table>

2nd Handweeding after R.C.

<table>
<thead>
<tr>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
<th>Time</th>
<th>Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.81</td>
<td>(O11)</td>
<td>2.50</td>
<td>(O62)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5.41</td>
<td>(O31)</td>
<td></td>
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</tr>
<tr>
<td>14.22 Average =</td>
<td>7.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The actual operations undertaken per set of farmers per acre is given in Table 1.

**CONTROL FARMERS' PERFORMANCE**

<table>
<thead>
<tr>
<th>1st Handweeding</th>
<th>Fiyaki</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 23.99 (072)</td>
<td>a) 4.82 (072)</td>
</tr>
<tr>
<td>a) 40.07 (123)</td>
<td>a) 2.43 (123 weeded by cultivator also)</td>
</tr>
<tr>
<td>a) 30.10 (133)</td>
<td>a) 5.87 (133)</td>
</tr>
<tr>
<td>b) 16.48 (93; 5 hired labour)</td>
<td>b) 1.53 (93, special case, outlier?)</td>
</tr>
<tr>
<td>b) 13.38 (103; followed by two more weedings)</td>
<td>a) 4.93 (103)</td>
</tr>
<tr>
<td>a) 26.52 (113) (included thinning)</td>
<td>(a+b) 19.58 Average = 3.92</td>
</tr>
<tr>
<td>a) 22.72</td>
<td>(a) 18.05 Average = 4.51</td>
</tr>
<tr>
<td>(a+b) 173.26 Average = 24.75</td>
<td>(a) 148.91 Average = 28.68</td>
</tr>
</tbody>
</table>

**Rotary Cultivator** | **EMCOT Cultivator** | **Hand Weeder**
---|---|---
Rotary Cultivator 6.73 | 4.80 | Cultiv. 0.69
Handweeding 19.71 | 18.23 | 29.91
Fiyaki 3.73 | 4.05 | 3.92

| | | |
| | | |
| | | |

Absolute differences are not very much. If the seemingly anomalous "hired labour" farmer (093) is taken out (he reduces the figure for control farmer) the total for Handweeder becomes approximately 38.

Farmers are enthusiastic. Claim

1) less time needed in general for weeding;
2) handweeding after mechanical weeding is light;
3) cheaper to hire labourers to do handweeding after mechanical weeding.
Point (1) is, although not very convincingly, demonstrated by the figures obtained and presented on page 4.

Point (2) is hard to verify.

Point (3): Farmers have indicated how much cheaper it now was for them to hire labourers.

The reports vary from:

<table>
<thead>
<tr>
<th></th>
<th>Previous price per ridge</th>
<th>Present price per ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary Cultivator</td>
<td>Average: 7.33 k</td>
<td>Average: 4.80 k</td>
</tr>
<tr>
<td>EMCOT</td>
<td>Average: 7.50 k</td>
<td>Average: 5.00 k</td>
</tr>
</tbody>
</table>

All farmers were "keen" to purchase "their" equipment. The price was not considered too high. One would prefer to pay in two installments. While this wish was indicated in personal interviews, earlier in the season, some farmers were not so enthusiastic, witness the answers to the relevant questions in the formal questionnaire.

Comparison between Rotary Cultivator and EMCOT, EMCOT plus and EMCOT:

<table>
<thead>
<tr>
<th></th>
<th>Rotary Cult.</th>
<th>EMCOT</th>
<th>EMCOT plus</th>
<th>EMCOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier to operate</td>
<td>2</td>
<td>1*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>same</td>
</tr>
<tr>
<td>Quicker in the 'r'</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Is easier to adjust</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Is weedng better</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Is easier for animals</td>
<td>3</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Tires one down quicker</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Comments on Rotary Cultivator:

- Hooks should be flattened. (2)
- Good for weeding grown up crops.
- Would like to use in cotton. Would recommend to friends. (3)
- Price of machine is more than work that machine can give.
- Would buy. Work pays for price. (2)
- Like the work of the hooks. Should look smaller in size.
- Rolls without problems. Hooks should be shorter.
- 3 farmers like it.
- One farmer with R.C. used it for only a couple of minutes but then abandoned it.

Comments on EMCOT plus Attachment:

- The joint between the blades and the rod holding the blades should not be welded, but joined with a nut.
- The cost is too high for the work. The blades are working fine. (2)
- The price is appropriate to the performance. (2)
- 2 farmers liked it, 1 wants to wait.
- One farmer used the EMCOT plus attachment for a short period but then abandoned it.
Sprayer tested: Barrow-type peristaltic pump sprayer.

Maker: I.T.O.C., Daudawa.

(1) Main components of the sprayer:
   (a) Plastic can
   (b) Bicycle wheel with revolving knobs.
   (c) Rubber hose (neoprene tubing).
   (d) Frame.
   (e) Nozzle.

(2) Principle of operation:

As the sprayer moves forward, three knobs attached to its ground-wheel (bicycle wheel) revolve while periodically in contact with a flexible tube, forcing spray liquid to flow from a plastic container to the nozzle.

(3) Specification:

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length max.</td>
<td>2 metres</td>
</tr>
<tr>
<td>Width &quot;</td>
<td>64 cm.</td>
</tr>
<tr>
<td>Height &quot;</td>
<td>71 cm.</td>
</tr>
<tr>
<td>Weight &quot;</td>
<td>not measured</td>
</tr>
<tr>
<td>Plastic can capacity (approx.)</td>
<td>9 litres</td>
</tr>
<tr>
<td>Number of knobs</td>
<td>3</td>
</tr>
<tr>
<td>Ground wheel dia.</td>
<td>28 inches</td>
</tr>
<tr>
<td>Rubber tube dia. (internal)</td>
<td>½ inch.</td>
</tr>
<tr>
<td>Pressure</td>
<td>5 - 8 lbs/in²</td>
</tr>
<tr>
<td>Swath width (nozzle height 20 cm)</td>
<td>70 cm.</td>
</tr>
<tr>
<td>Average output</td>
<td>53 cm³/rev.</td>
</tr>
<tr>
<td>Mechanical efficiency (approx.)</td>
<td>50%</td>
</tr>
</tbody>
</table>

Nozzle type: Impact, deflector type (Fan spray pattern)

(4) General description:

The sprayer has a very simple framework made of 3⁄8" dia. metal pipe with two 1" pipe connecting elements. The wheel of the barrow is a conventional bicycle wheel to which the three knobs are attached by means of a triangular plate. There is a tap before the nozzle for stopping or letting the liquid into the tube. The container is located on the frame behind the ground-wheel. The tube runs over the knobs, pumping and directing the liquid from the plastic can to the nozzle.

The vertical position of the nozzle can be varied according to the target level or the swath width desired.

The spray pattern produced is a fan type one in which the droplet distribution is rather uneven, more drops getting onto the edges of the swath.

(5) Advantages:
(a) This type of pump does not require a gasoline engine to operate.

(b) Therefore, we could save in weight and gasoline consumption compared with an engine-powered sprayer.

(c) The pump is very simple and suitable for conveying any kind of spray liquid.

(d) It is more easy to operate than a lever-operated knapsack sprayer.

(e) The machine can be made in any local workshop.

(f) Maintenance can be done by an un-skilled operator.

(6) Disadvantages:

(a) It cannot be used in rough terrain.

(b) It is suitable only for herbicide application because the pressure is low for fine atomisation and even distribution.

(c) The spray chemical contaminates the operator as he follows the machine on sprayed path.

(d) Without suitable filter or pre-filtered spray the nozzle is likely to be blocked.

(e) It is not versatile as it can be used for herbicidal work only.

(f) Low mechanical efficiency.

(7) Conclusion

The peristaltic pump sprayer has a great number of advantages as we have stated above. Perhaps, the operating pressure would go up to 10 lbs/in², in that case if the rubber tube has been tighter. The pressure is not constant, but it fluctuates in a certain range. The droplets produced by the sprayer are rather coarse and variable in size and dripping can also be observed at the nozzle.

Hitherto we have not obtained any result on this sprayer in the field, therefore we propose a reliable field test to assess its suitability for the farmers from all aspects.

Dr. F. Kiss
I.A.R. Agricultural Engineer.
## APPENDIX V

### DISTRIBUTION OF PROJECT'S MACHINES AS AT 19/11/73

<table>
<thead>
<tr>
<th>Machine</th>
<th>Location</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Peristaltic pump sprayer</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>2. Granule band spreading attachment for Planet Junior seeder</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>3. PJ seeder modified for band spreading with Ariana toolbar</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>4. Locally built granule applicator for Ariana toolbar</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>5. Prototype fully adjustable rotary hoe for Ariana</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>6. High clearance rotary hoe (fixed angle rotors)</td>
<td>Adamu Kuri, Daudawa</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Lawal Yahaya</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bawa na Adamau</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Iro Nagoshi</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Alh. Abubakar</td>
<td>1</td>
</tr>
<tr>
<td>7. High clearance rotary hoe (adjustable angle rotors)</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>8. Extra front spider wheel modification for rotary hoe</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>9. Crop shields for fixed angle rotary hoe</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>10. Adaptors for fitting final version rotary hoe to Ariana</td>
<td>IAR</td>
<td>2</td>
</tr>
<tr>
<td>11. Lightweight multi-purpose rotary hoe set</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>12. Modified IDC Ecmot Weeding Attachment</td>
<td>IAR</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Idi Abba, Daudawa</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Adamu Funtua</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Balan Gawo</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Alh. Kuku</td>
<td>1</td>
</tr>
<tr>
<td>13. Dahomey Weeding Attachment fitted to Ecmot mouldboards</td>
<td>IAR</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>MANR Kafin Soli</td>
<td>3</td>
</tr>
<tr>
<td>14. Dry season cultivator tine for Ecmot ridger</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>15. Quick detachable version of 14.</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>16. Expandable cultivator</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Under construction at Daudawa</td>
<td>2</td>
</tr>
<tr>
<td>17. Hand pushed rice weeder with spiked and curved tine rotors</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>18. Groundnut lifter</td>
<td>IAR</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Iro Nagoshi, Daudawa</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Alh. Tunau, Yankara</td>
<td>2</td>
</tr>
<tr>
<td>19. Kenaf ribboner</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td>20. Single ox yoke</td>
<td>Alh. Bala, Daudawa</td>
<td>2</td>
</tr>
<tr>
<td>21. Screw clamp for Ecmot depth wheel</td>
<td>IAR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Dambazu, Daudawa</td>
<td>1</td>
</tr>
</tbody>
</table>
APPENDIX VI.

MACHINE DESIGNS

1. Locally built granule applicator.
2. High clearance rotary hoe.
3. Experimental adjustable angle modification for IT Rotary Hoe.
4. IT Rotary Hoe adaptor for Ariana toolbar.
5. Experimental lightweight rotary hoes.
7. Dahomey weeding attachment for ridging ploughs.
8. IT chisel tine attachment for Emcot ridging plough.
9. IT quick detachable clamping method for Emcot plough attachments.
10. IT expandable cultivator.
11. IT rotary rice weeder.
12. IT groundnut lifter.
13. Prototype hand powered kenaf ribboner.
15. IT screw type depth wheel clamp for Emcot ridging plough.
1. "EMONY" Ridger Plough made by blacksmith Salum Ibrahim Musa of Puntua.

2. I.T.D.G. implements built by blacksmith Alhaji Mohamedu Tunau of Yankara


5. Peristaltic Pump Sprayer.

7. I.T. Granule Applicator in operation in the field.


8. I.T. Granule Applicator fitted to 'Ariana' Tool Bar.


11. Front view of I.T. High Clearance Rotary Hoe.

17. Light-Weight Rotary Hoe with two rotors and central sweep.

18. Light-Weight Rotary Hoe with two rotors in line.

19. Wheeled Push Hoe for crops planted on 30" spaced ridges.

20. Hand-Pushed Inter-Row Rice Weeder, close-up view.


23. "D.M.C." ridger plough with "Dahomey Mouldboard Extensions".

24. Close-up view of Dahomey mouldboard extensions on "D.M.C." ridger plough.

33. Single Ox Harness.

35. View of Daudawa Settlement farmer using single ox for inter-row weeding.

34. View of Single Ox Harness at use in the field.

36. A pair of oxen with the IT High Clearance Rotary Hoe in the field.
I.T. GRANULE APPLICATOR

Developed by: Intermediate Technology Project, Daudawa, North Central Nigeria.

Introduction: The granule applicator was developed as part of the I.T. Farm Equipment Development Project work programme attached to the Institute of Agricultural Research of Ahmadu Bello University.

The IAR Agronomy Department requested development of an applicator for fertilizer granules into which herbicide has been incorporated, the granules to be spread in a 15 cm. wide band on top of the ridges to control weeds in the crop rows while the inter-rows were mechanically weeded.

A Planet Junior hand pushed seeder was modified to spread a band of granules by replacing its seed tube with a fan shaped outlet.

A similar Planet Junior-based applicator was fitted to an Ariana toolbar and a simple direct drive from a driven wheel was used to replace the original bevel gears and shaft drive to the tractor—machine. Standard Ariana soil moving components were added to enable a ridge to be built and granules to be applied, either on the surface or incorporated into the soil, simultaneously.

A similar, more robust applicator with a larger hopper capacity was built from locally available mild steel sheet, water pipe and reinforcing rod, using normal hand tools and welding equipment, and fitted to an Ariana toolbar. It was found to be capable of spreading superphosphate granules in a 15 cm. wide band at rates between 10 kg. and 500 kg. per total hectare on the 75 cm. spaced rows used in the Daudawa area.

Description: In the drawings which follow, dimensions are given in inches with millimetre equivalents in brackets.

Page 1. Pictorial Views of assembled granule applicator.
Page 2. Hopper Unit, Side View.
Page 3. Hopper Unit, Rear View.
Page 4. Hopper Unit, Plan View.
Page 5. Metering Mechanism.

The applicator hopper A is made of \( \frac{3}{32}'' \) (2.4) thick mild steel sheet, and to increase its capacity it was extended vertically by 9'' (229) using \( \frac{1}{16}'' \) (1.5) mild steel sheet as indicated by B.

The hopper support frame pieces C of 1'' x \( \frac{3}{8}'' \) (25 x 3) mild steel, are welded to the attachment stalk D which is fabricated from 1'' x 1'' (25 x 25) angle iron and allows the applicator to be clamped firmly to an Ariana toolbar E.
The first part of the metering mechanism is made of $1\frac{1}{8}''$ (28) internal diameter pipe F welded to the bottom of the hopper. The granule flow adjuster G of $1\frac{1}{16}''$ (27) outer diameter pipe, which fits inside the pipe F, is provided with bearings of hardwood at both ends as indicated by H.

Even granule flow is maintained by the rotating movement of the agitator J which, when passed through the wooden bearings within pipe G, is provided with a distance piece K of $\frac{1}{2}''$ (12.5) bore pipe, washers L, and a split pin M. The integral agitator J and granule flow drive N is made from $\frac{1}{16}''$ (11) mild steel bar, rotation being by ground-drive from the 'spiked-wheel' N.

The granule spout P is made from $\frac{1}{6}''$ (3) thick mild steel, and even granule spread is accomplished by the provision of diverter pegs made of wire and positioned within the spout as shown at Q.

With reference to pages 7 and 12, the rate of application of granules per unit area is controlled by the position of the flow adjustment ratchet lever R. The ratchet teeth are at $\frac{1}{2}''$ (6.3) spacing, and to provide finer adjustment two holes are provided ('A' and 'B') on the lever at the point where it joins the metering sleeve arm S. To keep the ratchet engaged during field operation, a small coil spring is fitted through $\frac{1}{2}''$ (3) diameter holes between the metering sleeve arm and the ratchet lever.

This description and the accompanying drawings provide adequate detail of the fabrication technique used, and it is up to the recipient of this technical information to make whatever modifications in design and construction materials as is considered necessary to suit local conditions.
CALIBRATION OF I.T. GRANULE APPLICATOR USING SUPERPHOSPHATE GRANULES

ENVELOPE CONTAINING POINTS FROM 4 REPLICATIONS

Delivery per 10 revs. measured in bench test.

Delivery per acre calculated assuming effective rolling circumference of spiked drive wheel to be 4½ ft.

"A" and "B" are alternative holes in ratchet control lever; numbers are ratchet lever notches (zero = fully closed position)
I.T. HIGH-CLEARANCE ROTARY HOE

Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description:

This implement is designed for weeding of crops grown on ridges at 75 - 90 cm spacing. It cultivates both sides of one ridge at a time and therefore, unlike cultivators drawn between the ridges, does not require straight and parallel ridges for efficient weeding.

Cultivation is done by two gangs of four spider wheels, each having ten backward curved tines. The gangs are angled to maintain the profile of the ridge and give a slight "earthing up" effect. The width of the uncultivated portion along the crop row can be adjusted from 5 to 20 cm. The rolling action gives light draught and the implement will ride over stumps or other obstructions in improperly cleared land. The rotary hoe can be used for weeding closer to the crop than some cultivators without causing apparent crop damage.

An arch frame is used to give 75 cm clearance over the top of the ridge. The frame is pulled by two ropes, one on each side of the crop. The handles are offset to allow the operator to walk in the furrow. Skids for working and transport positions are provided.

Performance is good provided weeding is carried out early, while the weeds are small. The implement is not suitable for use in very hard soil conditions. It can be used in wet soil and has been used successfully for weeding cotton while water was standing in the furrows.

EXPERIMENTAL ADJUSTABLE ANGLE MODIFICATION FOR I.T. ROTARY HOE

Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description:

This modification was designed to allow the I.T. Rotary Hoe to be used on different ridge profiles.

A tube welded onto the U-piece carrying the rotor fits over a round stub welded to the clamp and is held in place by a thrust washer and split pin. A plate with a slot is welded to the clamp. A length of angle iron having four holes is welded to the U-piece. Any one of the four holes can be aligned with the slot and a bolt passed through to lock the angle of the U-piece.

The adjustable angle version would be a useful research tool for finding the appropriate rotor angle for conditions in any locality. This information could then be used to modify the assembly fixture for the farmers' fixed-angle machines.

Orthographic drawings use first angle projection.

Dimensions given in mm.
<table>
<thead>
<tr>
<th>ITEM</th>
<th>NAME</th>
<th>QTY</th>
<th>MATERIAL PER ITEM</th>
<th>MANUFACTURING NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Arch</td>
<td>1</td>
<td>2400 x 30 bore water pipe</td>
<td>Bend to shape, starting at centre, and saw off ends of pipe level.</td>
</tr>
<tr>
<td>B</td>
<td>Stub</td>
<td>2</td>
<td>150 x 30 x 30 M.S.</td>
<td>Square bar or hollow section fabricated from angle iron. Weld to A.</td>
</tr>
<tr>
<td>C</td>
<td>Main skid</td>
<td>2</td>
<td>400 x 50 x 10 M.S.</td>
<td>Weld to A.</td>
</tr>
<tr>
<td>D</td>
<td>Main skid strut</td>
<td>2</td>
<td>300 x 12 φ M.S.</td>
<td>Weld to A and C.</td>
</tr>
<tr>
<td>E</td>
<td>Handle</td>
<td>1</td>
<td>750 x 25 bore water pipe</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Handle carrier</td>
<td>1</td>
<td>600 x 30 bore water pipe</td>
<td>Prepare ends by partial crushing and weld to E and A.</td>
</tr>
<tr>
<td>G</td>
<td>Transport skid</td>
<td>1</td>
<td>350 x 50 x 10 M.S.</td>
<td>Weld to A.</td>
</tr>
<tr>
<td>H</td>
<td>Transport skid strut</td>
<td>1</td>
<td>250 x 12 φ M.S.</td>
<td>Weld to F and G.</td>
</tr>
<tr>
<td>J</td>
<td>Hitch loop</td>
<td>2</td>
<td>200 x 12 φ M.S.</td>
<td>Weld to A.</td>
</tr>
<tr>
<td>K</td>
<td>Rotor hub</td>
<td>2</td>
<td>380 x 25 bore water pipe</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Tine</td>
<td>80</td>
<td>150 x 12 φ M.S.</td>
<td>Bend to approx. 100 mm radius.</td>
</tr>
<tr>
<td>M</td>
<td>Reinforcing wedges</td>
<td>80</td>
<td>15 x 12 φ M.S.</td>
<td>Forge to shape and cut off from bar. Weld ten each of L and M into each spider wheel so that spider wheels fit over K. Weld spider wheels to K with tine positions staggered.</td>
</tr>
<tr>
<td>N</td>
<td>Axle</td>
<td>2</td>
<td>450 x 15 φ M.S.</td>
<td>Wood bearing impregnated with groundnut oil as per IDC Report No. 69-8. O.D. to be press-fit in K, I.D. to be running-fit on N.</td>
</tr>
<tr>
<td>O</td>
<td>Rotor bearing</td>
<td>4</td>
<td>100 x 30 x 30 hardwood</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>U-piece</td>
<td>2</td>
<td>745 x 25 bore water pipe</td>
<td>Bend to shape. Partially crush ends for welding to R.</td>
</tr>
<tr>
<td>R</td>
<td>Axle supports</td>
<td>4</td>
<td>40 x 15 bore water pipe</td>
<td>Fit R onto N to maintain alignment and weld R to P. Drill 2 φ hole through R and N for V.</td>
</tr>
<tr>
<td>S</td>
<td>Clamp</td>
<td>2</td>
<td>100 x 40 x 5 M.S.</td>
<td>To be sliding-fit on B. Drill 13 φ hole. Weld 12 mm nut over hole.</td>
</tr>
<tr>
<td></td>
<td>Clamping bolt</td>
<td>2</td>
<td>40 x 12 eye bolt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>retaining pin</td>
<td>2</td>
<td>25 x 2 φ split pin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thrust washer</td>
<td>4</td>
<td>2 mm thick washer</td>
<td>I.D. 15 mm, O.D. 30 mm</td>
</tr>
<tr>
<td>Assembly fixture</td>
<td>1</td>
<td>2050 x 40 x 5 M.S.</td>
<td>Construct X as shown. Fit (P + R) assemblies onto X using N. Fit S onto B at innermost position. Bring P and S together as shown and weld P to S.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>760 x 15 bore water pipe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description: The IT Rotary Hoe gangs can be used with the Ariana toolbar instead of with the high clearance frame. In this form they are suitable for early weeding of any crop and can be used through the season for low growing crops such as groundnuts.

The adaptors are made in pairs, of which only the left hand is shown in the drawing. The right hand adaptor is a mirror image of the left hand.

Each adaptor consists of a 200 x 25 x 25 M.S. upright section to fit the standard Ariana toolbar clamp and a 100 x 30 x 30 M.S. stub to carry the IT Rotary Hoe clamp.

If the ridges are exactly parallel two ridges can be cultivated using the Ariana toolbar with its rear frame extension to carry four rotary hoe gangs. This assembly can be used before planting to align pairs of near-parallel ridges for subsequent two row weeding operations.

Orthographic drawings use first angle projection.

Dimensions in mm.
EXPERIMENTAL LIGHTWEIGHT ROTARY HOES

Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description: These components were designed for use in three configurations:

(i) Donkey drawn inter-row cultivator for crops grown on 30" spaced ridges.

The two rotary hoe gangs are clamped on the side arms of the tubular broad arrow frame. Cultivated width is reduced by moving the gangs to the point of the arrow and vice-versa. The gangs may be angled to suit the ridge profile. A sweep tine cultivates the furrow bottom.

(ii) Hand pushed inter-row rice weeder.

The handle section is withdrawn from the broad arrow frame and the rotary hoe gangs are clamped onto it in tandem.

(iii) Wheeled push hoe for crops planted on 30" spaced ridges.

A frame carried on a bicycle wheel is used to hold the rotary hoe gangs, which are adjusted as in (i).

None of these configurations was found to be very successful under Daudawa field crop conditions. They would probably be more satisfactory if used on smooth soil surfaces, such as those of vegetable gardens, rather than the rougher surfaces in field crops.
Modified IDC Weeding Attachment for the EMCOT Ridging Plough

Original design by: Industrial Development Centre, Zaria, North Central State, Nigeria.

Modifications by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Note: These instructions to be used in conjunction with IDC Special Report No. 70 - 2.

Description of modifications:

(a) for local agricultural situation at Daudawa

(i) Crops at Daudawa are grown on 30" spaced ridges rather than 16" spaced ridges mentioned in the IDC Report. The overall width of the frame was reduced to 27" to prevent fouling of the crop.

(ii) The attachment should preferably be used with the EMCOT depth wheel in place. However, Daudawa farmers do not like using the wheel. The modified frame brings the weeding tines further towards the rear of the EMCOT, where they are less affected by the side to side swinging of the front of the EMCOT beam which occurs if the wheel is not used.

(b) for simpler and cheaper manufacture

The modified frame consists of one length of 90" x 2" x 3/8" mild steel, the rear end passing under the EMCOT beam, and two supports of 6" x 1" x 1/2" mild steel, rivetted together. The front end of the frame is fixed by the rear hake plate bolt of the EMCOT. A 2 1/2" x 3/8" bolt passing through the support pieces and over the EMCOT beam holds the rear of the frame.

(c) for convenience of the operator

If welding equipment is available, the need to use a spanner for adjusting the tool standards can be eliminated. The clamping nuts are welded to one of each pair of clamp plates and rings are welded onto the clamping bolt heads so that they be turned using a Tommy bar.

The remaining components (tool standards and weeding blades) are unmodified.

Orthographic drawing uses first angle projection.
DAHOMEY WEEDING ATTACHMENT FOR RIDGING PLOUGHS


Description: Two lengths of angle iron of approximately 1½" x 1½" x 3/16" section are shaped and bolted to the mouldboards of the ridging plough. Their leading edges are sharpened to scrape weeds from the sides of the ridges at the same time as remoulding the ridges.

The attachment is reported to be successful in the sandy soils where it was developed. Free scouring conditions are necessary to prevent soil from building up between the attachment blades and the ridger mouldboards. It has been tried out in the North Central State of Nigeria and was successful only at Kafin Soik, which has sandier soils than either Samaru or Daudawa, where it was tested without success. The attachment is so cheap and simple to make that it would be worth testing in any sandy soil area.
Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description: This attachment was designed to permit ripping in very hard soil conditions such as those existing in the dry season at Daudawa.

The attachment is bolted onto the Emcot beam in place of the standard ridging body. The chisel tine is welded to a 12 mm. thick mild steel plate which is itself welded or bolted onto a pair of standard Emcot beam extensions.

The tine used for the prototype was a discarded bar point share as used by the local Tractor Hiring Unit. This would be the most suitable material, but a length from a motor vehicle drive shaft would be a reasonably satisfactory substitute.

Low draught and good penetration are obtained by using a low rake angle tine as employed on modern tractor drawn chisel ploughs. In effect, the attachment converts the Emcot ridging plough into an ard type breaking plough.
**IT *QUICK DETACHABLE CLAMPING METHOD FOR EMCOT RIDGER ATTACHMENTS**

**Developed by:** Intermediate Technology Project, Daudawa, North Central State, Nigeria.

**Description:** Some attachments which have been designed to increase the versatility of the Emcot ridging plough (IDC Groundnut Lifter, IDC Ridge Splitter, IT Chisel Tine) are fitted to the Emcot beam in the same way as the standard ridging body, using a pair of beam extensions held to the beam by two bolts, the upper bolt also securing the Emcot handles. Fitting and removing these attachments is not at all difficult for a mechanic under workshop conditions, with two correctly sized spanners available and an assistant to help align the beam, beam extensions and handles. Under farm conditions, where the bolts may be damaged, soil-encrusted and corroded and the correct spanners unavailable, the task can be difficult and time-consuming.

For the quick detachable clamping method, the tops of the beam extensions are cut short so that the upper bolt is used only to secure the handles, which then do not have to be removed when changing attachments. Two loops of 30 mm. x 10 mm. M.S. bar are welded to the shortened beam extensions. These locate the beam extensions and transmit working loads to the beam. The lower bolt is replaced by a pin (cross drilled for a retaining split pin), which only has to support the attachment when the handles are raised. To change from one attachment to another it is only necessary to remove the retaining pin, slide one attachment off the beam and another one on and replace the retaining pin.
I.T. EXPANDABLE CULTIVATOR

Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria

Description:

A lightweight cultivator designed for weeding of crops planted in 70-90 cm spaced rows in sandy soils, to be pulled by one or two oxen or donkeys.

Tines are individually adjustable for depth, making the implement suitable for flat or ridge cultivation. Taper pins engage with notches in the tool standards and are hammered into the wooden beams to lock the tines at the required depth.

The cultivator is suitable for manufacture by village blacksmiths, minimum equipment for manufacture being:
- Forge
- Anvil
- Hammer
- Tongs
- Punch
- Chisel

Orthographic drawings use first angle projection. Dimensions are in mm.

<table>
<thead>
<tr>
<th>ITEM NAME</th>
<th>QTY</th>
<th>MATERIAL PER ITEM</th>
<th>MANUFACTURING NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Centre beam</td>
<td>1</td>
<td>1200 x 75 x 50 hardwood</td>
<td>Boles for taper pins drilled or burnt 9 ø and burnt out to form using hot taper pin.</td>
</tr>
<tr>
<td>B RHS Beam</td>
<td>1</td>
<td>700 x 75 x 50 hardwood</td>
<td></td>
</tr>
<tr>
<td>C LHS Beam</td>
<td>1</td>
<td>700 x 75 x 50 hardwood</td>
<td></td>
</tr>
<tr>
<td>D Hake plate</td>
<td>1</td>
<td>10 mm M.S. plate</td>
<td>Boles drilled or punched.</td>
</tr>
<tr>
<td>E Pivot plate</td>
<td>2</td>
<td>155 x 40 x 10 M.S.</td>
<td></td>
</tr>
<tr>
<td>F Pivot bush</td>
<td>2</td>
<td>75 mm length pipe</td>
<td>O.D. press-fit in 20 ø holes in B and C. I.D. turns on 15 ø bolt.</td>
</tr>
<tr>
<td>G Adjustor</td>
<td>2</td>
<td>270 x 20 x 6 M.S.</td>
<td></td>
</tr>
<tr>
<td>H Adjustor pin</td>
<td>1</td>
<td>150 x 10 ø M.S.</td>
<td></td>
</tr>
<tr>
<td>J Handle</td>
<td>2</td>
<td>1000 x 30 x 10 M.S.</td>
<td></td>
</tr>
<tr>
<td>K Handle tie bar</td>
<td>1</td>
<td>500 x 25 x 6 M.S.</td>
<td></td>
</tr>
<tr>
<td>L Handle grip</td>
<td>2</td>
<td>200 x 25 bore water pipe</td>
<td></td>
</tr>
</tbody>
</table>

(Key continued next page)
<table>
<thead>
<tr>
<th>ITEM</th>
<th>NAME</th>
<th>QTY</th>
<th>MATERIAL PER ITEM</th>
<th>MANUFACTURING NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Skid standard</td>
<td>1</td>
<td>300 x 25 Ø M.S.</td>
<td>Notches made with 6 Ø round file.</td>
</tr>
<tr>
<td>M</td>
<td>Skid</td>
<td>1</td>
<td>200 x 40 x 10 M.S.</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Tool standard</td>
<td>5</td>
<td>300 x 25 Ø M.S.</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Narrow tine</td>
<td>2</td>
<td>6 mm lorry spring leaf</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Sweep tine</td>
<td>3</td>
<td>ditto.</td>
<td>Fitted to rear tool standards.</td>
</tr>
<tr>
<td>S</td>
<td>Taper pin</td>
<td>6</td>
<td>90 x 12 Ø M.S.</td>
<td>Forged to taper.</td>
</tr>
</tbody>
</table>

Nuts and bolts on which side brims and adjustors pivot should be done up hand tight and the ends of the bolts peened over the nuts.

Rivets may be used instead of bolts.
**IT ROTARY RICE WEEDER**

**Developed by:** Intermediate Technology Project, Daudawa, North Central State, Nigeria.

**Description:** An alternative method for constructing a rice weeder similar in action to that depicted in the IT Photoprint Sheet.

The weeder uses 12 φ M.S. for the frame and tines because this material is on sale in most towns in the north of Nigeria, whereas steel plate has to be brought in specially from the larger cities.

Tines are made from 100 x 12 φ M.S., curved to 70 radius, the ends flattened to 3 thickness. Front gang has three spider wheels, rear gang has four, each of five tines and at 40 mm centres. Gangs are kept in alignment by spacers of 12 mm bore water pipe.

The two halves of the frame are made from 12 φ M.S. with blocks of 30 x 6 M.S. welded on for rotor bearings and for plates to join the two frame halves.

The blade is bolted to the frame at the same points as the handle.

Dimensions in mm.
**I.T. GROUNDNUT LIFTER**

**Description:**
A lightweight lifter suitable for groundnuts grown on 75 cm. spaced ridges in sandy soil.
Suitable for manufacture by village blacksmiths.
No need for accurate work, but relationship between hake, blade and handles should be within ± 50 mm.
of dimensions shown.

**Minimum equipment required for manufacture:**
Forge
Anvil
Hammer
Tongs
Chisel
Punch

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hake plate</td>
<td>2</td>
<td>Cut from 6mm thick mild steel plate. Holes drilled or punched.</td>
</tr>
<tr>
<td>B</td>
<td>Beam</td>
<td>1</td>
<td>1300 x 100 x 50 hardwood. Holes drilled or burnt with hot steel rod.</td>
</tr>
<tr>
<td>C</td>
<td>Side member</td>
<td>2</td>
<td>700 x 60 x 10 mild steel</td>
</tr>
<tr>
<td>D</td>
<td>Blade</td>
<td>1</td>
<td>Forged from 700 x 80 x 10 lorry spring leaf. Sharpened on both edges. Holes punched on centre line so that blade angle is maintained when blade is reversed.</td>
</tr>
<tr>
<td>E</td>
<td>Handle</td>
<td>1</td>
<td>3000 x 20 mm bore pipe filled with sand and plugged before heating and bending. Ends flattened before making holes.</td>
</tr>
</tbody>
</table>

All holes 12 mm diameter.
Rivets may be used if bolts are not available.
PROTOTYPE HAND POWERED KENAF RIBBONER

Developed by: Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description: Kenaf stalks are gripped by a pair of slow-turning, small diameter feed rolls and pass over an eccentrically mounted, square section, rotating breaker bar and then pass between a pair of fast-turning, large diameter, fluted rolls which strip the kenaf fibres from the unwanted pith.

All rotating components have hubs made from \( \frac{1}{4} \)" bore water pipe. Ball bearings taken from the centres of bicycle pedals are pressed into the \( \frac{1}{4} \)" pipes.

The chain drives are made using bicycle chains and sprockets.

Component

A Upper feed roll - driven at crank speed. 2\( \frac{1}{4} \)" O.D.
B " " " sprocket (44T).
C Lower feed roll - free turning, held against A by spring pressure. 2\( \frac{1}{4} \)" O.D.
D Breaker bar - 2\( \frac{1}{4} \)" square section, eccentricity 1". Direct coupled to crank handle.
E Double 44T drive sprocket - direct coupled to crank handle.
F Upper fluted roll - driven at 2.2 x crank speed. Made from 12" \( \phi \) discs welded to 1 x 1 x \( \frac{1}{4} \) angle iron bars. 20 bars per roll.
G " " " sprocket (20T)
H Lower fluted roll - similar to F. Spacing between F and H variable from \( \frac{1}{8} \)" clearance to \( \frac{1}{2} \)" engagement.
J " " " sprocket (20T)
SINGLE OX HARNESS


Description: A very simple and efficient harness suitable for manufacture in any village.

The yoke is made from 100 x 20 \( \phi \) M.S. The ends are bent to form hooks for the traces and the centre portion curved to suit the local cattle (approximately 150 mm. radius for the Bunaji breed of northern Nigeria). Sacking is wrapped around the yoke for padding.

The swingle tree is made from hardwood 600 x 50 \( \phi \).

The yoke is used with a rope tied loosely under the animal's neck. A pair of light rope reins passing through the animal's nose are used for control.

Dimensions in mm.
**IT SCREW TYPE DEPTH WHEEL CLAMP FOR EMCOT RIDGING PLough**

**Developed by:** Intermediate Technology Project, Daudawa, North Central State, Nigeria.

**Description:** The depth wheel of the Emcot ridger and those of several other ridgers and ploughs are clamped in position by a U-bolt, a clamping plate and two nuts. Many farmers find this arrangement inconvenient because of the need to carry a spanner in the field and the difficulty of turning nuts which have been damaged by a badly fitting spanner. The screw clamp is much easier to use and no spanner is required.

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Qty</th>
<th>Material per item</th>
<th>Manufacturing notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Spacer</td>
<td>1</td>
<td>40 x 30 x 10 M.S.</td>
<td>One of the original wheel supports is cut along line XX and spacer is inserted and wheel supports welded as shown.</td>
</tr>
<tr>
<td>B</td>
<td>Bridge piece</td>
<td>1</td>
<td>150 x 30 x 10 M.S.</td>
<td>Can be forged from one piece, but normally quicker to cut five pieces and weld them together. Two holes drilled for hake plate bolts. One hole drilled 13 Ø for clamping screw.</td>
</tr>
<tr>
<td>C</td>
<td>Nut</td>
<td>1</td>
<td>12 mm. nut</td>
<td>Weld over 13 Ø hole in bridge piece.</td>
</tr>
<tr>
<td>D</td>
<td>Clamping screw</td>
<td>1</td>
<td>150 x 12 mm bolt or 40 x 12 mm bolt welded to 100 x 12 Ø M.S.</td>
<td></td>
</tr>
</tbody>
</table>

Dimensions in mm.