5

Equipment for Ox-cultivation

5.1 INTRODUCTION

The success of any future ox-cultivation programmes will depend to a large extent on the availabity of appropriate equipment. The development of early schemes was inhibited by lack of ox-ploughs and spare parts while more recent schemes received imported implements which were not entirely suitable for local conditions *(Chapter 2)*. Experience from Senegambia indicates that a thorough programme of equipment evaluation should be undertaken before farmers make further purchases (Mettrick, 1978). For this reason, preliminary trials were carried out at Njala in 1980 and a programme of on-farm testing was prepared for 1981.

The aim of these trials was to obtain sufficient information on the qualities of the implements under test and to allow recommendations to be made on those most suitable for importation or local manufacture. The characteristics assessed included:

- efficiency;
- convenience;
- draught power requirement;
- versatility in different conditions;
- design features that can be readily improved.

A summary is given here of preliminary observations together with a discussion on the implications of the findings.

5.2 SINGLE PURPOSE PLOUGHS

5.2.1 Ransome 'Victory' Plough
(Figs 2.4 and 3.15)

Origin: Imported from UK 1928-1950.

Availability: UK manufacture stopped in 1954. Apparently a similar design is available from India (Boyd, 1976).

Price: Price of similar models from India not known.

Description: A strong mouldboard plough with adjustable stabilising wheel. The long beam is made of a single piece of hard steel running from the hake to the plough body. Vertical and lateral regulation is possible. Share size is approximately 25 cm/10".

Qualities: The 'Victory' is an exceptionally robust plough with very good control and stability. About half the original ploughs were still in use after over 30 years' work. Wheels, heels and shares tended to wear out after some years, and some farmers have continued to use the plough without a wheel, with shares made by village blacksmiths. The 'Victory' plough has been found excellent in the light boliland soil and swamps in the Mabole Valley. However, its 23-25 cm/9-10" share has been found rather large for swamps in the Koinadugu District.

Verdict: An amazingly robust plough with a long life. While further importation is not likely, it would be worthwhile to make or obtain sufficient spares to keep the old ploughs going even longer. Shares can be made cheaply by village blacksmiths, but wheels will have to be imported or made in a well-equipped workshop.

5.2.2 'Guinea' Plough
Fig 5.1

Origin: Privately imported from Guinea in the 1970s. Manufactured in France (Huard UCF) and China.

Availability: Farmers reported that these ploughs were readily available for private importation during 1980. Availability for official importation from Guinea or China not known.

Fig 5.1 **'Guinea' plough made in China, but imported from Guinea.**

Price: The approximately price in January 1981 in Koinadugu District was Le 70. This may not represent the true cost.

Description: A lightweight mouldboard plough, with adjustable stabilising wheel. The relatively short beam is made of a single hard steel bar from hook to plough body. Vertical and lateral regulation is possible. Share size 17.5 cm/7".

Qualities: A lightweight plough with some stability, although control is not particularly good. The very low handles cannot be adjusted. The vertical regulation is not easy. The bolts of the frame frequently vibrate loose, causing handling problems. Reasonable results were achieved in swamps and upland soils. Its light weight makes it easy to negotiate field obstructions such as stumps and roots. Farmers in Koinadugu District have found it adequate for swamp and upland work, but farmers in the Mabole Valley regard it as too small and light for their bolis.

Verdict: This plough is not particularly good, but it is very cheap and, if available, it could be a useful single-purpose implement for Koinadugu District.

5.2.3 Chinese wooden plough
(Figs 5.2, 5.3)

Origin: Imported from China for Chinese rice stations about 1974.

Availability: About 70 units were imported and distributed to rice stations and other institutions. Approximately 30 units were in Rolako stores in 1980. Further availability is not known.

Price: Not known, but probably low.

Description: A lightweight wooden-framed plough with a single handle. No stabilising wheel or skid. The share and mouldboard are symmetrical and made of cast iron. Vertical and lateral regulation is possible. Share size is approximately 23-25 cm/9-10".

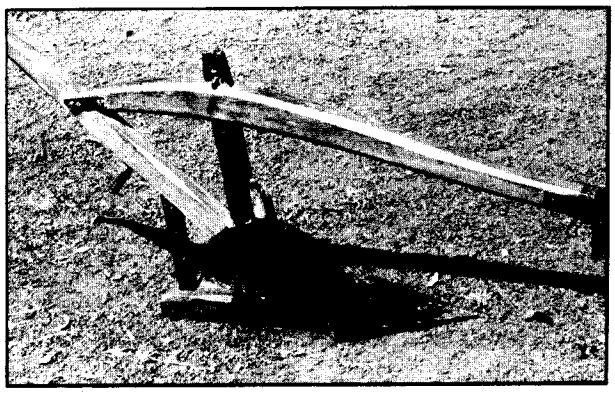

Fig 5.2 **Chinese wooden plough.**

Fig 5.3 **Chinese wooden plough in use.**

Qualities: A swamp plough not suited to upland work. It is very lightweight and of cheap construction. Even in swamps its stability is poor and control is difficult. Its power requirement is very variable with very high peaks of effort. The cast iron shares and mouldboard are brittle and easily broken. However, it gives good soil inversion and ploughing when control is achieved.

Verdict: This plough has not been favourably received. Its disadvantages (control and brittle mouldboards) would appear to outweigh any possible price advantage.

5.3 MULTI-PURPOSE TOOLBARS

5.3.1 Anglebar
(Figs 5.4, 5.9, 5.10)

Origin: Imported from UK from 1979 to 1981. Designed by Alan Stokes of Project Equipment Ltd, Oswestry and manufactured by both his company and P J Parmiter, Station Works, Tisbury, Wilts, UK.

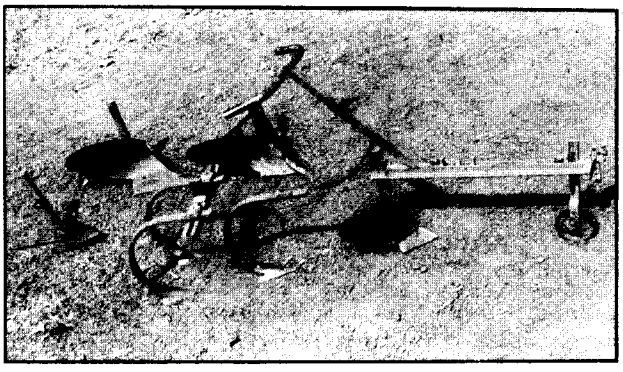

Fig 5.4 **Anglebar (1979 version) with 15 cm/6" plough, together with groundnut lifter, 23 cm/9" plough, ridger and 3-tine weeder.**

Availability: Two units ordered in 1979, 20 in 1980 by the KIADP, and 17 modified units in 1981 for on-farm evaluation. Further units available on order.

Price: For basic plough, approximately Le 317 in January 1981 and Le 853 for the complete system. *(See Table 5.1).*

Description: A tool frame with multiple uses designed for manufacture in developing countries. The frame comprises two angle-iron bars welded to spacer blocks, allowing room for insertion of attachment stalks. The adjustable stabilising wheel or skid is held by eye bolts. Vertical and lateral regulation is possible. The handlebar type handles are easily adjusted.

Implements that can be fitted include:

- Ploughs: 15 cm/6". 19 cm/7½" and 23 cm/9".
- Ridger: with adjustable wings and heel.
- Weeding tines: (3 or 5 tines), 15 cm/6" ducksfoot or 5 cm/2" points.
- Groundnut lifter: 28 cm/11" sweep share.
- Seeder: with removable rollers for different crops and spacings.
- Harrow: 17 steel points with 122 cm/48" working width.

Qualities: a) Frame: The anglebar is a medium weight and very versatile toolbar. The handles are comfortable and easily adjustable. The fitting of different implements is simple, with clamping and adjustment achieved with a tommy bar. However, the original eye-bolts tapped directly into the frame cause major problems when stripped, as repairs cannot be carried out in villages, *(Fig 5.5)*. The manufacturers supplied removable clamps which are effective and can be used for wheel adjustment, *(Fig 5.6)*.

Following problems in the equipment supplied by Parmiters, the system of implement attachment has now been changed to a longitudinal bolt and a removable wing nut, *(Fig 5.7)*. Tolerances on the frames are fine, so that slight variations in individual frame make the interchange of implements and handles difficult.

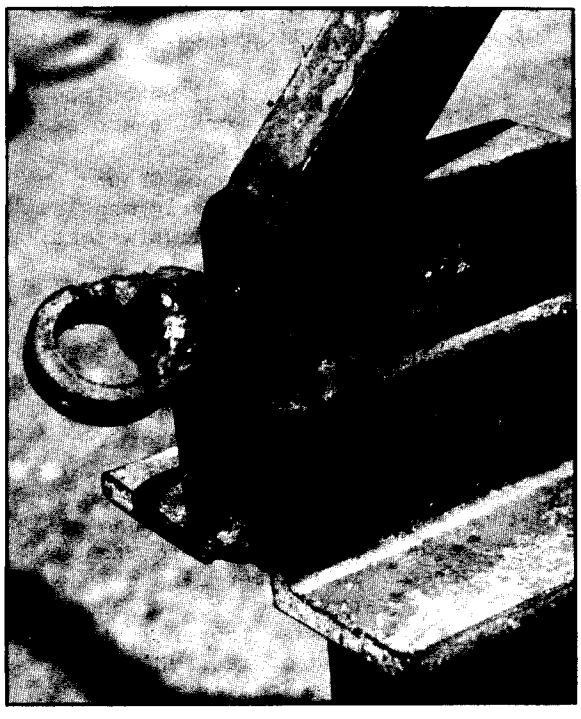

Fig 5.5 **Eye-bolt tapping into frame of early Anglebar. When this broke, the whole frame had to be taken for welding.**

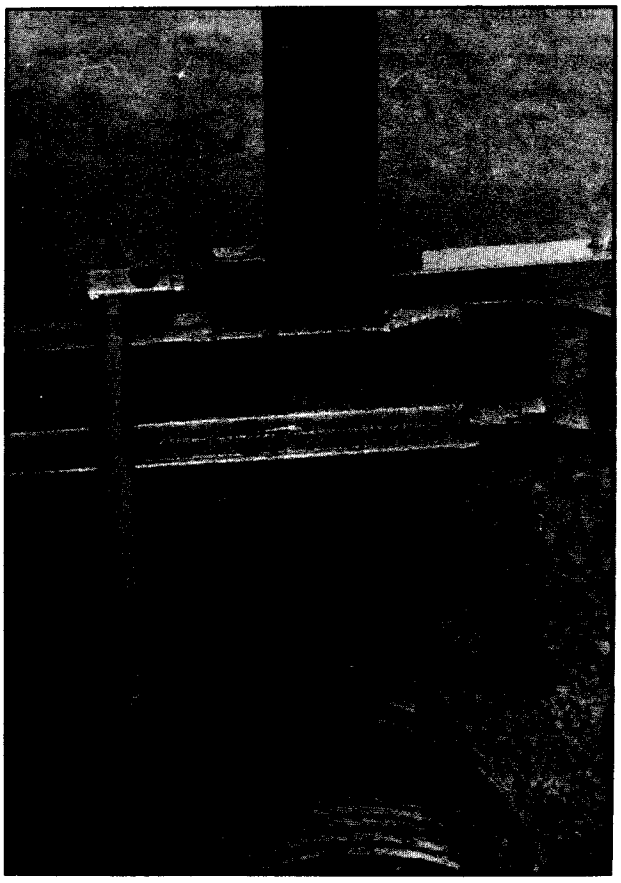

Fig 5.6 **Improved Anglebar wheel adjustment, with removable clamp held by split-pin.**

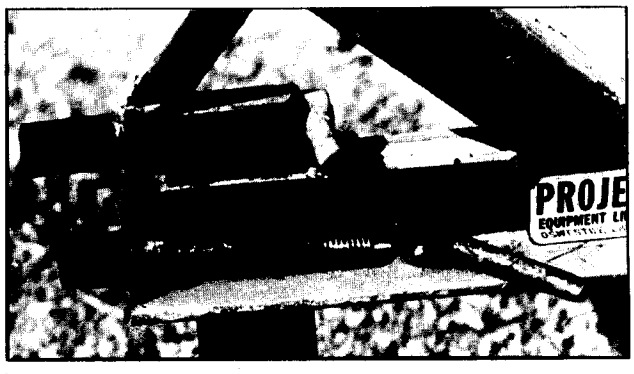

Fig 5.7 **Improved Anglebar plough attachment, with longitudinal eye-bolt and wing-nut. A pin and R-clip can also be used through the plough stalk.**

b) Hake: This has been extensively modified. The original design had a vertical bar with holes drilled for vertical adjustment. This was changed to a bar with adjustable ringbolt. The ringbolts carried the whole strain of ploughing and easily broke. The bars were therefore replaced with an efficient system comprising a notched bar and ring *(Fig 5.8)*. The whole hake can be easily offset by changing the position of a removable pin and R-clip. In overcoming various design problems the hake is now efficient, although the offset facility may be an unnecessary refinement for many farmers.

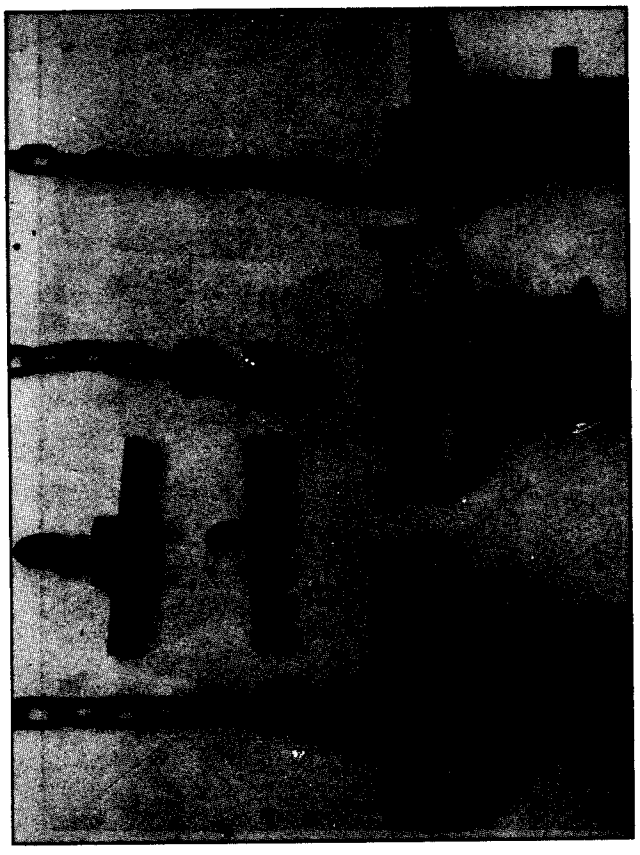

Fig 5.8 **Development of the Anglebar hake. Top: original design. Middle: design supplied in 1980/81 but eye-bolts broke. Bottom: 1981 improvement, with rack and ring replacing bar and clamp.**

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c) Wheels and skids: The original depth wheels were too small and were easily clogged. A self-cleaning system did not improve the wheel significantly and wheel bearings wore out extremely quickly under village conditions. A larger wheel with a sealed bearing is now available and has proved satisfactory. A double plastic/rubber wheel *(Fig 5.9)* gives excellent stability, but quickly disintegrates under harsh village conditions. The skid supplied with the anglebar, *(Fig 5.10)*, was extremely poor and universally rejected by farmers. A more suitable design based on the Pecotool skid *(Fig 5.11)*, is now available.

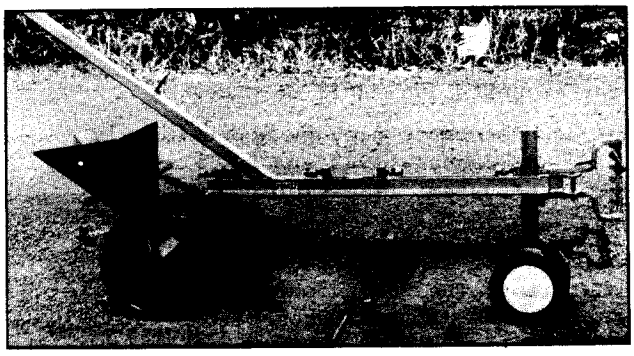


Fig 5.9 **Anglebar with seeder attachment and double wheel. Clamps are of the improved removable design.**

d) Ploughs: The 23 cm/9" plough gives excellent inversion and has had a very favourable reception from farmers in the Bombali District. However, this plough is considered by farmers to be too large for swamp cultivation and for upland ploughing in Koinadugu District.

The 19 cm/7½" plough, now with an extended stalk, is adequate but not as efficient as the 15 cm/6" plough. The 15 cm/6" plough has been found popular in Koinadugu District and for swamp cultivation, although some farmers report the whole plough is too heavy for swamp work. The early problem of short plough stalks has been overcome in the new specifications.

e) Weeding tines: The tines are heavy, with additional helper springs and this double spring design makes it very difficult to replace shares. The 5-tine system is too heavy for use in Sierra Leone, but the 3-tine weeder works efficiently.

f) Ridger: The heel makes the ridger very stable and good work is achieved. Wing adjustment is not very easy.

g) Groundnut lifter: Ground clearance was rather small in early models, due to the short stalk. It is lightweight, but effective.

h) Harrow: *(Fig 5.10)*. A welded, rigid frame steel harrow can be fitted to the Anglebar. It produces effective work, but is rather narrow (122 cm/48" working width).

i) Precision seeder: *(Fig 5.9)*. This is a roller seeder in which a ground wheel drives a wooden roller which regulates the movement of seeds between the hopper and the seed tube. This has not been found effective. Many seeds are broken due to the poor regulation system. The rubber flap of the regulator disintegrates quickly. If the regulator is low, the seeds get broken in the holes, but if the regulator is high, seeds can be broken between the roller and the regulator. The seeder is not supplied with a row marker, which is a disadvantage. It is probable that with more development work the seeder could be made effective but, as supplied, it does not appear to be efficient.

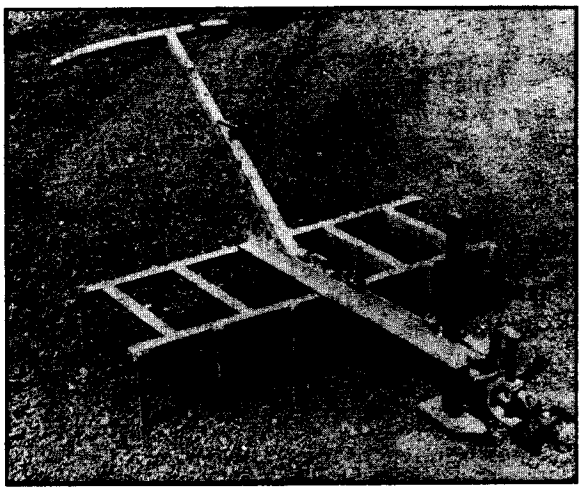


Fig 5.10 **Anglebar with harrow attachment. The front skid was of poor design.**

Verdict: After extensive modification, the Anglebar appears good for upland ploughing and is satisfactory in swamp conditions. It is a convenient multi-purpose toolbar and can be recommended for the farms of agricultural institutions. However, it is a refined implement and the problem of implement incompatability, due to minor variations and fine tolerances, reduces its value for farmer extension programmes. The problem of fine tolerances also reduces its suitability for local manufacture.

5.3.2 Pecotool
(Figs 5.11, 5.12, 5.13)

Origin: Imported from UK for evaluation in 1979 and subsequently modified in UK and Sierra Leone. Designed and manufactured by Project Equipment Ltd, Oswestry.

Availability: Two units ordered in 1979 and 2 modified units ordered in 1980. Further units available on order from UK; the local manufacture of these ploughs from imported components is possible.

Price: Approximate prices in January 1981 were: basic plough Le 198; complete system Le 710. *(Table 5.1)*.

Description: A simple toolbar designed for manufacture in developing countries. The strong frame is made of rectangular hollow section. It has either an adjustable stabilising wheel or skid. Vertical and horizontal regulation is possible. The adjustable handles are of a 'handlebar' design. Different working bodies can be attached to the frame with ring bolts. These include mouldboard ploughs (15 cm/6", 19 cm/7½" or 23 cm/9"), ridgers, seeders, groundnut lifters and weeding tines.

Qualities: Since the first models were imported, the Pecotool has been modified so that changing plough bodies and adjusting the wheel can be carried out using only a tommy-bar. Thus, only spanners are needed for changing ploughshares, landsides (heel) and mouldboards.

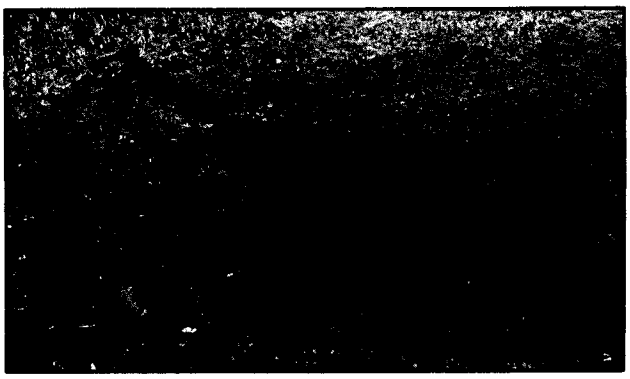


Fig 5.11 **Pecotool, 1979 design, with 15 cm/6" plough, ridger and broad skid of good design.**

Fig 5.12 **Pecotool, 1980 design, with weeding tines and narrow skid (not as satisfactory as broad skid).**

ınterchanging implements is relatively simple, but the bolts pass through four thicknesses of steel (handle, top and bottom of frame and implement bracket) and this can cause damage to threads if implements are changed very frequently *(Fig 5.14)*.

A new larger wheel is satisfactory and the hake has been simplified *(Fig 5.13)*.

The handles are comfortable and easily adjustable and are preferable to the Anglebar design.

The implements are the same as those of the Anglebar. The 23 cm/9" plough is excellent for the bolis of Bombali District and the 15 cm/6" plough is suitable for small animals or heavy upland or swamp soils. The 19 cm/7½" plough is reasonable, but not up to the standard of the other ploughs.

The ridger and the groundnut lifter are both good and the weeding tines are effective but heavy. The seeder is not recommended.

Verdict: The Pecotool can be used as a single purpose plough with alternative plough sizes for different areas and conditions. It can be used as a multi-purpose implement if required. It is simple to use, adjust and make. It is thus considered very appropriate to Sierra Leone conditions.

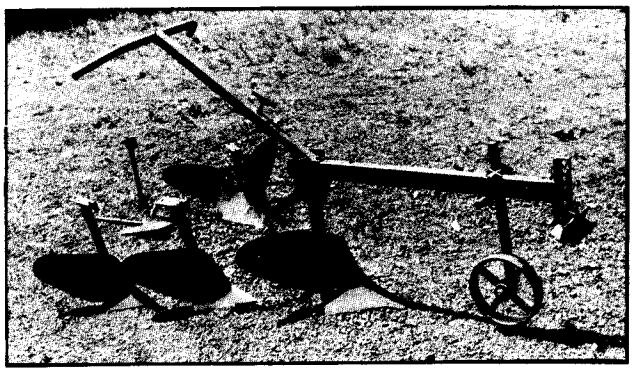


Fig 5.13 **Pecotool, 1981 design, with 23 cm/9" plough, 19 cm/7½" plough, 15 cm/6" plough, ridger, groundnut lifter and large wheel.**

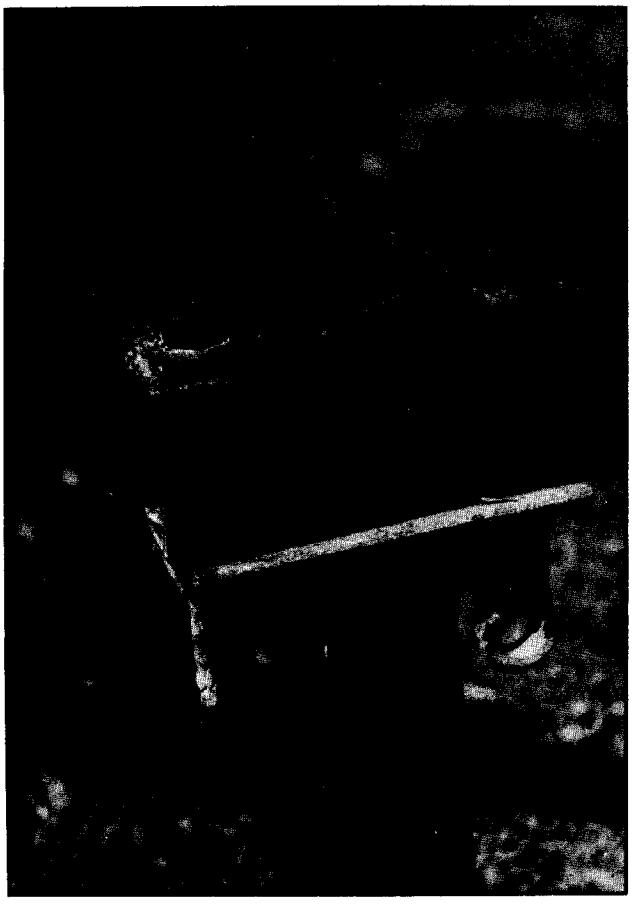


Fig 5.14 **Plough attachment on 1981 Pecotool, showing long eye-nuts which tighten on threaded stud.**

5.3.3 Sine Houe

(Figs 5.15, 4.16, 4.19)

Origin: Imported from Senegal in 1979 and 1980. Designed by Jean Nolle. Originally manufactured by Mouzon, Mouy, France. Subsequently manufactured by SISCOMA, Dakar, Senegal.

Availability: Two units ordered from SISCOMA in 1979; 20 units ordered in 1980. However, the SISCOMA factory was closed in 1980/81 and its future is uncertain. Large orders of a similar design can be obtained from Le Groupe Marpex, ODI International, 44000 Nantes, France. A similar design may also be available from Société de Forage Tropical, Cameroun.

Price: Approximate prices in January 1981: basic plough Le 276; complete system Le 817. *(Table 5.1)*.

Description: The strong frame is made of solid rectangular section steel bars welded into a T-shape. The adjustable stabilising wheel clamps on to the frame. Vertical and lateral regulation is possible. Some adjustment to the handle position is possible. Different implements fix on to the rear of the frame using removable clamps with eye-bolts. Implements that can be fitted include ploughs (15 cm/6", 20 cm/8" or 23 cm/9"), ridger, weeding or cultivation tines and groundnut lifter.

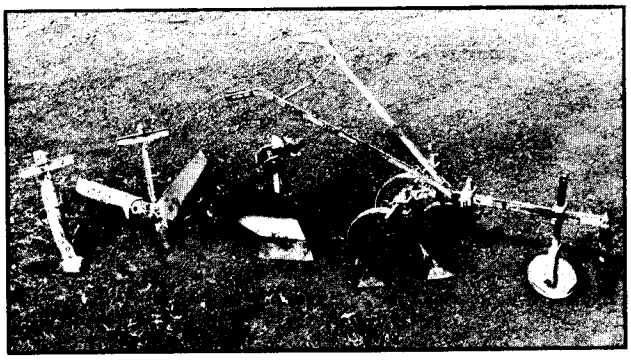


Fig 5.15 **Sine Houe fitted with 3-tine weeder, together with groundnut lifter, ridger and 20 cm/8" plough.**

Qualities: a) Frame: A strong multi-purpose toolbar with good control and stability. The implements are easily attached and interchanged using eyebolt clamps and a tommy-bar *(Fig 5.16)*. As clamps are removable, a broken or stripped eye-bolt or clamp can be replaced easily under village conditions *(Fig 5.17)*. However, a large proportion of the clamps supplied by SISCOMA have been faulty. The big diameter wheel is suitable for both upland and swamp work, but a skid can also be fitted. Handle adjustment requires a spanner and handle movement, and vibration is common. The chain hooks supplied by SISCOMA were too weak and they opened. Frame clearance in flooded swamps and grassy upland is good.

Fig 5.16 **Strong external clamp with eye-bolt on Sine Houe.**

Fig 5.17 **Sine Houe wheel clamp. When the eye-bolt broke, only the clamp had to be carried for repair.**

b) Ploughs: The 15 cm/6" and 23 cm/9" ploughs work satisfactorily, although the short mouldboards sometimes lead to poor soil inversion. The 20 cm/8" plough appears to be satisfactory in both upland and swamp conditions. The plough has had a good reception at Njala, but farmer reaction is mixed due to the mouldboard shape.

c) Weeding tines: The tines are light, easily fixed and the 16 cm/6" and 5 cm/2" shares are easily changed. Good work is achieved with the 3-tine unit, but the 5-tine unit is too heavy for work in Sierra Leone.

d) Ridger: Satisfactory work is achieved. The wings are easily adjustable. The lack of a heel reduces stability compared with the Anglebar/Pecotool ridger.

e) Groundnut lifter: This is robust and effective. It has a 35 cm/14" share with adjustable lifting angle.

Verdict: A good, strong, versatile toolbar that has been widely used elsewhere in West Africa. If the minor problems can be solved by the manufacturer, this would seem to be an appropriate toolbar for both simple ploughing and multi-purpose uses. The supply problem may be serious and it would seem desirable that samples of equipment made by suppliers other than SISCOMA should be tested in the field.

5.4 SEED PLANTERS

5.4.1 Project Equipment Seeder *(Fig 5.9)*

See notes on "Anglebar multi-purpose Toolbar" under 5.3.1 above.

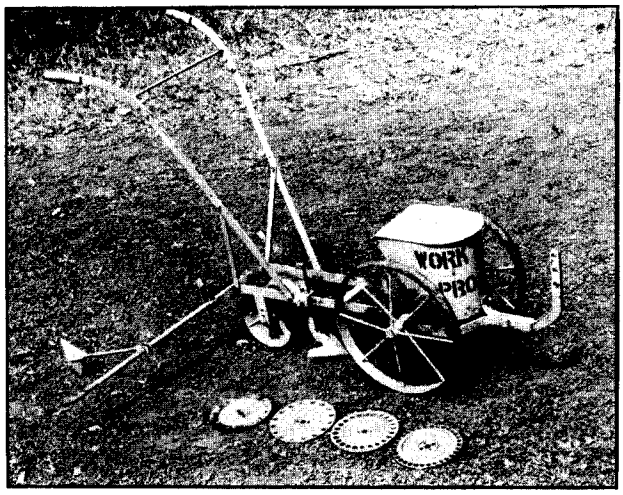


Fig 5.18 **Super Eco seeder, with interchangeable discs of 8, 16, 24 and 32 holes.**

5.4.2 Super Eco Seeder *(Figs 5.18, 5.19, 4.13, 4.14)*

Origin: Imported from SISCOMA, Senegal.

Availability: One unit imported in 1979, 10 units imported in 1980, from SISCOMA, Dakar, Senegal. It may be available from stock or by order if the SISCOMA factory reopens.

Price: Approximate price in January 1981: Le 298. *(Table 5.1)*.

Description: A single-row precision planter for independent use. Two large wheels drive a distribution disc, which regulates the seed movement between the seed hopper and the seed tube. Seeds enter holes in the distribution disc *(Fig 5.19)* and are transported to the top of the seed tube down which they fall. The seed spacing is determined by the number of holes in the interchangeable distribution discs. Sixteen-hole discs are used for maize and cowpeas, 24 holes are used for groundnuts and 32 holes for rice. The soil is opened with an opening shoe and seeds are covered by two small ducksfoot tines, after which soil is slightly compacted by a press wheel. The seeder has an adjustable hake handles and row guide for marking the position of the next row.

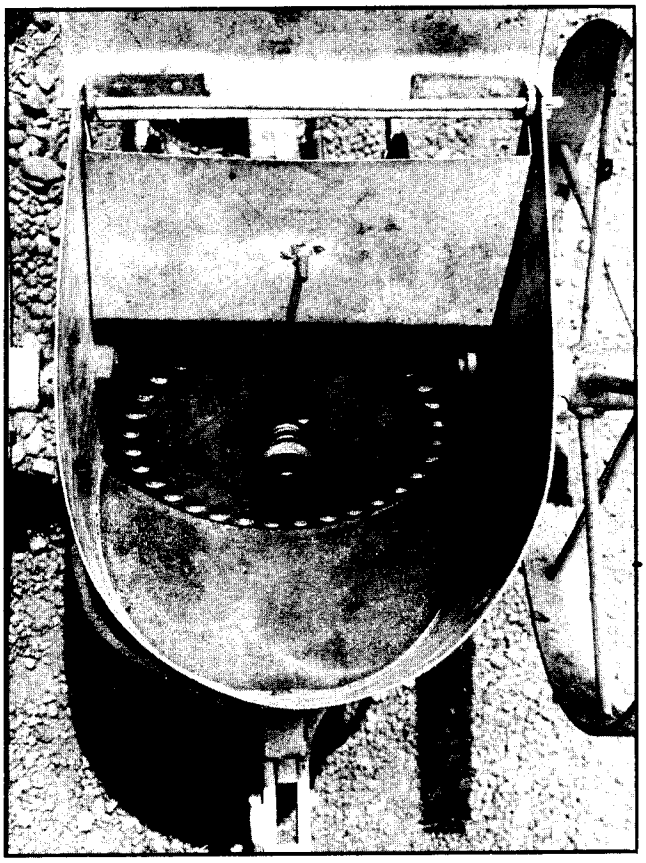


Fig 5.19 **Super Eco seeder showing seed hopper and distribution disc with cover removed.**

Qualities: The seeder is designed for use in light, relatively dry soils and well-prepared seedbeds. In these ideal conditions it works efficiently, but becomes clogged by weeds, trash and wet soil under more normal conditions. The use of a knife to open the soil in front of the opening shoe slightly reduced blockages caused by loose weeds, but this may have to be redesigned. For planting seeds the size of cowpeas, the holes of the distribution disc require countersinking to prevent seed blockages.

Verdict: A good seeder, but not yet sufficiently adapted to Sierra Leone soil and weed conditions. It is relatively complex and unlikely to be suitable for use on small farms. It could be useful on large farms, if fairly light soil has been well cleared and prepared.

5.5 HARROWS

5.5.1 Triangular Harrow
(Figs 5.20, 5.21, 4.10-12)

Origin: Made at Njala, Sierra Leone, in 1980. Modified from ITDG design. (ITDG undated).

Availability: Easily manufactured in Sierra Leone using readily available materials and skills of the village carpenter and blacksmith.

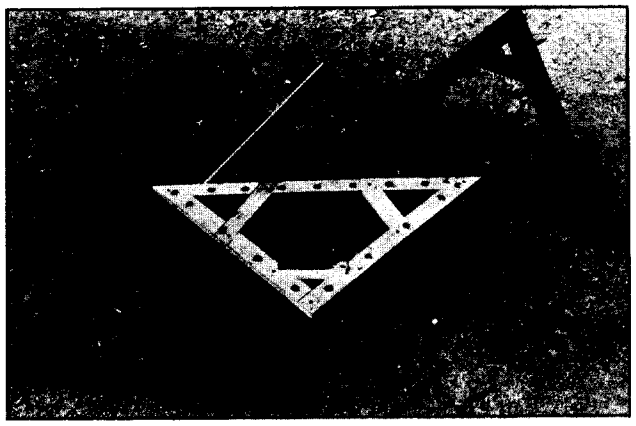
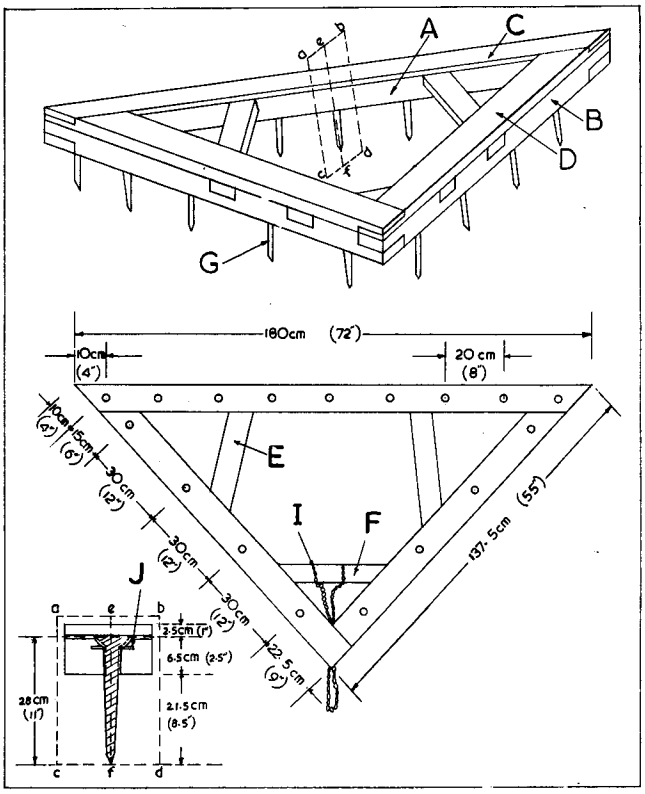


Fig 5.20 **Triangular spike tooth harrows.**



A Rear beam
1 6 x 10 x 180 cm (2.5" x 4" x 72")
B Side beam
2 6 x 10 x 137.5 cm (2.5" x 4" x 55")
C Rear board
1 2.5 x 10 x 180 cm (1" x 4" x 72")
D Side board
2 2.5 x 10 x 137.5 cm (1" x 4" x 55")
E Rear cross board
2 2.5 x 10 x 66 cm (1" x 4" x 26")
F Front cross board
1 2.5 x 10 x 61 cm (1" x 4" x 24")
G Tooth, (Mild steel)
17 2 cm (¾") dia, 25 cm (10") long
H Bolts, (with 14 washers)
7 1.5 cm (⅝") dia x 12.5 cm (5")
I Traction chain (1)
J Washers
17 2.25 cm (⅞")

Fig 5.21 **Dimensions of a triangular spike tooth harrow.**

Price: Could be manufactured in January 1981 for Le 50.

Description: A 180 cm/72" wide triangular wooden frame into which are inserted 17 mild steel teeth, positioned to give an effective working distance of 10 cm/4". The teeth are flattened on top to prevent them passing through the beam and are sharpened at the bottom. Three boards are fixed on top of the beams using bolts which hold the teeth in position providing, at the same time, a flat working surface. Details of construction are shown in *Fig 5.21.*

Qualities: Designed for local manufacture, the harrow is simple but effective. It has a large working width, but the teeth are widely spaced so that land has to be harrowed 2-3 times to obtain satisfactory results. The body is rigid and on uneven ground results are not uniform. In the swamp it achieves good puddling after several rounds, but it can be difficult to manoeuvre in small swamps. The harrow can be inverted to provide a smooth surface during transport to the field, or for producing a level seedbed. Logs can be added to increase weight for levelling, or to increase the working depth. It can be used inverted for levelling swamps, but there is a danger of it exaggerating existing holes and mounds.

Verdict: Simple to make and effective in use in large fields and swamps.

5.5.2 Zig-zag Harrow
(Fig 5.22)

Origin: Some imported from UK and France from from 1928-1950 of the Ransome and Plissonier makes. More recently some have been privately imported of unknown manufacture from Guinea.

Availability: Farmers reported that zig-zag harrows were available for private importation from Guinea in 1980. Zig-zag harrows are available on order from several manufacturers (Boyd, 1976).

Price: Unknown.

Fig 5.22 **Zig-zag harrow at Falaba, with 'Guinea' plough.**

Description: A zig-zag steel fram about 70 cm/28" wide, with 15 steel teeth bolted into the frame in five offset rows.

Qualities: This has a strong and robust design and many still in use are over 30 years old. The narrowness of the width can be increased by linking two or more harrows together. It can be used effectively for breaking clods and covering scattered seed, but the close spacing of the tines leads to clogging by weeds. It is suitable for upland harrowing, but rather heavy and narrow for use in flooded swamps.

Verdict: Durable and effective in use, but rather narrow.

5.5.3 Project Equipment Harrow
(Fig 5.10)

See notes under Anglebar multi-purpose toolbar.

5.5.4 Chinese Swamp Harrow
(Figs 5.23, 5.24)

Origin: Imported for Chinese Rice Stations in 1974.

Availability: Only a few units were imported, but they could easily be manufactured in Sierra Leone.

Price: About Le 50 in January 1981.

Description: A 160 cm/63" wooden beam containing 13 steel points at 12 cm/4½" intervals. Wooden uprights and handlebar. The attachments for ropes are also wooden.

Qualities: Easily manufactured locally. Simple and convenient to use in flooded swamps and effective for preparing a ploughed swamp for rice transplantation.

Verdict: This harrow is simple to make, convenient and effective to use, but not suitable for upland work.

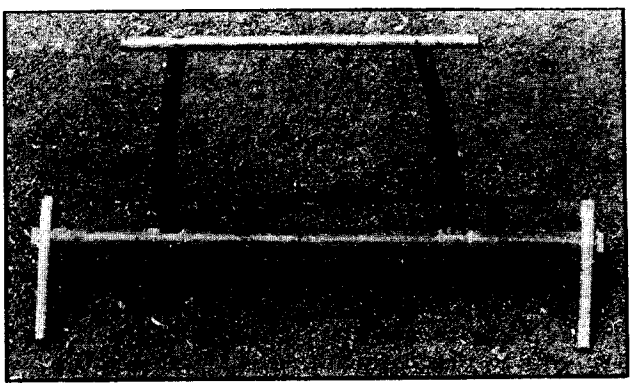


Fig 5.23 **Chinese swamp harrow.**

Fig 5.24 **Chinese swamp harrow in use. The Chinese swamp leveller is used in a similar way.**

5.6 SWAMP LEVELLERS
(Fig 5.25, 4.12)

Two implements were used for swamp levelling, a Chinese design used on their rice stations *(Fig 5.25)* and the inverted triangular spike tooth harrow. Both are designed for local manufacture and could be easily available at low cost. Both are effective, but the Chinese design is perhaps better.

This leveller is used in the same way as the swamp harrow *(Fig 5.24)* and is convenient to use. It is not robust, but it is easily repaired. The triangular harrow is much heavier, less convenient to manoeuvre but more durable; it is a dual purpose tool.

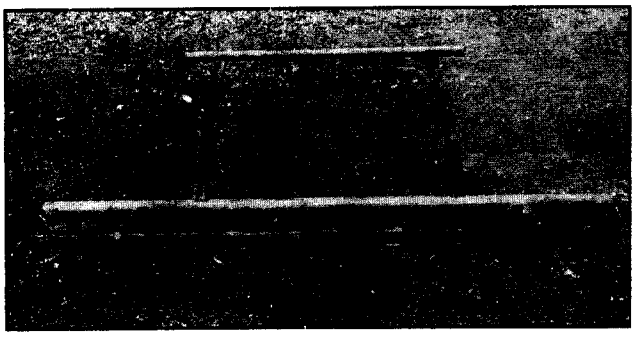


Fig 5.25 **Chinese swamp leveller.**

5.7 CARTS
(Figs 5.27 , 4.18, 3.30)

Two types of cart were made at Njala in 1979 and 1980, but further work is required to evaluate different designs of axles, bearings and wheels.

Details of construction of a strong and durable cart are given in *Fig 5.27*, together with its key and notes. The superstructure of this cart is based on an angle-iron frame with wooden platform and wooden removable sides. The body bolts on to an axle which could be made locally by adapting an old car axle. One such cart has been made at Njala using a ready-made axle imported from SISCOMA, Senegal. This has been found to be very good although relatively expensive. The combination of the welded angle-iron fram and the SISCOMA axle can be recommended as a high quality cart of reasonable weight.

However, for the farmer preferring a much cheaper cart, the traditional *omolanke* or 'town cart' design is recommended. These carts are made from old car axles with angle-iron struts attached to a wooden platform to which sides may be fitted. While the differential housings are heavy and the all-wooden frame is less durable than the angle-iron frame, these disadvantages are offset by the savings in cost. The use of pneumatic tyres is recommended and, while well-worn tyres can be used, sound tyres with good inner tubes save the frustration of frequent punctures.

If punctures are a problem, tyres can be packed with sawdust rammed through four holes drilled in the rim. The resulting increased weight and greater friction, together with the need for occasional recompaction, have to be balanced against the cost of a set of good tyres and tubes.

A wooden cart using wooden bearings, water pipe axles and locally made wheels has been built by the Tikonko Agricultural Extension Centre *(Fig 5.26)*. Although there were some problems of stiffness in the beginning, this has been found to be a useful cart, if a little heavy. However, despite the use of local materials, it was not cheap to make.

The design presented in *Fig 5.27* is for a high quality cart; the *omolanke* or 'town cart' is a cheaper alternative.

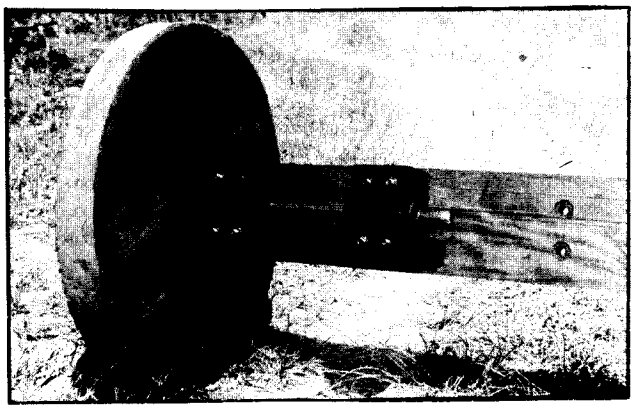
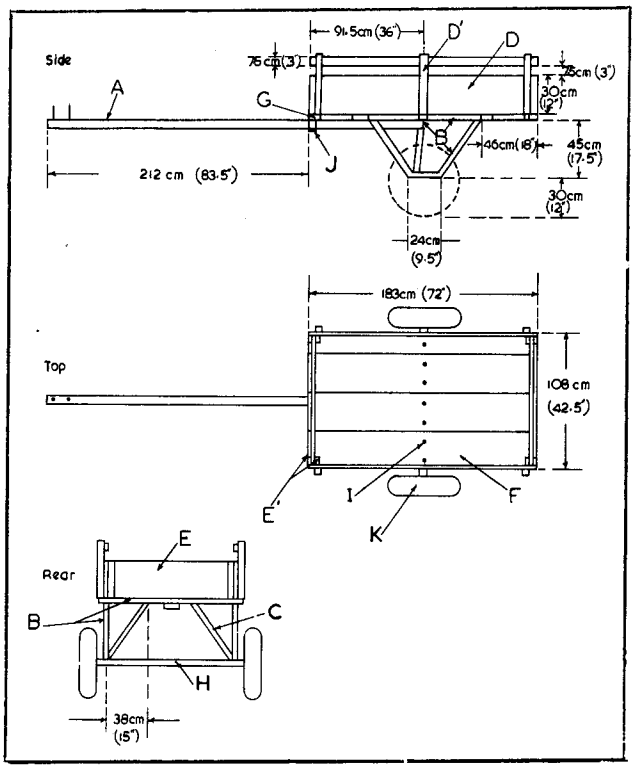


Fig 5.26 **Axle for an ox-cart made at Tikonko Workshop using wooden wheels and wooden bearings.**

5.8 DISCUSSION ON EQUIPMENT REQUIREMENTS

5.8.1 Plough size

No plough size will be perfect for all conditions in Sierra Leone. The farmers in the Mabole Valley area of Bombali District require a large plough of 23 cm/9" for their upland farms and bolis. For them the Ransome



Notes

Frame B of angle-iron, welded together, with pipe cylinders G welded to frame to accept removable sides.

Floorboards F bolted I to frame with spacers F' between the three crossbars and the boards, to bring boards to level of the top of the angle-iron.

Removable sides D have extended uprights D' which slot into pipe cylinders G.

Removable end boards E slide into vertical guides E'.

Frame B bolts into axle H; and reinforcing braces bolt into both frame and axle. Drawbar A bolts into centre of frame and is held by U-brace J at the front of the frame.

Key & Material requirements

A Drawbar (Water pipe)
1 300 cm (120") x 617 cm (2½-3")

B Frame (Angle Iron)
3 108 cm (42.5") x 4.5 cm (1¾")
2 183 cm (72") x 4.5 cm (1¾")
2 135 cm (53") x 4.5 cm (1¾")

C Braces (Water pipe)
2 52 cm (20½" x 3 cm (1¼")

D Side boards
2 2.5 cm x 30 cm x 183 cm (1" x 12" x 72")
2 2.5 cm x 7.5 cm x 183 cm (1 x 3" x 72")

D' Side uprights (Wood)
6 5 cm x 5 cm x 50 cm (2" x 2" x 20")

E End boards
2 2.5 cm x 30 cm x 108 cm (1" x 12" x 42½")

E' End guides (Wood)
8 2.5 cm x 5 cm x 30 cm (1" x 2" x 12")

F Floorboards
3 2.5 cm x 30 cm x 183 cm (1" x 12" x 72")
1 2.5 cm x 15 cm x 173 cm (1" x 6" x 72")

F' Spacing boards
3 2 cm x 4.5 cm x 108 cm (¾" x 1¾" x 42½")

G Pipe cylinders (Waterpipe)
6 4.5 cm (1¾") x 3.5 cm (1½")

H Axle (Solid section bar (or other as available), complete with bearings and hubs.
1 4 cm (1½")

I Nuts & bolts
21 1.5 cm x 7.5 cm ($\frac{5}{8}$" x 3")

J U-brace (Flat iron)
1 1.5 cm x 40 cm (1¾" x 16")

K Tyres
2 165 mm x 380 mm or other as available

Fig 5.27 **Dimensions of an ox-cart**

Victory plough has been excellent, but of the new ploughs they favour the 23 cm/9" one made by Project Equipment, with either the Pecotool or Anglebar frame.

When offered the choice of purchasing the cheaper 'Guinea' plough for Le 80, or an Anglebar for Le 360, 48 farmers out of 54 opted for the expensive plough. However, these same farmers find the 23 cm/9" plough too large for their swamps where they require the 15 cm/6" size.

In Koinadugu District the smaller plough is much preferred and the large 23 cm/9" is not as popular as the smaller, lighter 'Guinea' plough.

Intermediate sizes have been tried as a compromise and the 20 cm/8" SISCOMA plough was found to be very satisfactory at Njala while the 19 cm/7½" Project Equipment plough was less successful.

It is therefore concluded that only two plough sizes should be made available: a large 23 cm/9" plough mainly for farmers in Bombali District and a 15-18 cm/6-7" plough for the swamps and upland soils of Koinadugu District.

5.8.2 Single or multi-purpose equipment

Demand in Sierra Leone at present is chiefly for ploughs. The quality and price of the plough is a primary consideration while the potential for multiple uses of equipment is of secondary importance to farmers. However,

all the multi-purpose tool frames tested are of high quality with good ploughing control and adjustment; they can all be used as simple ploughs. They all accept different plough bodies making it possible to standardise on one tool frame, with two options for plough size.

Experience in Senegambia led to the recommendation for standardising on one type of ox equipment; this was a multi-purpose implement for use in a complete system of cultivation practices (Mettrick, 1978). But in Sierra Leone, ploughs are mainly used for rice cultivation where rice is a subsistance rather than a cash crop. There is, however, a great potential for the use of ox-cultivation for groundnuts and cowpeas where ox-weeding is extremely effective; ox-ridging is also of value for cassava and sweet potatoes.

It is concluded, therefore, that Sierra Leone should standardise on a single tool frame that can accept different plough sizes. In terms of quality and cost, the tool frame should be acceptable for use as a single purpose plough, but should also be able to accept different attachments.

5.8.3 Method of implement attachment

In multi-purpose implements, a compromise has to be made between strengh of attachment and convenience of adjustment. Because of the demand for simple ploughs, strengh is of first importance, but nuts and bolts should be avoided wherever possible. Preference should be given to eye-bolts and eye-nuts which are easy to adjust with a tommy bar, but they must also be strong enough to withstand overtightening. In all cases there must be adequate provision against misuse and all components that might break must be easily replaceable, or able to be repaired at village level.

The system employed in the Sine Houe is acceptable, as are the new specifications for the Anglebar and the Pecotool. These toolbars now use eye-bolts and removable clamping systems.

5.8.4 Wheels and skids

Trials in 1980 showed that a well designed skid *(Fig 5.11)* was preferable to a wheel in swamp cultivation and was also effective for upland cultivation. The wear and tear on wheels where the bearings are surrounded by abrasive particles is very great; but when the wheels are in good condition, they are more convenient for manoeuvring ploughs in upland soils.

Skids are much cheaper and more durable than wheels and since they were found to be good on the Pecotool, skids were ordered for the Anglebar. Unfortunately those supplied were of a different design and were rejected by farmers. It would still seem worthwhile, however, for well designed skids to be obtained for evaluation.

Wheels must be of a large diameter and the Sine Houe wheel, 20 cm/8" in size, is acceptable in both upland and swamp. The original Anglebar wheels (16 cm/6") were found to be too small and clogged badly. Meanwhile the new specification of both Pecotool and Anglebar gives a larger wheel with sealed bearings; first impressions are good.

In conclusion, it would seem that farmers prefer wheels of about 20 cm/8" diameter; well designed skids, however, should be made available as a cheaper alternative.

5.8.5 Spare part provision

It is essential to have an adequate supply of spare parts. The basic components, kits or ready assembled ox-ploughs ordered from overseas should all include a reasonable quantity of spare parts. In view of the long life of ox-ploughs it is recommended that the initial provision of spares should be for ten years.

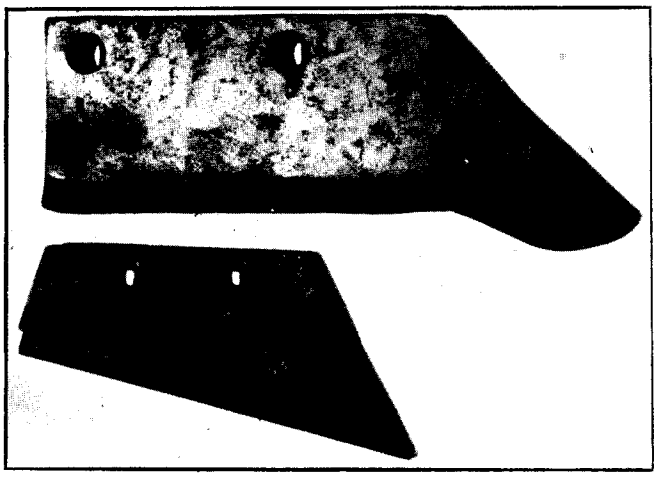


Fig 5.28 **Worn ploughshares on top of new shares. These Anglebar shares from 23 cm/9" plough (top) and 15 cm/6" plough (bottom) wore out in just four weeks.**

In the Mabole Valley, ploughshares wear down very quickly in the abrasive soils and two per season may be required *(Fig 5.28)*. Landsides (heels) may have to be replaced at least every two years and new mouldboards and chains after five years. Wheels may require replacing every two or three years in abrasive conditions and new clamps or ring-bolts every three. New countersunk ploughshare bolts are generally required each time a share or landside is replaced. Thus, for each plough frame, the following spares are recommended for 10 years' use:

15 shares	30 share bolts
7 landsides	14 landside bolts
1 mouldboard	4 mouldboard bolts
4 wheels	1 chain

Plus 3 of each clamp or ring-bolt

It might be possible to manage with fewer spares, but this would probably reduce the efficiency of the ploughing.

Most wearing parts and bolts can be obtained from large-scale manufacturers overseas at relatively cheap prices, ie high quality mass produced ploughshares from UK or Senegal cost about Le 9. On the other hand the National Workshop at Clinetown in Freetown quoted Le 25, while a small provincial workshop with fewer overheads quoted Le 14. Then, again, in villages blacksmiths can make shares from old vehicle springs for as little as Le 4 per share, although these are generally less uniform and more difficult to fit than mass produced shares.

5.8.6 Imported equipment v local manufacture

There are no large-scale steel manufacturing facilities in Sierra Leone so that ox-equipment will have either to be imported complete or locally assembled. National policy favours local assembly which could have many advantages, especially in organisation. Both the IAD Projects and the farmers themselves would be able to order fully tested and appropriate implements; the development of an efficient spares organisation would then be justified. Hitherto the *ad hoc* importation of batches of ready made ox-ploughs without making provision for the importation or standardisation of spare parts has caused many problems.

It is recommended, therefore, that ox-ploughs be ordered either as kits of ready made components, or as a combination of some such components and some basic steel for local manufacture. An integral part of this ox-plough fabrication would be the provision of spare parts which should be imported with the components.

The National Workshop at Clinetown in Freetown still has the equipment of the old railway workshops and could undertake the fabrication of ox-ploughs, but it has no facilities for the storage of spare parts. It is therefore recommended that the fabrication of ox-ploughs be undertaken by the Ministry of Agriculture & Forestry in its workshop at Rolako. Established in 1974 by the Chinese, this workshop has power, standby power, workshop machinery and excellent storage facilities and is at present underutilised.

Rolako is on the main road from Freetown, close to Makeni and is convenient to the Mabole Valley area where there is a big demand for ox-ploughs. It is also on the road to Koinadugu District where ox-ploughs are also in demand. Here the existing MAF transportation facilities could be used both for receiving raw materials from Freetown as well as well as carrying ploughs and spares in Bombali District and to the more isolated areas around Koinadugu.

Table 5.1

COST OF IMPORTED OX-EQUIPMENT

At March 1981 prices

Equipment	*Price Ex Works*	*Price Including Shipping*	*Freetown Cost*
Anglebar system[1]	£	£	Le
Frame, wheel, plough & chain	93	127	317
3-tine cultivator/ weeder	49	67	167
Groundnut lifter	10	14	34
Ridger	36	49	123
Seeder	62	85	212
System	**250**	**341**	**853**
Harrow attachment	36	49	123
Pecotool system[1]			
Frame, wheel, plough & chain	58	79	198
3-tine cultivator/ weeder	46	63	157
Groundnut lifter	10	14	34
Ridger	32	44	109
Seeder	62	85	212
System	**208**	**284**	**710**
Sine Houe system[2]	CFA	CFA	
Frame, wheel, plough & chain	40 000	52 500	276
3-tine cultivator/ weeder	12 400	16 200	86
Groundnut lifter	12 900	16 900	89
Ridger	9 900	13 000	68
Seeder	43 100	56 600	298
System	**118 300**	**155 300**	**817**

[1] Anglebar system and Pecotool system supplied by Project Equipment Ltd, West Felton, Cswestry, UK. Prices valid March 1981; 30% added for shipping; 5% (inc shipping) added for dock clearance.

[2] Sine Houe system. This was manufactured in Senegal by SISCOMA until 1980. In October 1980, the firm went into liquidation. At the time of writing it was not clear whether or not the factory would reopen. It is possible that bulk orders of this equipment could be supplied from Mouzon, France or SFT, Cameroun. Prices quoted are based on an August 1980 quotation of SISCOMA with 25% added for inflation; 25% added for shipping; 5% (inc shipping) added for dock clearance.

Le 1 = £0.40 Le 1 = CFA 190

The firm of Project Equipment offers a special 'package deal' whereby they provide the equipment and expertise for setting up facilities for the local manufacture of the Anglebar and/or Pecotool. They also supply the steel and specialised components. As Rolako is already relatively well equipped,

this would involve only the supply of jigs, plans and components. A supervisory period of 2-3 weeks would also have to be arranged.

Other firms might also provide a similar service. SISCOMA, before it went into liquidation, was prepared to supply ploughs in a knocked down form ready for local assembly as long as 500-1000 were ordered.

The Rolako workshop could also be used to make harrows and ox-carts for Bombali District. A workshop at Kabala should be able to meet the demand for harrows and carts from Koinadugu District.

5.8.7 Conclusion & Summary

It is recommended that the country standardises on a toolbar able to take either 23 cm/9" or 15-17 cm/6-7" ploughs. This toolbar should also be able to take weeding and ridging attachments so as to encourage the use of ox-cultivation for cash crops such as groundnuts or for labour intensive operations such as ridging.

A large wheel, 20 cm/8" in size, is recommended, with a skid being offered as a cheaper alternative.

Adjustments should use heavy duty ringbolts or ring-nuts and all bolting and clamping systems must be easily repairable or replaceable.

Local fabrication from imported components is recommended and the facilities of Rolako Workshop would be suitable for this as well as for storage and distribution. Adequate spare parts must be ordered.

The Pecotool plough has all the qualities required for Sierra Leone and Project Equipment would be willing to assist in the setting up of a local fabrication facility.

The Anglebar, after extensive modification, is considered a useful implement, but fine tolerances reduce its value for local manufacture.

The Sine Houe would probably be suitable, but the supply situation is uncertain.

The cheap 'Guinea' plough still has a useful role to play in Koinadugu District.

Seeders are not to be recommended at present; ox-carts could be made either at Rolako or Kabala using old car axles or new imported axles; simple triangular harrows, swamp harrows and swamp levellers could be made at District or village level.

Table 5.2

APPROXIMATE WEIGHTS OF EQUIPMENT

	Kg	lb
Ploughs		
'Victory'	38	84
'Guinea'	22	47
Chinese wooden	14	30
Pecotool 15 cm/6"	27	58
Anglebar 15 cm/6"	26	57
Sine Houe 15 cm/6"	36	78
Sine Houe 20 cm/8"	39	86
Anglebar 23 cm/9"	33	71
Sine Houe 23 cm/9"	40	87
Ridgers		
Pecotool	32	69
Anglebar	31	67
Sine Houe	35	77
Weeders (3-tine)		
Anglebar	39	85
Sine Houe	32	69
Groundnut Lifters		
Anglebar	24	53
Sine Houe	32	70
Seeders		
Super Eco	33	72
Anglebar	34	75
Harrows		
Triangular spike-tooth	25	55
Chinese swamp	10	21
Anglebar	49	108
Levellers		
Chinese swamp	10	21