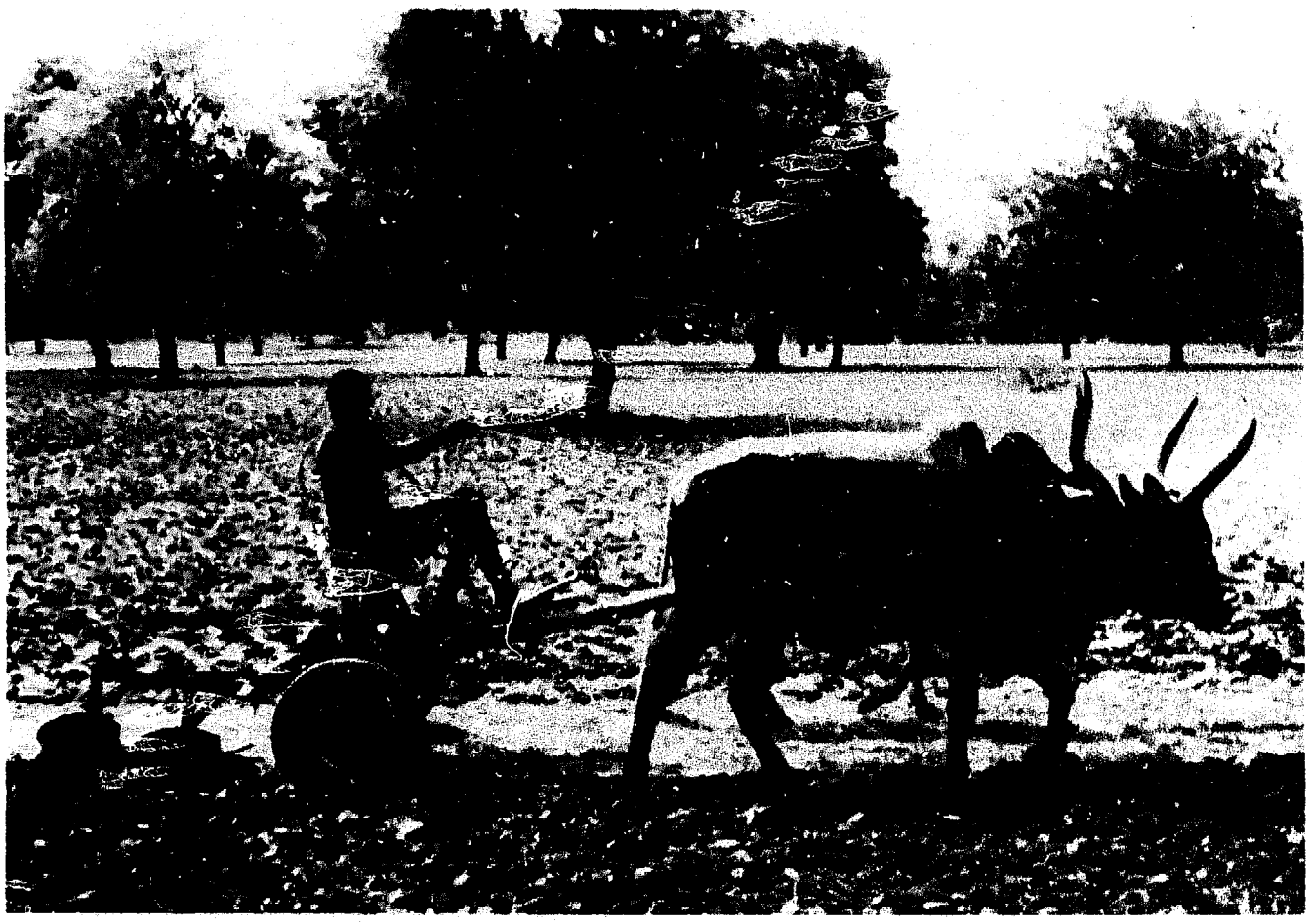
Paul Starkey

Animal-Drawn Wheeled Toolcarriers:

Perfected yet Rejected

Aus der Arbeit von GTZ



Vieweg

2. Introduction to Wheeled Toolcarriers

2.1 Geographical predominance of single purpose implements

The great majority of animal-drawn implements in use in the world today are designed for one operation. The most common implements are plows used for primary tillage. Thus in Africa there are about three million *maresha* ards in use in Ethiopia (ards or scratch plows are made by village artisans mainly of wood but generally with a simple steel share), and elsewhere in Africa about three million steel mouldboard plows are employed. In India, numbers of traditional wooden plows (ards) are put at 40 million, while there are seven million mouldboard plows in use. Comparable numbers would be in use in the rest of Asia, and in Latin America one might estimate there would be a total of five million plows in use, the majority of them of steel mouldboard designs. Although there were many millions of animal plows in use in Europe and North America earlier this century, numbers in present use are well under one million. Thus an approximate figure for the world total of animal-drawn plows would be 100 million. Other implements in use are far fewer than this.

Different designs of seedbed preparation equipment such as harrows and levellers would be second on the list, but these are not universally used as in many countries two or three passes of the plow, whether of the ard or mouldboard design are used for seedbed preparation and weed control. In most countries seed planting is performed by hand, and numbers of animal-drawn seeders would be about 0.2 million in Africa, 5 million in India and 10 million worldwide. Weeding is usually carried out using hand-held implements, and the use of animal-drawn weeding cultivators would be about 0.5 million in Africa, 2 million in India and 5 million worldwide. Some farmers will use an ard, mouldboard plow or ridger for inter-row weeding. Animal-drawn grain harvesting equipment was developed in Europe and North America in the second half of the last century, but such equipment is presently used in very few countries. The lifting of groundnuts is more common, although world use would probably be below one million. Animals are commonly used for transport, and there are about 0.2 million animal-drawn carts in use in Africa, 15 million in use in India and 35 million worldwide.

Thus geographically most animal-drawn implements in use in the world would be classified as single purpose tools, although they may have more than one function (e.g. the use of simple ard plows for primary/secondary tillage or tillage/weeding).

2.2 Animal-drawn equipment in Europe and America

At the peak of animal power in Europe and North America in the first half of the present century farmers used separate implements for plowing, harrowing, seeding, weeding, harvesting and transport. This is clearly illustrated in the nationally and internationally circulated equipment catalogues of the period. In these there were very few

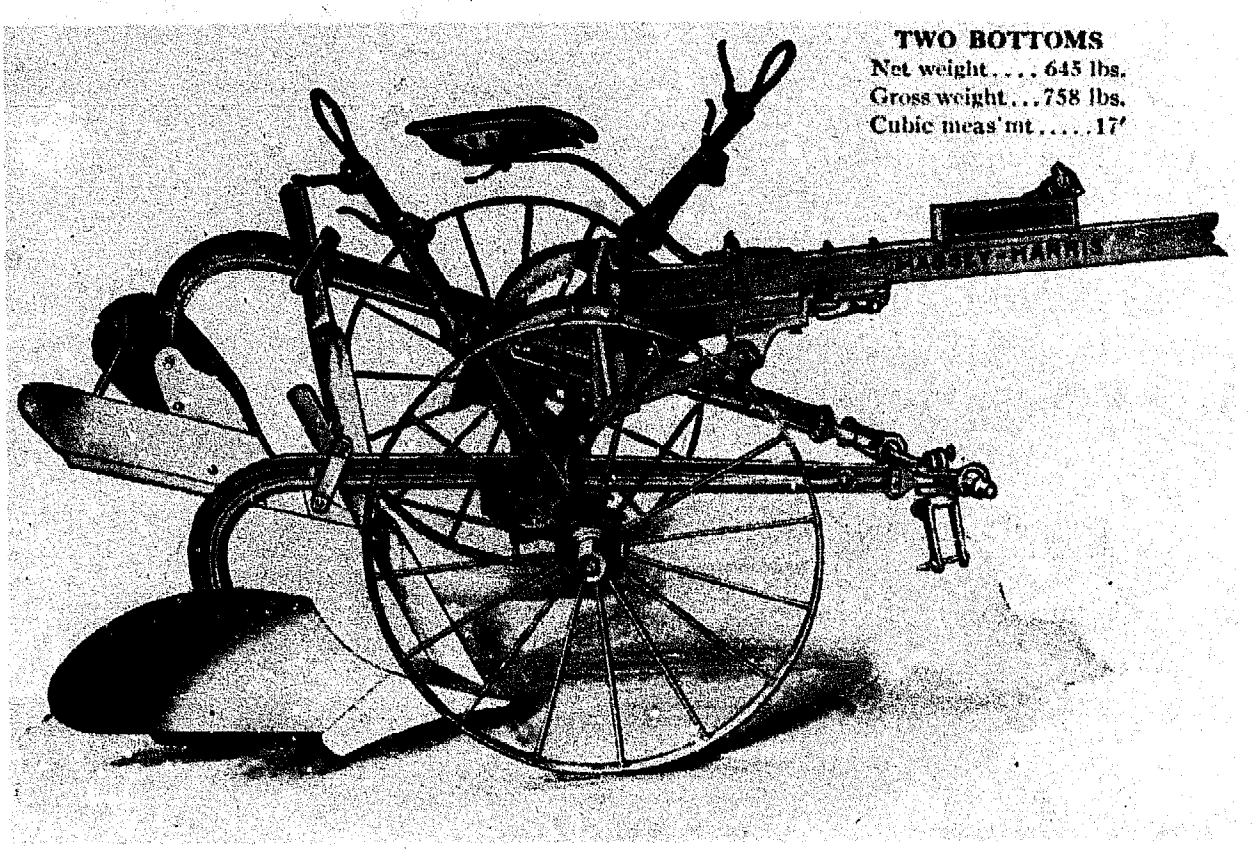


Fig. 2-1: Ride-on "Sulky" plow, Massey-Harris Catalogue, 1927. (Source: Institute of Agricultural History, Reading).

examples of multipurpose equipment, and the different manufacturers sold hundreds of thousands of single purpose implements at this time.

In the first half of this century there were several examples of wheeled weeding/cultivating implements to which could be fitted a selection of different tines. These had steel wheels and either straight axles or stub axles supporting a frame on which different combinations of tines could be mounted. Some of these were developed to allow several different secondary tillage operations. For example the British "Martins Patent Cultivator" of 1920 (fitted with an operator's seat) could be used as a three furrow ridger and the Canadian Massey Harris cultivator of 1927 could be used for inter-row weeding, full-width weeding and root-crop lifting. In Germany and Switzerland multipurpose animal-drawn implements known as "Vielfachgerät" spread to a limited extent between about 1910 and 1950 (H. Binswanger, personal communication, 1986). These steel-wheeled cultivators, such as the "Hassia Model 54" manufactured by Troster in Germany, were not ride-on implements, but were steerable from behind and could carry out a range of secondary cultivation operations including weeding, punching holes for potato planting and root-crop lifting. Seeder units could be fitted, but they were not used for primary cultivation (plowing) or for transport.

As the history of agricultural equipment is full of small scale initiatives, there may well have been earlier attempts to develop multipurpose implements for a wider range of activities. If such prototypes were developed they did not diffuse successfully for it is clear from historical records that the most common and successful animal-drawn implements have been designed for specific operations.

Fig. 2-2: Ride-on "Sulky" plow pulled by three horses in United States, from International Harvester Catalogue, 1920. (Photo: Institute of Agricultural History, Reading).

Historically plowmen have walked behind their plow guiding it. However in the latter part of the 19th century and in the first half of the present century there was a tendency in Europe and North America to design plowing, weeding and harvesting equipment that provided a seat for the operator above the working implement. For example "sulky" plows were ride-on single mouldboard plows. These were generally used with several large horses. They had two steel wheels, but unlike the straight axle multipurpose cultivators, the wheels were usually offset. These implements were easier to transport to the fields than conventional mouldboard plows, and the seat provided some operator comfort, but they required strong animals and were more expensive than conventional equipment.

With the development of tractors, ride-on farming operations became standard but farmers continued to use separate imple-

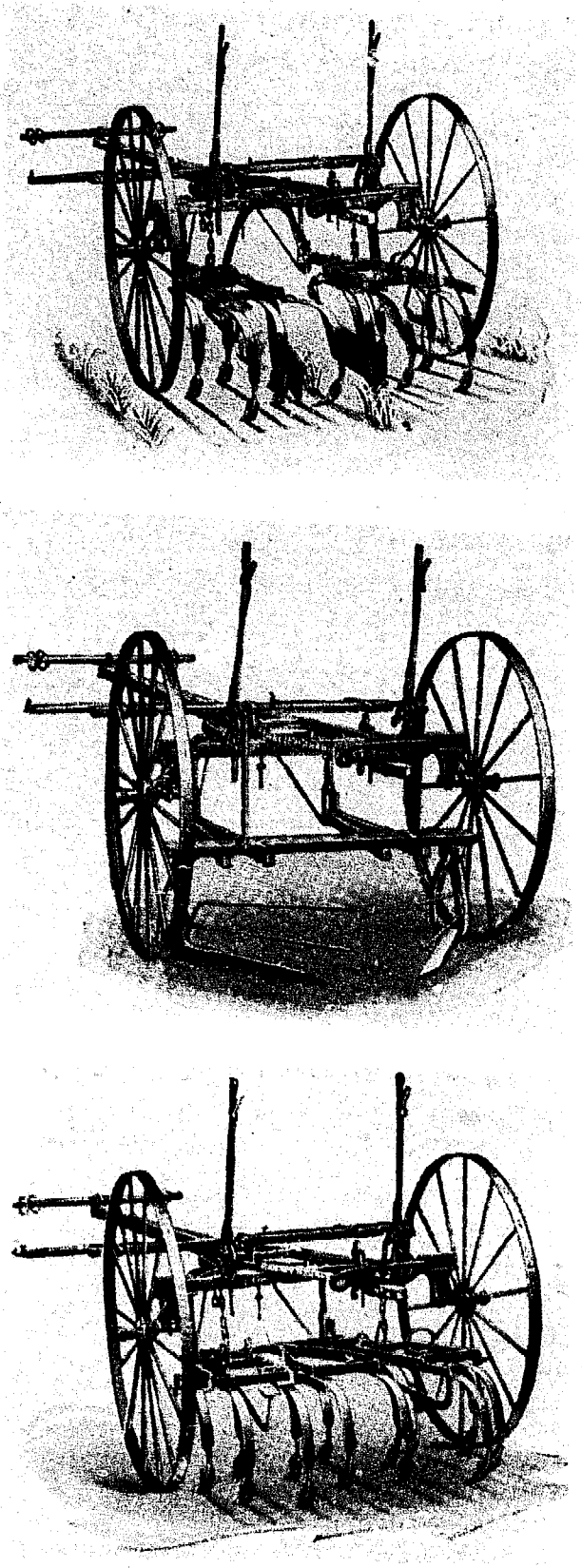
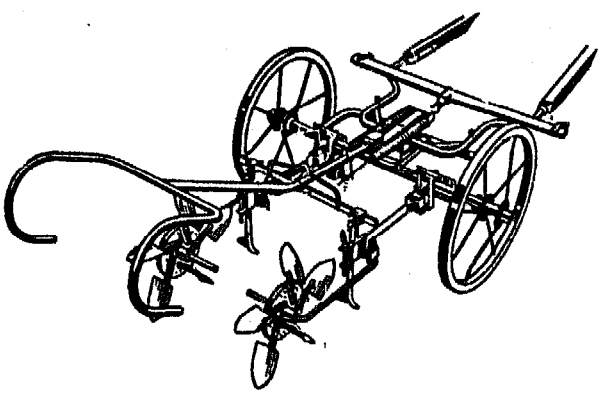


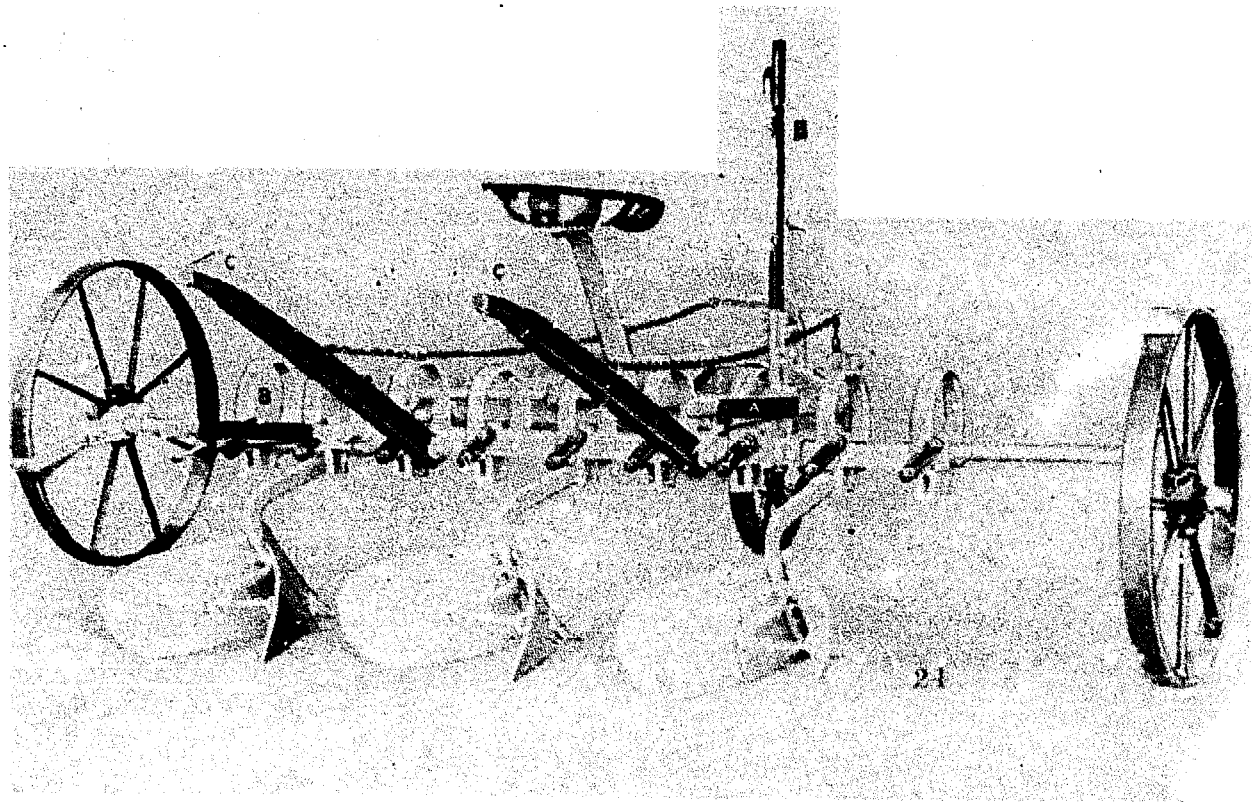
Fig. 2-3: Multipurpose animal-drawn wheeled cultivator in Massey-Harris Catalogue, 1927. a) Two-row weeder. b) Root lifter. c) Tine cultivator. (Source: Institute of Agricultural History, Reading).

ments for different tasks. In the early stages of tractor development similar equipment was pulled either by a team of large horses, or by a tractor. However around 1920–1930 toolbars were developed for the front, side and rear of tractors to which different implements could be attached. During the period 1930 to 1960 several manufacturers sold multipurpose toolbars for use with various tractors. The use of rear toolbars became common and was combined with the use of standard three-point linkages. This system had particular advantages for combining depth control during working operations with ease of transport to the field.

It was from this tractor-based concept of a toolbar combined with ride-on equipment that the idea of animal-drawn toolcarriers appears to have been developed. Some early implements were designed in such a way that they could be modified for use either with animals or with a tractor. Most early workers in the field strongly emphasised the clear tractor analogy (they were called bullock tractors in India) and stressed that these implements would assist in the rapid transition to full tractorization (Labrousse, 1958; Chalmers and Marsden, 1962; Khan, 1962; Constantinesco, 1964; Willcocks, 1969; Nolle, undated).

Fig. 2-4: Vielfachgerät Model "Hassia 54" fitted with attachment for making holes for planting potatoes. (Troster catalogue, 1957).





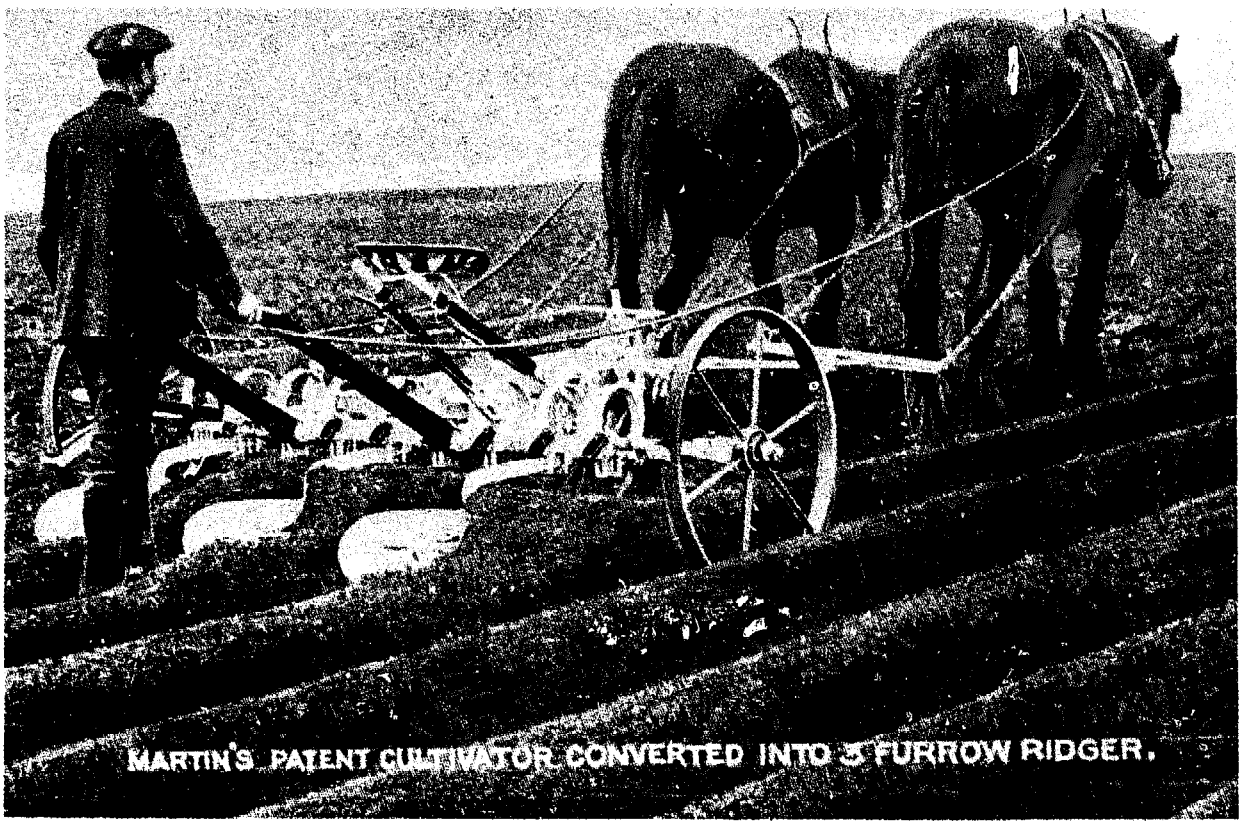


Fig. 2-5: Martin's Patent Cultivator fitted with ridging bodies, 1920. (Photo: Institute of Agricultural History, Reading).

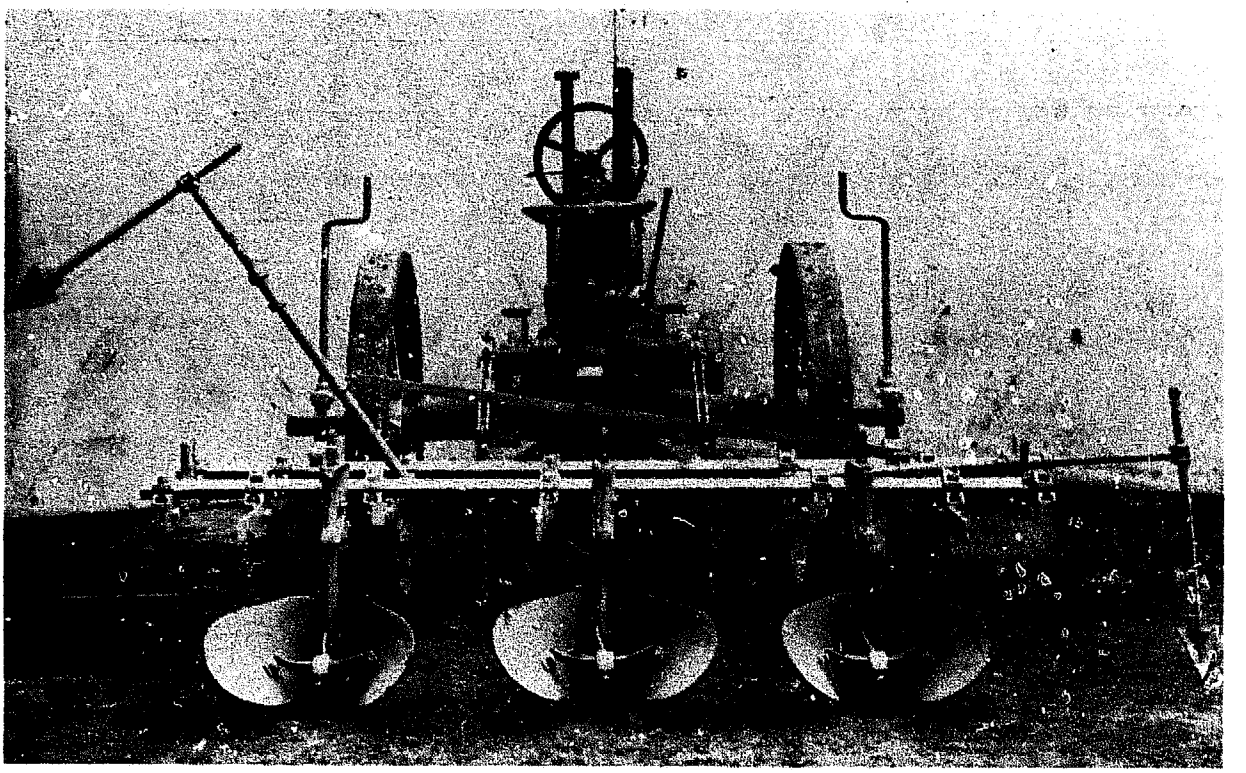


Fig. 2-6: Toolbar with ridging bodies on a John Deere tractor, 1938. (Photo: Institute of Agricultural History, Reading).

2.3 Pioneering work on wheeled toolcarriers

While there have been many different designs of multipurpose wheeled toolcarriers developed in five continents in the past thirty years, there have been three main centres of promotion and development: France, Britain and India. Prototypes and production models from these countries have been distributed throughout the developing world and have often been the basis of modified designs for local production.

During the 1950s there were several researchers working independently on multipurpose implements for use with horses on French farms (Pousset, 1982). However, much of the pioneering work on toolcarriers was carried out in Africa by the French agricultural engineer Jean Nolle, who has recently published a detailed and semi-autobiographical account of his innovations during the period 1955 to 1985 (Nolle, 1986). Nolle attempted to develop his three principles of simplicity of design, multipurpose use and standardization of components into a philosophy to which he later gave the acronym MAMATA (Machinisme Agricole Moderne à Traction Animale).

Jean Nolle's first design developed in Senegal in 1955. "Le Polyculteur Léger" incorporated many of the the characteristics found in present day wheeled toolcarriers. It comprised a metal chassis and drawbar supported on two wheels with pneumatic tyres. There was an operator's seat and a handle for raising or lowering the implements that included a mouldboard plow, up to three seeders, flexible tines, groundnut lifter, harrow and ridger. A platform could be fitted to make the toolcarrier into a cart. As will become apparent, this first design made in Senegal was the basis for many more designs in subsequent years.

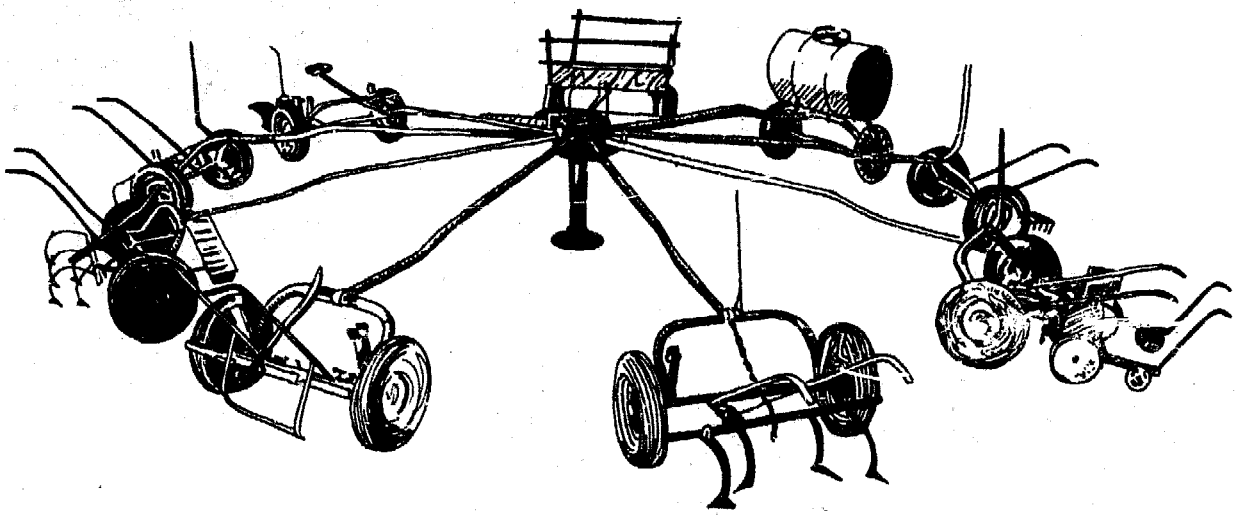


Fig. 2-7: "Polyculteur Attelé Nolle" from publicity leaflet c. 1962.

In the late 1950s there was no large agricultural implement factory in Senegal (this was established in the early 1960s) and French manufacturers, notably Société Mouzon, were quick to see a potential market. Thus the first large-scale production of Nolle's polyculteur design was in France, and wheeled toolcarriers were shipped from France to Senegal and many other countries. Having left Senegal in 1960, Jean Nolle travelled extensively in Africa, Asia and Latin America and continued to expand his range of designs. In the early 1960s he worked on a series of more complicated toolcarriers de-

Fig. 2-8: Nolle Hippomobile used as "Sulky" plow in France, 1961. (Photo: Jean Nolle).

signed to be pulled by up to three horses, primarily for use in France. Prototypes were known as "hippomobiles" and a total of fifty toolcarriers derived from this design were manufactured by the French company Mouzon under the acronym AVTRAC. These had tractor style three-point linkages that could carry a range of implements including reversible plows.

From 1962 and 1963 following visits to Madagascar and Uganda, Nolle developed the "Tropicultor" which was to be his most important design of wheeled toolcarrier and one that he was continually to modify and refine during the next twenty years. This wheeled toolcarrier was initially called the Tropiculteur, but Nolle himself changed this to Tropicultor, a name designed to be international and more acceptable to speakers of English and Spanish. The principles of the Tropicultor were similar to his previous designs, and they could take a wide range of up to twenty different implements, including plows, seeders, cultivation tines, groundnut lifters and ridgers. They could all be used as basic carts, and some were modified for specialist applications such as logging, pesticide application and even (using a petrol motor) for mowing and harvesting. The Tropicultor had a chassis of tubular steel bowed upwards to give high ground clearance for weeding operations. The Tropicultor had independently adjustable wheels, a raisable, adjustable bar for tool attachment and a metal drawbar with adjustable angle (Nolle, 1986). The Tropicultor and its derivatives became the most widely manufactured design of wheeled toolcarrier, accounting for over half of world sales.

In 1982 Jean Nolle refined his Tropicultor concept still further, and created the "Polynol", which incorporated several design improvements on the Tropicultor and could take thirty different implements. However this more expensive version of the Tropicultor was not commercially successful, and only thirty were sold by Mouzon between 1982 and 1987.

Derivatives of Nolle's early work have now been commercially manufactured in France for thirty years and due to Nolle himself, the manufacturers, the agricultural engineering centre for tropical countries (CEEMAT) and many bilateral and multilateral aid projects, France became the primary focal point in the history of wheeled toolcarriers. Jean Nolle himself has carried out development and advisory work in 72 countries.

Nolle (1985) observed that the English had been quicker to realize the significance of his innovative Polyculteur design than the French. Certainly in 1958, only a few years after Nolle's early work in this field, the National Institute of Agricultural Engineering (NIAE) in Britain started work on its own design of wheeled toolcarrier. NIAE (now known as "AFRC-Engineering", the Institute of Engineering Research of the Agriculture and Food Research Council) subsequently became the second world focal point of wheeled toolcarrier development, and continued to be closely associated with this technology for the next twenty five years. The NIAE toolcarrier (sometimes known as ADT – animal-drawn toolbar) had some basic similarities with the Nolle designs in that it also comprised a steel chassis and drawbar supported on pneumatic tyres, that could be converted for use as a cart. There was an operator's seat and a pivoting toolbar that could be raised and lowered, onto which was attached a variety of cultivation equipment. The objective of the NIAE design was to provide "a simple means for a gradual breakaway from hand work and traditional implements" that would "help the farmer to become toolbar minded and eventually ready for full mechanization" (Chalmers and Marsden, 1962; Willcocks, 1969). In the early development stage NIAE considered putting emphasis on the use of single

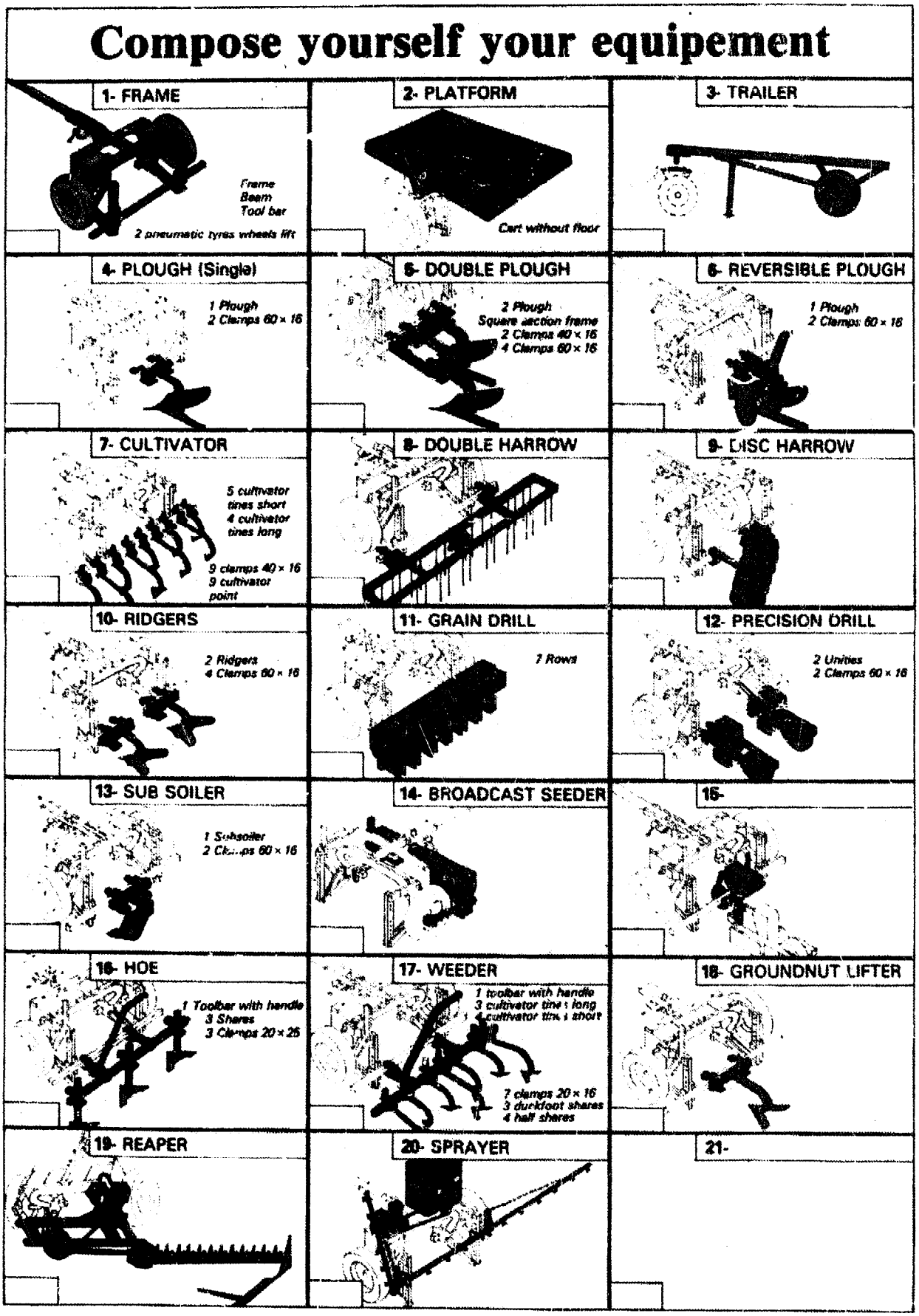


Fig. 2-9: The diversity of operations of the Tropicultor (Mouzon brochure, c. 1978).

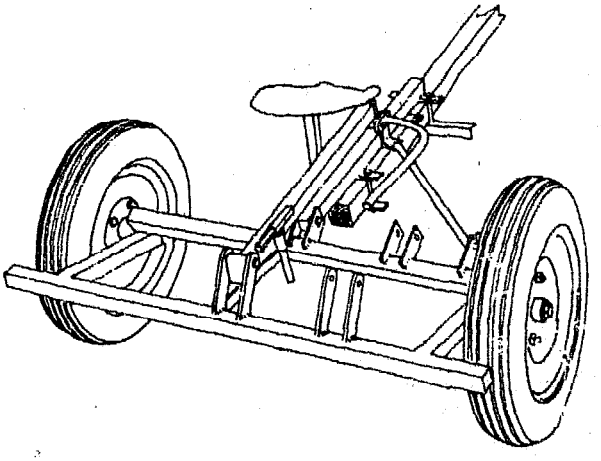
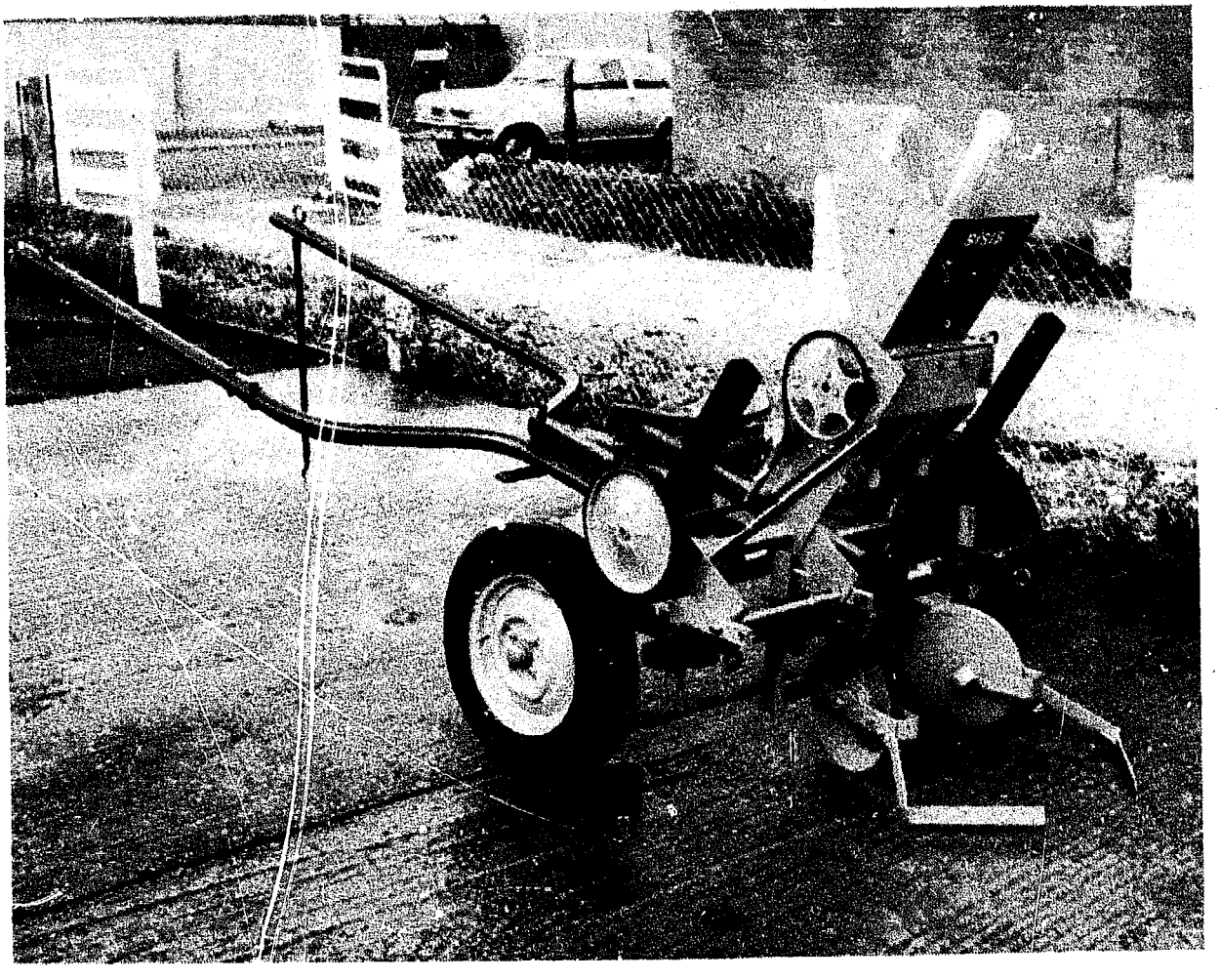


Fig. 2-10: NIAE ADT wheeled toolcarrier (Willcocks, 1969).

purpose implements, but this was rejected in favour of the wheeled toolcarrier concept which it was felt would encourage the drilling of crops in parallel rows, thereby establishing the principles and practices associated with sophisticated machinery (Willcocks, 1969).

Prototypes of the NIAE toolcarrier were tested in Uganda and Tanzania in 1960 and an early version was demonstrated at a Commonwealth Directors of Agriculture conference in 1961. As a result of this demonstration, NIAE research reports and publicity relating to the "French" designs, small numbers of toolcarriers commercially manufactured in Britain under trade names such as Aplos and Kenmore were sent to many developing countries in the 1960s and 1970s. The main thrust of research and development on the NIAE toolcarrier itself occurred in the early 1960s and a report of this work was published by NIAE in 1969 (Willcocks,

Fig. 2-11: NIAE toolcarrier with SISIS seeder, fitted with shafts designed for single animal use in Latin America, Silsoe, U.K. 1976. (Photo: AFRC-Engineering archives).



1969). Subsequent involvement of NIAE staff at Silsoe in the U.K. in the late 1960s and early 1970s was limited to the intermittent development and testing of a range of toolcarrier attachments including plows, ridgers, harrows, weeders, sprayers and several types of seeder. In addition to its research and development functions, the Overseas Division of NIAE assisted with technical advice to relevant projects supported by British Aid (ODA), and in this capacity NIAE staff were associated with the evaluation of wheeled toolcarriers in several developing countries.

During the 1960s and early 1970s about 900 toolcarriers based on the NIAE design were exported to The Gambia and much smaller numbers were sent to about 25 countries in Africa, Asia and Latin America including Brazil, Chile, Costa Rica, Ethiopia, India, Kenya, Malawi, Mexico, Nigeria, Pakistan, Tanzania, Thailand, Uganda and Yemen. Subsequently NIAE collaborated with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in the production of a completely new design of wheeled toolcarrier. This new toolcarrier is generally known as the Nikart, although officially this is just the name of the version manufactured near ICRISAT's headquarters in India.

At about the same time as the initial French and British initiatives, some original Indian designs of toolcarrier were developed and entrepreneurs started to manufacture them (Khan, 1962; CEEMAT, 1964). While early models were not commercially successful, research and development on different designs continued in India. Later, when the technical, financial and promotional resources of a major international research centre (ICRISAT) working with both Jean Nolle and NIAE were channelled into wheeled toolcarriers in India, local factories were able to benefit and to export toolcarriers from India to other developing regions. Thus India has been the third main focus for research, development and manufacture of wheeled toolcarriers.

2.4 The development of simpler toolbars

Soon after Jean Nolle had designed his Polyculteur in Senegal in 1955, it was clear to him that while the wheeled toolcarrier would be suitable for larger farms, of say 10 ha, that had strong animals, the majority of farms in Senegal were smaller, and many only had the power of one donkey. Thus although he described it as a regression in technology, in the late 1950s Nolle designed a simple longitudinal implement which he called the Houe Sine. This was in many ways similar to a plow in design, with a single depth wheel, a hitch for attaching the traction chain and a steel beam. Various simple cultivation or weeding shares could be clamped to the toolbar, and also a fertilizer applicator. After some time, Nolle became aware that his original Houe Sine design was being used simply as a single purpose weeding implement, which was against one of his major principles of "polyvalence" or multipurpose use. Thus in the early 1960s Nolle worked on diversifying the Houe Sine, giving it a T-frame, with a small transverse toolbar at the end of its longitudinal beam, to which could be attached a plow body, ridger, discs, cultivating tines or a groundnut lifter. Although the Houe Sine has been continually evolving, the principles of its design have remained unchanged since the early 1960s and these include the simple longitudinal toolframe with a variety of attachments and the standardization of components such as clamps. Comparable toolbars include the heavier Arara, the lighter Houe Occidentale and several designs developed by the British engineer Alan Stokes such as the Unibar, the Anglebar and the Pecotool.

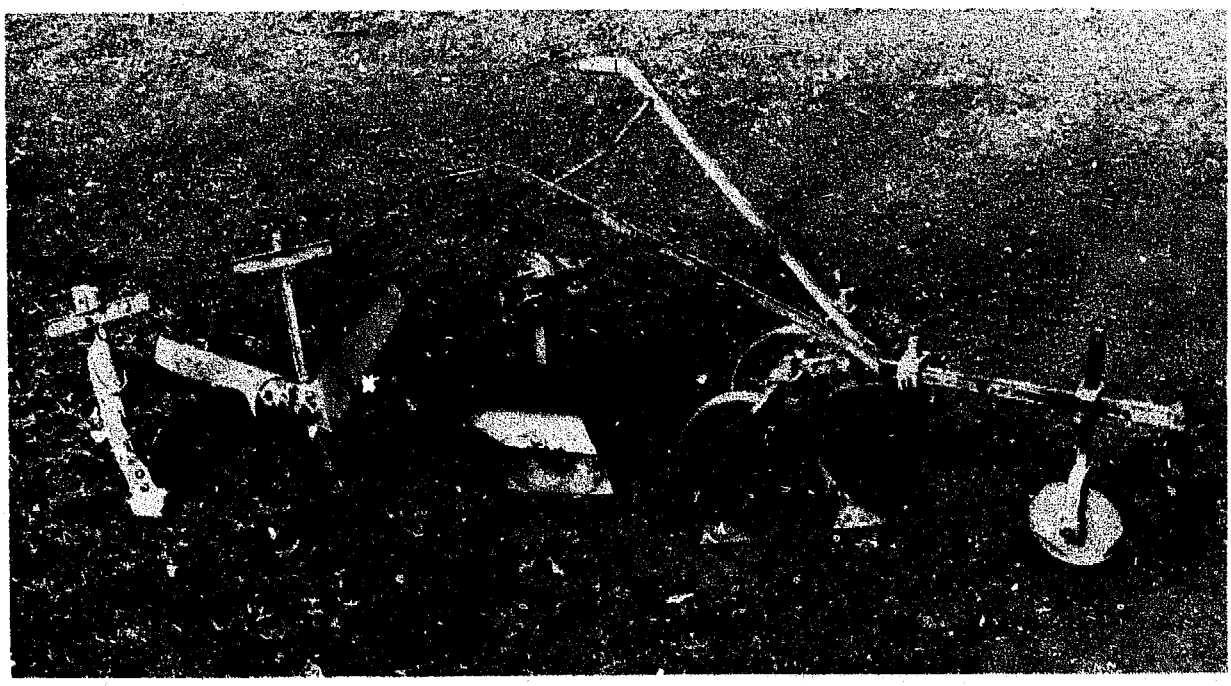
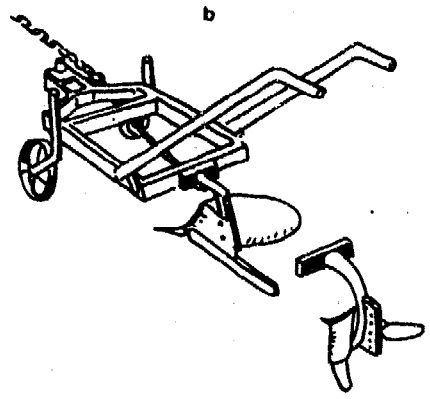


Fig. 2-12: A "simple toolbar" (SISCOMA Houe Sine) fitted with cultivating tines, with alternative attachments of groundnut lifter, earthing body and mouldboard plow. (Photo: P.H. Starkey).

2.5 Distinction between wheeled toolcarriers and simple toolbars

Although the Houe Sine and comparable implements are multipurpose toolbars, they are very different in operation, weight and price to the wheeled toolcarrier. However, as will become clear in subsequent sections, there has been considerable confusion, particularly in the English literature, between simple toolbars and wheeled toolcarriers. Both have been referred to as "multipurpose toolbars" and often they have been put together in statistics, with the result that misleading



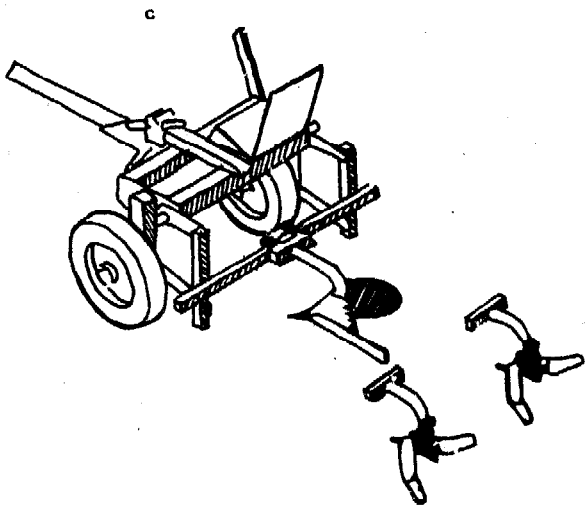


Fig. 2-13: Definitions: a) simple toolbar b) intermediate toolframe c) wheeled toolcarrier.

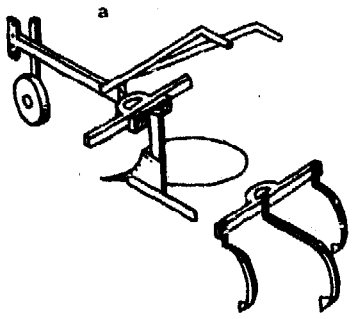
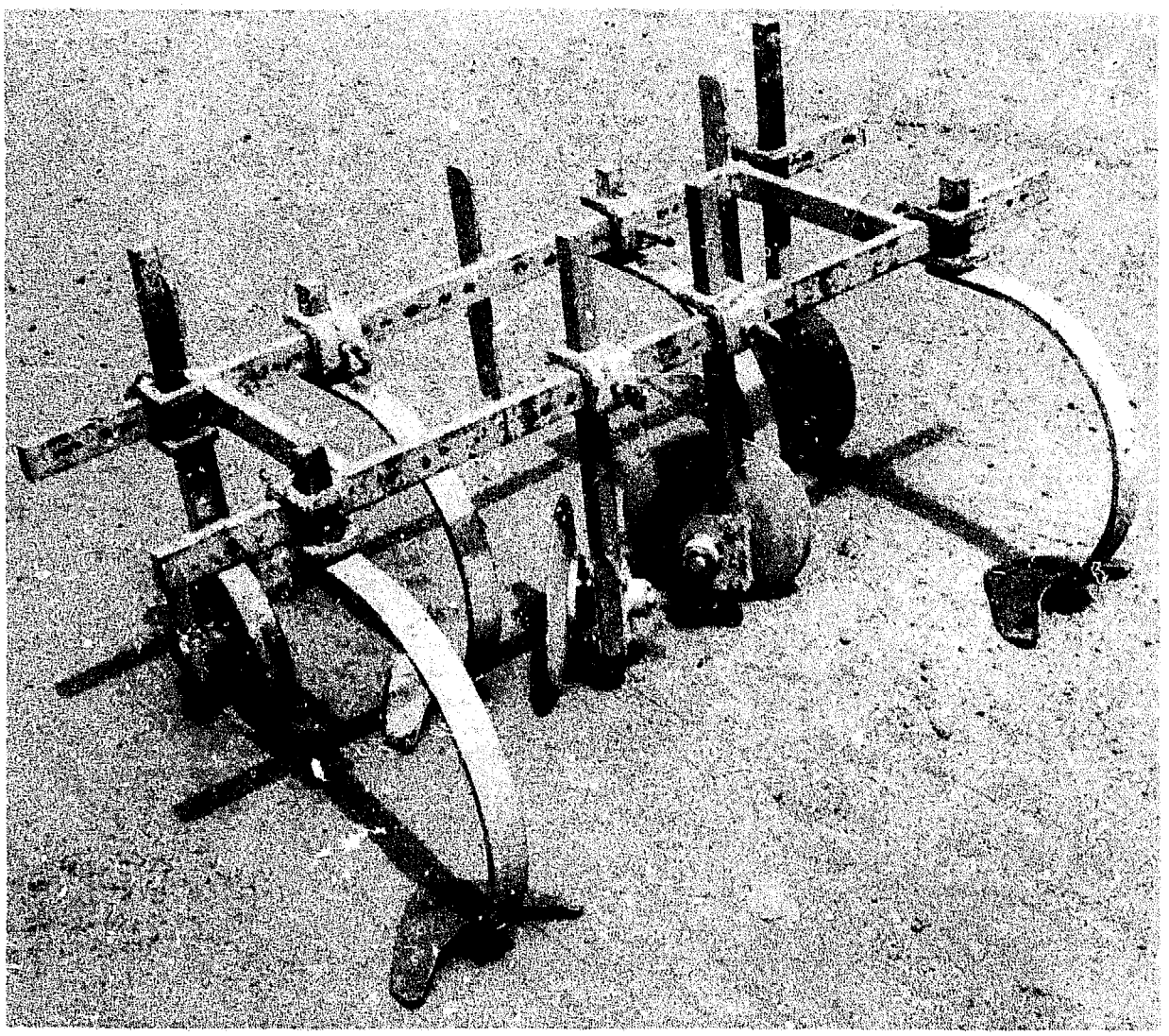


Fig. 2-14: A range of three "toolbars" made in Brazil: Policultor 300 (simple toolbar); Policultor 600 (intermediate toolframe); Policultor 1500 (wheeled toolcarrier). (CEMAG, undated).

conclusions have been drawn. In French, a clear distinction was made between the large "Polyculteur" wheeled toolcarriers and the smaller "Multiculteur" toolbars such as the Houe Sine (CEEMAT, 1971). Unfortunately no clear distinguishing definitions have been adopted in English. Therefore in the following analysis the term "wheeled toolcarrier" will be used to describe the "Polyculteur" type of implement, which is generally based on a transverse chassis, two wheels and a long beam. The term "simple toolbar" will be used to describe the lighter multipurpose implements based on a longitudinal beam, known in French as Multiculteurs.

Although there is a very clear difference between the heavy wheeled toolcarrier and the lighter simple toolbar, there have been some intermediate designs, starting in the late 1950s with Jean Nolle's Houe Saloum, a weeder and groundnut lifter. In 1961 this was developed into the Ariana, which has the general appearance of two parallel Houe Sine toolbars joined to form a rectangular frame. The Ariana resembles the Houe Sine in many respects, particularly as (in accordance with Nolle's principle of standardization) many of the components, including twin depth wheels, implement attachments and clamps are of the same design. Also it is

Fig. 2-15: An "intermediate toolframe". This prototype from The Gambia is similar to the Ariana (Photo: P.H. Starkey).



designed to be pulled by a traction chain and to be steered from behind and it is not convertible to a cart. However it does share some of the characteristics of the wheeled toolcarrier as it is heavier, more expensive and more difficult to manoeuvre than a simple toolbar, and it does allow for multiple row seeding and weeding. Intermediate implements such as the Ariana are not as important, in this discussion, as either the simpler or the more complicated models. Although more intermediate implements have been made in the past twenty-five years than wheeled toolcarriers (about 15 000 Ariana-type implements compared with 10 000 wheeled toolcarriers), they have not had either the adoption success of the simple toolbars (over 350 000 Houe Sine type toolbars sold worldwide), nor the promotional efforts that research centres and development agencies have given to the wheeled toolcarriers. A certain small element of confusion relates to them in national statistics, as they are sometimes included with the wheeled toolcarriers and sometimes with the simpler toolbars. In the following discussion they will be referred to as "intermediate" type toolframes, and they will not generally be considered with the wheeled toolcarriers.

2.6 The three phases of wheeled toolcarrier development

The developmental history of wheeled toolcarriers has been a continuous process, but it seems convenient to consider it in three main evolutionary stages. The first stage is represented mainly by a few early initiatives in Africa from 1955 to 1975 supported by French and British technical cooperation. During this same period there were also some attempts to develop wheeled toolcarriers for farmers in France (Pousset, 1982), Poland (Kosakiewicz and Orlikoswski, 1966) and India (Garg and Devnani, 1983), but these programmes did not appear to have significant impact either in their own countries or elsewhere. During this first phase small numbers of wheeled toolcarriers manufactured in Britain and France were also tested in Latin America and Asia.

Fig. 2-16: Designed in 1962, modified by ICRISAT, and promoted worldwide, the Tropicultor spans all phases of development. Here seen with seeder and fertilizer distributer at ICRISAT Centre, 1985. (Photo: P.H. Starkey).

The second developmental phase started in India in 1974 when the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) started a major research programme using wheeled toolcarriers, drawing on existing French, British and Indian designs. The research station trials were very encouraging, and reports became increasingly optimistic between 1975 and 1981. Optimistic reports have continued to emanate from ICRISAT up to the present time. These together with complementary reports from organizations in Britain and France, have encouraged the third stage of wheeled toolcarrier development – the wider international evaluation of this technology.

This third phase at present spans the years 1976 to 1987, and at the time of writing this text was continuing largely unabated. During these last ten years an increasing number of bilateral and multilateral donors dispersed significant sums of money assisting national programmes in at least thirty countries in Africa, Asia and Latin America to test or promote wheeled toolcarriers. While there have been attempts to develop toolcarriers suited to smallholder farmers in Britain (Barton, Jeanrenaud and Gibbon, 1982) and France (Morin, 1985), most of the effort has been directed at the Third World. In early 1987 there were development workers in at least twenty different countries actively engaged in evaluating or promoting this technology.

In the following chapters case histories from all three phases are reviewed in as much detail as practicable. Then some generalizations arising from the case histories are discussed, and finally potential lessons from wheeled toolcarrier development and promotion are highlighted.