Paul Starkey

Animal-Drawn Wheeled Toolcarriers:

Perfected yet Rejected

Aus der Arbeit von gtz

Vieweg

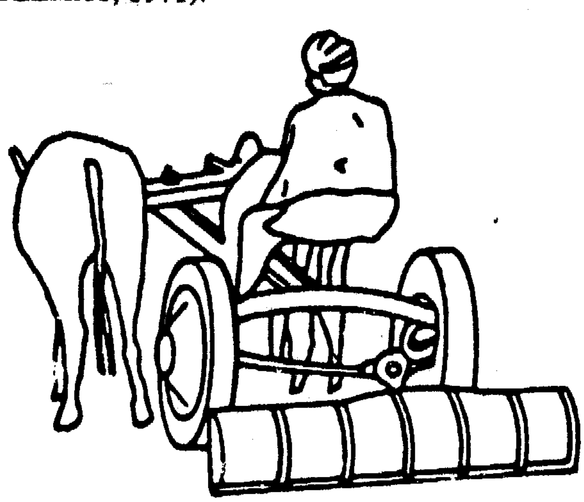
4. Experience in India: 1961—1986

4.1 Initiatives of manufacturers and state research stations, 1961–1975

In India animal traction is an integral component of most farming systems and perhaps 150 million draft animals, notably cattle, are employed, together with about 40 million traditional plows and six million steel plows. Farm machinery development has for many years involved both research institutes and private manufacturers.

The French agricultural engineering institute CEEMAT noted that research and development work in India on wheeled toolcarriers has had a long history and that commercial production of models such as the Nair toolcarrier started about the same time as the earliest French initiatives of Mouzon (CEEMAT, 1971; FAO/CEEMAT, 1972). An early photo of one Indian model, the *Universal Otto Frame* appeared in an international journal in 1962 (Khan, 1962). A review of many designs of Indian toolcarriers was prepared by Garg and Devnani (1983). These authors describe two early commercial developments, the *Universal Otto Frame* developed by Voltas Ltd. in 1962 and the *Balwan toolcarrier* developed by Escorts Ltd. of Faridabad in 1967. Both allowed a variety of tools including plows, ridgers, harrows, weeding tines and levellers to be attached to the chassis. Both had systems for raising and lowering the implements, adjustable wheel positions, pneumatic tyres of the type widely used on animal-drawn carts and drivers' seats. The Otto Frame had a seed drill option. In both cases manufacturing was discontinued due to lack of market demand (Garg and Devnani, 1983).

Fig. 4-1: Impression of a Nair toolcarrier with levelling blade in India in the early 1960s. (CEEMAT, 1971).



During the 1960s and 1970s toolcarriers were also developed at several research stations in India. These included the IIT *Kharagpur Multipurpose Chassis* developed by the Indian Institute of Technology in West Bengal in 1961. This was an intermediate toolbar design using small metal wheels and had similarities to the Ariana of West Africa. It did not develop past the research prototype stage.

In 1979 the firm of SARA Technical Services of New Delhi tried to obtain international funding to allow it to develop its own wheeled toolcarrier known as the *Bultrac* (SARA, 1979). This was a ride-on implement with steel wheels, designed initially for use with disc harrows. The prototype was not commercially developed.

4.2 Experience of national and state research institutes, 1975–1986

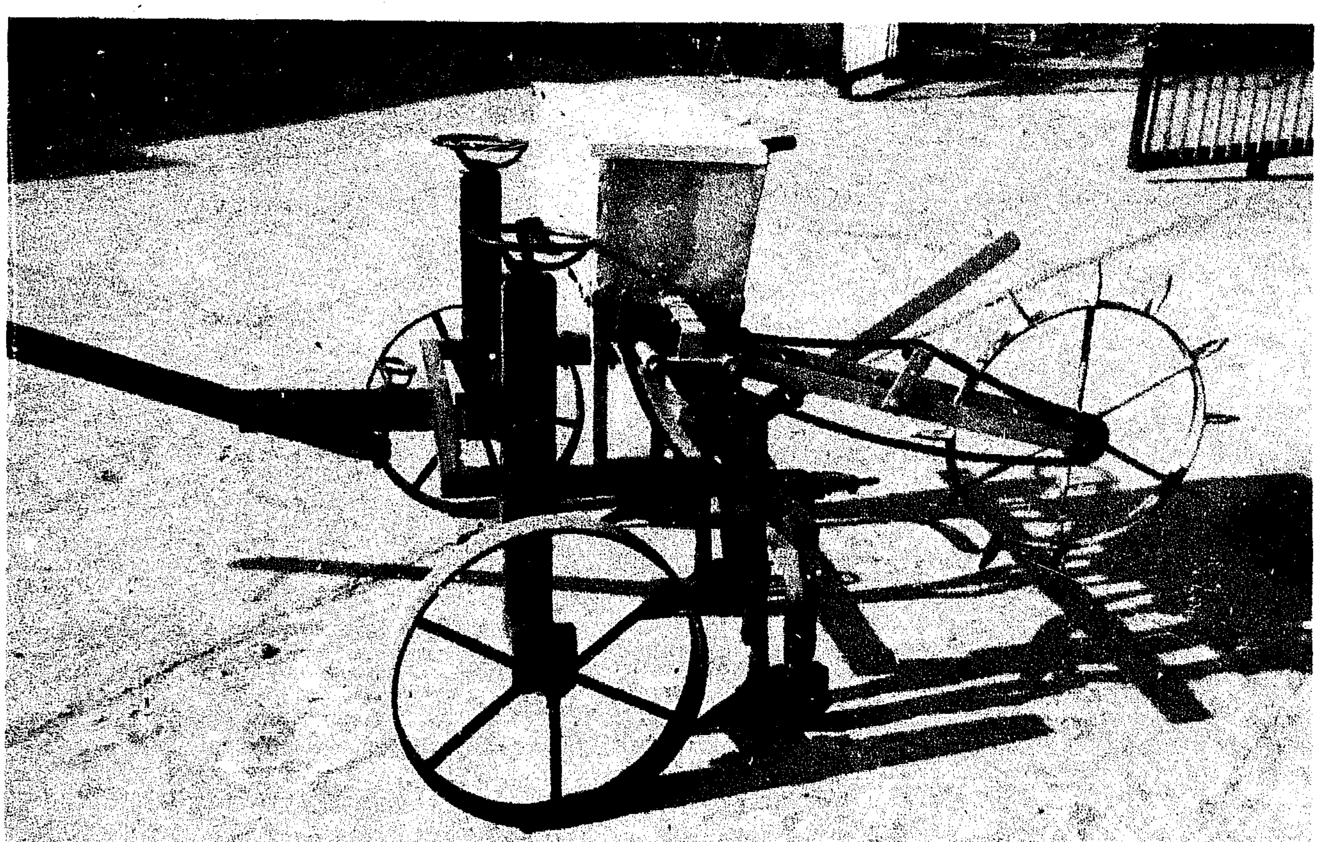
In the past ten years several different toolbars have been developed by the All India Coordinated Research Project for Dryland Agriculture (AICRPDA). These include three lightweight models based mainly on seeder/fertilizer units. By 1983, two of these designs had progressed to the stage of limited commercial production, being promoted mainly for their planting functions. By comparison, one heavier model designed for primary cultivation and transport as well as seeding, was still at a prototype stage.

The *Malviya Multi-Farming Machine* developed by AICRPDA at Baharas Hindu University, Varanasi is under commercial production and it is primarily a two-row seeder with cultivation possibilities rather than a comprehensive toolcarrier. It uses a square section chassis, and two steel transport wheels, and in addition to the seeder/fertilizer distribution attachments it can carry various weeding tines and a mouldboard plow. It is a lightweight implement and is not designed for transport and there is no operator's seat.

A somewhat similar lightweight toolcarrier, also designed mainly as a seeder is the *Shivaji Multipurpose Farming Machine* developed under the AICRPDA at Sholapur, Maharashtra. This comprises a single square section bar supported on two metal wheels designed for implement transport and not load-carrying. The main seed/fertilizer units can be mounted onto the toolbar, as can chisel points and intercultivation tines. All implements can be raised and lowered. This machine has also been commercially produced.

A third lightweight multipurpose tool based primarily on a seeder was developed by AICRPDA at the College of Technology and Agricultural Engineering of the University of Udaipur in Rajastan. It comprises a solid

Fig. 4-2: CIAE wheeled toolcarrier, Bhopal, 1986. (Photo: P.H. Starkey).



square section toolbar supported on small metal wheels. In 1983 it was still at a prototype stage.

A heavier machine using pneumatic tyres has been developed by the AICRPDA at Punjabrao Krishi Vidyapeeth, Akola, Maharashtra. The *Akola toolcarrier* has an angle-iron chassis, pneumatic tyres, adjustable wheel track, seats for two operators and a mechanism for raising and lowering implements. The implements included harrows and simple seeders. This had not passed the research prototype stage in 1983.

Another heavier machine based on the pneumatic tyres used on many bullock carts has been designed by the Department of Agricultural Engineering at Tamil Nadu Agricultural University, Coimbatore. The TNAU *Multipurpose Toolcarrier* based on a chassis made of steel pipe was initially designed for primary cultivation and transport, and the implements available include plows, tines, bundformers and a cart body. The operator sits on the frame and a pedal is used to raise and lower implements. In 1983 it was only considered a research prototype (Garg and Devnani, 1983).

The Central Institute for Agricultural Engineering (CIAE) at Bhopal having monitored developments in toolcarrier research and development at various institutions in India, including ICRISAT, felt it was important that a low cost wheeled toolcarrier should be developed. Thus CIAE decided to develop its own design based on a square section toolbar supported by small steel wheels, each adjustable using screw jacks. Plow bodies, ridgers, tines and seeders can be clamped to the toolbar. An operator's seat can be fitted and the toolcarrier can perform limited transport operations, but it is essentially a lightweight implement designed for low cost and simplicity rather than strength. Ten toolcarriers were made for on-farm feasibility trials in 1984, which proved encouraging and the toolcarrier was to be given wider testing in 1985–1986 (CIAE, 1985). In 1986 work was still being undertaken on prototype development, and it was considered that it still required further testing with farmers to establish its durability and economic appropriateness (Devnani, personal communication, 1986).

4.3 Work at ICRISAT in India, 1974–1986

4.3.1 The mandate of ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is an international research centre with its headquarters at Patancheru, near Hyderabad in India. It is one of the network of international centres established by the Consultative Group on International Agricultural Research (CGIAR) and through the CGIAR it is funded by several multilateral and bilateral donor agencies. ICRISAT is mandated to develop improved farming systems for the resource-poor farmers of the semi-arid tropics, to identify constraints to agricultural development and evaluate means of alleviating them, and to assist in the transfer of technology to the farmer through cooperation with national and regional research programmes. While ICRISAT's target group are farmers of limited means, cultivating primarily with family labour, with few inputs and without the benefit of regular irrigation, ICRISAT's immediate clients are the scientists of the national research institutions of the semi-arid countries who are responsible for producing new technologies for their countries (TAC, 1986).

Since 1974 ICRISAT has been closely involved with the development of wheeled toolcarriers and since 1980 it has been the leading organization in the world at promoting this technology through demonstrations, paper presentations, publications and training. ICRISAT began operations in 1973, and one objective was to develop improved farming systems for rain-fed agriculture in the semi-arid areas. ICRISAT has a long time horizon, estimating that it may take up to seven years to develop a technology under research conditions, one or two years of verification and project initiation, between one and ten years for initial adoption and up to twenty years for widespread adoption (ICRISAT, 1982).

4.3.2 Identification and refinement of the Tropicultor (1974–1977)

The ICRISAT research farm at Patancheru was started in 1973 with fifteen hectares of cultivation using both tractors and traditional bullock-drawn implements. Since 1974 most research at ICRISAT relating to Farming Systems and Resource Management has been carried out using animal power and hand labour and in 1974 the Farm Equipment and Tools Programme started using a wheeled toolcarrier, the *Kenmore*, manufactured in Britain (ICRISAT, 1975). The Annual Report for 1974–1975 was the first ICRISAT annual report to include a photograph of a wheeled toolcarrier and this seems to have started a precedent as all subsequent annual reports and about one third of all ICRISAT publications not specific to the mandated crops have also had photographs of wheeled toolcarriers. The ICRISAT Research Highlights of 1985 was one of the

Fig. 4-3: Tropic .ltor being used for weeding and hand-metred fertilizer application, ICRISAT Centre. (Photo: ICRISAT archives).

first general ICRISAT publications for a decade not to include photographs of wheeled toolcarriers.

Initially the main use of the wheeled toolcarrier at ICRISAT was to make ridges more quickly and more precisely than traditional implements. The ridges were needed to allow the rainy season cultivation of water-holding black soils (Vertisols) which are seriously underutilized in India during the monsoons. Subsequently in 1975 a broadbed system of cultivation was evaluated that might replace traditional narrow ridges as a means of soil and water conservation, and initial results were very encouraging. After trials with 75 cm beds, it was found that 100 cm beds with 50 cm furrows were more stable, better at controlling erosion and could permit crop cultivation in black soils during the rains. ICRISAT scientists considered that the implements available in India in 1975 were not suited to the broadbed system, as time for bed preparation was high, and planting precision was poor. It was therefore decided to

Fig. 4-4: The major components of a Tropicultor. 1. Platform over chassis (used as seat). 2. Channel assembly. 3. Beam or dissel boom. 4. Toolbar lifting handle. 4. Toolbar. 6. Wheel (can also be fitted on inside of frame). 7. Pneumatic tyre. 8. Stub axle. 9. Toolbox. 10. Pitch screw. 11. Adjustable toolbar supports. (Tropicultor Operator's Manual, ICRISAT 1985).

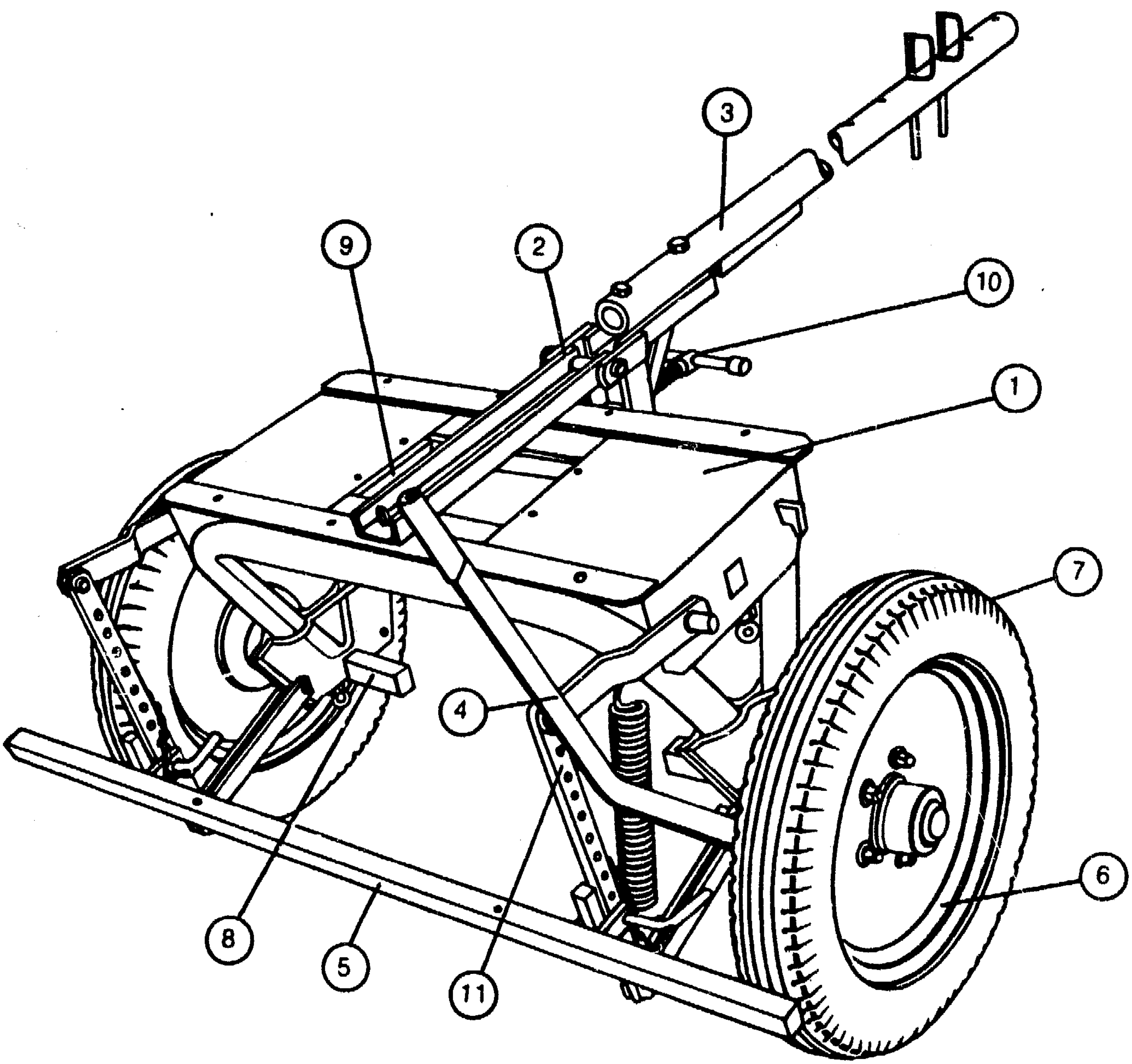


Fig. 4-5: Tropicultor fitted with four-wheel trailer, ICRISAT Centre. (Photo: ICRISAT archives).

search for animal-powered implements that could be used in the broadbed system and which could save both time and energy. Wheeled toolcarriers appeared most suitable, and several designs were evaluated in 1975 (ICRISAT, 1976).

ICRISAT did not attempt to re-invent the wheeled toolcarrier, but rather evaluated a variety of pre-existing models, including the Kenmore (UK), the Otto Frame (India), the Polyculteur (Senegal) and the Tropiculteur (France). The preferred design was the Tropiculteur, manufactured in France by Mouzon, and the 1975–1976 ICRISAT Annual Report contained three photographs of this toolcarrier looking remarkably similar to present-day models. ICRISAT obtained the services of the French agricultural engineer Jean Nolle, who since starting his pioneering work in Senegal had designed several wheeled toolcarriers including the Tropiculteur, and who therefore was the world's leading specialist in this field. Jean Nolle carried out consultancy assignments for ICRISAT in 1976 and renamed his design *Tropicultor* to make it more international (Nolle, 1986). ICRISAT subsequently purchased the rights to allow the local manufacture in India of the Tropicultor (ICRISAT, 1979).

Originally designed in 1963, the Tropicultor has been modified and refined over the years, but essentially it consists of a strong chassis made of steel tube supported on wheels with pneumatic tyres. The wheels which are mounted on stub axles give an adjustable track and can be fitted either inside or outside the chassis. A wide range of implements can be clamped to a square section toolbar hinged to the chassis, which can be raised and lowered with a lever. The Tropicultor can carry one or more operator and a one tonne payload. Following several years of technically successful on-station trials and some on-farm evaluation, in 1985 ICRISAT published a detailed and well illustrated manual on the use of the Tropicultor. This covers implement assembly and a range of field operations including plowing, tine cultivation, harrowing, making broadbeds, seeding and weeding. This manual was designed for publication in different languages, to aid the adoption of the Tropicultor in different areas (ICRISAT, 1985).

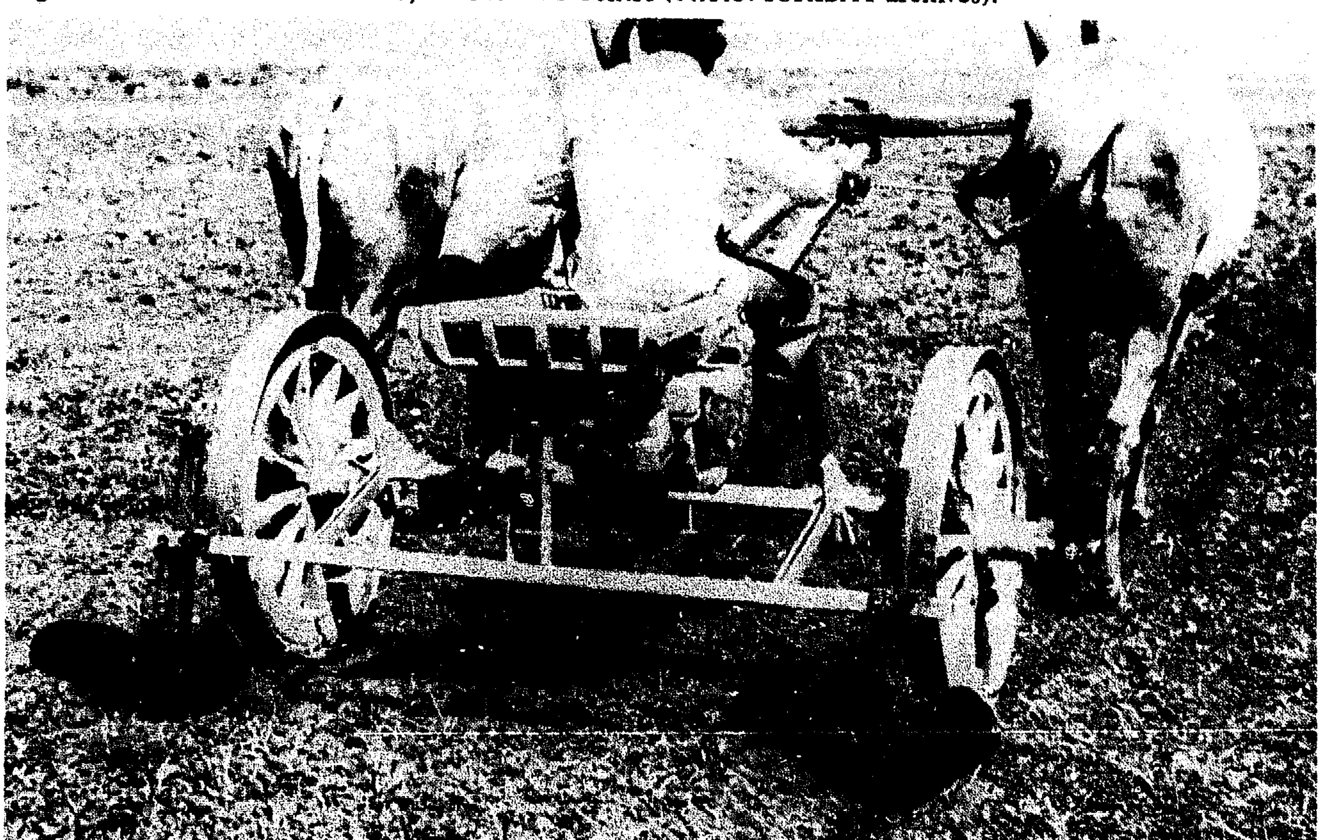
Even in the early years of research at ICRISAT there was concern over the cost of wheeled toolcarriers which were technically efficient but also too expensive for most farmers in the semi-arid tropics. Efforts to "decrease the cost" of the Tropicultor started as early as 1975 (ICRISAT, 1976) and subsequently three attempts were made by ICRISAT to develop cheaper toolcarriers.

4.3.3 The Akola cart-based wheeled toolcarrier (1978–1982)

One attempt to develop a low-cost toolcarrier started in 1978, and was the only toolcarrier to be developed at ICRISAT that was not derived from a French or British design. The toolcarriers were based on the relatively small and lightweight passenger bullock carts made of wood by artisans in the Akola region of the Maharashtra State of India. Akola carts were purchased and their axles were converted to take the implements designed for the Tropicultor. Four units were tested, and during on-station trials in 1978 and 1979 they performed operations with a precision comparable with that of the more expensive Tropicultor. Lal (1986) considered the cart-based toolcarriers were an important development, being based on existing artisanal technology and at an estimated cost of about $ 300 (primarily the cost of the implements) they were less than one third of the cost of the Tropicultor. Although it was based on traditional cart axles and wooden spoke wheels, the cart-based toolcarrier was not designed to allow easy conversion between cart and toolcarrier. Nevertheless load-bearing platforms could have been built onto the axle if required.

The initial trials with the Akola cart-based toolcarrier were sufficiently optimistic to

Fig. 4-6: Akola cart-based carrier, at ICRISAT Centre (Photo: ICRISAT archives).



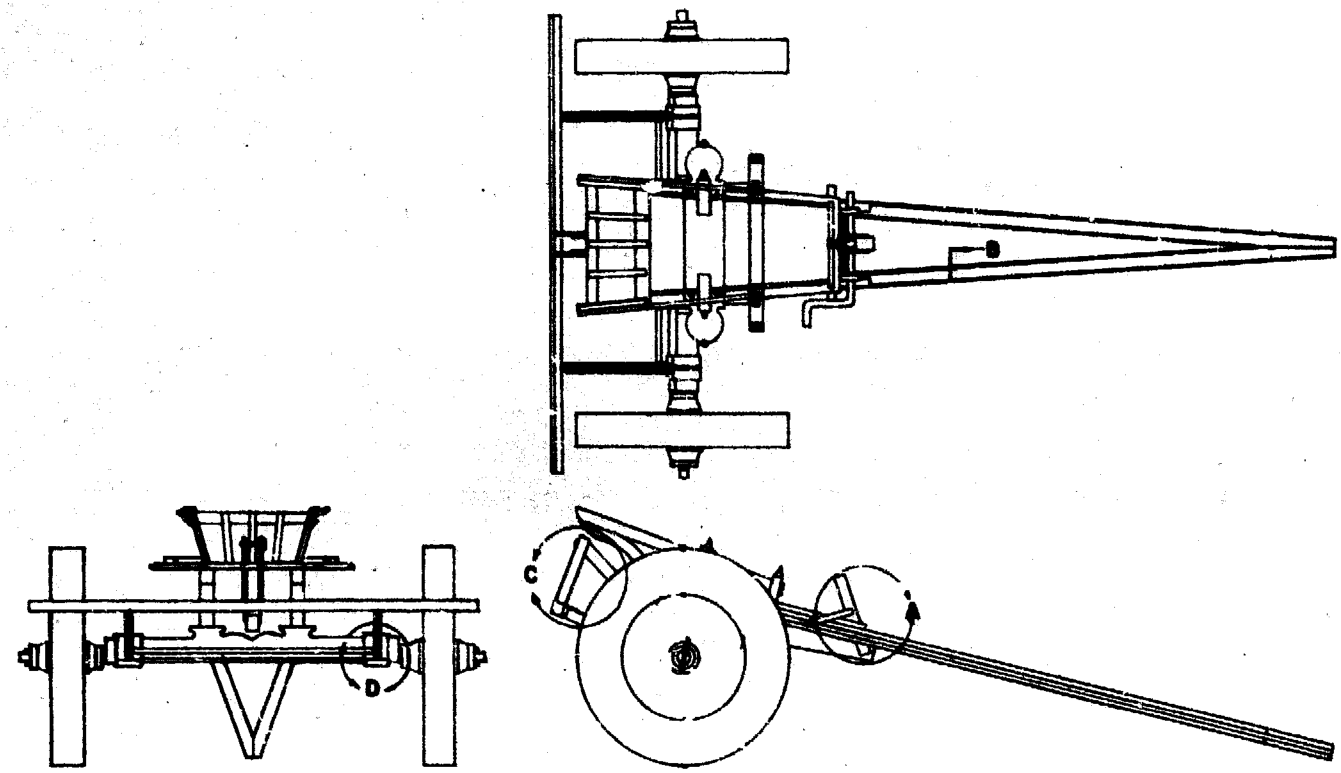


Fig. 4-7: Drawings of Akola cart-based carrier: A) Front levers of lifting mechanism; B) Tapering double wooden beam; C) Rear toolbar and lifting mechanism; D) Axle bracket. (Lal, 1986).

justify a season of comparisons with 22hp tractors at "operational" level (2–3 ha) in 1979 and one objective of these on-station trials was to "study the economics" of the cart-based toolcarrier (ICRISAT, 1980). Operations using the cart-based toolcarrier were easier and more trouble-free than with the tractor (ICRISAT, 1980) but work on the Akola toolcarrier was not continued. The reasons for the rejection of this toolcarrier were not given in the optimistic report of Lal (1986), who considered that it was due primarily to his own departure and the fact that no one else was sufficiently interested in taking on research on lower cost implements. Other researchers at ICRISAT cited problems of standardization of dimensions, structural weakness, limited endurance and rising costs of wood (ICRISAT, 1984; Bansal, Awadhwal and Takenaga, 1986).

It should be noted that the Akola cart toolcarrier was a hybrid of traditional and modern technologies, for it had been designed to use all the tools of the Tropicultor. The main reasons for its rejection seem to have been related to the engineering problems (and costs) of the hybridization process. This necessitated reliably *adapting* the carts to take *precision implements* made of steel. No attempt had been made to adapt other artisanal technology (such as traditional "Desi" plows and blade harrows) to the toolcarrier concept, or develop village-level artisanal solutions to the perceived engineering problems.

4.3.4 The NIAE/ICRISAT (Nikart) wheeled toolcarrier (1979–1986)

A second initiative to develop a cheaper toolcarrier started in 1979 when the British National Institute of Agricultural Engineering (NIAE) with funding from the British Overseas Development Administration (ODA) started to collaborate with ICRISAT on the design of a new toolcarrier intended to be simpler and of lower cost (ICRISAT, 1979).

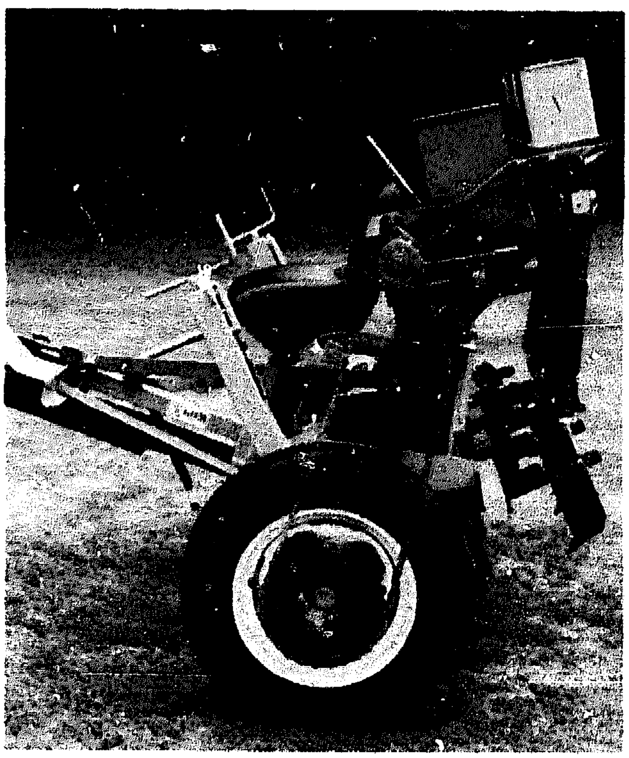
A review of existing models was carried out, and it was found that none of these were being marketed at an acceptable cost.
Four major design problems were identified on existing toolcarriers:
– Implements were designed to be as versatile as possible. As a result farmers often had to pay for features they would not use. (For example Kemp considered that the NIAE wheeled toolcarrier of the late 1950s and 1960s had been excessively versatile.)
– The tool-lifting mechanisms were heavy and difficult to operate.
– The implements' designs were often unattractive to local manufacturers as they made use of materials not readily available.
– Depth control during operation was much more difficult than on single purpose implements, resulting in poor work quality (Kemp, 1980).

As a result of the review, a design philosophy was adopted that would attempt to combine multipurpose use with simplicity yet would intentionally limit some of the options for versatility in favour of lower production costs. Among the design specifications were the capability to perform conventional tillage as well as the broadbed cultivation, one-man ride-on operation, on-the-move depth adjustment and rapid conversion to a one tonne cart (NIAE, 1981).

Fig. 4-8: Early NIAE/ICRISAT (Nikart) toolcarrier prototype being tested with tractor in the U.K., 1980. (Photo: AFRC-Engineering archives).

Early prototypes of the new wheeled toolcarrier, which became widely known by the name *Nikart,* were made at NIAE and were tested by ICRISAT at Patancheru in 1979. In 1980 four slightly modified units were successfully tested at Patancheru, and there was then a need for further examples for on-farm testing. The British Intermediate Technology Development Group (ITDG) was contracted in 1981 to supervise the start of local production at the privately owned Mekins Agro Industrial Enterprises workshop at Hyderabad. The ITDG consultant found that although the Nikart had been designed to be made from locally available materials, there had still been the need to make certain design changes to take account of the *actual* availability of different steel sizes and qualities. The consultant concluded that the original Nikart design had in practice been separated from the realities of the resources and skills available to the small-scale producers (Barwell, 1983), although one specific objective of the design team had been to avoid this problem (Kemp, 1980). NIAE considered that there had been no contradiction between design philosophy and practice, as the contracting of IT-Transport to assist in establishing the manufacturing process and identifying any necessary changes had been an integral part of the research and development programme (D. Kemp, personal communication, 1987).

Fig. 4-9: Early Nikart-type implement with fertilizer-planter, manufactured in the U.K. as GOM Toolcarrier, 1980. (Photo: AFRC-Engineering archives).

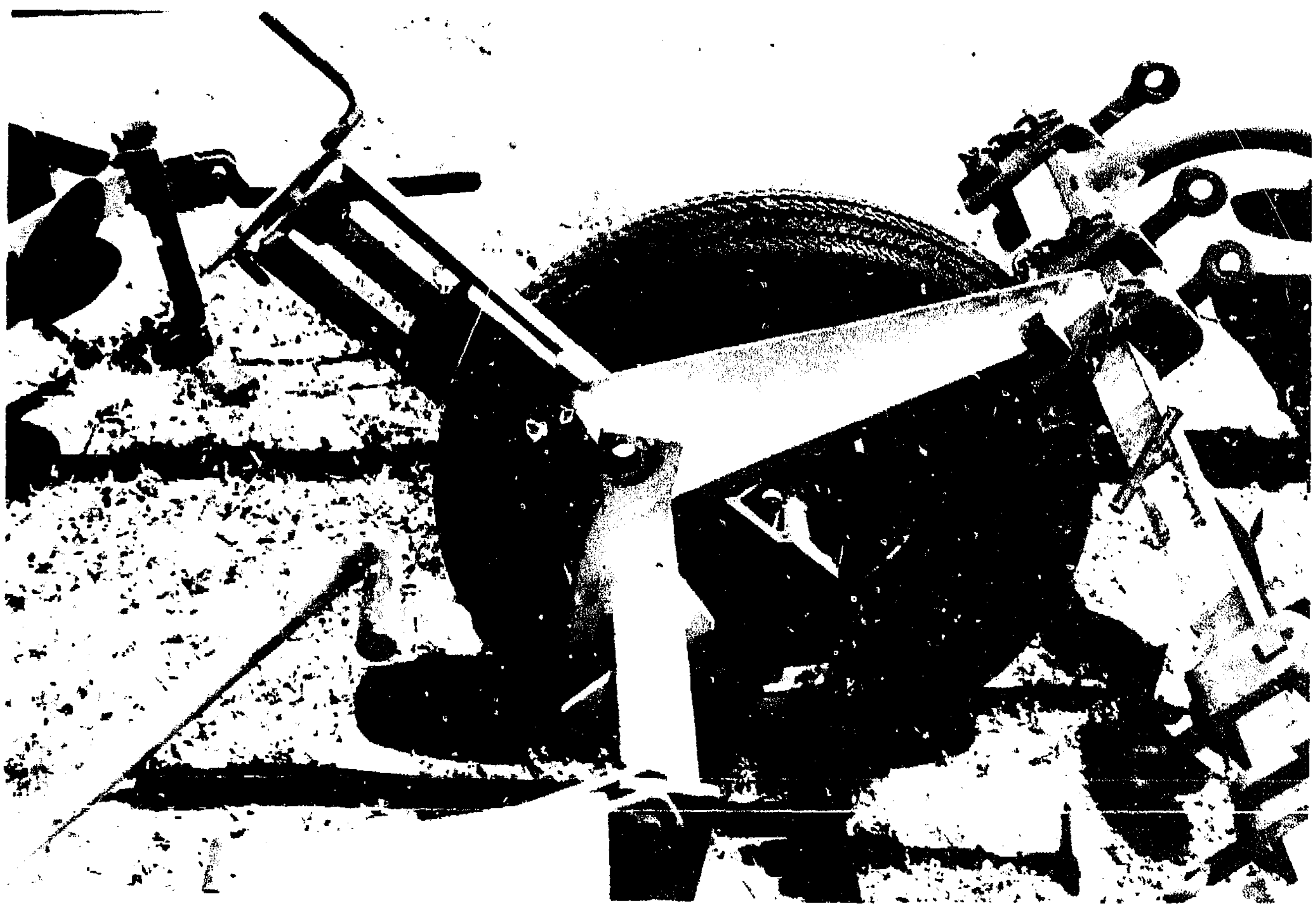


The Mekins workshop produced about 100 Nikart wheeled toolcarriers during the period 1981 to 1984 (Fieldson, 1984; Kshirsagar, Fieldson, Mayande and Walker, 1984) and 32 in the period 1985–1987 (Agarwal, personal communication, 1986). During the same time it also manufactured about 1100 Tropicultors. Almost all sales have been to development projects and institutions, some of which have lent them to farmers or sold them with 50–80% subsidies. Several other workshops in India including Medak Agricultural Centre, Kale Krish Udyog (Pune) and Sri Lakshmi Enterprises (Bangalore) made small numbers of Nikart-type prototypes between 1981 and 1984, but all preferred to manufacture Tropicultors, and all subsequently stopped making toolcarriers.

ICRISAT and NIAE have also promoted the Nikart design in other semi-arid areas. The version most widely distributed has been the *GOM Toolcarrier* manufactured in the U.K. by Geest Overseas Mechanization. Between 1981 and 1986 about 100 GOM Toolcarriers were sold to aid agencies and development projects in at least twenty different countries including Botswana, Burma, Ethiopia, Mali, Mexico, Mozambique, Philippines, Sudan and Zimbabwe. Most were sold in small numbers for evaluation, and by early 1987 there had not been any significant follow-up orders. By 1986 Geest was pessimistic about the prospects for its own manufacture of these toolcarriers due to the inability of small farmers to afford them, and the prohibitive costs of manufacturing such items in the U.K.

Fig. 4-10: Mekins Nikart with fertilizer-planter (Photo: ICRISAT archives).

Fig. 4-11: Precise and simple screw depth adjustment on early Nikart: on later models the mechanism was encased to protect it from dirt. (Photo: FMDU, Botswana).



The British ODA, in cooperation with NIAE, assisted the start of production in Mexico of the *Yunticultor toolcarrier* based on the Nikart research and development. A smaller initiative, also with technical support from NIAE, was started in Honduras, and a prototype *Yunticultor Mk II* was developed to make local fabrication more easy. By 1986 about 100 Mexican and 20 Honduran Yunticultors had been made. Few had been bought by farmers and most sales were to government agencies, development projects and research stations. These Latin American experiences are discussed further in Chapter 6.

One of the main objectives of the Nikart project had been to reduce the price of the basic toolcarrier by at least \$ 150 in comparison with the cost of the Tropicultor. Initially this objective appeared to have been achieved for in 1985 prices quoted by the Mekins workshop were \$ 400 for the Nikart without implements and \$ 600 for the Tropicultor without implements. (The implements were interchangeable, and the basic set for either was about \$ 500 excluding a seeder.) This price differential had been maintained in deference to the assistance the workshop had received to start Nikart, but the quoted prices were largely theoretical as there was negligible demand for the Nikart.

In practice the savings in manufacturing cost of the Nikart due to lower weight and lack of wheel track adjustment, had been offset by the relatively complex system of height adjustment and the amount of precision welding required to manufacture the frame. In addition the early cost-saving device of the use of old car tyres for the Nikart had ceased due to problems of supply, quality and convenience of manufacture, and Indian-manufactured Nikarts were supplied with new Animal-Drawn Vehicle (ADV) tyres. The Mekins Director considered that the actual manufacturing costs of both the Nikart and the Tropicultor were similar, and by October 1986 the Mekins price differential between the basic toolcarriers almost disappeared in India at Rs 5 750 for the Tropicultor frame and Rs 5 500 for the Nikart frame (\$ 500 for export sales). Other Indian manufacturers had previously also shown preference for the Tropicultor over the Nikart and unpublished data of Ghodake and Mayande (1984) suggested that even with economies of scale and the stimulus of competition, the supply prices of the Tropicultor and Nikart would be within 3% of each other.

In Europe in early 1987, the anticipated price savings of the Nikart design might be indicated if one were to compare the price of a GOM Toolcarrier with a simple set of implements (about US \$ 1250) with a comparable Mouzon Tropicultor set (about US \$ 1450). However any such price comparisons should be treated with great caution, since both the products and also the sales conditions of the two firms are very different, and both prices are liable to fluctuate with currency movements.

Operationally the Nikart was found to be effective, although even at an early stage it was found that few users changed between the cart mode and the cultivation mode (Kemp, 1983). While it was at first cheaper than the Tropicultor, at \$ 400–500 for the basic carrier (without cart or implements) it was still very expensive. Thus even before the Nikart project had been completed, in 1978–1979 an even simpler tool, the *Nolbar* or *Agribar* was being developed.

4.3.5 The Agribar (Nolbar) wheeled toolcarrier (1978–1986)

The *Agribar* was the name given in 1981 to a derivative of the Nolbar. The *Nolbar* (presumably named after the designer Jean Nolle) had been tested at Patancheru in 1978, and in 1979 comparative trials had been carried out between the Nolbar, the Akola cart-based toolcarrier, the Tropicultor and a 22hp tractor. The Nolbar/Agribar had been designed to simplify still further the toolcarrier concept, and reduce cost (and flexibility) still further. It was designed as a simple, transverse toolbar (rather than a full chassis) pulled with a long, integral steel draw-pole. The bar is supported on two small (30 cm) wheels, with independent levers that raise or lower each end of the bar. On early models there was no operator's seat, and when one was provided it tended to give the driver a feeling of insecurity and instability. Handles in the centre of the bar can be used for implement guidance by an operator walking behind the toolcarrier. There is no provision to convert the bar to a cart. The attachments are the same as those for the Tropicultor or Nikart except that, being lighter, it cannot support as many soil preparation implements at the same time. In some respects the simplicity of the Agribar gives it some resemblance to the Ariana intermediate type of toolbar, but it differs significantly in that it uses a drawbar, and the toolbar can be raised and lowered.

In comparative trials in 1979–1980 the Nolbar/Agribar was found capable of all broadbed operations, but the time and effort required to raise and lower the implements at the end of each row made it less efficient in operation than the other toolcarriers. From 1978 to 1984 the Agribar was tested and adapted at Patancheru and was also (briefly) tested at Sotuba and Cinzana Research Stations in Mali. In 1985 it was tested by farmers in India but to date it does not appear to have been tested by farmers in Africa (ICRISAT, 1984 and 1985). In theory the Agribar is being commerically manufactured at the Mekins workshop, but to date total sales have been only thirty, of which fifteen have been exported for evalua-

Fig. 4-12: Agribar, fitted with seat, with ridging bodies, ICRISAT Centre. (Photo: ICRISAT archives).

Fig. 4-13: Agribar with hand-metred planter and fertilizer applicator, ICRISAT Centre. (Photo: ICRISAT archives).

tion in West Africa and Somalia. Priced at Rs 1500 in India and at $ 200 for export (without implements), the Mekins Agribar is only 25–33% of the cost of a Tropicultor. Although it has been under development for nine years at ICRISAT, farmer evaluation, sales and promotion have been minimal. In 1987 ICRISAT will publish a manual on its use, using the style of the Tropicultor manual.

On the ICRISAT station at Patancheru, the preferred toolcarrier has been the Tropicultor, and the on-station uses of this have been further diversified with the development and testing of prototype high-clearance pesticide sprayers and dust applicators and rolling crust breakers (ICRISAT, 1984 and 1985). At the ICRISAT research stations in Mali and Niger, the Nikart is preferred for its greater precision of depth control (see Chapter 5).

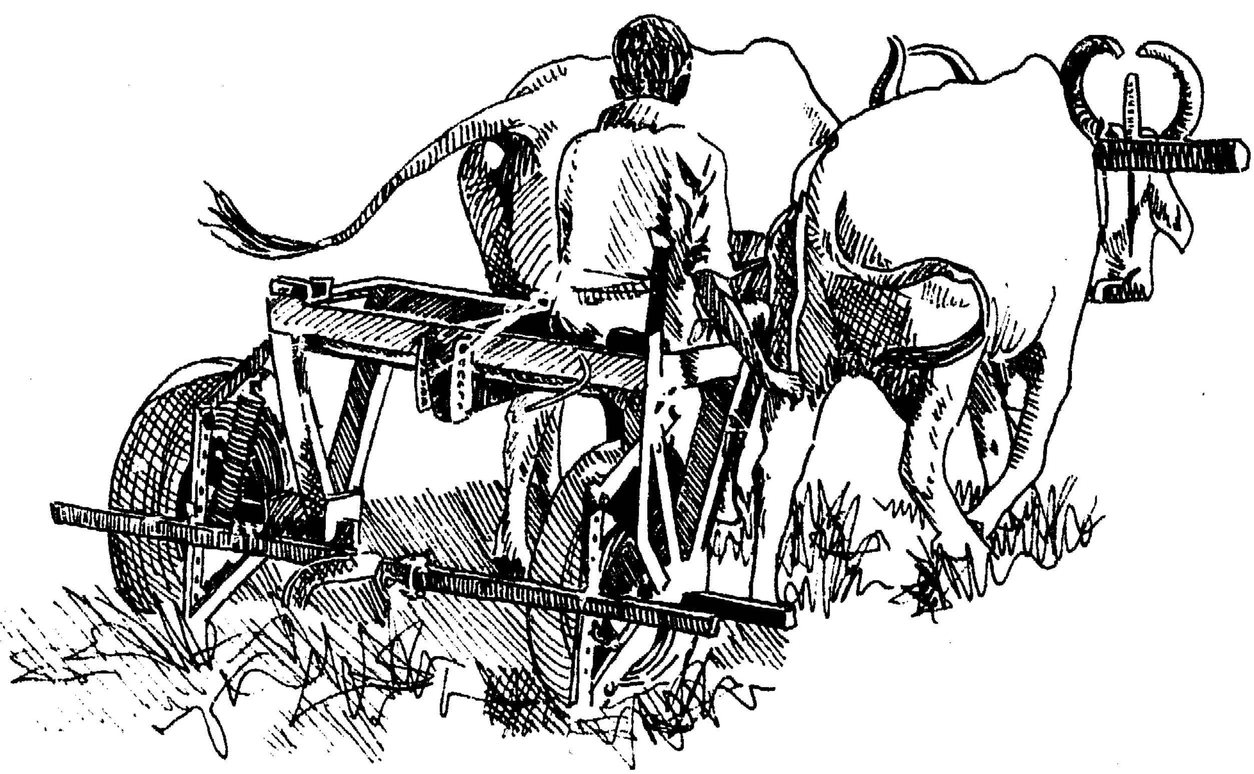
4.3.6 On-station and on-farm "verification" trials

Since 1975 wheeled toolcarriers have been used to cultivate over 100 ha of crops a year at ICRISAT's Patancheru research station (Bansal and Srivastava, 1981). From 1976 to 1981 the Farming Systems Research Program and the Economics Program of ICRISAT combined to evaluate at an operational scale the use of a complete package of "improved watershed-based technology" of which wheeled toolcarriers were considered an integral component (Virmani, Willey and Reddy, 1981; Ryan and Sarin, 1981). Small watersheds were systematically developed on the research station and from the carefully recorded and monitored trials it was clear that the combination of watershed bunding, the broadbed and furrow system using wheeled toolcarriers and the use of fertilizers and high yielding varieties produced significantly greater yields than traditional agricultural practices. This on-station work gave rise to great optimism, and a series of on-farm "verification" trials were initiated, in collaboration with Indian national programmes.

In 1978–1979 ICRISAT supervised small plot experiments in the villages of Aurepalle in Andhra Pradesh and Shirapur and Kanzara in Maharashtra State. These were followed in 1979 to 1981 with the development of watersheds of about 12 ha in each village, and the use by farmers of the broadbed and furrow technology. ICRISAT provided all relevant inputs of equipment, fertilizers, seeds and pesticides (Sarin and Ryan, 1983). Early results suggested some problems with the technology, which had not proved successful in Alfisols (red soils), medium-deep Vertisols (black soils) or in areas affected by variable rainfall. Emphasis was therefore placed on the use of the technological package in deep Vertisols in regions of assured rainfall. The village of Taddanpalle (or Taddanpally) 40 km northwest of the ICRISAT Center was selected as representative of the appropriate conditions and in 1981 a watershed of 15 ha was developed by fourteen cooperatting farmers, with intense scientific and technical guidance from ICRISAT scientists (Ryan and von Oppen, 1983). The relative success of the first season's work at Taddanpalle led to a similar scheme in the nearby village of Sultanpur in 1982. A great deal of information was collected from the village studies and this showed there were both advantages and disadvantages to the new technology. As discussed in a following section, there are several examples of the positive aspects of the "on-farm verification" being selectively reported. However the final outcome in *all* the villages in which watersheds were developed is that none of the farmers continued with the technology and in general farmers were not prepared to buy

Fig. 4-14: Tropicultor with steerable weeder being used in on-farm verification trials in India. (Photo: ICRISAT archives).

Fig. 4-15: Agricart wheeled toolcarrier plowing on farm in India (note RH wheel is inset). (Based on photo: ICRISAT archives).



or hire the wheeled toolcarriers, even at subsidized prices.

Thus by 1986 ICRISAT was not aware of *any* villages in India in which the wheeled toolcarrier and broadbed and furrow system had been proven by sustained farmer use and adoption. There were only a few examples of any use of broadbeds or wheeled toolcarriers. In one village, Antwar, about 100 km from Patancheru, three land-owning brothers had been experimenting with the broadbed and furrow system for three years and had obtained six Tropicultors and one Nikart. In this scheme the toolcarriers had been used on family land and had been loaned to twenty farmers without charge. The toolcarriers were only used as carts when all traditional carts were unavailable and in December 1986 the dry season cultivation of fields was being undertaken with traditional Desi plows due to the high draft of the toolcarriers. In 1986 visiting dignitaries were taken to this village as an example of the ICRISAT technology in use. Other examples of users of the technology in 1986 were also atypical and included a community research farm at Adgenar near Aurangabad, where the organizers and farmers are interested in the wheeled toolcarriers but none of the three toolcarriers provided by a development project had been used in 1986 (a dry year), and previous utilization rates had never been high. At the village of Neoli near Latur, the father of an ICRISAT researcher had purchased a Tropicultor and in 1986 used it for plowing about three hectares of upland rice (not on the broadbed system) and for fifty days of transport.

Such isolated examples indicate that to date "verification" (in the sense of farmers proving that the claimed benefits of a technology are real) has not yet been achieved. However this has not prevented some highly optimistic reports being produced as recently as September 1986 claiming that the wheeled toolcarrier technology has been "verified".

4.3.7 Optimistic economic studies on wheeled toolcarriers (1979–1986)

Relatively early in the ICRISAT research programme, studies were carried out on the economic costs and benefits of the use of wheeled toolcarriers (Binswanger, Ghodake and Thierstein, 1980). This study tried to estimate the hire rate a contractor would have to charge to pay for a toolcarrier over a period of ten years assuming he bought the toolcarrier with a commercial loan, and required a 10–20% profit over his actual outgoings. Several models with different assumptions were presented but although the toolcarriers were assumed to have significant working rate advantages over traditional implements, even a low cost toolcarrier (with steel wheels) with high utilization rates for agricultural use (eighty days a year) and transport (one hundred days a year), and only a 10% margin of profit appeared more expensive than existing hire rates for traditional cultivation services. Thus, while the toolcarrier could undoubtedly save time and drudgery, it was concluded "even under the most favourable circumstances assumed such machines cannot compete on a cost basis with the traditional implements in traditional agriculture."

Binswanger et al. noted that there was a social cost involved, for wheeled toolcarriers would make 1.5 bullock drivers unemployed on each 15 ha on which it was assumed they would operate. However the authors noted that the toolcarriers might become both socially and economically justified if there were compensatory yield increases. If such increases were large enough they could generate sufficient extra work to offset the unemployment of the bullock drivers. In on-station research carried out between 1976 and 1978, significant yield advantages had been attributed to the soil management systems associated with the toolcarriers, and while these had not been fully verified in on-farm conditions, there was an indication that particular benefits might be achieved on the deep Vertisols (black soils). Thus the authors concluded that on-farm research relating to wheeled toolcarriers was amply justified, but cautioned that wheeled toolcarriers would not be competitive unless they could generate yield advantages in excess of 200–400 kg/ha (Binswanger, Ghodake and Thierstein, 1980).

Binswanger et al. intentionally avoided the problem of relating farm size to toolcarrier ownership by assuming that a contractor would be able to hire out such an implement to several farmers and thereby cultivate a total of 15 ha. This has been considered to be a realistic maximum for the area that could be cultivated with a toolcarrier and this figure allows costs per unit area to be minimised. However another ICRISAT worker discussed this particular problem, noting that the majority of farmers in India have much smaller farms than 15 ha (Doherty, 1980). Doherty argued that small group ownership of toolcarriers would be sociologically difficult and if large groups could be formed they might find greater benefits from tractor ownership. He also argued that farmers prefer individual ownership of implements to hiring from entrepreneurs. Doherty pointed out that some of the assumed potential yield advantages of the toolcarrier would come from the associated soil management techniques involving developing small watershed areas. However he highlighted the likely social problems of redeveloping drainage patterns between farms owned by different families of different social and economic backgrounds. Thus, while also advocating more on-farm research in this area, he emphasised the need for developing low cost implements that could be afforded by individual farmers, on-farm yield increases that could justify the investment and socially viable systems for transferring such technology (Doherty, 1980).

Despite the cautions of Doherty voiced in 1979, from 1979 to 1985 ICRISAT economists continued to base economic assessments of toolcarriers on the "optimising" assumptions of Binswanger et al. (1980).

An example of the optimism of ICRISAT economists is seen in the paper of Ryan and Sarin (1981) who stated: "We discuss the economics of the improved technologies that have been evolving from research at ICRISAT Center and in villages, aimed at enabling crops to be grown in deep Vertisols in the rainy season. . . This improved system utilizing graded broadbeds and furrows has generated profits . . . These profits represent a return to land, capital and management, as the cost of all human and animal labor, fertilizers, seeds and implements have been deducted . . . Based on these figures the extra profits from the new system could pay for the wheeled toolcarrier in one year provided that it was utilized along with improved technology on at least four hectares." Although the details of the cost assumptions used in the calculations were not provided in these papers, the profits quoted were based on "annual costs of implements". Towards the end of the paper the high cost of the toolcarrier was acknowledged, but it was pointed out that attractive rates of return would be available to entrepreneurs hiring out wheeled toolcarriers for 180 days a year.

Perhaps the most optimistic economic analyses by ICRISAT were presented by Ryan and von Oppen in 1983 and were based on initial on-farm verification. Referring to results from the village of Taddanpalle for 1981–1982, the authors stated: "These data show a 244% rate of return on the added expenditure, confirming the experience at ICRISAT Center (250%), and giving us confidence about the technology options on village farms . . . The relative success of the Taddanpalle experiment led to a further experimental area in adjoining Sultanpur village in 1982–83."

They then attempted to make a benefit-cost analysis, admitting that at the early stage of adoption, this was a hazardous exercise. The assumptions included an annual growth of toolcarriers of 45% per year (rising to 0.5 million units in use in the year 2003) and additional profits based on Taddanpalle experience of Rs 1434/ha. This gave a benefit to cost ratio of 5 : 1 by the year 2000 if each toolcarrier could work on ten hectares (a 300% internal rate of return), and 7 : 1 if the toolcarriers were used on fifteen hectares. The additional costs of the provision of extra agricultural officers, fertilizers stores and banks to service the new technology were not included, nor were any benefits attributable to soil conservation considered (Ryan and von Oppen, 1983).

Highly optimistic economic statements relating to wheeled toolcarriers continued to be made by ICRISAT economists until 1985. Ghodake (1985) drew heavily on the content of Ryan and Sarin (1981) and repeated the suggestion that a wheeled toolcarrier could be paid for in one year on four hectares although he did note that the wheeled toolcarrier might not actually be an essential component of broadbed technology for which it was being advocated.

The agricultural engineers at ICRISAT have seldom included any economic data in their reports and papers. However, in 1985, a paper was published giving an economic comparison of the Akola toolbar, the Tropicultor, the Nikart and the Agribar. Assumptions were based on 14 ha annual use, plus 400 transport hours for the toolcarriers that could be used as carts. With these assumptions the Tropicultor had the best marginal benefit-cost ratio attributable largely to the reduction in hourly cultivation costs achieved by assumed transport operations. However, in terms of simple cost per hectare, the Agribar appeared most promising, and was suggested as a low cost alternative to the heavier machines for the broadbed technology (Mayande, Bansal and Sangle, 1985). In another approach, wheeled toolcarrier technology was promoted for its energy efficiency (Bansal, Kshirsagar and Sangle, 1985).

4.3.8 General promotion of toolcarriers by ICRISAT (1981–1982)

While most of ICRISAT's work on wheeled toolcarriers had actually been based on the broadbed and furrow system of cultivation, and their economic justification derived from on-station trials using that system, ICRISAT publications started to consider wheeled toolcarriers as a valuable technology in their own right. Thus Information Bulletin No. 8 on "The Animal-Drawn Wheeled Tool Carrier" (ICRISAT, 1981) stated:

"The animal-drawn wheeled tool carrier . . . is able to perform virtually all operations that can be done with a tractor, thus providing to many farmers the versatility and precision previously available to only a few . . . The present multipurpose machine permits farmers to carry out their basic operations of tillage, planting, fertilization and weeding in a timely and precise manner to increase productivity and, as a bonus, it can be used as a cart to provide transportation. . .

Such a system of machinery promotes agriculture by increasing farmers' income and making available to them machinery that enables:

– rapid execution of cropping operations (timeliness of planting, weed control, etc.),

– better use of fertilizer (quantity and placement),

– alleviation of labour bottlenecks,

– rational use of animal power,

– more precise planting of crops." (ICRISAT, 1981).

The picture presented in this Bulletin of what seemed almost ideal equipment, perhaps a panacea of agricultural engineering, was short-lived, as feedback reached ICRISAT from village experiences.

In response to the general promotion of wheeled toolcarriers by ICRISAT and cooperating manufacturers, a large toolcarrier project (the largest to date in India) was undertaken in Nasik District of Maharashtra State. In the planning stages it was envisaged that 350 Nikart toolcarriers would be sold, but when offered the choice of Tropicultors and Nikarts, the farmers opted for Tropicultors. In 1982/1983 about 266 farmers had been sold Tropicultors at 80% subsidies under the Maharashtra Integrated Rural Energy Project. The toolcarriers had been supplied complete with plow bodies, tines and carts, and in line with the promotion for general use there had been a clear emphasis on the transport potential of the toolcarriers (Fieldson, 1984; Kshirsagar, Fieldson, Mayande and Walker, 1984).

It is illuminating to follow the progress of this scheme. After only one or two seasons, by 1984 few farmers used the Tropicultors on any significant scale for cultivation, generally perceiving them as too heavy and the implements not suited to local soil conditions. By 1986 it was relatively difficult to find any farmers who used their Tropicultors for cultivation. One farmer was specially contacted because he reportedly still used his toolcarrier, but in practice he only used the Tropicultor on one small plot and it was clear from the lack of wear on the implements that they had not been extensively used since manufacture. Many farmers had stopped using their Tropicultors even as carts, preferring the more stable and more easily repairable traditional carts. During village visits in 1986 several Tropicultor carts were seen to be still in use, but more significantly, considering the cost of the toolcarriers and research predictions concerning potential for transport use and life expectancy, abandoned frames and cart bodies were also seen. Thus this general promotion project showed a pattern very similar to some of the early African schemes: an early rejection of toolcarriers for cultivation and a slower abandonment for transport purposes. This has implications for both technical and economic assessment, for if farmers actually own implements but stop using them, the problem is not simply one of cost or profitability for they have already invested in the technology. It implies some technological problems relating to the use of wheeled toolcarriers in local farming systems and village life.

As the results of the on-farm trials and promotional schemes became known to ICRISAT scientists, doubts slowly started being expressed in papers and publications.

4.3.9 Doubts relating to wheeled toolcarriers (1981–1986)

Doubts about the overriding economic advantages of wheeled toolcarriers only slowly entered the ICRISAT literature. Ghodake, Ryan and Sarin (1981) warned that exacerbated labour bottlenecks could lead to the rejection of broadbed technology. Sarin and Ryan (1983) noted that on-farm verification trials in Alfisols (red soils) in Aurepalle village near Hyderabad had failed to show advantages for the broadbed and furrow technology. In Shirapur village in Maharashtra State the deep Vertisols (black soils) were too hard to allow plowing with wheeled toolcarriers and a single pair of bullocks, and the toolcarrier could not control weed infestation on the raised beds. In medium-deep Vertisols at Kanzara village in Maharashtra State plowing with the wheeled toolcarrier required multiple pairs of bullocks and did not lead to greater profitability when com-

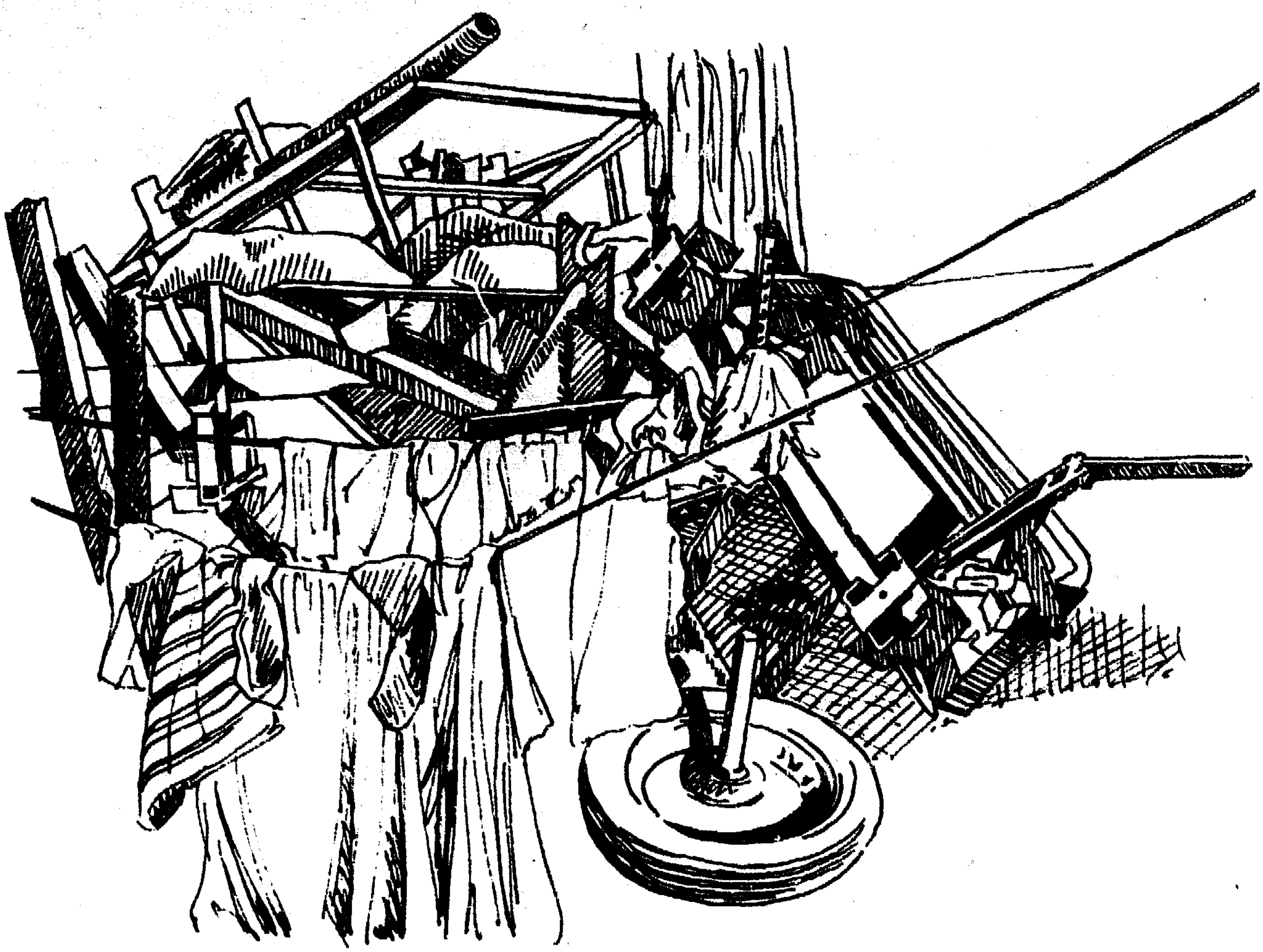


Fig. 4-16: Some toolcarriers and components bought by a Maharashtra State project in 1982 were still unused (for agricultural purposes) in 1986. (Based on photo: P.H. Starkey).

pared with traditional techniques. It was concluded that while wheeled toolcarriers were efficient, less costly alternatives should be explored (Sarin and Ryan, 1983).

Further questioning of the applicability of the station-derived technology was provided by von Oppen, Ghodake, Kshirsagar and Singh in 1985. The authors confirmed that the Vertisol technology had been consistently successful on station but admitted that "the continuing need for management support, and input supplies and the emergence of further constraints seem to impose much narrower limits on the technology than had earlier been anticipated." Constraints identified by on-farm trials included exacerbated human labour peaks, bullock power and fodder constraints, inadequate credit, difficulties in fertilizer supply, increased weed growth and technical problems of repairs and maintenance of wheeled toolcarriers. It was noted that the farmers involved in the on-farm verification trials did not consider wheeled toolcarriers as indispensable to the broadbed and furrow technology, and were not prepared to pay realistic hire or purchase costs for the wheeled toolcarriers. It was concluded that further research was needed into the various components of Vertisol technology, including the development of lower cost wheeled toolcarriers. It was also suggested that such research should be carried out in closer cooperation with farmers, perhaps by national programmes rather than by ICRISAT.

Hints of possible doubts entered the Information Bulletin No. 8 on "The Animal-Drawn Wheeled Tool Carrier" between the

1981 and 1983 editions (ICRISAT, 1981 and 1983). Many changes between the two editions were small and provided additional technical information relating to the toolcarriers, such as weight, use of the Nikart and the additional operation of land shaping. Small subtle changes were related to possible problems when the toolcarriers are used off the research station, for example indicating that farmers must adjust the load to the capacity of their animals. However perhaps the most important change was that, while the 1983 booklet was still very positive and stressed the potential benefits of toolcarriers, it also had a new heading "Drawbacks of the toolcarrier" which noted that they cost more than small farmers could normally afford and their maintenance might be difficult under village conditions. The 1981 conclusion that "such a system of machinery promotes agriculture by increasing farmers' income" was subtly modified to "in the long run it can increase agricultural production and farmers' income particularly in regions where there is a high ratio of land per farmer."

This last change is interesting as in much of India holdings are small, and the ratio of land to farmer is generally higher in Africa and Latin America than Asia. The 1983 toolcarrier promotional booklet (ICRISAT, 1983) was also given a very distinct change in its overall impression through the inclusion of photographs of toolcarriers in use in Brazil, Botswana, Mexico and Mozambique in addition to India. This reflected the increasing interest of ICRISAT in the potential for toolcarriers in other parts of the world, in addition to their use in India. However it also tended to create the impression that the technology had diffused worldwide.

The greatest doubts to date have been expressed in the report of the British NIAE by Fieldson (1984) and the resulting paper by Kshirsagar, Fieldson, Mayande and Walker (1984). These observed that few wheeled toolcarrier machines had been sold in India without large subsidies; annual utilization had been low; hire markets had not developed; farmers did not perceive that the wheeled toolcarriers had overriding advantages over traditional implements; most manufacturers had stopped making wheeled toolcarriers due to insufficient market demand and future prospects were not bright.

4.3.10 Continued optimism (1985–1986)

Despite the doubts expressed in internal papers, few externally circulated ICRISAT papers have shown *any* indication of the problems being faced in the field by wheeled toolcarriers. In a paper presented at a seminar at IRRI in 1985, ICRISAT staff managed to cite Fieldson's very pessimistic report and still present a very optimistic overall picture: "Now the farmers in SAT regions of India have started appreciating the usefulness of WTC. This trend is rather encouraging. It reflects the collaborative efforts by the Government extension agencies and national research institutions. Occasional subsidies from the Government also assist. As a result of all this the sale of WTC in India is improving, even though direct purchase by individual farmers and non-governmental agencies is only about 11% (Fieldson, 1984)." (Awadhwal, Bansal and Takenaga, 1985).

In April 1986 an article in the newsletter of the Regional Network on Agricultural Machinery (RNAM) described the farm machinery research of ICRISAT and the development of wheeled toolcarriers (Bansal, 1986). No mention was made of farmer response to the wheeled toolcarriers, and the impression was given that they were being increasingly used by Indian farmers. Most recently three ICRISAT scientists participated in the "Animal Power in Farming Systems" workshop in Sierra Leone in September 1986 and pre-

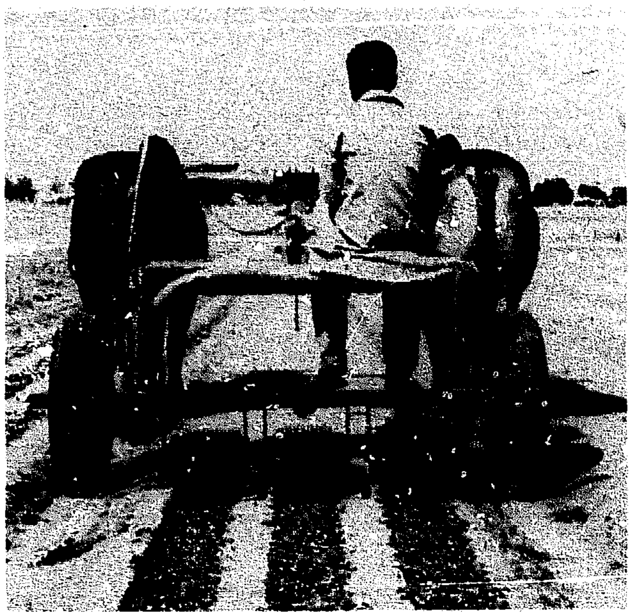


Fig. 4-17: Tropicultor with rolling crust breaker, at ICRISAT Centre, 1986. (Photo: N.K. Awadhwal).

sented a highly positive picture of the progress of wheeled toolcarriers in India (Bansal, Klaij and Serafini, 1986). The overall optimistic tone presented can be gauged by the following quotations:

"In the past decade a successful "technology package" for Vertisols was developed . . . The WTC has been used to overcome the problems of working these soils . . . After the successful experiences at the ICRISAT Centre with the Tropicultor . . . The Nikart is about $ 80 (US) less expensive than the Tropicultor that cost $ 500 (US) . . . It is also well suited to the manufacturing capabilities of small industries in developing countries. At the ICRISAT Centre animal-drawn WTCs have been successfully integrated in improved farming systems developed for the management of Vertisols. On-farm verification has been carried out in different regions of the Indian SAT. Data from two villages, Taddanpally in Andhra Pradesh and Farhatabad in Karnataka State, illustrate the role of improved farm equipment in a new farming system. . . In Taddanpally . . . the use of the WTC led to substantial labor savings for field operations . . . higher yields . . . increased labor productivity . . . ICRISAT has demonstrated that a properly conceived animal-traction-based crop management strategy can have significant impact on productivity." (Bansal, Klaij and Serafini, 1986).

There is no hint in the paper of the problems being experienced with the adoption of wheeled toolcarriers in India or that farmers at Taddanpally and Farhatabad did not continue to use the "successful" technology, after its "verification". Nor was there any indication that the "$ 500" Tropicultor had no implements and would actually cost four times this figure shipped with implements to a West African port.

4.4 Prospects for wheeled toolcarriers in India

4.4.1 Opinions based on general principles

Opinions as to the long-term importance of wheeled toolcarriers in India have varied. In his comprehensive study on farm machinery and energy research in India, Shanmugham (1982) commented favourably on the principle of the wheeled toolcarrier or "bullock tractor" but did not go on to put high priority on research into such implements. Rather he advocated research on more simple plows, commencing with a study of why the traditional wooden plow is still so popular in India. He cited figures on changing patterns of equipment use. While numbers of steel mouldboard plows in use increased steadily from one million in 1951 to five million in 1972, Shanmugham stressed that this should be seen in the context of a rise in the number of wooden plows from 32 million to 39 million from 1951 to 1972. While the number of traditional plows declined very slightly during the latter years of this data, the change to mouldboard plows still seemed slow. Shanmugham noted that the rapid rise in different forms of seed-drill or sowing devices (to four million in 1972) appeared more significant than changes in the types of plow in use.

The Director of the Central Institute of Agricultural Engineering (CIAE), Bhopal has also stressed the importance of low cost implements and simplicity of design, and while favouring the continuation of research and development on wheeled toolcarriers to allow faster and more timely cultivation, he has placed emphasis on a simple and low cost model (CIAE, 1985). The expensive and high quality Tropicultor has been tested on many research institutes in India and on some farms, and in general it has been found effective for both cultivation and transport. However a research centre in Pune observed that in the prevailing farming systems the Tropicultor had no special technical advantage over the various simpler (and much cheaper) implements used by local farmers (CIAE, 1985).

Brumby and Singh (1981) in a study for the World Bank reviewed information on the spread of implements in India and detailed many of the reasons suggested by farmers and professional agriculturalists for the observed low adoption rates of the steel mouldboard plow. These were often related to higher cost, heavier weight, small draft animals, the need for blacksmith training, difficult farm topography and sociological factors such as caste and systems of communal equipment use. In addition inadequate credit, weak research-manufacturing linkages and poor implement availability and back-up services were cited as factors that *might* have contributed to low adoption rates. However these authors questioned the adequacy of these arguments and preferred the explanation that technology that was available and not rapidly adopted was simply not cost-effective. They cited the rapid uptake of pumpsets and seed drills as examples of relatively expensive and complicated machines that were being rapidly adopted by Indian farmers, as these were perceived to be highly cost-effective.

Brumby and Singh went on to suggest that the wheeled toolcarrier represented an available and largely unused technology that had vast potential in India to increase the area of cultivated land and increase yields on existing lands. The options for actively promoting the toolcarriers included financing private contractors, credit provision, cooperative formation and the provision and demonstration of equipment to research and training farms. However, rather than advocate such immediate promotion, Brumby and Singh specifically recommended that ICRISAT, with World Bank support, carry out a study of the advantages, adaptability and constraints to the acceptance of the wheeled toolcarrier.

4.4.2 Opinions based on farmer surveys

In 1984 staff from ICRISAT and NIAE carried out a survey of farmers who had obtained wheeled toolcarriers and also of the various manufacturers of these implements to obtain an indication of future market demand (Fieldson, 1984; Kshirsagar, Fieldson, Mayande and Walker, 1984). The findings were clear: few machines had been sold without large subsidies of 50–80%; annual utilization had been low; hire markets had not developed; farmers did not perceive that the wheeled toolcarriers had overriding advantages over traditional implements and carts; farmers did not believe wheeled toolcarriers were indispensable to the ICRISAT improved Vertisol (black soil) technology package; most manufacturers had stopped making wheeled toolcarriers due to insufficient market demand. It was concluded that prospects for wheeled toolcarriers in dryland agriculture in India were "not bright".

Two separate ICRISAT consultancy missions in 1986 involved visits to villages and farms

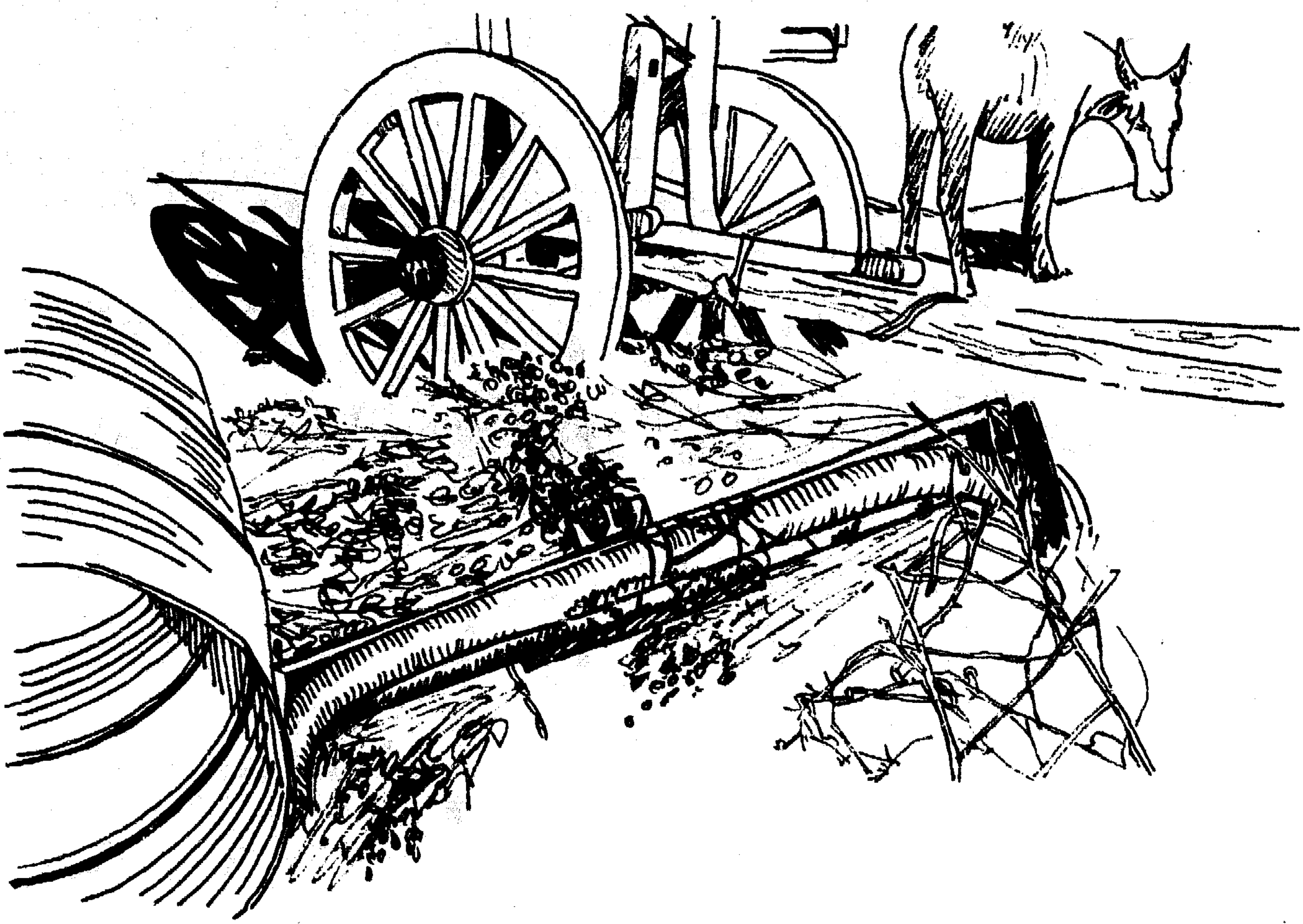


Fig. 4-18: Abandoned Tropicultor chassis in Maharashtra State, 1986. (Based on photo: P.H. Starkey).

to assess the impact of the ICRISAT wheeled toolcarrier technology in India and the observations of the 1984 survey concerning low utilization, lack of entrepreneurial hiring and lack of farmer enthusiasm were endorsed (Reddy, 1986; Starkey, 1987). At subsequent Resource Management Program seminars to discuss the consultants' work, the concensus of the ICRISAT scientists present was also clear: prospects were indeed not bright.

4.4.3 Opinions of manufacturers

One method of evaluating future prospects is to analyse patterns of manufacture and sales. There are difficulties in this as very few sales have been to farmers, traders or distributors but rather have been to development projects who have bought them through large contracts, and have subsequently allocated their stocks to farmers, usually charging only 20–50% of the ex-works price. Some stocks bought in 1982 remain in store. The pattern of production is illustrated in Table 4.1.

In the years 1979–1982 ICRISAT provided technical assistance to Mekins Agro Products (Hyderabad), Medak Agricultural Centre (Medak), Kale Krish Udyog (Pune) and Sri Lakshmi Enterprises (Bangalore) who all made wheeled toolcarrier prototypes and limited production runs. 1983 and 1984 were the years when large contracts were given by development organizations. Subsequent large contracts were few, and all the workshops except Mekins stopped toolcarrier production. The influential firm of Voltas which had initially acted as an agent for Nikart sales also abandoned the wheeled toolcarrier. The implication is that few (if any) workshops and commercial firms see

Table 4.1: Estimation of Wheeled Toolcarrier Production in India, 1979–1986

Toolcarrier	Numbers produced								
	1979	1980	1981	1982	1983	1984	1985	1986	Totals
Tropicultor[1]	27	35	30	53	516	385	140	165	1 351
Nikart		20	38	10	39	44	20	12	183
Agribar					2	5	15	10	32
Totals	27	55	68	63	557	434	175	187	1 566

[1] Figures include the Tropicultor-style toolcarrier marketed under the name Agricart.

(Figures relating to toolcarrier production and sales in India are not always consistent due to differences in calendar/financial years, manufacture dates/sale dates, local/export sales and differences in accounting for unsold stock and prototypes. While they indicate general trends in production, these figures should not be used to estimate the numbers of wheeled toolcarriers in use in India, since significant numbers have either never been used or were used and then abandoned.)

Sources: Agarwal, 1986; Awadhwal, Bansal and Takenaga, 1985; Fieldson, 1984.

any sales potential for wheeled toolcarriers in India.

For the past two years, the only manufacturer of wheeled toolcarriers in India has been Mekins Agro Products of Hyderabad. In 1982/83 and 1983/84 Mekins had been making over 300 toolcarriers a year. However, sales of wheeled toolcarriers in recent years have been only 140–190 per year, despite being the sole manufacturer and despite energetic promotion tours of India, Africa and the headquarters of major aid donors. The sales figure of 189 for 1986 had only been achieved through a negotiated order for 110 Tropicultors for Upper Krishna Project, Karnataka, and various small orders for various aid projects in Africa.

The Mekins Managing Director was very pessimistic about the prospects for the wheeled toolcarrier in India and the company had been diversifying into single purpose implements such as pole plows and ridgers. Wheeled toolcarriers were basically too expensive for the local farming systems. Even in the unlikely event of there being a major demand that would justify investment in additional tooling and presses, prices could only be reduced by about 25% (a figure that agrees with the estimates of Ghodake and Mayande, 1984). Mekins considers there are negligible prospects of direct sales of wheeled toolcarriers to farmers or traders, but there may well be a continued small demand of 100–200 per year from development projects in India and elsewhere.

4.4.4 Conclusions on prospects for wheeled toolcarriers in India

It appears almost universally agreed that the present prospects for the high cost wheeled toolcarriers in India are minimal. Lower cost toolcarriers such as the Agribar and the CIAE toolcarrier have not yet been fully evaluated by farmers, but the evidence suggests that purchase price is not the only factor limiting the spread of wheeled toolcarriers. The existence of 50–80% subsidies has brought the Tropicultor package down to what might be a realistic price of the cheaper toolcarriers but has still not stimulated significant farmer interest. Furthermore, the fact that farmers who own high quality toolcarriers do not use them greatly (even though their marginal daily cost is now minimal) suggests that the problem is not simply economic. Thus suggestions that cheaper toolcarriers are "the solution" do not seem justified by the evidence. It is therefore concluded that *unless* a system of using wheeled toolcarriers is developed that is clearly economically, socially and technically appropriate to village conditions, there will be no significant demand for these implements in India.

4.5 Other wheeled toolcarrier initiatives in Asia

The work on wheeled toolcarriers in India has been the most significant in Asia in terms of the numbers of original designs produced, and the extent of promotion. In many other countries in Asia there have been small-scale evaluation trials, and some original designs have been produced in Pakistan and Thailand, although these have not passed the prototype stage. NIAE ADT toolcarriers have been tested in Pakistan, Yemen and Thailand, and Tropicultors have been used in Afghanistan, Pakistan and Yemen. In early 1987 small numbers of GOM Toolcarriers (Nikart type) were ordered for evaluation in Burma and the Philippines.

Fig. 4-19: NIAE wheeled toolcarrier being used for ridging in Yemen, 1973. (Photo: AFRC-Engineering archives).