Improving the *Hata* donkey-drawn weeder in Niger: experiences and results

by

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Abstract

The labour burden of traditional farmers in the semi-arid tropics of West Africa can be considerably reduced through mechanisation of weeding by donkey-drawn Hatas *(houe à traction asine). The* Hata *prototype has completed its first working season under on-farm conditions. Some drawbacks have been discovered and these, together with experiences gained during 1991, will be used to develop a new 1992 model, which will be disseminated in the Republic of Niger in collaboration with several development projects.*

Weeding with the Hata *can take less than half the time of manual weeding (17.9 vs 41.1 hours/ha). Weeding efficiency of the* Hata *approaches that of manual weeding; double-pass measurements on* Hata *operations showed efficiency values of 76% for zero-tilled fields and 85% for ridged fields, compared with 96 and 91%, respectively, for manual weeding.*

Future investigations will focus on the suitability of the Hata *for different soil conditions. Other applications of the* Hata, *such as scarifying, will also be studied. The objective of this research is to enable poor small-scale farmers in rural areas of other African countries to use the* Hata *in their farming activities.*

Introduction

Weeds are a constant problem in agriculture: they compete with crops for nutrients, water and light, and hence reduce crop yields. It is estimated that about one-third of harvest losses worldwide can be attributed to weeds (Strobel, 1991).

In the semi-arid tropics of West Africa weeding is primarily done by hand. This can cause labour bottlenecks because the first weeding is necessary while sowing is still in progress.

The Institute for Agricultural Engineering at the University of Hohenheim, Germany, is developing animal drawn implements to improve traditional agriculture in the Sahelian zone in general and in the Republic of Niger in particular. One such implement is a donkey-drawn hoe, the *Hata* (houe à traction asine), for mechanised weeding on sandy soils.

From research prototype to on-farm implement

The design criteria for the *Hata* were (and still are) that the implement should:

- be light enough for donkey traction, as donkeys are the most common draft animals in Niger
- be understood, manufactured, repaired and maintained by local village blacksmiths; hence, forging and riveting were the chosen fabrication and fitting techniques
- cost less than 10 000 CFA francs (about US$ 40), so that as many farmers as possible can afford to buy it.

The first *Hata* prototype was presented at the West African Animal Traction Networkshop in Kano in 1990 (Betker, 1993). This prototype was tested on-farm during the 1991 rainy season and, based on the experience gained from these trials, an improved implement was constructed (Figure 1).

Structural improvements of the *Hata*

The first *Hata* prototype consisted principally of a flat iron triangle to which three traditional hand tool blades were fastened. To increase the rigidity, a U-profile was attached to the triangle's axis of symmetry. The model was completed by fixing a handle in the U-profile.

The current model of the *Hata* (Photos 1 and 2) incorporates several improvements: a depth control system; a better position of the hook for draft beam attachment; different shaped blades; and a redesigned handlebar.

Depth control and rigidity

During weeding on sandy soils the front blade often penetrated too deeply. The operator had to press down on the handle to adjust the working depth back to 3–5 cm. Inexperienced farmers often overcompensated, so that the blade came out of the soil. Not only was this inefficient, because parts of the fields remained unweeded, but the work became

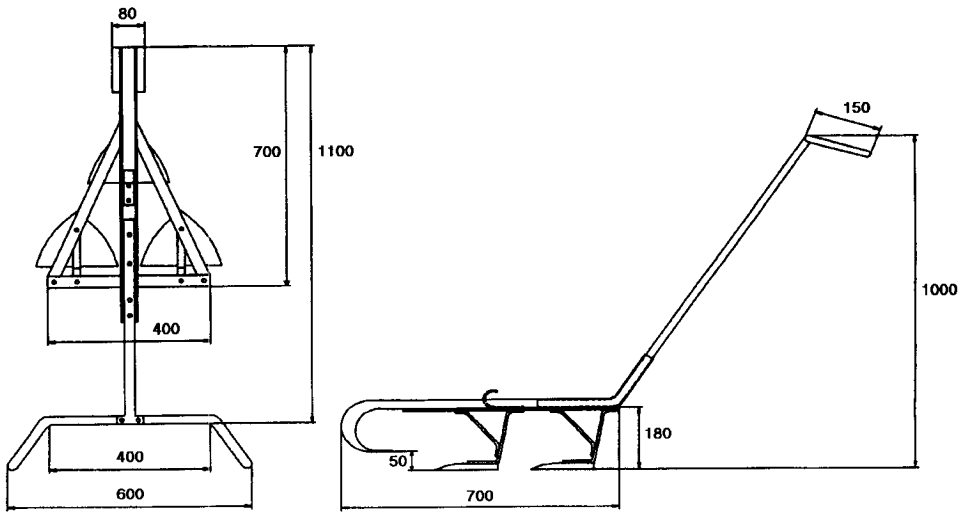


Figure 1: Improved Hata *(houe à traction asine). All dimensions in millimetres*

unnecessarily exhausting for both the farmer and the animals.

This problem was solved by fitting an additional skid at the front of the *Hata*. A supporting wheel would have had a lower frictional resistance, but the skid is cheaper and easier to make; it can be forged out of the central U-profile.

The U-profile is the backbone of the implement and guarantees sufficient robustness. To enable the skid to be forged, the U-profile had to be extended by 200 mm. At the rear end, the U-profile is extended by 150 mm in order to increase the rigidity of the connection between the handle and the main body of the *Hata*.

With the new depth control mechanism the flow of materials has been improved, ie, crop residues and other materials can easily be turned aside, without clogging the implement.

Hook position for draft beam attachment

Farmers like to be as close as possible to the donkey when working, in order to exercise better control. In general it is easier to steer the animals using a short draft rope or chain. However, this results in an undesirable increment in the angle of the line of draft force; the front blade might leave the soil due to the increased vertical draft force component. Unfortunately it is not obvious to most farmers that the implement works better the smaller the angle of the draft force.

Therefore, the hook for draft beam attachment was repositioned: it is now fitted further back on the U-profile by means of two rivets. The back rivet is also used to attach the front blade mounting.

The new hook position also simplifies manipulation of the working depth, as the operator can easily tip the implement around this joint point.

Blade design

Initially the blade of the traditional hand tool, the *Hiler*, was chosen for the donkey-drawn implement. It was thought that this would facilitate acceptance of the *Hata* by farmers in Niger.

However, the *Hiler* blades are not strong enough for animal traction use. The ends were often distorted and the two close rivets which adjust the blades on their bases sometimes could not withstand the torques which occurred while weeding. Also, the *Hiler* blade is used for pulling and pushing whereas the *Hata* blades are only pulled. Thus the rear of the *Hata* blade does not need to have the special shape of the *Hiler* blade.

For optimal results it is necessary that the tool cuts as it is drawn. Therefore the new blades are characterised by a more pointed shape. In addition, stronger material was used. The compact design allowed a wider spacing between the rivets for even greater strength. Figure 2 shows both traditional *Hiler* blade and the innovative *Hata* blade.

Figure 2: Traditional Hiler *(left) and innovative* Hata *blade design*

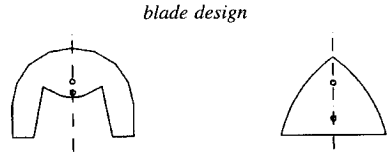


Photo: Pamela Mueller

Photo 1: Farmers tilling with a Hata *cultivator in Niger*

Handlebar

The handlebar is the interface between the user and the implement. It should allow easy steering and effective control, especially when the implement hits stones or roots. Ergonomics was an important factor in the design. The height, width and winding can be adjusted to suit the farmer (Göhlich, 1987). The handlebar design is shown in Figure 1.

Field studies with the improved *Hata*

The *Hata* was compared to the traditional hand tool, the *Hiler*, in terms of labour time requirement and weeding efficiency. Field studies were carried out with and without depth control on either zero-tilled or ridged fields. Two passes were made per measurement.

Labour time

Using the manual *Hiler*, both inter-row and in-row weeding are carried out at the same time. Single pass animal-drawn weeding works only between the rows; in-row weeding would then require supplementary time-consuming manual work. However, on-farm mechanised double-pass weeding is possible because of the large spacing between the pockets. The first pass takes care of in-row weeding and the second weeds the inter-pocket spaces.

Table 1: Demand for labour time

	Total time (hours/ha)	
	Zero-tillage	*Ridges*
Hata without depth control (two passes)	20.3	20.0
Hata with depth control (two passes)	17.9	19.0
Hiler	41.1	28.4

Total labour time is the sum of working time, turning time, preparation time and supplementary time, as applicable.

The calculation of total labour time for both *Hata* models takes account of the fact that two persons, an adult and a child, are usually involved in on-farm weeding operations: the farmer steers the implement and the child controls the donkey.

Weeding with the *Hata* was found to be considerably faster than manual weeding with the *Hiler* (Table 1).

Weeding efficiency

Weeding efficiency is a measure of the working quality of an implement. It is determined as amount (in kg dry matter) of weeds cut or lifted by the weeding operation, expressed as a percentage of the total weeds in the field before treatment.

Two types of weeding efficiencies can be calculated. In the first, the efficiency is given in relation to the working width of the implement. In the second, the weeding efficiency is calculated in terms of the area between the rows. The latter option was used to obtain the values presented in Figure 3. Clearly the efficiency of the improved *Hata* approaches that of the traditional hand tool.

Weeding efficiency was higher on ridged fields because the ridges helped in steering the animal and implement. On the other hand, the total amount of weeds on ridged fields was lower, because ridging helps to control weed infestation.

Summary and recommendations

On-farm application and testing of the donkey-drawn hoe *Hata* has been realised in cooperation with several development projects in the south-western areas of the Republic of Niger. The

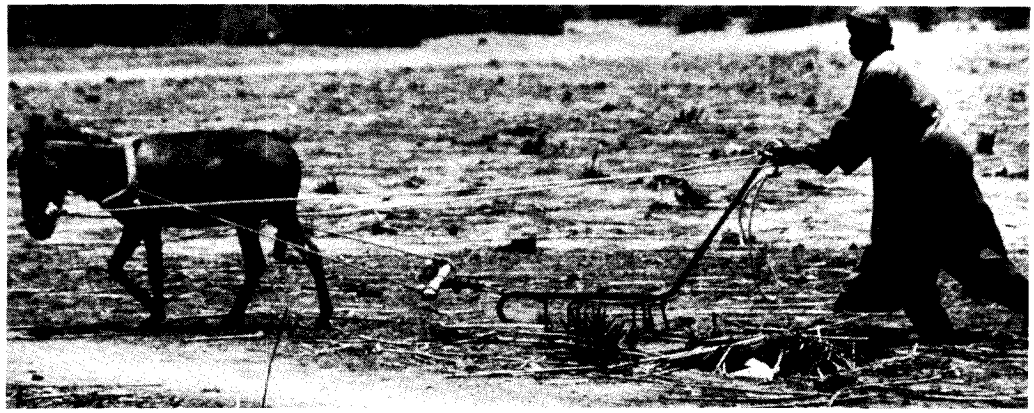


Photo: Frank Emhardt

Photo 2: One person working with a donkey-pulled Hata *cultivator in Niger*

practical experiences gained during the 1991 rainy season have helped tremendously in the on-going improvement of the implement.

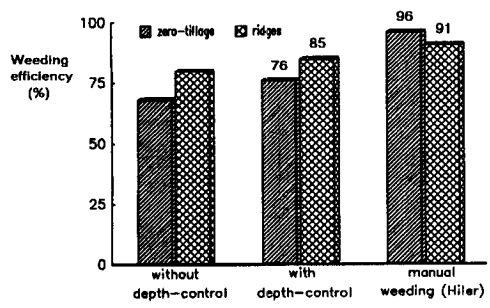
On-farm experiments with the *Hata* show a remarkable decrease in labour time compared with traditional hand tool weeding. The efficiency of mechanised weed control approaches that of manual weeding and could be enhanced.

The *Hata* can be made and maintained in the country's rural areas. However, the fabrication of a durable model depends strongly on the abilities of village blacksmiths. Therefore, an overall strategy of mechanisation must incorporate sound and thorough training of local blacksmiths.

Farmers also need training on how to use the implement and how to dress the animals properly. Better education of farmers would help to involve more donkeys in farming activities; at present, of the estimated 500 000 donkeys in Niger (FAO, 1987), only about 10 000 are used for work (Starkey, 1988).

The *Hata* is designed for use on sandy soils, and was sometimes damaged when used on heavier soils. In such cases farmers did not rely on the blacksmiths to repair the hoe, but continued their work manually. Research is therefore underway to develop the *Hata* for use on heavier soils. A stronger *Hata* could then be used for other purposes such as scarifying. Such technically improved *Hatas* might be also socially and economically viable in other African countries.

Figure 3: A comparison of weeding efficiencies



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