Experience with the introduction of animal-power systems in Zambia

by

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Abstract

Animal-power stationary machines, such as mills, pumps, presses and threshers, potentially have many advantages over motor-driven systems. For example, they use locally available renewal energy sources (oxen or donkeys), they have low investment, operating and maintenance costs, in local currency, and they can be manufactured and repaired locally. For the past few years the German Appropriate Technology Exchange (GATE) has been trying to promote the use of animal-powered grinding mills in rural areas of Zambia. Although the technical aspects of technology transfer posed no problems, experience to date shows that rural women prefer to have their maize processed by motor-driven hammer mills wherever these are available, and regard animal-power mills as old-fashioned. Also, animal-powered mills are very often not competitive in economic terms. The prospects for the dissemination of animal-powered grinding mills are therefore very limited, and their operation can only be cost-effective in extremely remote and/or inaccessible areas where fuel prices are far above the national average.

Introduction

In 1984 the German Appropriate Technology Exchange (GATE), a department of the German Agency for Technical Cooperation (GTZ), initiated a programme for the "Documentation, Improvement and Adaptation of Animal Power Systems". The programme has been operating in West Africa (with a regional centre in Senegal) since 1984, and in eastern and southern Africa (with a major base in Zambia) since 1990. (A third regional programme has been operating in South America, mainly Bolivia, since 1990.)

In the context of this programme, animal-power systems are defined as technical devices which use the muscle power of draft animals to drive stationary machines such as mills, pumps, presses and threshing machines. These systems have been playing an important role in agriculture for centuries in various societies in Europe and North Africa. In many regions of Africa, however, they are unknown, despite their potential contribution to the mechanisation of agricultural smallholdings which mainly depend on hand-operated tools for food processing and water lifting.

Ambitious motorisation programmes, launched to substitute for these labour-intensive hand operations, have been failing in many rural regions of Africa because the machinery is cumbersome and because fuel and spare parts are both scarce and expensive. But for the past two decades the use of animal draft power in Africa has been increasing, and so the basic idea of the GATE programme is to promote animal-power systems as an intermediate solution for the technology gap between manual and motor-driven technologies.

Animal-power technology is seen as having the following advantages over motor-driven systems:

- use of locally available, renewable energy sources (oxen, donkeys) which are often seasonally underutilised
- low investment, operating and maintenance costs
- import dependence is low, because components can be manufactured and repaired locally
- low maintenance requirements and easy to handle at village level
- designed for a small number of users in rural areas, thus contributing to a decentralised satisfaction of basic needs.

Based on these features, the primary target regions for animal-power systems are:

- remote rural areas and/or thinly-settled regions where obtaining fuel and spare parts is difficult
- regions where draft animals are already widely used and opportunities are being sought to use them to even more economic advantage
- small villages/communities where the number of potential users is too low for motor-driven systems to be operated economically.

Eastern and southern Africa programme

The German consulting company Oekotop was commissioned by GATE to execute the regional programme in eastern and southern Africa. This

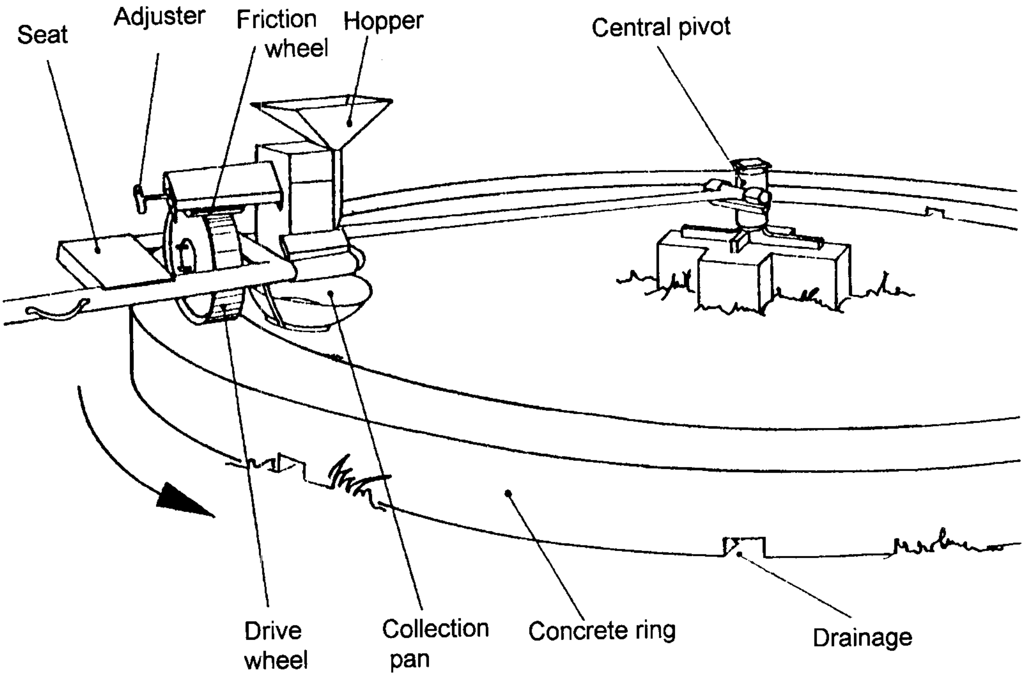

Figure 1: Diagram of the animal-powered grinding mill. One or two draft animals move in a circle and set a drive wheel in motion on the concrete ring. The rotational force is transmitted to a friction wheel connected to a shaft. This drives one millstone against another with the grinding unit

programme started as the Animal Power Technology Project (APTP), with a one-year pilot phase in Zambia followed by a two-year dissemination phase (1991–92) covering also the Mbeya region across the border in Tanzania. Results from the pre-feasibility studies led to the decision to focus on the promotion of three different types of animal-power systems: grain mills, water-lifting systems and oil presses. The introduction of animal-powered grinding mills (Figure 1 and Photo 1) was given top priority, as the availability of local grinding facilities became a crucial bottleneck for the rural population in Zambia during the structural adjustment programme in 1990.

Technical aspects of technology transfer

The APTP has been using two approaches to transferring animal draft power technology from West Africa to eastern and southern Africa: both aim at producing local prototype animal-power systems which are adapted to local needs and manufacturing facilities.

For the introduction of animal-powered grinding mills, APTP imported the West African prototype which had been developed for sorghum processing by a Belgian engineering company in cooperation with Senegalese craftsmen. This prototype had to be tested to determine its basic suitability for maize processing, and it was assumed that it would have to be modified, depending on the on-station test results and the availability of materials at local production units in Zambia.

For the test and modification programme, APTP cooperated closely with two research and development centres and with various potential manufacturers having different production equipment and levels of staff training. Experience so far shows that only well-equipped or medium-scale engineering companies are able to manufacture animal-powered grinding mills independently. Production of these systems is therefore restricted to urban/peri-urban areas, thus disqualifying the assumed advantage of decentralised local manufacturing.

The entire procedure from the first assembly of the imported prototype to the completion of the local version of an animal-powered grinding mill took about 12 months. The most time-consuming part of this procedure was the multiple feedback between field tests and local manufacturers.

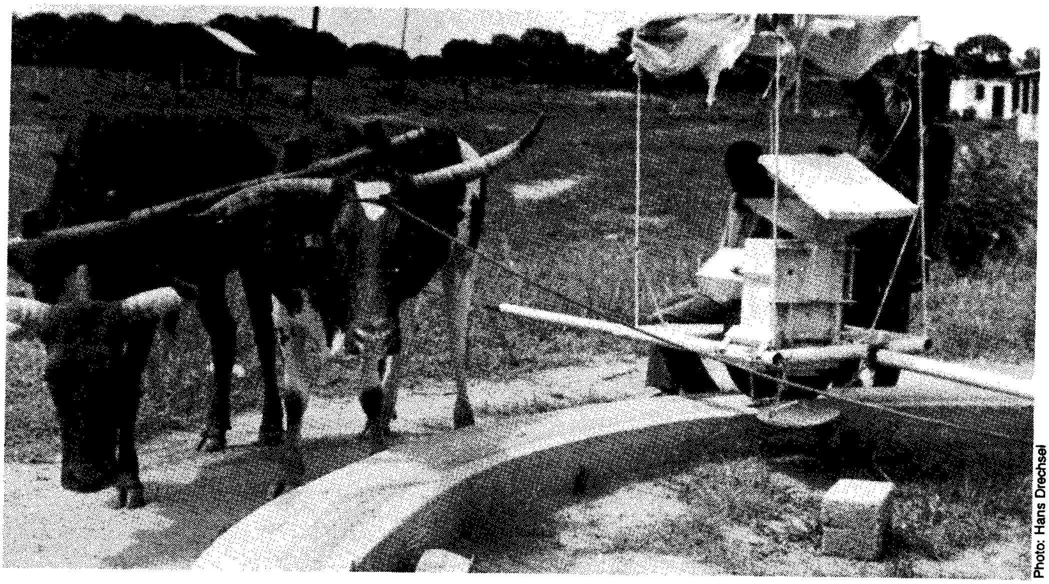

Photo: Hans Drechsel

Photo 1: Animal-powered grinding mill in Zambia

For the introduction of an animal-powered water-lifting system (Photo 2), which is similar to the traditional "Delou" in North Africa and called "Bidon verseur", APTP chose another approach. Due to its simple technical design and its status of dissemination in West Africa, APTP requested a direct transfer of know-how to Zambia. Within a four-week consultancy the project engineer of the West African Animal Power Systems programme passed on his experience to the Technology Development and Advisory Unit of the University of Zambia, Oekotop's major counterpart in research and development. The consultant produced a Zambian prototype for testing and copying.

Both approaches to technology transfer from one African region to another proved to be feasible. Generally, the first approach (import of a prototype) is cheaper and advantageous for the on-going adaptation of implements, but it takes much more time. The second approach (import of know-how) is faster, but much more expensive in terms of financing the short-term consultancy of an expert.

Institutional aspects

APTP cooperates with a wide range of institutions and organisations at local, national and international level. They can be divided into counterparts for technology adaptation and technology dissemination.

The major cooperation partners for the adaptation process are:

- Agricultural Engineering Section, Ministry of Agriculture, Lusaka, Zambia
- Kasisi Agricultural Training Centre, Lusaka, Zambia
- Technology Development and Advisory Unit (TDAU), Lusaka, Zambia
- Institute for International Cooperation, Vienna, Austria
- Mbeya Oxenization Project, Tanzania
- Project Consult, Königstein, Germany (Regional Animal Power Systems programme, West Africa, Dakar, Senegal)
- Institute for Agricultural Engineering, University of Hohenheim, Germany.

For the dissemination of animal-power systems APTP has established contacts with more than 30 institutions ranging from non-governmental organisations which implement local projects (eg, Africare, Village Industry Service) to international organisations such as ILO (International Labour Office) and UNIFEM (United Nations Development Fund for Women) mainly sponsoring comprehensive development programmes.

The overall response to the introduction of animal-power systems in Zambia was positive at both levels, largely because of the evident failure of motor-driven systems as a solution for the bottlenecks of smallholder production in remote rural areas. Nevertheless, quite a number of institutions expressed their scepticism concerning the viability of animal-power systems in economic and socio-cultural terms.

When faced with a decision on whether or not to adopt this new technology, local projects and

Photo: Hans Drechsel

Photo 2: Animal-powered water lifting system of type "Bidon verseur" in Zambia

sponsoring institutions adopted a policy of wait-and-see, which can last up to two years from the first inquiry to the final decision. Clearly, early dissemination of a new technology can only be achieved by high financial and material inputs, ie, pre-financing quite a number of demonstration units.

Acceptance by the target groups

Rural women, the major target group for food processing technology innovations in Zambia, usually know two alternatives for maize processing (Löffler, 1991):

- pounding by hand with mortar and pestle, which is extremely arduous and time-consuming (60 hours per month)
- using a hammer mill, which can also be arduous as women may have to walk long distances to the mill.

Women show a strong preference for using hammer mills whenever there is one within a distance of up to 15 km, even though they have to pay a grinding charge. Hammer mills have been setting standards and aspirations in terms of output and consumption patterns even in remote rural areas without hammer mills. The costs and outputs of animal-powered grinding mills and hammer mills are compared in Table 1.

A similar preference for hammer mills is shown by potential entrepreneurs. As the distribution of hammer mills was frequently subsidised by 50% until early 1990, these mills turned into "money machines" as soon as the rural population in Zambia was cut off from maize meal sources following the structural adjustment policy. In order to cushion these negative effects of the structural adjustment, more hammer mills were built in rural areas in 1990/91, usually without considering local requirements and preconditions. These circumstances have obviously been reinforcing the demand for hammer mills, even in small communities.

To summarise, the rural population is crying out for hammer mills, which are seen as the only desirable (modern) grinding technology. Animal-powered grinding mills are regarded as an old-fashioned technology whose output is far too low in comparison to hammer mills. This means that animal-powered grinding mills will be accepted only where hammer mills cannot be installed or run economically.

Economic efficiency

One of the basic assumptions governing the introduction of animal-powered grinding mills in rural areas has been that an animal-power system can compete with motor-driven mills at locations with a low consumer potential (Priewe, 1989). Experiences in Zambia have shown that this assumption is not valid in all regions.

Based on relevant empirical input/output parameters for animal-powered grinding mills and hammer mills in 1990, and the assumption that government subsidies would continue to be cut in 1991, it was calculated that hammer mills and animal-powered grinding mills would have equal break-even charges in 1991 (Löffler, 1991).

Table 1: Comparison of animal-powered grinding mills and hammer mills

	Hammer mill	*Animal-powered mill*
Retail price 1990 (ZK)	200 000	50 000
Retail price 1991 (ZK)	300 000	100 000
Average output rate (kg/hour)	200	20
Average break-even charge per tin (ZK)	30–40	40
Average charge per tin (ZK)	30–35	20–25

All prices in Zambian Kwacha
(US$1 = ZK90 in December 1991)
1 Tin = unit of 20 litres of maize (15–17kg)

Generally this prognosis did not prove true, because:

- prior to the presidential and parliamentary elections in 1991, subsidies for hammer mills were extended or re-introduced
- animal-powered grinding mills were affected by a disproportionately large increase in the production price, as mass production and large-scale stock-keeping for hammer mills proved to be less susceptible to the tremendous increases in production costs in 1991
- on-station output results for animal-powered grinding mills could not be completely reproduced under village conditions
- daily and weekly hours of operation of animal-powered grinding mills were lower than expected, mainly due to lack of draft animals.

In fact, the arithmetical break-even charges for animal-powered grinding mills sharply increased in 1991, from 30 to 40 Zambia Kwacha (ZK) per 20 litre tin, while the average hammer mill charge stagnated at 30–35 ZK (US$ 1=ZK 90 in December 1991). Thus animal-powered grinding mills are generally neither competitive nor cost-covering, if the installation and operation of a hammer mill is feasible in the same location. So the operation of animal-powered grinding mills only can be cost-covering and competitive with hammer mills in extremely remote and/or inaccessible areas where fuel prices are far above the national average.

Constraints to the dissemination of animal-power systems

Apart from the above-mentioned economic and socio-cultural obstacles to the introduction of animal-powered grinding mills, other factors also limit the viability and dissemination of animal-powered systems. For example, remote rural areas often do not have sufficient trained draft animals to operate additional animal-power systems, even during seasons when draft animals are under-utilised on other work. Also, using animal draft power for food processing and water lifting often clashes with the traditional, gender-specific division of labour. Men usually have the right of disposal over draft animals and use them for their specific field of work. Thus, the access of women to draft animals still depends on the approval of men.

Conclusions

Because of the macro-economic conditions in Zambia and for a wide range of technology-specific reasons, the prospects for the dissemination of animal-powered grinding mills are very limited. Considering all site-specific requirements for the operation of animal-powered grinding mills, there are hardly any locations which fully meet the various preconditions for these systems. Because the operation of animal-powered grinding mills is generally not viable in economic terms without subsidies, in the final analysis the promotion of animal-powered grinding mills becomes a decision of general principle concerning conflicting objectives: economic viability of a technology versus its potential to alleviate poverty, improve food security and ease the workload of women in selected rural areas.

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