Use of animal power in West African farming systems: farm level problems and implications for research: perspectives from Mali

by

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Abstract

The paper examines on-farm problems related to adoption of ox-drawn animal traction technology. The problems are examined in terms of four interrelated factors: the farmer; equipment (design, efficiency, complementarity); management of work animals (feeding, housing, health) and cropping systems (production of forage crops and the harvesting, stocking and feeding of crop residues). Specific research approaches are suggested based on on-farm conditions and resources. A summary is given of the role of five different institutions working on animal traction research, development and extension in Mali, and some implications of such institutional configurations are examined. A plea is made for greater coordination and interdisciplinary effort using a farming systems approach. Problems of evaluation methodologies and technologies requiring high levels of management have been noted in recent animal traction research and development work. It is concluded there is a need for common data sets, in the design and evaluation of research, to permit meaningful comparisons within and between countries.

Introduction

In this paper, animal traction refers specifically to use of oxen for tillage and transportation within integrated crop-livestock systems. The long-term benefits of animal traction are well known, and include:

- improving timeliness of farming operations,
- augmenting family labour,
- providing manure, which together with the incorporation of crop residues, has beneficial effects on soil management,
- providing transport for farm and family needs and for generating income and savings,
- providing alternative uses of crop residues and by-products.

However in spite of over 35 years of efforts to introduce animal traction in the West African semi-arid tropics, its adoption by farmers has been slow and uneven. Even in areas where its adoption has been relatively widespread the full benefits of animal traction, in terms of overcoming seasonal labour bottlenecks, efficiency of farming operations, increased yield and income, have not generally been realized. In Mali, this is seen in the regions served by the Compagnie Malienne pour le Développement des Textiles (CMDT), the Office de Développement Intégré des Productions Arachidières et Céréalières (ODIPAC) and the Opération Haute Vallée (OHV).

Various reasons, some intuitive and some based on empirical observations, have been advanced to explain differential adoption of animal traction technology by farmers in the

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Sahel. These are discussed later in this paper. There have been several research and extension programmes in the past designed to improve the performance of animal traction technology, to resolve farm level constraints and to assist farmers in adopting the technology. While considerable success has been noted in specific small areas within the Sahel, the level of success has not been commensurate with research and extension efforts and resources devoted to it.

This could be attributed to fragmented research efforts and the lack of a clear direction of research, combined with unrealistic policies of extension relating to farmer training, follow-up and credit. Although animal traction use involves long learning periods of 4-6 years, researchers have tended to focus on profitability on a short-term cash-flow basis. Researchers have also emphasized the return to family labour without accounting for synergetic efforts within the system. Many interventions and innovations that have been designed have not been geared to the constraints and resources of the actual farming systems. Examples of inappropriate innovations can be seen in the area of equipment, housing, and off-season feeding using excessive quantities of concentrates. Given the potential and possibilities of animal traction in large tracts of the Sahel, especially in Mali, this paper argues for well-integrated and coordinated research and extension efforts based on better understanding of farming systems.

Reasons for differential adoption

In literature dealing with animal traction research and extension in West Africa, several reasons have been advanced for low levels of adoption or non-adoption of animal traction technology. These are discussed below.

Economic reasons

High initial investment costs

Cash-flow problems in the short run, deferred benefits associated with long learning periods, lower returns to family labour and overall lower profitability as measured by Net Present Value (NPV) or Internal Rate of Return (IRR) have been cited as reasons for non-adoption. High initial investment costs, particularly for first-time adopters, associated with severe cash-flow problems in the short run have been observed in southern Mali. Ten-year projections elsewhere in the Sahel (Barratt *et al.*, 1982) indicate 20-30% income reduction during the first four years despite an IRR of 15%. Since many Sahelian farmers sell very little of their output, to cover such deficits requires either cash income or a shift towards cash crops.

Deferred benefits

Realization of full benefits to new adopters is often deferred for many years, and this is associated with the long learning period. As many as eight years may elapse before investment in animal traction package breaks even.

Extensification

Several studies and surveys have indicated that there have been no differences in yields and output per unit area between farmers using animal traction and those not using it. However animal traction has generally led to an increase in cultivated area (BECIS, 1983).

Lower returns to family labour

In studies in Burkina Faso and Mali, animal traction provided lower returns to family labour (the primary constraint on the farm) than manual cultivation. Furthermore animal traction tended to be labour-shifting rather than labour-saving and exacerbated the labour constraint at weeding and harvest times. This was due to larger cultivated areas, which increased the area to be weeded and harvested. The weeding problem was also compounded by lack of weeding equipment, or its low level of acceptance. A survey of 21 animal traction (oxen) projects in Africa revealed that less than one fifth of those participating in animal traction programmes used weeding equipment.

Lack of mutually complementary equipment

In West Africa the general tendency has been to emphasize the plow as the main item of animal traction equipment. Weeding equipment, including blade-harrows, has received less research and development, and less extension attention. Farmers have frequently been observed using their plows as weeding tools, even though they are inefficient for this operation. However multipurpose toolbars *(multiculteurs)*, with plowing and weeding attachments, are gaining acceptance.

Off-season labour requirements

The labour requirements to maintain work animals on the farm during the off-season, and the opportunity cost of off-farm work during the January-May dry-season period have often been cited as reasons for non-adoption of animal traction. This does not seem to fully explain non-adoption, because the caring of animals during grazing and browsing is generally the responsibility of children or adolescents, both in the cropping season and the off-season. Furthermore in most areas, except those bordering Côte d'Ivoire and Senegal, off-season migration of adults or active workers does not seem to be a major phenomenon.

The limited availability of forage and crop residues during the dry season has been a constraint and an off-season management problem.

High mortality rates

Where the introduction of animal traction has not been accompanied by animal health services, high rates of mortality (as high as 40%) caused many farmers to revert to manual tillage practices. However experience in southern Mali shows that animal mortality is relatively easy to control and has been brought down to an acceptable rate of 2.5 per cent.

Lack of institutional services

Credit has often not been available for the purchase of both oxen and equipment, although this involves substantial cash outlays. Very few extension agencies offer credit for animal traction. Exceptions are those promoting cash crops like cotton, maize and tobacco with programmes of marketing and some extension services supported by donor agencies.

The lack of spare parts and repair services has been considered as a main factor in explaining non-adoption, particularly in early observations. However more recently in Mali several blacksmiths (often trained by extension agencies) have been providing these services including the manufacture of plows, spare parts and carts in the villages themselves.

Farmer training in the proper use of equipment and oxen has often been severely lacking. A large majority of adopters still use two or three persons for plowing with a pair of oxen or a donkey. While the people are often one adult and two children, this work may be one of the reasons why the labour-saving advantage has not been more clear.

Lack of comprehensive and systematic approaches

The tendency has been to begin and end the animal traction programme with a plow and a pair of oxen. Several mutually related issues have not been systematically approached by multidisciplinary teams. These have included credit and equipment; animal health and housing; the harvest and conservation of bush forage and crop residues for off-season feeding; the training of farmers to improve skills in plowing and the training of animals. Thus low and uneven adoption can partially be attributed to the failure of both research and extension programmes to develop comprehensive and systematic approaches. The institutional failures may explain the lack of uptake, rather than widespread decisions by farmers not to adopt the technology. Otherwise, it is

difficult to explain why certain farmers are still demanding equipment from village-based blacksmiths in the absence of institutional credit.

It is only recently that a comprehensive pre-extension programme in southern Mali has been initiated. The programme, developed jointly by the farming systems research division (Division de Recherches sur les Systèmes de Production Rurale, Institut d'Economie Rurale: IER-DRSPR) and the extension agency (CMDT), concentrates on farmers who are not using animal traction but who meet the redefined credit criteria (Verbeek, Sanogo and Kleene, 1986). The animal traction package consists of: a pair of oxen and a multipurpose toolbar, both provided on credit; the training of oxen and farmer over a 21-day period; an animal health care package; the inclusion of fodder crops in the recommended rotations; and technical advice on major farm operations. The programme was designed on the basis of farming systems research findings and in its first year of operation a total of 80 farmers are participating. Socio-economic and production data are being collected, but results are not yet available.

Animal traction research, development and extension in Mali

Institutional framework

There are five governmental agencies in Mali which are actively involved in research, development and extension of animal traction and related technologies to farmers (in this context the term development refers to the production of a prototype based on research which is then tested and modified, before being extended as a final product; it is not used synonymously with extension management). Each of the five agencies is specialized in its subject matter areas and has specific functions and mandates. These research and development agencies are:

- *Division du Machinisme Agricole (DMA).* The division of agricultural engineering of the Ministry of Agriculture (MoA) is responsible for the design, development and testing of equipment such as plows, carts and weeders.

- *Ministère chargé des Ressources Naturelles et de l'Elevage (MCRNE).* The ministry for natural resources and its national livestock research institute (INRZFH) are responsible for research on livestock including disease control and treatment, nutrition and fodder development.

- *Institut d'Economie Rurale (IER).* The institute of rural economy under the Ministry of Agriculture is responsible for agricultural research aimed at yield-increasing technologies, such as tillage methods and practices, weed control and management, planting methods (dates, densities, planting in rows, ridges and furrows) and cropping systems using animal traction.

- *Direction Nationale de l'Agriculture (DNA).* The national directorate of agriculture is responsible for transferring technologies developed by these three institutes to the farmers through various extension agencies under its control.

- *Direction Nationale de l'Elevage (DNE).* The national directorate of livestock under MCRNE is responsible for ensuring the availability of field/extension services relating to the control and management of animal diseases and overall animal husbandry programmes.

Thus five agencies and two government ministries are involved in the development and transfer of animal traction-related technologies to farmers in Mali. At present the role of private agencies in stocking and distributing animal traction inputs is limited.

Interrelations and the need for coordination

The efficiency of animal traction in farming operations is a complex function of at least five interrelated factors:

- *Equipment:* its design, size, weight and flexibility to adapt to different soil types and crops.
- *The work animals:* their training, health and nutritional status.
- *Availability of animal husbandry technologies:* techniques to promote on-farm maintenance of animals such as: housing using locally available materials; system of conservation of hay, forage and crop residues; collection and disposal of dung and urine; systems of combining concentrates with roughage; cropping systems capable of producing increased quantities of nutritive crop residues and fodder.
- *Farmer characteristics:* their training in the use of equipment and animals; their management of animals; their ability to make adjustments in the technologies offered to fit their specific needs; their own resources to acquire equipment and animals in the absence of institutional credit; their capacity to produce and manage feed and fodder for livestock.
- *Institutional support:* The essential elements of institutional support include: the availability of credit; equipment repair facilities; spare parts; extension advice and its adjustment to individual situations; training; animal health services at or near the villages.

It is because of the interrelationships of these five factors that there is a clear need for coordination and collaboration between different agencies. While there has been much agreement on the need for coordination and interdisciplinary approach, evidence of all the agencies coming together with a unified research plan for village level action has been sporadic at best. What is clearly needed is an interagency task force consisting of researchers dealing with animal traction issues. This group should then select a manageable number of equipped farmers on the basis of some key criteria (level of equipment, number of years of continuous use, farm size, family size, crops grown) in two or three regions of high potential but relatively low adoption of animal traction technology. Each of the research disciplines (agronomists, engineers, livestock specialists, economists and extension specialists) should make observations relevant to their concerns, synthesize their observations and design tests/approaches to resolve the constraints and/or to improve the performance of the system taking into account the interrelationships of the factors described earlier: farmers, equipment, animals, technologies and institutional services. This would provide common, minimum data sets on interrelated factors for several categories of farmers for comparison. Such a coordinated approach/study should be of a longitudinal nature conducted over 3-4 years.

In agricultural research in Africa in general, there have been much talk and discussion of the need for coordination. What is urgently needed is action, and a plan for implementing the action, no matter how simple, limited or crude it may be.

Farm level problems and research approaches

Observations from various animal traction projects indicate a range of farm level problems. Representative problems are enumerated below and discussed briefly suggesting approaches for testing.

On-farm feeding of draft animals

The feeding of work animals in the period July-December is not considered as a signifi-

cant problem, due to the availability of forage and grazing. However a key problem is how best to overcome the off-season feeding constraints and improve the physical condition of traction animals just before the rains come, in order to cope with the heavy work demands of July-August. Some appropriate areas for research may be the following:

Harvesting, stocking and management of crop residues

In general groundnut and cowpea crop residues are quite carefully harvested and stocked. However in general sorghum and millet crop residues are left in the field and are consumed directly by the herds returning from transhumance. A large proportion of the standing sorghum-millet stalks remaining in the field after harvest is trampled and wasted. It is possible to estimate the quantity of stover required for a pair of work oxen during the dry period (January-June). Thus a few tests could be conducted where the required quantity of stover from the top half of the residual plant is harvested and stored. This could be fed to the work oxen during the January-June period in combination with small quantities of groundnut and cowpea residues. Additional labour demands for harvesting and transporting the stover and its impact on the labour constraint at harvest time should be studied.

Improving the quality and quantity of crop residues

Cropping systems should be developed to produce enough good quality crop residues. Observations in Mali indicate that in communities which are not self-sufficient in cereals there is a strong resistance to growing crops for fodder alone. A potential solution seems to be the introduction of rampant-growing (fodder type) and high-yielding cowpeas either as pure or mixed crops. The introduction of catch crops is another potential solution. These are crops which are sown rather late in the season after all the principal crops on a farm are planted. These are leguminous in nature, such as horse gram and mung bean, and serve twin purposes. Firstly they produce both nutritious food grains for family consumption (or sale) and plant residues for work oxen. Secondly they enrich the soil while providing plant cover to reduce erosion. These crops demand minimum management. Land that is otherwise left fallow can be put under a catch crop.

Supplementary feeding

The impact of feeding small quantities of supplementary concentrates, together with sorghum-millet stover, could be assessed during 6-7 weeks preceding the beginning of plowing/tillage operations in June. Such a practice is well established in the semi-arid tropics of southern Asia. In such areas, traction animal fodder (primarily rice, sorghum, and millet stover) is supplemented with approximately 700-800 grams of peanut cake, cotton seed or horse gram (grain) per head per day, to boost animal condition and health. Researchers in the past have often suggested the use of 2-3 kg of purchased concentrates per head per day which has usually been totally uneconomical.

Stock and storing crop residues

This is an area to which no attention has been paid by researchers. What are different stocking/storing modes? Often farmers tend to stock on the roofs of sheds (hangars) made out of locally available materials. On top of the roofs the residues are exposed to high summer temperatures, and it would be valuable to learn the effect on nutritive quality and palatability of storing in shade underneath the hangar roofs.

Competition with other livestock

Where limited quantities of groundnut and cowpea fodder are produced, it would be interesting to establish whether farmers prefer to feed it to small ruminants or to feed it to draft animals. If the preference is for the former, it might be possible to determine what other browse or forest produce could be substituted, so that in the critical weeks before the planting season, more of the available nutritive fodder could be made available to work oxen.

Animal housing

This is another on-farm problem which has received limited attention. Several structures have been tried without a follow-up of farm level acceptance. Open coralling and traditional cattle sheds (hangars) are the most common systems of housing in Mali. A third method that has been observed involves the earth being excavated up to a metre and a hangar installed. The apparent beneficial effect was that the un-eaten stover was spread as bedding which partially decomposed absorbing dung and urine. Every two months or so the compost so formed was removed to the field. Each of these structures has advantages and disadvantages. Any improvement in this area should start with a study of farmers' existing practice in areas where animal traction has been relatively well accepted. Appropriate modifications might then be identified and introduced that would make the animal housing more effective.

Training

A critical on-farm problem area is the lack of farmer training in animal traction particularly for first-time adopters. Skills of plowing, tillage in general, and the handling and training animals may need to be imparted. It is commonly observed that at least three individuals (an adult and two adolescents) operate a single plow or toolbar *(multiculteur)*. This may be one reason why the labour-reducing aspect of animal traction has not been clearly demonstrated. Experience on the research stations in Mali has clearly shown that farmers and labourers can be taught the necessary skills, such that one person can operate a plow or toolbar drawn by a pair of oxen. It is more a question of extension, and perhaps research agencies should organize training sessions rather than additional research efforts.

Animal health and management

The non-adoption of animal traction is often a direct function of real or perceived mortality rates of work animals. It was observed that in one area the major reason for low levels of animal traction adoption was the recorded mortality of 40-45%. However, in the area of one extension agency in Mali, mortality has been brought down to the more acceptable level of 2.5%. This has been achieved by close linkage with veterinary services, preventive measures, farmers training and the timely treatment of affected animals. Training farmers to look out for disease symptoms is an essential step.

Labour shifting

Another key on-farm problem reported in research into the constraints to the adoption of animal traction is that animal traction in the Sahel is a labour-shifting rather than a labour-saving technology. This seems partly due to the increased labour demands at weeding time due to larger areas being sown when animal traction is employed and to increased weed populations due to row planting. It is also related to increased labour demands at harvest time due to the larger areas and greater overall yield.

The phenomenon of labour shifting is to a certain extent due to the lack of complementary and mutually supporting technologies. In this case the lack of appropriate weeding equipment or its non-adoption for some reason seems particularly important. Similarly labour demands at harvest time could be reduced by the use of ox-drawn or donkey carts, whether rented or owned, to transport the harvest. There is a severe lack of reliable information on this aspect; for example it is known that transport of the harvest from the fields to the homes is labour-consuming, but not what proportion of the total harvest labour is required for such transport.

Differential applicability of animal traction

In evaluating animal traction, it is important to bear in mind that its applicability varies with the nature of different cropping enterprises. For example, maize, cotton, rice and groundnuts require relatively better seedbed preparation than do sorghum-millet-based systems. This could lead to different strategies of adoption. Some farmers will be owner-adopters, some owner-adopter-hirers, and others renter-adopters. Farmers with excess capacity may choose to hire out their oxen and equipment, while attending to certain cultural practices manually.

Implications for research programmes

Research perspective

It is clear that researchers need to understand farmers' perspectives. Farmers alone have an integrated view of the whole system. This calls for a farming systems perspective. Researchers need to understand how the problem of adoption or non-adoption of animal traction manifests itself under different systems and conditions. Without this understanding it would be impossible to develop technologies to improve the various systems and conditions.

Coordination and collaboration between research and extension

Mali is well endowed with a farming systems research organization and this presents a great opportunity to coordinate and integrate different aspects of animal traction research and development. Institutional coordination is important where several agencies are involved in research, development and extension. The nature of on-farm problems described in earlier sections is such that unless different institutions work in unison, there will be no improved package that combines all essential elements and addresses the farmer, the equipment, and the feeding, housing and health of the animals.

Clarification of concepts and concerns

In several writings on the subject of animal traction and/or integration of farming with livestock activities one cannot help observing a lack of clear concepts and concerns. In the opinion of this writer, one has to start with clear assumptions and approaches to the twin issues of farming-livestock integration and animal traction. Some illustrative ideas are suggested:

- The nature of farming-livestock integration for a range of farms should be defined and clarified. An example would be the management of one to two pairs of work oxen on a farm with a certain number of small ruminants.

- The effects of animal traction on the traditional relationship between cattle-owners and herders. In the opinion of the author existing relationships may not be disturbed given the small number of work animals that are likely to be retained on the farm. The research should focus on possible improvements to present systems. The traditional practice of cattle-owner-farmers assigning the management of animals to herders, together with the symbiotic relationship between cattle-owners and herders, is one that is likely to continue for a long time.

- Distinguishing the effects of animal traction in terms of completeness and complementarity of equipment promoted and/or used on a farm.

- Focus on animal traction practices and equipment which are feasible or have been feasible elsewhere under similar conditions and constraints. An example that comes to mind is the research effort related to deep plowing and incorporation of crop residues (primarily sorghum-millet

stubbles). It is impracticable in the Sahel and of doubtful benefit.

Clarification of methodology

Several methodological imperfections and divergencies have been noted in explaining economic reasons for non-adoption. Some examples of problem areas, taken from the study of Crawford and Lassiter (1985), include:

- failure to differentiate adequately between the quality, quantity and timing of labour required to maintain a pair of oxen
- using labour figures derived from herding range cattle and assuming that they would be similar for the maintenance of draft oxen
- giving unrealistic opportunity costs for the labour required to maintain a pair of oxen during the off-season.

In this context researchers often neglect two facts. Firstly draft animal maintenance competes minimally for the services of adult males and secondly it is assumed that non-farm employment through migration to urban centres is equally accessible to all rural communities and there is unlimited urban demand for migratory labour during this period.

High management research approach

Animal traction technology has been the victim of high expectations. It was expected to introduce certain high management practices such as deep plowing for incorporating plant residues and high level of weed control in subsistence cereal crops like maize and millet. Serious doubts exist as to the feasibility and even desirability of deep plowing in the rainfed semi-arid tropics of West Africa. Using the same high level of weed control in sorghum and millet as used in high value cash crops such as cotton and tobacco seems unjustified. If research on animal traction is to be useful to policy-makers and extension agencies some of the methodological imperfections must be eliminated. Researchers should seek to eliminate certain high management approaches and focus more on what is feasible and practicable.

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