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A VILLAGE LEVEL EXTENSION GUIDE FOR
THE INTRODUCTION AND MAINTENANCE
OF ANIMAL TRACTION*

by

Merritt W. Sargent**

Department of Agricultural Economics
Michigan State University
East Lansing, Michigan 48824

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**Ph.D. Candidate, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan

TABLE OF CONTENTS

| | <u>Page</u> |
|--|-------------|
| INTRODUCTION | 1 |
| OBJECTIVES | 2 |
| THE CHOICE OF ANIMAL TRACTION | 3 |
| THE FARM POWER SOURCE | 4 |
| The Choice of Animal | 5 |
| Animal Training | 7 |
| Animal Maintenance | 10 |
| Animal Finishing | 11 |
| EQUIPMENT | 12 |
| The Choice of Equipment | 12 |
| The Use and Maintenance of Equipment | 14 |
| THE CROPPING SYSTEM | 16 |
| Stabilized Land Use and Soil Quality | 16 |
| Dry Season Feed Requirements | 17 |
| Credit Repayment Requirements | 18 |
| Family Food and Cash Needs | 19 |
| THE CREDIT SYSTEM | 19 |
| Credit Capacity | 20 |
| Insurance | 21 |
| VILLAGE LEVEL ORGANIZATION | 22 |
| CONCLUSION | 23 |
| APPENDICES | 24 |

INTRODUCTION

This guide provides an overview of the issues arising from the introduction and support of animal traction at the village level in francophone West Africa. The guide underlines the interrelated nature of a farming system based on the use of draft animal technology, demonstrates how the various components interact, and relates the parameters of an animal traction farming system to the decision-making process on the individual farm.

The direct clients for this guide are village-level extension agents. They are the vital link in the communication network between rural populations and the organizations responsible for education, training and logistical support in the agricultural sector. An inadequate or inappropriate understanding by the village extension agent of the impacts the choice of a new technology will have on the organization of the individual farm, what new constraints as well as capacities apply and what new costs as well as new benefits are implied by the choice of technology will seriously reduce his effectiveness as an extension agent and provide misleading information to those who ultimately make the choice to use or not use a given technology.

There is a long history of programs to introduce draft animal technology in francophone West Africa. Since 1960 alone, there have been well over one hundred significant programs of rural development based on the use of animal traction in the nine countries. With such importance

being given to this technology over the years, particularly since the drought and the rise in the price of petroleum products, it is all the more incumbent upon these agencies and institutions (provincial, national and international) to insure that this critical link in the development process--the village level extension agent--be adequately trained, informed and supported. Only then can the village level extension agent be expected to provide the encouragement, information and logistical coordination farmers will expect.

The appendices to this guide will provide practical guides to training and maintenance for the various components in an animal traction farming system. They are basic outlines which can be adapted to different agro-climatic zones and economic conditions.

This guide draws upon the author's ten years of work with a wide range of animal traction programs in francophone West Africa, a recently completed two-year farm management survey of farms using animal traction in northern Benin and the experiences and advice of many colleagues both at Michigan State University and in francophone West Africa. The quantitative aspects of this guide are derived primarily from the study in northern Benin, but it is felt that they are generally applicable to the zone.

OBJECTIVES

The objectives of this guide are: to provide an understanding of the interacting dynamics of animal traction in small-holder agriculture; to provide analytical tools which will assist village agents in helping farmers to make choices and reorganize their farms and, to provide practical guidelines for the training, maintenance, and support activities necessary to the various components of the system.

In dealing with animal traction, the village extension agents' interaction with farmers will concern one or more of these components, how they interact, and how they relate to the farms' capacities and constraints. To effectively inform, encourage and support farms using animal traction, village extension agents need to have a full understanding of five components: farm power source, the equipment, the cropping system, the credit system and village organization.

THE CHOICE OF ANIMAL TRACTION

Since the use of animal traction is disruptive of the farming system, both the farmer and the village extension agent should have an explicit understanding that the decision involves more than exchanging a hand hoe for a plow. First, the nature of the animal traction technology involves a level of investment well beyond the cash capacity of the majority of rural small-holder farms. Consequently, a medium-term credit system is needed and farming practices must be reorganized in order to enjoy the pretended benefits of animal traction as well as to meet the terms of credit. Clearly, the simple replacement of the hand hoe with an animal-drawn plow will not meet these requirements.

Secondly, the introduction and support of animal traction requires the integration of livestock and crop agriculture. In fact, the major arguments for using animal traction on small farms involve the symbiotic relationships between crop and livestock activities, the need to sedentarize land use and improve soil quality and the tangible financial benefits of the joint-product activity to the farmer. Thirdly, the cart, by far the most expensive tool, is too often automatically included in the package without reference to how much it will be used and whether it

is worth the cost. While these concerns will be discussed in detail in the text, they are underlined here to demonstrate the far-reaching implications to the farmer of his choice to use animal traction.

Before a farmer chooses to use animal traction and make subsequent management decisions about the use of animal traction, the village extension agent must present as much information as possible so that farmers will not be seriously surprised by unexpected consequences of this decision. A typical example would be to tell a farmer that he will be able to farm more land with animal traction and enjoy higher yields, without making clear that he will also have to weed his fields with animal traction. If he does not, he will not get the higher yields he expects and it is often the case that his yields will drop.

In the same manner, telling a farmer that he can obtain credit for his equipment purchase without assuring that the farmer understands the level of credit, what the installments will be and what the relative role in the total package of each tool is can lead to untenable decisions.

All these issues will be fully discussed below but are used illustratively to underline that the initial adoption and continued use of animal traction is based primarily on the farmer's perception of the technology and how it fits into his farming system. It is the village extension agent who will provide the information, skills and logistical support with which the farmer will make and implement his decision.

THE FARM POWER SOURCE

One major component of an animal traction system is the source of traction power. This involves which animals to use and how to choose, train, maintain and liquidate them. The major parameters to these

issues are discussed in terms of what decisions have to be made and the possible impact of those decisions.

The Choice of Animal

The first issue to be resolved is the species of animal to be used. There are essentially two levels to this choice which are related to species available, capacity to maintain the animals, traction force required to perform the crop operations, meat production potential and costs. At one level, provincial agencies and national governments decide which species is to be encouraged. On another level, farmers, with the help of extension agents, will choose the individual animals.

In francophone West Africa the choice is essentially limited to donkeys, horses and cattle. Of these, only cattle can be seen as an investment in the production of meat. Furthermore, if the crop operations include serious plowing (a depth of 15 cm. or more), cattle are the only animals suited to this task. On the other hand, if the agronomic guidelines for crop operations call for shallow plowing (5 cm.) or other minimum tillage techniques (scarification), donkeys or horses may be adequate.

Similarly, while farmers are most interested in animals which are readily available at the lowest cost, they should realize that the horse or donkey cannot perform the heavy work of cattle. Horses are more quickly debilitated by sleeping sickness (trypanosomiasis) and both horses and donkeys have little or no resale value as meat. But if the only tasks expected of the animal are seeding and cultivation, the choice of horses or donkeys may be reasonable.

Having agreed on which species of animal to use, age is perhaps the most important factor in the choice of a particular animal. Animals should

not be too young to work and not so old that they have to be replaced after only one or two years of work. At age three (two to four teeth), cattle are able to work, though not at full capacity. Moreover, training these animals is easier than training adults (six to seven years). Beginning with three year olds, one can expect four to five years of work. With seven to eight year olds, the animals will have reached their maximum weight and the costs of keeping them on the farm bring no further benefits from the sale of meat; the farmer simply pays either in terms of labor or cash to maintain their weight. As a result, a farmer should be encouraged to acquire a new young pair the year before he sells his old pair. This enables the farmer to replace an old pair with trained and experienced animals. Similar criteria apply to the choice of horses or donkeys. However, since they have no significant resale value, they can be kept until they are ten years old or more.

In addition to the age of the animal, attention should be given to the animal's shoulders (broad), hooves (healthy), chest (full) and general shape (legs not too long and back straight). If a head yoke is to be used, the animal should have a good set of horns; or if a shoulder yoke is to be used, it should have a small hump above the shoulders.¹

It should also be noted that if the farmer is going to work with two cattle, attention should be given to their relative size, since one of the cattle will be walking in the furrow while the other will be above it. Consequently, the animal on the right side of the pair should be slightly taller in the shoulder than the partner.

¹Additional details are presented in the appendices.

Animal Training

Since training the animals is one of the most important learning tools, the village extension agent must have the undivided attention of the farmer who will be using them. The members of the family who will actually be working the animals should be present and actively participate from the first day of training.

The training program should be used as a forum where appropriate structures for on-farm stables can be demonstrated, where adequate feed diets can be taught and where the detection and care of basic animal health problems can be learned. The training program can also serve as an opportunity to begin planning the reorganization of the farmer's land use patterns. In addition, the training program offers the opportunity to prove to farmers who have never handled large animals that harnessing of an undomesticated animal can be done quite easily. And if several farmers train animals at the same time, each farmer has the opportunity to handle a range of animals with different habits, characters and difficulties and thereby be better equipped to train a second team in the future.

Generally, the first questions to arise during the training period, particularly with cattle, involve castration and nose rings. Castration improves weight gain and renders the animals more docile. But in order to alter the hormonal system and put on more weight, the animal must be castrated quite young. By the time most animals are acquired for animal traction (three years of age) however, they are too old to demonstrate better weight gains due to castration. Furthermore, the breeds of West African cattle are barely large enough to perform the tasks asked of them (the 10" mouldboard plow is designed for two 500 kg. bulls). To the extent

that castration renders cattle more docile, they may become too mild or dispirited to work very hard. Finally, since the animals chosen for work will be the better specimens of the local breed, they would also be the preferred studs. Working cattle can be used as studs on a short-term basis, but care should be taken to limit the time an animal is used for this purpose as he can lose his training.

In francophone West Africa, the use of nose rings or ropes for quick and good animal control is widespread. Using nose rings, however, raises two problems. First, it is difficult to assure a reliable and reasonably priced source of stainless steel rings. If the farmer is habituated to the use of nose rings or nylon rope, this supply must somehow be ensured. Without a reliable supply, the farmer will use what is available. Raw iron or wire are the substitutes for rings and hemp for nylon rope. In both cases, the risk of infection is much higher and the farmer will have frequent recurring costs.

Secondly, farmers tend to rely on nose rings or ropes as a substitute for a good, thorough training. In fact, the farmer should not have to use rings during normal work tasks. At most, nose rings or ropes should be used only to abruptly stop or turn animals. When misused, nose rings can lead to several problems. Constant pressure on the animal's nose raises his head and greatly diminishes his traction strength through the shoulders. Too much pressure can tear the ring or rope out of the animal's nose. If this occurs, the nose will never heal and another ring cannot be used. In some cases, nerve endings will be permanently exposed causing extreme pain and eventually requiring the animal to be slaughtered.

Unless absolutely necessary, it is preferable not to use nose rings. However, if they must be used, great care should be taken to ensure that the farmer knows how to use them. In any case, they are a poor substitute for adequate training.

The steps in training animals are straightforward. The first task is to get each animal accustomed to having people close by and to walking calmly in a straight line. Then the harness or yoke should be placed. Whenever the harness or yoke is on, there should be some weight attached to it so that the harness or yoke rides correctly on the animal's head or shoulders. When the animals are accustomed to the harness or yoke and to having another animal next to it, work with light tasks such as the weeder or empty cart should begin. The tasks should become progressively harder, ending with plowing, the most difficult task. The quickness with which the farmer can reach the plowing task will vary with each animal. Two to three weeks is generally sufficient.¹

The most important aspect of training animals is to handle them in the same fashion. During the training, the procedure for getting the animals ready to work should always be the same. If a pair is being used, the animals should always be yoked on the same side. Similarly, since animals are frightened by the unexpected, the procedures for attaching the yoke or harness should always be identical. From the very beginning, identical voice commands should also be used for stopping, starting or turning. Changing a word or sound can be confusing to the animal and can delay the time when it can be worked using voice commands. In addition, the animals should not eat before working and should have three to five hours of grazing per day. If possible, locally

¹Practical details are given in the appendix.

available supplements should be given daily, such as cotton seed, cereal bran or cereal beer residues (2-3 kg. per day).¹ Moreover, as a safety precaution in the early stages of training, a rope to one or both of the hind legs should be attached to stop the animal quickly if necessary.

Even if all these guidelines are followed, the formal training program provides only an initial training for the animals and for farmers in how to handle, house, and feed the animals. If the animals are not harnessed regularly (every day for the first few months and three to four times per week thereafter), they will quickly forget what they have learned.

Animal Maintenance

The training program offers the opportunity to show farmers what kinds and how much feed stuffs are required. During the cropping season, roughage is widely available. A supplement, as noted above, however, should be used. Perhaps even more important is the availability of salt. Since the efficiency with which cattle convert roughage to weight depends directly on the availability of salt, rough market salt should be substituted if prepared salt licks are not available or too expensive.

Provisions should be made for dry season maintenance primarily in terms of stocking groundnut hay and rice straw. If any forage crop has been grown, at least a final cutting should be stored when labor is available. During the dry season, if the farmer is dependent on locally available feed stuffs, it is difficult to maintain a rate of weight gain. The more realistic objective over the dry season is to prevent any weight loss. Using groundnut hay and other stored crop by-products can achieve this objective. Without it, animals can not only lose 25 percent

¹Details are given in the appendix.

of their body weight, but are also so seriously weakened that they become easy prey to any number of diseases and are poorly prepared for the plowing season, their most arduous task.

During the cropping season, daily pasturing should take place in the hot hours of the day since the major work hours will be early morning to the sun's zenith. Two to three hours of work could be done late in the afternoon during very busy seasons. If the farmer is able to train two animal units (two horses or two pairs of cattle), he can work one unit in the morning and one in the afternoon.

The other aspect to animal maintenance is health care. The endemic diseases common to the region strike quickly and either kill or seriously debilitate animals. The most effective way to deal with the animal's health is through regular programs of preventative care. Regular animal vaccinations against Anthrax, Rinderpest, Pasteurellosis and Bovine Pleuropneumonia (for cattle) should be made. Three treatments for trypanosomiasis and at least two dewormings should be given each year.

The farmer should also be encouraged to establish health cards for each animal. If the veterinary service or the village animal traction association has a program of health cards, the farmer should participate. If not, he should keep his own records.

Obviously, if an animal dies, it represents a great loss to the farmer. But even if an animal falls ill and recovers during the plowing season, an entire year's work can be lost.

Animal Finishing

After the animal's last season of work and before it is sold, it may benefit the farmer to put the animal on a finishing diet. The intention of this diet is to put weight on the animal as fast as possible.

Thus, a finishing diet is essentially a program of no work: a maximum amount of the animal's feed is brought to it rather than the animal going to pasture; careful health care, feed supplements, salt and minerals are provided.

How long the animal is to be kept on this diet will depend on how long the farmer can afford it, and on the fluctuations in the price of animals. Generally, further on in the dry season the price of animals rises. The farmer should choose when he will be most satisfied to sell his animals.¹

EQUIPMENT

Because of the variety of equipment available, which equipment is used, how it is used and for what purposes is perhaps a much more difficult decision to make. The set of equipment to be used is generally not a decision for the farmer or the village extension agent, but is determined in the design phase of the project by the provincial and national administering agencies. Instead, the question for the farmer is to decide which tools within the available set he needs. Once the equipment package is chosen, the farmer must learn to use and maintain it.

The Choice of Equipment

For illustrative purposes, this discussion will refer to a set of equipment which is common throughout the region: the ARARA line produced by SISCOMA in Senegal, including a ten-inch mouldboard, a plow, a ridger, a seeder, a set of three groundnut lifter blades, a five-tooth cultivator

¹Particulars on finishing diets are found in the appendix.

and a two-wheeled cart. The total package would cost approximately 100,000 CFA today. It is important for the village extension agent to assist the farmer in determining which tools he will use often enough to justify their cost.

As the most expensive tool in the package, the cart deserves careful discussion. If the cart is simply to be used for the farmer's own transport needs, the farmer must decide if it is worth the 40,000 CFA plus the repair expenses. If the farmer wishes to rent his cart, it should be remembered that the first few carts in a village will have more transport work than they can handle; but if there are thirty carts in the village, none will have very much work.

In general, the reasonable distance to expect from an animal-drawn cart is perhaps twenty kilometers per day. It might be helpful to the farmer to examine the demand for transport services and the number of carts within a twenty kilometer radius. The relative cost of carts given their cash earning potential is often overlooked, yet the cart itself often doubles the amount of credit the farmer needs for equipment.

The seeder is another expensive tool in the package. Its advantages are rapidity and a uniform plant population density. However, it does cost about 20,000 CFA for a single-row seeder. In climatic areas such as Senegal, where the length of the rainy season is so short that farmers have very little time to do land preparation and planting, the increased yields due to quick and timely planting may justify the cost. In other areas where the pressure on planting is not so intense and manual labor is available, the seeder may not be necessary in the initial package.

The five-tooth cultivator is also expensive (approximately 15,000 CFA), particularly if it is only used for weeding. Groundnut lifter blades are cheaper. When they are set to cut very shallow, they skim the surface of the soil cutting off the weeds in the same fashion as the five-tooth cultivator. If, on the other hand, some fields have the seed beds prepared using scarification techniques, the cultivator is an appropriate tool.

The ridger is required only for crops grown on ridges. The groundnut lifter is useful because it permits a rapid unearthing of groundnuts at a time when there is a peak demand for labor, i.e., competition with the harvesting of cereal crops. Several groundnut lifter blades might be needed for different crop spacings if weeding is done. If any plowing is to be done, obviously the plow is a necessary component to the package. Nevertheless, it is fairly common to observe farmers using a ridger without having plowed first. Depending on how hard the soil is after the dry season, this could seriously damage the ridger which was not designed to be used without an initial plowing. The most common damage is a twisting or bending of the arm which attaches the ridger and its wings to the chassis.

There are many other possible tools, but in each instance it is important that the farmer see each tool in the context of his farm activities and recognizes a real need for what the tool can do.

The Use and Maintenance of Equipment

The training program must also assure that farmers know how to use each tool. This can be done by having the farmers assemble and disassemble each tool several times. Adjusting the tools should also

be clearly demonstrated. For example, both the depth of plowing and the width of the furrow can be adjusted which in turn makes the work harder or easier for the animals.

Each farmer should be aware of the parts likely to wear out the most frequently. This is very important since worn parts can throw off the balance of the tool and accelerate wear. The parts to be watched include the plow point, the plow heel, the ridger point, the axle on the front wheel of the chassis, the axles on the seeder, and the bearings on the cart wheels. A speedy replacement of these parts can avoid serious damage to the equipment.

The effective life of the tools is directly linked to a good program of equipment maintenance. In addition to timely replacement of worn parts, there are several general practices which will prolong equipment life. Since weather is the biggest enemy of equipment, the stable for the animals should be large enough to accommodate the cart and the equipment. In addition, all wood (the yoke, the cart's tongue, and the cart itself) should be treated with crank case oil to protect it from the rain and termites. All moving parts also should be regularly greased; this includes the axles on the seeder and chassis, and the bearings on the cart wheels.

The village extension agent should make a point during his regular visits of noticing how well a farmer is maintaining his equipment and continually linking day-to-day maintenance to the life of the equipment. Just as the farmer should plan for feed stocks for his animals in the dry season, he should be aware of daily maintenance needs to preserve his equipment.

THE CROPPING SYSTEM

The major concerns which determine the cropping system a farmer will use are credit repayment requirements, the need to stabilize land use, dry season feed requirements, soil quality, and the family food and cash needs. As stated in the introduction, these are all inter-related. No one concern is dominant.

Stabilized Land Use and Soil Quality

By definition, animal traction requires that all trees and root systems be removed from the crop land. Uniform working of the soil cannot be achieved if trees have to be avoided or roots are always snagging the equipment. Snagging on roots can also injure the animals or break the equipment.

Tree removal, however, is a large investment for any farmer. If he has no mechanical means of assistance, it will generally take two to three years to clear the land of trees and their roots. In the first year, scrub and small trees will be removed while fires will be set at the base of larger trees to kill them. In the second and third years, the larger trees, now dead, will be cut down and removed in pieces. If after four or five years of cultivation the farmer has to move on, not to return for ten years or more, land clearing is all the more expensive.

In order to stay on the land for longer periods, other investments need to be made, particularly in soil quality. Several practices can be followed. Each year the composted manure from two cattle can be spread and plowed-under on one hectare. If there is time at the end of the rainy season, crop residues can be plowed under before the ground hardens.

If cover crops are grown on fallow land and if the farmer can commit the labor at the end of the rainy season, they also can be plowed under.

The cover crops used must meet certain criteria. In addition to providing feed to animals and nutrients to the soil, they will have to be drought resistant. They must be able to regenerate if unexpectedly burnt. Moreover, when the time comes to return the land to other crops, it must be fairly easy to remove the cover crop from the land--plowing under must effectively kill off the crop. In all of these options the farmer has to trade off the competition for available seasonal labor against having to move every five years. Perhaps less obvious to the farmer is the investment in soil quality which will not only improve yields, but also, and perhaps more importantly, will stabilize his yields. This is critical since the unpredictability of a farmer's yields is as difficult to deal with, if not more so, than the absolute level of yields. The animal traction tillage techniques also encourage better moisture utilization, as well as the incorporation of organic matter which contributes to more uniform nutrient availability. It should also be noted that a balanced rotation system facilitates a more stable rate of nutrient off-take.

The necessary clearing of his land will make the farmer increasingly vulnerable to rain and wind erosion. To offset this, farmers might use cover crops on fallow fields as well as set aside land for tree crops and establish wind breaks. Under these circumstances, the tree crop should also be a commercial tree so that the farmer might enjoy some tangible benefits from his investment, i.e., fruit trees and/or firewood.

Dry Season Feed Requirements

In determining his cropping system, the farmer should also account for the dry season feeding of his animals. Any legume, groundnuts or

cowpeas, for example, can provide valuable hay for storing. Rice straw can be stored and, if found unpalatable, can be sprinkled with salt water the day before feeding. If cover crops have been grown, this can provide an additional source of dry season feed.

There is often a tendency to observe farmers choosing the highest priced crop to grow without considering the potential use of the crop's by-products. Cotton is a good example. While the cotton itself is highly priced, the rest of the plant is useless and in fact has to be burned. Groundnuts, on the other hand, are completely useable: the nuts for market and cooking oil, groundnut cake as a feed supplement, the hay for animal feed, and the shells for composting.

Credit Repayment Requirements

Given the choice of animals and equipment, the choice of land area and cropping systems must reflect the annual payments to be made. This is perhaps the most important issue to an animal traction system.

The village extension agent does the farmer a disservice if he engages the farmer in a debt without a reasonable expectation that he will be able to meet the credit terms. All the planning and training decisions leading up to this issue were made in the hopes of creating a more productive farming system, not only for this year, but for years later as well. The village extension agent must realize that if, in the final accounting, the farmer cannot meet his payments, he will not enjoy a significant reinforcement to the continued use of animal traction. Furthermore, the village extension agent's credibility will suffer.

Family Food and Cash Needs

In designing the cropping mix, the farmer will want above all to assure his family's needs. The village extension agent should understand that land put into commercial crops is land taken away from food crops. On the basis of average yield expectations, farmers will have a good idea of how much land needs to be put into food crops and the village extension agent should accept that estimate.

The cash needs in a family will include at minimum taxes, school fees, clothing, and certain consumer items (sugar, salt, etc.). That cash will be derived primarily from crop and livestock sales. The extent to which the farmer has to liquidate livestock or stored crops before he is ready is an indication that he is overly indebted or did not get the results planned for from his farming activities. Here again is the forum in which the performance of the village extension agent will be evaluated by the farmer.

THE CREDIT SYSTEM

A wide range of credit systems has been used throughout francophone West Africa for animal traction. It can vary from three payments in two years to five payments in eight years. The interest rate can vary from zero to nine percent. In any case, this is usually a choice not available to the farmer or the village extension agent. The only choice is to pay cash or accept the terms of credit offered. The village extension agent can, however, assist the farmer in determining how much credit the farmer can reasonably expect to carry.

Credit Capacity

The issues the village extension agent must highlight with the farmer in order to assess his credit carrying capacity basically constitute a farm budget. Decisions have been made about what will be grown and how much. The farmer has also determined what he needs in terms of animal traction and other inputs. After deducting costs there must be enough left over to handle the credit requirements and still leave an encouraging net income to the farmer.

In making this assessment, the village level agent should use average yields in the area. This insures that revenues will be conservative estimates. Often before a farmer is granted credit some such estimate is made. If the assumptions are too optimistic, the farmer's actual performance will be misleading, not only to the credit agency, but to the farmer himself.

In the same context, reference should also be made to the number of workers in the family when determining credit worthiness. As noted earlier, animal traction tends to expand land area cultivated. But the village extension agent should keep in mind that some operations will remain manual (grain crop harvesting). Thus, while animal traction allows farmers to expand land area, enough labor should be available to execute those parallel operations which remain manual. If not, yields will very likely not rise, and possibly even fall.

Another aspect of credit-carrying capacity are the pre-conditions often set for access to credit by a provincial agency. The village extension agent, in collaboration with the loan officer, will then be responsible for monitoring farmers' adherence to those pre-conditions. These pre-conditions may include a minimum area in cash crops, lodging

the animals and equipment in a shelter, purchasing animal health cards or perhaps a minimum ratio of labor availability to land cultivated. Given the pre-conditions a farmer can meet, the amount of credit made available and the nature of the package he uses can be determined in light of his capacities.

Insurance

The other side of credit is insurance. If the farmer has accepted a debt which is several times his annual earnings, met the pre-conditions for the loan, and has diligently attempted to apply the use of animal traction to his farm activities, he deserves to be protected from unforeseen calamities (drought, fire, etc).

If for reasons beyond the control of the farmer a given year was a catastrophe, the farmer should be able to defer his annual payments at no penalty. On the other hand, if payment is not met and there is no apparent explanation, the package should be repossessed. Assuming that the animal traction program is well-designed, an early and prompt foreclosure can encourage farmers to carefully assess their needs and capacities when determining their credit requirements.

For the animals themselves another form of insurance should be made available on a regional level. Part of the fee for the health card should include an insurance premium which is based on regional mortality rates among working animals. If the farmer follows the advice on care of his animals, purchases the health cards, follows the treatments and still loses an animal, that animal should be replaced at no cost to the farmer.

Both these approaches to protecting the farmer's investment must be fully explained to the farmer. And when a case arises, the deferral

of payment, the replacement of the animal, or the repossession of the package should be formal, well-publicized, and swift. Clearly, however, the village extension agent must be very sure of his information first.

VILLAGE LEVEL ORGANIZATION

Village level organizations based on the use of animal traction can perform many valuable functions. They can facilitate the supply and stocking of inputs and spare parts, expedite the marketing of output, and stockpile veterinary medicines and equipment. And equally as important, such an organization can provide a forum for information, expression of grievances, and even redress what is perceived as unjustified repossession or foreclosure. Finally, the association can serve as a coordination point between farmers and rural artisans for the supply of repair services and spare parts manufacture.

These functions should be assumed by the associations in stages. In its initial stage, the Animal Traction Association should stockpile spare parts, veterinary medicines, and perhaps some veterinary equipment (needles and syringes). Particularly in situations where rebates are given to village organizations for collectively selling their output, the Animal Traction Association should also collect the members' production and sell it collectively using the rebates to facilitate the stockpiling of inputs. Obviously, each member will pay for the inputs he uses.

As the usefulness of the Animal Traction Association demonstrates itself, the village extension agent should encourage the use of the association as a forum for the exchange of information and experiences, for the discussion of problems not only at the farm level but also

between farmers and the provincial services, and for the presentation and adjudication of complaints.

When an Animal Traction Association has the active participation on the part of its members, it can begin to assess the credit capacity of members, provide collateral for loans and collect loan payments. Furthermore, investments in local infrastructure such as a workshop for artisans working on Animal Traction equipment or a vaccination chute for animals can be financed through the association.

The creation of such an association should be the voluntary decision of the farmers. The role of the village extension agent is to encourage farmers to see the benefits and demonstrate how provincial agencies will assist such organizations. Once it is established, the village extension agent should help insure that the provincial agencies supply the promised services and consult with the association in the animal traction activities.

CONCLUSION

This guide has briefly outlined the major concerns for a village extension agent in the introduction and maintenance of animal traction. In the appendix, I suggest some basic worksheets which might facilitate a village agent's discussions with farmers. These worksheets are intended to remind the agent and the farmer of the specific concerns in the various elements of an animal traction farming system. Finally, throughout the preceding discussion and consistently underlined in the worksheets is the necessary interdependency of the components of an animal traction system. Too often the poor performance of animal traction programs can be linked to a lack of concern for this interdependency.

APPENDICES

The following set of guidelines presents, in an abbreviated format, checklists for the major elements in the introduction and maintenance of animal traction. I have limited the discussion to the use of cattle as the choice of species. I have also chosen not to discuss specific equipment. There is such a wide range of brands and types of equipment in use in francophone West Africa that it serves little purpose to discuss a particular tool. In their training, extension agents and farmers should assemble and disassemble all equipment, learn how to adjust it and understand the different ways it can be used.

Each of these checklists will require adaptation to a particular ecology and socio-economic reality with which a particular project must work. These guides are not intended to be exhaustive. It is assumed that extension agents will have gone through an extensive training program in animal traction techniques. These guidelines are intended to act as reminders for work in the field.

- APPENDIX A: THE CHOICE OF ANIMAL
- APPENDIX B: ANIMAL TRAINING
- APPENDIX C: ANIMAL MAINTENANCE
- APPENDIX D: ANIMAL HEALTH CARDS
- APPENDIX E: FINISHING DIETS
- APPENDIX F: CROPPING OPERATIONS
- APPENDIX G: CROP MIX
- APPENDIX H: CREDIT CAPACITY

APPENDIX A

THE CHOICE OF ANIMAL

Once the species of animal is determined, in this case cattle, the individual animals must be chosen. There are several basic characteristics to look for in choosing animals for draft work.

- AGE - The most common technique for determining the age of cattle is an examination of the animal's teeth. In the lower jaw, two adult teeth is approximately equivalent to two years old; four adult teeth is three years old; six adult teeth is four years old; eight adult teeth is five years old.
- Generally an animal with four adult teeth (3 years) is large enough to be trained and begin work and yet young enough so it will have a reasonable number of years work left (4-5 years).
- SEX - The vast majority of animals used are males, yet there are no reasons prohibiting the use of females. Experiences in the Sine-Saloum region of Senegal with the use of females attest to this.
- FORMAT - The animal should have a muscular back and hindquarters, a deep and well-rounded chest, short legs and solid hooves, a hump on its back (if using a shoulder yoke) and a strong and well-formed set of horns (if using a head yoke). The pair of animals should be as similar as possible, particularly in age and height.

- CHARACTER - Extremely docile animals should be avoided since they risk not being very aggressive work animals. Aggressiveness may simply reflect a spirited animal and not necessarily a mean or vindictive animal. This distinction is important. Spirit is a desirable characteristic to choose because, once trained, a spirited animal will work more energetically.
- HEALTH - At minimum, an animal should have an assured and regular walk, regular breathing, a smooth and supple coat, a good appetite, and a cool and humid muzzle. The manure should show no traces of intestinal parasites. From the veterinary service, information can be obtained concerning the recent health of the herd from which the animal comes. An actual examination by the veterinary agent might push up the price of the animal and this decision should be made on a case by case basis.
- PRICE - The alarming rise in cattle prices in West Africa over the last ten years and the increasing difficulty in obtaining animals at any price in some areas have encouraged farmers, particularly those already using animal traction, to acquire calves (at much lower prices) and raise them to working age. This not only assures the farmer that he will have replacement animals when he needs them but also allows the farmer to personally monitor the health and development of the animals.

APPENDIX B

ANIMAL TRAINING

The initial training of oxen will usually require about three to four weeks. This will vary depending on the temperament of the animals, their age and health and on the skill of the trainer. It should be remembered that these animals are essentially undomesticated and not familiar with being handled by human beings.

The critical factors in training oxen for animal traction work are patience, consistency in handling the animals, alertness to avoid accidental injury to both the animals and the people working them, and avoidance of physical mistreatment of the animals. The animals should be trained from the beginning by the same people who will be working them. All operations should be carried out in the same manner; the yoke should be placed and removed in the same manner every time; voice commands should never change; the two animals should work and be stabled always on the same side of each other, etc. Animals are most irritated by what they do not expect, and a consistent manner in handling them minimizes the unexpected. At each phase of training, the behavior of the animals will indicate if they should move on to the next phase. It serves no purpose to force the animals through training. A patient willingness to let the animals learn is necessary. Animals will always signal if they are going to kick, lunge or lash out in some other way. It may be the laying back of its ears, tossing its head, moving its tail frantically or flexing its muscles either in the shoulders or hindquarters. Alertness to these signals can avoid possible injury to the animal or the people around it. People working in front of the animals could carry a short stick. When

an animal lunges, a quick rap to the muzzle will stop it in its tracks. Unnecessary beating of the animal can open wounds in the coat of the animal and in extreme cases cause internal injuries. The worst effect of beating, however, is to the relationship between the animal and its handler. Much of the animal's ability to work will depend on its affinity to its handler. As an example, for an animal which lays down as a means to refuse work, the most effective technique is to pinch its nostrils closed and hold its mouth shut. Shortly, it will come up for air.

The training period is an opportune time to demonstrate basic health care and maintenance of animals to the owners. If the training is being done on the farm, the stable required as part of the preconditions to the equipment loan should be simple and constructed out of local materials. It should be large enough to house the animals and the equipment. A simple construction of posts and a straw roof is adequate (4m x 6m). The animals' backs should face the prevailing direction of the rains and the floor should decline slightly from head to tail of the animals. Daily cleaning of the stalls, the feeding of supplements and the monitoring of basic health can all be demonstrated during training.

CASTRATION - The most common technique for castration in West Africa seems to be using "Burdizzo" castration pliers. This is a safe, relatively painless and effective method. The major problem is usually access to the pliers.

The decision to castrate deserves serious thought. The animals are usually obtained too old for castration to have any significant effect on their weight. Animals rendered too docile will not work well. Because animal

traction cattle tend to be the best specimens in the herd, they are also the preferred studs. The decision to castrate should not be made automatically.

ACTIVITIES

The following guide to training has been presented in terms of the number of days possibly spent on each activity. These are only suggestive and moving from one activity to the next should be determined by the behavior of the animals.

NO. OF DAYS

- 3 - When the animals are first brought to the site of training, they should be stabled for three days and all feed and water brought to them. This allows the animals to get used to having people close by and to its partner. At this time, if the noses are to be pierced, this should be done on the first day to allow any resultant swelling to heal.
- 2-3 - The first task is to get each animal to walk calmly with someone walking in front of them. This is done one animal at a time with a rope to the horns and one on a hind leg. The person in front should get progressively closer to the head of the animal. Voice commands should also be introduced at this time.
- There are two work sessions each day. In the morning, work should start about 7:00 a.m. and continue to the sun's zenith and in the afternoon from 16:00 to 18:00

NO. OF DAYS

- 2-3 - When the animals can walk calmly, the yoke should be placed. Depending on the temperament of the two animals, a hitching post may be necessary. Two posts are sunk 1 meter into the ground leaving two meters above ground and they should be about 2 meters apart. A cross beam is attached with rope at the height of the animals. Attaching it with rope means it can be cut loose quickly if necessary. The animals should always be on the same side of each other.
- In habituating the animals to the yoke, there should always be some traction weight on the yoke (particularly the shoulder yoke) so that it rides properly on the animals. A small log is sufficient in the first days. At this time the use of identical voice commands should continue and the animals should be taught to walk together in a straight line, to stop, to start, to turn, and to back up.
- 3-4 - As the animals become familiar with each other and with the various commands, they can be hitched to some of the lighter field tools. In loose soil, they should begin pulling the weeding tool and the ridging tool. The loose soil may irritate them at first. The use of voice commands should continue as well as all the movements begun in the first days.
- 3-4 - Once again, as the animals demonstrate a more relaxed attitude towards the new tasks, additional tasks requiring

more effort should be introduced. At this stage, plowing in loose soil can begin. Also during this phase, getting the animals used to the cart can begin. This may irritate the animals as the cart can ride up behind them. They should be taught how to brake the cart going down a slope. In most cases, the animals will instinctively raise their heads and brake with their legs but they should be introduced to this slowly and carefully. They could panic if they are surprised by the necessity to do this.

- 8 - As the animals handle these tasks better, the weight can be increased in the cart and they can begin the most difficult task: plowing in unplowed soil. The animal on the right will have to get used to walking in the furrow, the voice commands continue and the animal's stamina can be assessed.

This phase should continue for a number of days, not only because it is the most arduous work, but also because the techniques for yoking, unyoking and handling in general can be standardized for the animals and the farmer.

The number of days for each task is only approximate. The behavior of the animals will indicate if the pace can be increased or should be decreased. In fact, this constitutes only a preliminary training and unless the animals are yoked regularly, they can easily forget what they have learned. If the animals are trained at the end of the rainy season, they should be yoked to the cart three to four times a week. If they were trained just before the rainy season, the land preparation activities will provide the necessary follow-up training.

Throughout the training sessions, emphasis should be placed on doing each task in an identical fashion. Inconsistency in handling the animals confuses them and makes it more difficult to learn.

If single cattle are to be used for certain tasks, the calmest of the two should be chosen and fitted with a single animal yoke. Operations such as seeding and weeding can be executed very efficiently by a single animal. If both animals can be trained to work alone, the farmer will have more disposable work hours per day precisely for operations where timing is important. The animal will have to get used to having ropes or chains going down both sides. This irritates some animals. The most important criteria for an animal working alone is the ability to walk calmly in a straight line as it will be walking in a growing field between the crop rows.

APPENDIX C
ANIMAL MAINTENANCE

There are many improvements which can be made in the feed supply for working animals. The introduction of forage cultivation, the production of silage, much less the provision of feed supplements, has gained only very scattered acceptance in West Africa.

Until the need for such investments is accepted and incorporated into farm planning by farmers, the objectives for animal maintenance should more realistically be directed towards locally available supplements in the working season and towards avoiding weight loss in the dry season.

- PASTURE - An animal will need 15 - 20 kg. of pasture grass per day. This can be translated to 6 - 8 hours of pasturing per day. In terms of available fallow land, a widely used standard is that each animal needs access to as many hectares as there are months in the dry season.
- SUPPLEMENTS - The most readily understood supplement to pasture in West Africa is the use of leguminous hay (groundnut and/or cowpea) and rice straw. As the nutritional value of pasture falls in the dry season, farmers should incorporate a legume into the crop mix and store the hay for the dry season. The rate per animal should be about 8 kg. per day. As a supplement, 1 hectare of groundnut hay should be adequate per animal for a seven month dry season.

During the working season, a higher energy supplement should be available. Grains such as millet or maize can be given at 2 kg. per animal per day. The notion of providing human food to animals is not widely accepted. More likely possibilities are bran from various grains, groundnut cake (1 kg./animal/day) and cotton seed. In the case of cotton seed, no more than 2 kg./animal/day should be given as there is a risk of a toxic reaction. Furthermore, if the cotton seed is not palatable to the animals, soaking it in water with the daily salt ration will solve this problem.

SALT

- For the proper transformation of feed to weight, ruminants must have access to salt. Salt licks may be expensive and difficult to obtain. A mixture of 3 parts rough salt (found in any market) and 1 part ground bone is a start towards a salt and mineral supplement. Each animal should have 20 to 30 grams per day. This can be mixed in with the daily feed supplement or with the water.

WATER

- Animals should never be given water on an empty stomach or after hard work. The animals should have access to water twice a day for a total of 20 to 40 liters per day. This is a very basic maintenance diet intended to provide enough energy during the working season and to maintain the animals' weight over the dry season. More elaborate diets will be possible when, on the one hand, farmers perceive a substantial benefit to such

investments and, on the other hand, governments institute programs to improve the supply of feed sources on a national basis.

APPENDIX D

ANIMAL HEALTH CARDS

The distribution of animal health cards is intended to insure that all working animals benefit from a full range of annual preventative care. Each animal will have a card which is purchased annually for the cost of the medicines. The cards should have space available to note the date of each treatment and there should be receipts in duplicate--one for the veterinary agent and one for the owner.

The annual set of treatments will vary according to the veterinary problems of a particular area. The following is the set of treatments used in northern Benin:

- TRYPANOSOMIASIS - No vaccine is available for this disease. A suppressant is used and because of its short half-life, it is administered three times per year.
- INTERNAL PARASITES - Deworming medicine is administered twice a year: once before the working season and once at the beginning of the dry season.
- RINDERPEST - Once the animals are vaccinated, the immunity should last for the animals' lives. Nevertheless, there are still outbreaks of the disease in the region, and special attention should be given to this vaccination. It is given at the end of the rainy season.
- ANTHRAX - The vaccination is given once a year in the dry season.

- PASTEURELLOSIS - This vaccination is repeated each year at the end of the rainy season.
- PERIPNEUMONIA - Peripneumonia is vaccinated for each year in the dry season.

The card should have room to list all the interventions by the veterinary service over and above these preventative measures. This permits the recording of a health history for each animal. If there is an animal insurance scheme incorporated into the project, this can also be recorded on the health card. In that animal traction animals will benefit from more individualized surveillance from the veterinary service, the calculation of annual premiums should not be based on mortality rates in the national herd, but rather on lower mortality rates due to improved health care. A common annual premium in use in West Africa is 1500 CFA/animal/year. If the conditions for insurance have been adhered to and the premiums paid, a farmer's lost animal will be replaced at no charge.

APPENDIX E
FINISHING DIETS

The underlying motivation for placing working cattle on finishing diets is a market calculation. The demand for red meat in West Africa has increased at an alarming rate over the past ten years. This general increase in prices is paralleled by strong seasonal fluctuations in seasonal prices. As the dry season progresses, the animals' condition worsens due to the increasing scarcity of feed and its poorer quality. Consequently, the price for animals increases, particularly for healthy, well-finished cattle.

When a farmer completes the last work season for a particular pair of cattle, the notion of a finishing diet is to bring as much of an animal's feed to it (preferably all of it) and to minimize how much the animal has to walk around looking for its food. How long the animals are kept on these finishing diets will be a function of price movements for beef and how long the farmer can afford the additional investment of labor and feed supplements. Most existing programs are set up on a six-month time frame.

The finishing diet, as the work diet, should be composed by locally available feed sources. The use of crop by-products, often not used or used inefficiently, is the basis for the diet. The animals are kept in a regularly cleaned stable. They should be treated for trypanosomiasis and internal parasites. General health should be monitored regularly.

There are many possible combinations of pasture hay and supplements from crop by-products which can be used. Particular combinations should be defined by the livestock service for each particular area. Possible

supplements are legume hay (groundnut and/or cowpea), rice straw, cotton seed and bran from milled grains. A salt and mineral supplement should also be provided as well as up to 40 liters of water per day.

An example, a possible combination might be the following, given on a daily basis:

10 kg. - Pasture hay dried at least one day and preferably in the shade.

8 - 10 kg. - Legume hay also stored in the shade.

1.5 kg. - Cotton seed which can be made more palatable by soaking it in water and the salt/mineral supplement.

30 grams - A salt/mineral supplement. Manufactured salt licks are expensive and not always readily available. The Sine-Saloum Region of Senegal produces 4.5 kg. salt licks locally for 200 CFA (1971) with the following composition:

65.6% - Salt

19.6% - Powdered calcified bones

0.34% - Copper sulfate

0.04% - Cobalt sulfate

1.3% - Magnesium oxide

13.1% - Suspension agent

An approximation of this can be prepared on the farm with three parts rough salt (found in any market) and one part powdered calcified bones.

0.5 kg. - Bran taken from any milling operation can be of mixed grains (sorghum, millet, maize, rice). It can be mixed with the pasture hay or the water.

40 liters - Up to 40 liters of water should be given per day, especially as the dry season progresses. The animals should not drink water on an empty stomach. They should have access to water twice a day.

Studies in Senegal have shown a 0.5 kg. net weight gain per day using a diet similar to the one described above.

APPENDIX F
CROPPING OPERATIONS

The wide range of tools currently in use in West Africa makes it difficult to precisely discuss the particular cropping techniques performed with animal traction. The specific adaptation of a tool to a cropping technique will have to be elaborated for each project. There are, however, some general comments which can be made concerning each crop operation. They are presented here with the understanding that they serve only as reminders to the more specific use of each tool.

PLOWING - There are 6", 8" and 10" mouldboard plows currently being used in West Africa. Only with the 10" plow can one achieve a plowing depth of 20 cm., probably the most one can expect from animal traction in West Africa. All plows can be adjusted both for the depth and width of the furrow. The traction line should trace a straight line from the yoke to the front of the plow chassis, where the traction chain attaches, and on to the plow share.

The primary concern in plowing any field is to do it in such a fashion that the amount of time the plow is out of the soil is minimized. The first furrow is drawn around the outside of the whole field. Taking the long dimension of the field, the field is divided into 20 meter strips along the shorter dimension of the field. Starting with the center long line of each strip and plowing in a clockwise direction, the field is plowed. There should be a 10 minute rest for each hour of work. Uniformity of plowing

facilitates subsequent operations and if the field is planted on the flat, the direction of the plowing should be perpendicular to the slope of the land.

- RIDGING** - Most of the ridgers in use in francophone West Africa are not designed to be used in unplowed soil. This will depend on the nature of the soil, but in soil too hard or too heavy, the ridging tool can be damaged. The lower the wings of the ridger are placed, the more soil is thrown on to the ridges, the harder the work for the animals and the wider the space between the ridges. The depth the tool works at is regulated in the same way as for plowing (lowering the front of the chassis).

Here again, ridging should be done in 20 meter wide strips to minimize the amount of time the tool is out of the ground while turning the animals. Ridging should be perpendicular to both the direction of plowing and to the slope of the land, hence for crops to be planted on ridges, the plowing is done in the same direction as the slope of the land.

- HARROWING** - For crops to be planted on the flat, harrowing is often useful in breaking up the plowing into a flatter, more uniform seed bed, particularly if an animal-drawn seeder is to be used. If the teeth of the harrow are not biting deep enough, additional weight (rocks) can be placed on top of the harrow. Harrowing is done in two perpendicular directions and may require more than one passage.

SEEDING - The most common seeder in use is a single row seeder which can be adapted to all grain crops and groundnuts. It can be pulled by both animals or a single animal. It is a fairly expensive tool but is particularly important where the planting season is severely constrained (i.e. Senegal). Its other advantages are providing a uniform plant density and straight crop rows which facilitates weeding. Planting should be done perpendicular to the slope of the field; however, in fields with very sharp slopes there is a risk of plants, particularly young ones, being washed out.

WEEDING - The greatest variety in tools is found in the weeding implements. Animal traction facilitates the expansion of area plowed, ridged and seeded. However, if weeding techniques are not also adopted, most farms will be hard-pressed to weed all the fields at the proper times by hand.

For crops grown on ridges and for crops requiring hilling after they have begun growing; the adjustable ridger is the appropriate tool. It should be set to dig at a shallow depth and the wings adjusted to throw soil around the base of the plants.

For crops grown on the flat, there is a wide range of cultivating implements based on the use of spring tines in many different forms. They work at a shallow depth, uprooting weeds and aerating the soil. They do tend to be quite expensive and if they are to be used only for weeding,

it may be more economical to use the peanut lifter blade. Set to bite at a shallow depth, the peanut lifter can do the same job as a spring tine cultivator and it is much cheaper.

These weeding operations can be done by both animals or by a single animal. If the spacing of the crop along the row permits, weeding can be done in two perpendicular directions. If the animals are prone to eat the plants as they walk through the field, it may be necessary to muzzle them.

HARVESTING - The only direct intervention for animal traction in harvest operations currently in use is groundnut lifting. The timing of groundnut lifting will most directly influence how thoroughly the crop is unearthed. If it is done too late and as the ground gets progressively harder, more and more of the crop will be left in the ground. Once unearthed, the groundnuts should be left exposed to the sun for a few days so that they are properly dried.

SCARIFICATION - The idea of using minimum tillage techniques for seed bed preparation, already in use in some areas, is gaining increasing support. This is the other possible use of the spring tine cultivators. In certain areas of the West African region, planting cereal crops before the rains begin is practiced. Scarification facilitates a more efficient use of the first rains.

Both animals should be used for scarification. The depth should be set for about 5 cm. and the field should be worked in two perpendicular directions.

The preceding discussion has presented some general concerns for animal traction cropping techniques. They are intended to refresh what extension agents have already learned in their training programs. The other major use of animal traction is in transport work. Concern should be noted for the load capacity of the various carts and its distribution in the cart. Uneven loading can raise the animals' heads (weight too far back in the cart) and diminish their traction power or it can lower their heads (weight too far forward) and force them to fight against the cart. A poor habit commonly observed is people riding on the tongue of the cart. This makes the work unnecessarily difficult for the animals.

APPENDIX G

CROP MIX

In choosing a crop mix for a particular farm, a number of issues must be taken into account. The crops grown and the amount of each crop grown must meet the farmer's food and cash needs, loan repayments (for animal traction in particular), the maintenance of soil fertility at minimum and hopefully its improvement, and the provision of feed for his work animals. Such crop mixes will vary among projects, and in some cases, even within a given project. Specific mixes will have to be defined for each particular situation by the agricultural service, but some general guidelines can be presented here.

In all situations, attention must be given to the relative prices of the crops, to the reliability of their market outlets and to their relative requirements in farm labor. A common example is the cultivation of cotton. More often than not, cotton is a relatively high-priced crop, both on a per kilogram basis and on a per hectare basis. The market for cotton is always assured in one form or another by the national government. However, in relation to other crops grown in West Africa, cotton has the highest per hectare labor requirements of all crops. Furthermore, the requirement of as many as 6 to 7 insecticide sprayings executed at the appropriate times introduces serious additional risks, particularly if the supply of insecticide and spraying equipment is not reliable and, in some cases, the insecticide itself is not efficacious.

A farm with one pair of oxen, depending on its labor force, will most likely need to work at least 5 hectares. With a larger labor force they could obviously do more, perhaps as much as 8 hectares. The minimum

of 5 hectares is related to the family food requirements and to loan repayments. If the standard animal traction techniques are used systematically, a family of three workers can easily maintain a 5 hectare farm, and very likely even more.

For the sake of this presentation, a family of 10 persons with the equivalent of 3 male workers having 10 hectares of disposable land, of which 6 is cropped, is assumed. Half the crop area will be devoted to food crops. These may include sorghum, maize, millet, cowpeas, and possibly yams. The rest of the land is put into cash crops, such as groundnuts, cotton or rice. In northern Benin, a possible rotation might be yams, a sorghum-maize combination for two years, groundnuts for two years, a year of cereals (probably millet), and followed by four years of fallow. In this case, surplus cereals and yams would be sold. Such a rotation system will supply family food needs, generate adequate cash revenues given average expected yields, and is fairly well-balanced in its nutrient off-take. The two years of groundnuts will help to fix nitrogen in the soil. Also, the two hectares of groundnut hay will provide a valuable dry season feed supplement for the work animals. The manure collected annually should be spread on the two hectares of sorghum-maize combination. If there is additional disposable land, the fallow period should be lengthened.

This example demonstrates the concerns in choosing a crop mix. Specific mixes will vary across the West African region, but they must take into account the food and cash needs, the health of the soil and feed requirements for the animals.

Because animal traction necessitates the clearing of all tree cover, some compensating activity should be incorporated into the crop mix. This

could involve the planting of wind breaks and even a straight-forward tree crop. The trees chosen should also have a commercial value (firewood, fruit, cashews, etc.). Compensating for the removal of tree cover from crop fields helps to stabilize micro-climates, is an anti-erosion technique and can provide another source of income.

APPENDIX H
CREDIT CAPACITY

In most animal traction projects, an assessment of a farm's ability to repay the loan for equipment and, in some cases for animals, is required. In many cases, this may be limited to a minimum crop area in cash crops or it may entail a simplified formal assessment of credit carrying capacity. Even if such an assessment is not specifically required by the project, it can be a useful aid in discussing the adoption of animal traction with farmers.

Depending on the tools a farmer needs and whether or not he will need animals on credit also, the project can provide the annual payment schedule. The extension agent and the farmer must determine what crops and how much of each crop must be grown such that, with reasonable expectations, the farmer will be able to meet the terms of the loan. Perhaps, the key assumption in this calculation is the level of yields. Experiment station work in West Africa can lead one to expect very significant increases in yields. However, in practice these increases (often in the neighborhood of 100%) are seldom, if ever, enjoyed. A wiser, more conservative technique is to use current average yields in the area. This will result in a conservative estimate of gross revenues which, on the one hand, takes into account, in an informal way, risk and on the other hand, understates the case for animal traction.

The following example is taken from the preceding appendix on crop mixes. The area is northern Benin and the prices are from 1976. In this project, credit is not available for animals. A full set of equipment,

including a cart, but not a seeder, costs about 75,000 CFA and the loan was for 5 years at 6% interest. This amounts to a 17,805 CFA annual payment.

GROSS CROP REVENUES

| CROPS | AREAS | AVE. YIELDS | PRICE | GROSS REVENUES |
|---------------|-------|-------------|--------|----------------|
| Yams | 1 ha. | 5000 kg. | 20 CFA | 100,000 CFA |
| Sorghum/Maize | 1 ha. | 700/300 | 30/30 | 21000/9000 |
| Sorghum/Maize | 1 ha. | 700/300 | 30/30 | 21000/9000 |
| Groundnuts | 1 ha. | 800 | 40 | 32,000 |
| Groundnuts | 1 ha. | 800 | 40 | 32,000 |
| Millet | 1 ha. | 700 | 20 | 14,000 |

Gross cash revenues would include all the groundnuts, and perhaps 700 kg. of grain and 1,000 kg. of yams for a value of 105,000 CFA. This calculation uses modest yields, does not include other sources of income, such as transport and appreciation of the animals, nor does it include the other costs of farm inputs. Nevertheless, it can be readily calculated in the field and provides an indication of loan repayment feasibility. In general, it is unwise for the annual loan repayment to exceed 25% of gross cash revenues. Depending on the training of extension agents, more detailed assessments of credit carrying capacity can be conducted. This is presented as a minimum necessary technique only. Its use is intended more as an aide to farmers in deciding whether to adopt animal traction or not and, if so, in choosing their equipment package. Eliminating the cart, for instance, would reduce the annual payment to 11,870 CFA.