SECTION IV: SUMMARIES OF SMALL GROUP DISCUSSIONS

GROUP ONE: PRECONDITIONS FOR SUCCESSFUL ANIMAL TRACTION ADOPTION

REPORTED BY: PAUL STARKEY

Group discussions aimed to identify conditions that could be considered prerequisites for success in animal traction. Such preconditions were broadly defined as exogenous, resulting from the environment in the broadest sense (agro-climatic, social, economic and infrastructural environments) or endogenous, being characteristics of the farm or farming family. Questions were posed as to whether certain endogenous resources, technical skills or management abilities were essential to the successful adoption of animal traction. By defining such preconditions, it was envisaged that some practical guidelines relating to successful adoption criteria could be presented, through a farming systems perspective.

The success of any animal traction program will depend on a unique combination of exogenous and endogenous factors specific to the area of introduction. The principle factors affecting the adoption of draft animal power differ not only between the different West African countries represented, but even within countries, and within relatively small areas, such as those of the various Togolese projects visited. While the broad categorization into exogenous and endogenous factors can be useful, the complex interaction of the two categories makes precise definitions difficult. Recognizing the great diversity of conditions and the dangers of generalization, some very broad observations can be made. These may be considered under the broad headings of the profitability of draft animal use, socio-cultural factors, knowledge, financial resources and the availability of appropriate services. It is emphasized that these headings are neither comprehensive nor discrete categories, and in any situation there is a complex interaction of the various factors.

PROFITABILITY OF DRAFT ANIMAL USE

For animal traction to be viable, the use of the draft animals must be either economically profitable or have distinct social benefits. In cases where work animals are used solely for transportation, forestry operations or for powering pumps or machinery, profitability will depend largely on the availability of animals, labor and feed resources and the relationship between operating costs and the income or benefits obtained. Farm profitability depends on numerous complex and interacting criteria, but when animals are used for crop cultivation the following prerequisites may be defined.

1. Land.

Farmers must have reliable access to land of appropriate quality and quantity. The minimum area of land will vary with cropping intensity and

the value of the crops produced, and so will be highly area-specific. Farmers with land areas below the critical minimum may still use animal traction through systems of hiring or communal ownership.

2. Agro-climatic factors, soil conditions and availability of natural pasture.

Environmental conditions will determine if cultivation with draft animals is feasible, and also whether or not it is profitable. Certain exogenous characteristics such as steep slopes, insufficient rain or soil and low fertility militate against animal traction. Availability of natural pasture will depend on the climate and farming system. While animals can be fed from specially grown forages or purchased feeds, the introduction of draft animal technology is likely to be more successful in areas of adequate natural pasture.

3. Labor.

Availability of labor is a critical endogenous factor affecting draft animal use. Use of draft animals requires labor for cultivation operations or transport, besides the care and maintenance of animals throughout the year. The labor required may involve several members of a farming household, or labor may be hired. The use of draft animals for plowing large areas can create labor bottlenecks at other times, for example, at weeding or harvesting. If there is gender partition of farming operations, which is common, the use of draft animals may decrease the labor of one sex while inceasing that of the other. The profitability of animal traction will increase as more labor-saving operations are used. Efficient management of operations and thorough training of cattle can save labor, for example by having one person control a pair of oxen; but such labor use is rare in West Africa. An important criterion is that the labor required for care and maintenance should not distract from other important farm operations.

4. Adapted animals.

For animal traction to be successful, adapted animals (those that are disease-resistant or disease-tolerant) must be readily available. It is stressed that, in village situations, adaptation is much more critical than size. Thus the small trypanotolerant taurines of West Africa are particularly appropriate as draft animals in areas of trypanosomiasis risk. Not only must animals be adapted, they must be readily available, and ease of purchase and resale is particularly important. The combination of adaptation and availability will generally mean that indigenous animals are used, and the use of exotic breeds or novel species is seldom likely to be appropriate. Crossbreeding schemes are unlikely to make a significant contribution to the success of draft animal programs, as they are generally expensive and complicated to manage. There is a complex inter-relationship between the importance of animal adaptation, the availability of animal health services and systems of animal husbandry and nutrition.

5. Existence of adapted cultivation systems.

Successful animal traction requires proven systems of crop cultivation,

adapted to local agro-climatic and soil conditions. Before animal traction is promoted, appropriate cropping systems should have been tested and proven. In a few cases traditional cropping systems may be suited to animal traction. More frequently, changes in fallow length and stumping of land that are associated with draft animal use necessitate new crop rotations or associations to maintain soil fertility.

6. Market for produce.

For animal traction to be successful, farmers must be able to sell produce to pay for implements and other inputs. The use of the word "cash crop" in this instance may be misleading, as farmers may be able to sell the staple food crop to obtain sufficient income. Nevertheless, an assured market for a high-income crop is particularly advantageous to draft animal adoptors. The success of draft animal programs associated with cotton and groundnut marketing operations is of particular note.

The price of the inputs—notably for animals, implements and services required to maintain these—must be proportionate to the benefits gained. In particular the value of the crops produced must be commensurate with the overall costs of animal traction. Several case histories discussed in the workshop illustrated the problems farmers face when offered expensive equipment packages while the value of their production is low.

SOCIO-CULTURAL FACTORS

The social environment must be supportive of farmers adopting animal traction. Previous knowledge of animal husbandry is not a prerequisite and animal husbandry skills are not limited to certain ethnic groups. Nevertheless, familiarity with animal husbandry is clearly advantageous. The local population must be prepared to accept the principles of animal traction so that individuals can learn the necessary skills. The importance of status should not be underestimated, for animal traction may be adopted even when apparently unprofitable if it confers enhanced social status. The natural tendency of farmers to diminish their risks may be significant, and the decision to adopt or not adopt animal traction may be based on whether it is perceived as basically spreading risks, or whether it makes the farmer more vulnerable to exogenous variables over which the farmer has little or no control. The division of farming roles between men, women and children in a farming society may influence the adoption of animal traction. Investment in animal traction is more likely if the investing heads of households have their own labor diminished, through the use of the draft animals. It must be stressed that such socio-cultural factors are not fixed, and can change with time. In addition to the exogenous socio-cultural environment, the endogenous motivation of individual farmers is a prerequisite for successful adoption.

KNOWLEDGE

Before farmers can adopt draft animal power, they must be aware of its possibilities. This is an endogenous precondition. However, knowledge comes through contact with external sources, by seeing other farmers using animal traction, by hearing descriptions of draft animal use or from specific publicity activities such as agricultural shows or demonstrations.

FINANCIAL RESOURCES

Adoption of animal traction involves considerable capital investment in animals and equipment. Farmers must either have sufficient resources to allow this investment or they must have access to a form of credit, which could be provided through traditional, modern, commercial, governmental, or NGO credit arrangements. Farmers already owning suitable animals require much less capital or credit to enable them to employ draft animals. While not a precondition, appropriate animal ownership is a marked advantage in favor of successful animal traction adoption.

SERVICES

Successful adoption of animal traction requires the provision of certain external services to support the farmer. These services may be provided by other farmers and traditional expertise, by modern commericial agencies or by governmental or NGO development agencies. It should be stressed that governmental provision of these services is not a precondition. Historically, the development of draft animal use in Europe, North and South America, Asia, and North Africa did not involve significant government intervention or formal development projects. In these cases, the diffusion of knowledge and the provision of training services, health services, equipment and research and development activities have involved traditional artisans, entrepreneurs and local initiatives. There is ample evidence from the rest of the world, and even West Africa, that draft animals can be introduced and sustained through private services, whether traditional or modern. Animal traction technology frequently diffuses over international boundaries, where it may be sustained without any direct government-sponsored interventions. Farmers can provide their own research and development, adapting their cultivation systems and equipment to find ways of improving the technology. Nevertheless, throughout Africa animal traction is being promoted by agricultural development projects and government services. Short-term projects may speed the rate of adoption, but in the long-term such activities are unlikely to maintain animal traction if other preconditions, notably socio-economic profitability, are not met.

1. Equipment, spare parts and repair services.

Farmers require access to appropriate equipment and maintenance services. In many African countries appropriate animal traction equipment is not readily available, and its provision may be a precondition to successful introduction. The mere sale of such equipment is not sufficient, however, for farmers must be able to readily obtain spare parts and repair services when equipment fails. Village blacksmiths frequently provide such services, and may be vital to the success of animal traction programs, but they are frequently constrained by difficulties in obtaining raw materials. Such a secondary factor can indirectly constrain draft animal adoption through the restriction of a vital service.

2. Health, husbandry and nutrition services.

The degree to which farmers require animal health and nutrition services, including husbandry and management advice, depends largely on the

ecological zone and the previous animal husbandry experience of the farmers. In places of long term draft animal use, traditional skills and resources have been used to provide management and health care. However, many projects introducing animal traction have experienced high mortality rates, often associated with the movement of animals, the use of unadapted breeds or species and insufficient attention to nutrition factors. In such cases, the provision of appropriate animal health services is a prerequisite. In particular, prophylaxis or treatment for trypanosomiasis may be critical in much of West Africa. For the long-term viability of animal traction, husbandry practices must be well adapted to the environment, and, in general, greater attention should be given to traditional systems of maintaining animal health.

3. Extension and training services.

In areas where animal traction is clearly beneficial, farmers will obtain information and advice from other farmers, and may obtain assistance in training through hiring the services of others with appropriate skills. Thus the provision of government extension workers need not be a precondition for successful animal traction adoption. However, in areas where there is little experience of draft animal use, extension and training services can speed rates of adoption, or can improve management techniques, provided an adapted cultivation system has evolved or has been developed. Inappropriate extension can actually retard farmer adoption, as other farmers see the problems encountered by early adoptors taking unsuitable advice.

4. Research and development services.

Preconditions for the success of animal traction include the existence of appropriate cultivation systems, adapted equipment and suitable systems for maintaining the health and nutritional status of animals. Such systems come from adaptive research. Throughout the world, innovative farmers have carried out their own research, and consequently, over time, have developed highly adapted systems of draft animal utilization. Historically, in most parts of the world, innovations in animal traction have been developed and spread by progressive farmers, and not by government research bodies. However, in many parts of Africa, proven systems of animal traction use have yet to be developed, and in such cases the provision of appropriate research and development services would be a precondition to any animal traction program. Such research should start with the farmer, and should be carried out on a multi-disciplinary systems basis. Studies focusing only on one factor, such as equipment, nutrition, health, crop-rotations or socio-economic factors are unlikely to meet the necessary preconditions for an appropriate, adapted system of draft animal utilization.

PRACTICAL IMPLICATIONS OF THE DEFINED PRECONDITIONS

In any region, country or area there will be a unique combination of endogenous and exogenous factors that will determine whether or not animal traction is appropriate. Prior to any animal traction research or development activity, a farming systems-based socio-economic study should be performed to ascertain the various economic and social costs and benefits of using draft animal power. Such a study need not be a

comprehensive baseline survey with statistical analyses; more subjective, broad-based assessments can usually identify the major limiting factors.

Following such a study, it should be possible to decide whether or not animal traction is socially and/or economically profitable. A note of caution is required here, for experience from numerous West African animal traction programs suggests that in many project appraisal documents, animal traction has been said to be profitable, while subsequent evaluation documents have highlighted the problems of unprofitability.

If the initial study indicates that animal traction is socially and economically beneficial, then factors that are limiting the rate of adoption or the efficiency of utilization can be defined. These factors include land, agroclimate, labor, adapted animals, adapted cropping systems, marketing opportunities, price equilibria, socio-cultural factors, knowledge and financial resources or the provision of appropriate services (see Fig. 3). One choice that can be made by the national government, agricultural project or development agency is to allow the technology to develop without intervention (which should be possible given its social and economic profitability). The alternative decision is to intervene to speed up the rate of adoption, or increase the efficiency of utilization. Such intervention will inevitably involve costs, so emphasis should be placed on the most cost-effective methods of intervention. This will almost certainly mean concentrating resources on those factors which are seen to be limiting. For example, if capital is limiting, then credit may be required; if knowledge is limiting, then extension services may be desirable; if animal health is limiting, prophylaxis may be indicated. It may also be prudent to initiate farming systems research to identify methods of further improving profitability and efficiency of utilization. The result of such interventions should be increased rates of adoption and/or improved efficiency of draft animal utilization. This is illustrated schematically on the left-hand side of Figure 4.

If an initial study indicates that animal traction is not economically or socially profitable given prevailing conditions, then a policy decision is required by the national government, agricultural project or development agency that will determine whether or not to intervene to change the cost/benefit equilibrium of animal traction. If the decision is for non-intervention, then animal traction is unlikely to be adopted, as farmers will reject the technology due to its social or economic unprofitability.

If a policy of intervention is chosen, it will involve costs to the government, project or development agency, and so resources should be directed at the key limiting factors. For example, direct or indirect subsidies can decrease farmer costs, farmer income can be increased by changing pricing or marketing policies, or subsidized services may be provided. Such interventions may then make animal traction profitable for individual farmers, which can be confirmed by a reassessment of the socio-economic study. If this is the case one re-enters the schematic diagram (Fig. 4) at the point of profitability. Many examples of such interventions exist in West Africa, where decisions taken at national or project levels provide resources that alter existing cost/benefit equilibria to make animal traction adoption possible. Such decisions may

be taken for social reasons, or more often in the belief that animal traction will become profitable and self-sustaining once a certain level of adoption is reached.

An alternative strategy, which may not be mutually exclusive, is to initiate farming systems research with the aim of identifying improved systems of utilization that can make animal traction socially and economically profitable. Such research would be multidisciplinary, but would concentrate on identifying limiting preconditions. For example, if natural pasture was found to be limiting, research could concentrate on systems of improving animal nutrition; if equipment costs were seen to be critical, emphasis could be placed on developing less expensive equipment or developing systems to improve the efficiency of equipment. Such interdisciplinary research may result in more intrinsically profitable systems of animal traction being identified, in which case, following re-assessment, one re-enters the schematic model at the point of profitability, as illustrated in Figure 4.

CONCLUSIONS

The diversity and complexity of farming systems makes it impossible to provide a definitive list of preconditions for successful animal traction. Nevertheless, some generalizations have been presented, and these fall into five broad interacting categories: socio-economic profitability, socio-cultural factors, knowledge, financial resources and the availability of services. It is of particular note that several commonly held perceptions of prerequisites are not considered as essential preconditions. For example, previous animal husbandry experience, animal size, and the provision of project or governmental services are not essential to the long-term success of animal traction, although they may be important factors in determining the speed of adoption. Using the principle of limiting factors, a schematic model has been presented. The model is necessarily simplified, for it represents extremely complex combinations of interacting social, economic and environmental criteria, which are not constant, but which evolve with time. However, it is intended that such an approach may allow a farming systems research perspective to assist in decision-making at the national, project or development agency level.

FIGURE 3.

SUMMARY OF PRECONDITIONS FOR SUCCESSFUL ANIMAL TRACTION

	EXOGENOUS FACTORS	ENDOGENOUS FACTORS
1.	FARM PROFITABILITY	
	a) agroclimate, soil types,	land availability
	b) availability of natural pasture	
	availability of natural pasture	
	c)	labor availability
	d) availability of adapted animals	
	e) existence of adapted cultivation system	
	f) market for produce	
	g) price of inputs relative to sale price of produce (equilibrium of costs and benefits)	
2.	SOCIO-CULTURAL FACTORS	
	social acceptance	farmer motivation
3.	KNOWLEDGE	
	information or examples	knowledge
4.	FINANCIAL RESOURCES	
	credit	capital
5.	SERVICES (traditional, governmental or commercial)	
	a) equipment/spare parts/repairs	
	b) extension and training	
	c) animal health and nutrition	
	d) research and development	

FIGURE 4.

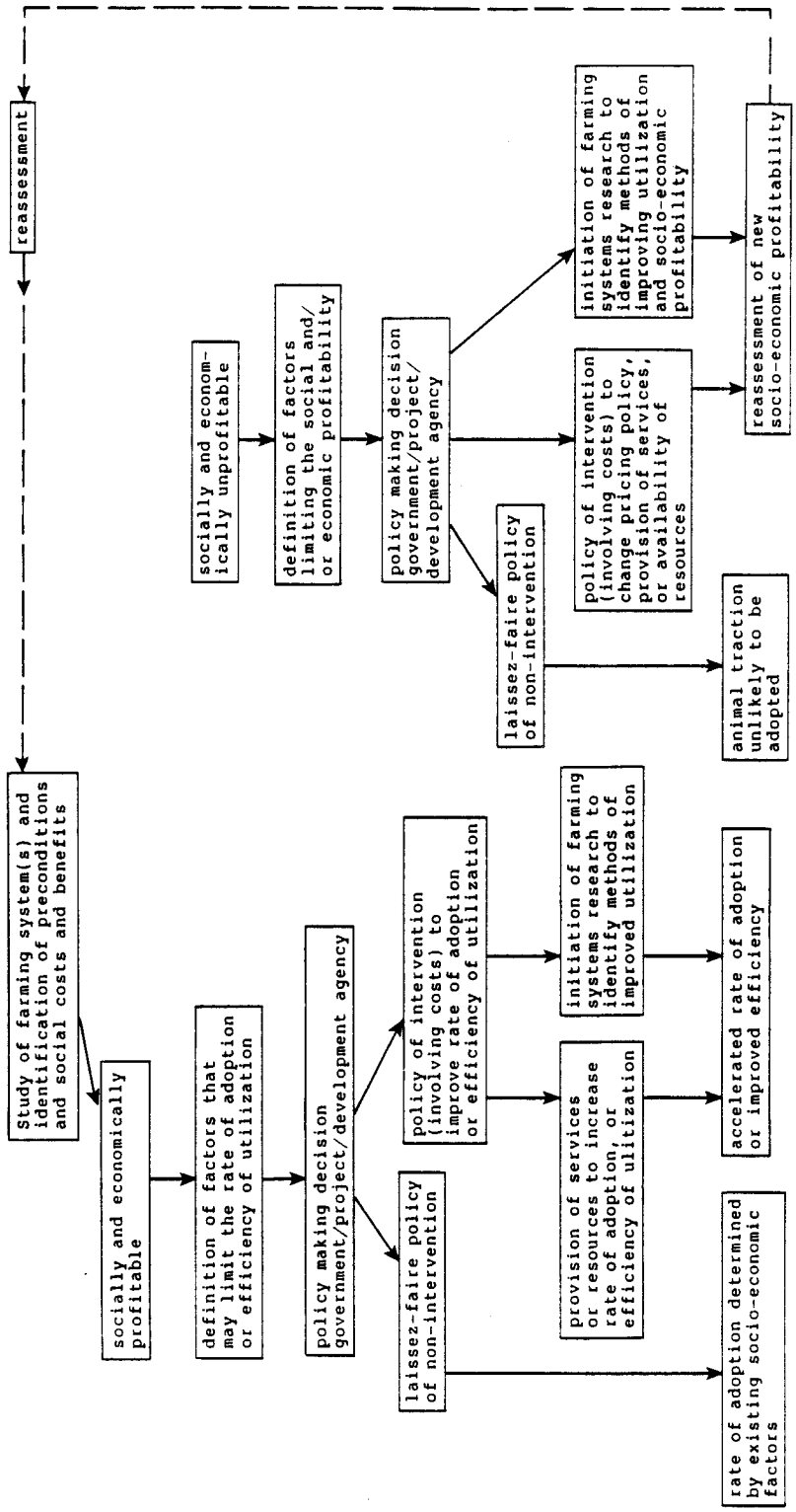

Figure 4. MODEL OF IMPLICATIONS OF IDENTIFYING PRECONDITIONS FOR ANIMAL TRACTION ADOPTIONS

GROUP TWO: FEED RESOURCES AND ANIMAL FEEDING

REPORTED BY: SANDRA RUSSO

A major problem facing livestock in West Africa is feeding and maintenance of animals, especially during the dry season and into the start of the rainy season. Our charge was to discuss the major problems facing livestock owners (particularly draft animal owners) and to come up with viable short and long term solutions to the problems of animal feeding.

PROBLEMS

Four basic problem areas relating to draft animal feeding in West Africa were identified :

1. Use of animals part time or full time;

2. Feeding programs ranging from no selective feeding through some attention paid to feeding all year;

3. Tradition of livestock ownership and rearing; and

4. Feed availability, climate, land pressure, cultural biases, and water availability.

USE OF ANIMALS

Farmers having draft animals do not necessarily utilize them continually or at the same level of work during the year. Some animals may only be used for plowing, others for additional agricultural operations (ridging, cultivating, harvesting, groundnut lifting, etc.) or for transport and some animals are used for both agricultural work and transport. While it appears obvious that the different work loads to which animals are subjected would require different levels of feeding, it may or may not be obvious to the animal owners. In a situation, for example, where animals get no supplemental feed and are expected to obtain their nutrient requirements from bush grazing: at the beginning of the planting season a hard working animal may not have enough time in the day to graze or may be too far from the bush to get to the grazing that is available. As another example, a pair of oxen used for both agricultural work in the rainy season and for transport in the dry season have different ration needs at the different levels of work, and may require no more than a minimum maintenance ration for the latter.

FEEDING PROGRAM

The range of feeding practices for draft animals goes from zero selective feeding to some selective feeding year-round. In the more humid areas of West Africa (e.g., Sierra Leone), biomass production on the natural grasslands is more than adequate to meet nutritional needs of livestock, including draft animals. In northern Togo, farmers practice

some selective feeding of their animals. Depending on resources available, they may use cottonseeds or groundnut hay as additions to the natural grasslands during the dry season. Farmers in semi-arid areas (e.g., The Gambia, northern Senegal) use their draft animals almost all year, primarily for transport. The animals are very important in the farming system (i.e., valuable) and consequently are rarely left alone to graze. They are fed either near the owner's compound or in the immediate vicinity of the village. Owners must therefore provide for some sort of year-round animal feeding.

TRADITION OF LIVESTOCK OWNERSHIP AND REARING

Farmers now using animal traction in West Africa can be divided into two broad categories:

1. Those farmers with only cropping experience who have never owned large livestock and

2. Those farmers with livestock experience as owners or herders. In this category are also:

   a. Farmers who have managed animals for transport (donkeys, horses, camels) but not for agricultural work; and

   b. Farmers who have managed agricultural work animals (usually oxen) but not transport animals.

Without going into even more categorical detail, the problems of animal feeding would be seen from a different perspective by each category of farmers. Crop farmers are presumed to have the least knowledge of animal nutrition while those farmers who have owned only non-ruminants (donkeys, horses, pigs, poultry) have a view of animal nutrition that would require some modification.

FEED AVAILABILITY

Factors affecting feed availability for draft animals include:

1. Climate

2. Land pressure

3. Cultural biases

4. Water availability

This listing should not be interpreted as all-inclusive. Many other factors also affect feed availability.

In semi-arid zones, a greater need exists for a fodder program. Long dry seasons and usually sparse vegetation (less biomass) predicates a supplemental feeding program. In semi-arid areas, there are more animals per area despite the limited biomass resource, implying a relationship with disease factors (less incidence of disease). In humid areas, with greater

biomass production and increased incidence of disease, less attention is paid to feeding programs and supplemental feed.

Land pressure in West Africa manifests itself in several ways vis a vis animal feeding. In a few countries urban and suburban areas have a large population of transport animals with almost no access to grazing. These animals rely entirely on purchased feeds of various natures.

Land pressure around village areas means that there may be little, if any, land available in fallow or permanent natural grassland. No room exists for pasture crops or the pasture areas are located far from the village and work areas. Usually in West Africa there is no land ownership by individuals. A farmer therefore has no incentive to improve the land, to plant pasture or forage crops, or to make a dam or a well, when there is no assurance that land will remain under his or her control in the next season. Where usufruct rights (rights to use) to land exist for at least a few years either by tradition or authorities, inability to control migrating herds may still make land improvements uneconomical.

Areas which have no history of animal use may impose actual physical barriers to feed availability in that access to grazing and watering areas may not exist and the necessity for such passage may not be recognized or honored. There may be a tradition of resentment or fear of livestock and their owners, particularly seen in clashes between crop farmers and transhumant peoples, that could also affect feed availability for other animals.

SOLUTIONS

While the problems were broken down into four areas specifically related to feed availability and management, the solutions were more systems-oriented and seen as vertical. Solutions were listed as:

1. The need for farmers to recognize the nutritional needs of their livestock;

2. The need for on-station and on-farm research on developing better/more feed resources;

3. The need for information transfer to farmers via various channels;

4. The need to increase feed supply; and

5. The need to assess water and passage problems.

RECOGNITION OF NUTRIENT REQUIREMENTS

Farmers with no tradition of livestock rearing must have nutrition information included when they are introduced to animal traction. Those farmers already using animals and/or animal traction probably need more detailed information on variation in nutrient requirements depending on work load, season, availability of feed, etc.

ON-STATION AND ON-FARM RESEARCH

Both on-station and on-farm research should continue to be supported by national programs and donor agencies. The history of forage research and techniques of crop residue management is very short in West Africa. While researchers can certainly learn and apply results from the rest of the world, it cannot be assumed that results will always be applicable to West Africa. Research on testing of forage legumes, for example, has only begun recently in many parts of Africa and in most cases the quantity of seed available is too small to be used for other than experimental purposes. Mechanisms for seed multiplication have to be established so that promising varieties can be tested on farmers' fields.

On-station research must be kept closely tied to the real world of the farmer. Experiments on silage-making or treating low-quality feeds with chemicals to improve the digestibility are often of no more than academic interest as the farmer is unlikely to be able to afford the resources (forage chopper, alkali, etc.) to produce such feeds. Even research on management of crop residues (stocking, stacking, storing) may seem low-cost if the labor required to cut, stack, and transport is not taken into consideration.

Agronomic research on forages and feeds is a long-term prospect and the questions to be answered may seem infinite. Caution must be taken to avoid trying to answer all quesions in one experiment in the rush to get information to the farmer. The urgency exists but it should be tempered with sound scientific reasoning.

INFORMATION TRANSFER TO FARMERS

Farmers can receive information on animal feeding and nutrition through several channels:

1. Extension and research staff;

2. Mass media;

3. Farmer organizations; and

4. Other farmers.

The research and extension staff may need training themselves in animal nutrition especially in areas where draft animals have recently been introduced. In FSR/E, links are presumed to exist between research and extension staff but not all projects have an FSR/E focus and not all projects have such linkages. These linkages should be encouraged at the national level in order for extension agents to pass information on to farmers and for farmers to be able to tell researchers (via the extension agents) their reactions to the new research.

In West Africa, radio can be a powerful tool for extending information to farmers. Newspapers are less likely due to their urban focus, distribution pattern, and the illiteracy of the rural population, especially among women.

Farmers clubs, committees, and organizations are other useful means of

communicating information. In areas where extension programs are non-functional due to lack of mobility, a surprising amount of information still manages to get around. Ideally, of course, regular meetings of extension and research staff should be held with farmers' groups not only to pass along information but to answer questions and clear up possible misunderstandings.

INCREASING FEED SUPPLY

Mechanisms for increasing the feed supply are many. They may be location specific, but often are not, and can be used not only for draft animals but for other ruminant livestock as well.

1. Encourage the farmers toward better storage and management of crop residues already produced. In most instances, after harvest residues are left in the field for animals to eat but a high percentage of the residues are wasted because of trampling and scattering. Not all residues could or should be stored because in the typical low-resource farming system, residues and manure provide the only organic matter/fertilizer for maintaining soil fertility. Some of the residues could be stored and saved; the rest left scattered in the field. The former is a key issue as farmers generally let their animals graze the croplands right after harvest when the natural grasslands are still highly productive. Saving some of the crop residues would extend the feed supply longer into the dry season.

2. Since the use of animal traction allows the farmer to increase crop acreage, there should be more crop residues produced and, hence, more feed available.

3. With increased acreage due to animal traction, the farmer could produce more of certain crops with dual purposes, e.g. groundnuts as a cash crop and groundnut hay.

4. In humid regions, cut-and-carry supplemental feeding of locally adapted grasses (e.g. Napier) could be a cost-effective means of feeding draft animals.

5. Another location specific source of feed is the cutting of grass to make hay (e.g., Andropogon in The Gambia) or making silage in small pits or containers (e.g. northern Ghana).

6. A sensitive issue is the improvement of fallow and grazing lands. Technically, it can be done but the questions of land tenure and resource availability (including farmer knowledge and willingness, seed, fertilizer, herbicides, etc.) make this problem a very difficult one for which to provide generalized solutions.

7. Nigeria, notably, has been experimenting with alley cropping, fodder banks and living fences. This research is in the pre-extension stage and seems to be applicable to the more humid regions of West Africa.

8. After the first or second weeding of a cereal crop (maize, sorghum, millet), a legume intercrop could be seeded to provide either a legume hay or grazing for the next dry season. Seed would have to be readily available (e.g., cowpeas) and inexpensive so the farmer would have some motivation for doing the extra work. Preliminary results with relaying Stylosanthes in The Gambia (seed is not commercially available) indicate that the legume can provide grazing midway through the dry season and that the re-seeding and presence of the legume could be beneficial to the next season's cereal crop.

9. The feed needs of urban transport animals has already been discussed. In northern Senegal, for example, entrepreneurs travel as far south as The Gambia or Casamance to purchase groundnut hay, primarily for horses. Production of groundnuts as two cash crops (nuts and hay) could become economically very interesting to rural farmers.

10. Most of the cash crops produced in West Africa (cotton, goundnuts) produce by-products. If these are not also exported, the agro-industrial by-products could be an important source of feed for draft animals. In Togo, for example, trucks travel throughout the country collecting cotton. Generally empty trucks leave the factories en route to cotton sellers. The trucks could carry cottonseed to the farmers rather than traveling empty. A problem with this very practice occurred in Southern Mali where farmers routinely purchased cottonseed for livestock feed and were left with a major gap in their feed supply when suppliers began to export the cottonseed.

ASSESSING WATER AND PASSAGE RIGHTS

Access and availability of water is a political-ecological issue. More boreholes means more livestock, especially in semi-arid zones where existing vegetation cannot support current herd levels. Water issues were not discussed except as related to passage rights. When farmers begin to see the benefits of animal traction, especially access to transport of crops to market, water and passage rights may be increased to allow draft animals to get to grazing areas and watering holes and to allow for road-widening so that carts can pass.

GROUP THREE: METHODOLOGIES FOR ON-FARM EXPERIMENTATION WITH ANIMALS

REPORTED BY: JAMES OXLEY

LACK OF PRECEDENTS

A major concern expressed by the group was the paucity of examples of and experiences with on-farm trials involving animals. The FSSP Livestock Task Force identified this as an area of need and as a result the FSSP, in cooperation with the International Livestock Center for Africa (ILCA), has been encouraged to co-sponsor a workshop in Africa on this specific subject June 23-28, 1985. A few cases of on-farm research in which animals are involved can be cited but most research with farm livestock has been done on research stations without being tested on farms. Some research is underway on draft animals in West Africa where feed, equipment, types of animals and other interventions are being tested but the results are preliminary and the methodologies involving livestock illustrates to some degree the difficulties and problems encountered in conducting integrated animal-crop research, particularly from the farming systems perspective. While the interdisciplinary approach is basic to FSR/E, the tendency has been to exclude the animal component because it complicates the analysis or seems complicated by its very nature.

COMPLEXITY OF PROBLEMS

The animal itself is a complex biological system which involves such parameters as health, nutrition, genetics, reproduction and behavior, any one or combination of which lend themselves to possible interventions. Also the multiple uses to which animals are put complicates the issue. For example, some bovines are used primarily for draft purposes but ultimately also for meat. Others are kept for only meat and/or milk. Despite all these factors which can make for a complex situation when one looks at the animal within the farming systems context, the group agreed that it should direct its efforts toward the principles of on-farm experimentation, leaving the details of design and statistical snalysis to the researchers who will have to develop these for any given intervention.

ON-FARM TRIALS

Dr. Zandstra's remarks in his keynote address provided the background for the group's discussion. He pointed out that good farming systems research methodology is applicable to livestock in mixed farming systems. As characteristic of all farming systems research, each trial must respond to the farmer's needs, which have been identified by the researchers during the diagnostic phase. For example, the objective might be to identify a way of providing more fodder (through introduction of a forage crop) for a pair of oxen at the end of the dry season in order to improve their condition for the oncoming plowing season. At the same time the technique of conducting forage trials on a nearby research station or extension farm may be necessary where different forages or forage systems (crop rotation) are being explored and the variables measured. On-station oxen trials, paralleling those on farms, can provide supporting information. From the

on-station information the most promising intervention can be tested on farms. Feedback from the farm trials will help the researcher in his or her station experimentation. Also, it is important for extension personnel to be informed and involved in both the on-station experimentation and the on-farm trials.

The important concepts of on-farm trials may be outlined as follows. The participation of different disciplines is of great importance. In the example above, the need exists for an animal scientist, agronomist and agricultural economist working together from the planning through the completion stages. Starting with a clear definition of the objectives, the trial must include the variables to be studied (time of planting, time of feeding, amount of feed consumed duration of feeding, etc.). Then the measurement methods need to be determined (weight or estimated volume of forage grown; body weight or body measurements and/or body condition scores of oxen; endurance recovery periods of oxen measured over time). Regardless of what measurements are used, it is important to limit them to only key measures and keep them as simple as possible. Though subjective, much information can be gained from recorded observations of changes in animal feeding, working and behavioral patterns.

The sample and design phase of on-farm trials requires the designation of the experimental unit (perhaps a 1/2 ha field for forage production, or a pair of oxen for the animal unit). The number of replications for the suggested trial should be a minimum of six farms, each with a pair of oxen and a similar area of forage production; and another six farms identified as the control or check farms which represent the traditional system.

A schedule of measures plotted over a given period of time will enable the researcher to plan and to secure data in a timely manner. Forage supplementation would likely occur during the last one or two months of the dry season and for the first month of the rainy season (with the schedule determined by on-station trials or the best judgement of the researchers). A minimum of one year duration, completing a normal yearly cycle, is recommended for a forage oxen trial as described here. Second and even third year trials should be considered as a means of confirming the intervention and measuring year-to-year effects.

Careful selections of cooperators must be stressed, as they are the key to successful on-farm testing. Researchers will have to rely on the judgement of extension agents, other farmers or area leaders plus information gained from interviewing farmers and from the diagnostic survey.

In the execution and monitoring of on-farm trials, the researcher/extension worker will need to develop a good relationship and understanding with farmers. This is done by getting their confidence through visiting farms at frequent intervals; keeping farmers informed of progress and results on their farm and on others' farms; holding key field days; and in general by conveying an attitude of caring, concern and helpfulness. It is important for the person in charge of on-farm testing to make sure the exact treatments are implemented, and, particularly with livestock, that careful monitoring is done on the feeding, working schedule, and general health and condition of the oxen.

The farmer must be protected against undue risks as a result of participating in the trials. In cases where animals can be adversely affected by a treatment, the farmer must be assured against personal loss. Project resources are often used to make up any losses accruing from experimentation.

Insofar as data collection and analysis are concerned, the person in charge of on-farm trials will need to develop field and animal plans and appropriate forms on which to record data and other observations. With some animal feeding and management trials, high costs and operational complexities dictate that careful and exhaustive analyses be done. In addition to establishment of treatment differences, the analyses should stimulate the impact of the partial results on the whole production system (for example, the effect of improved oxen nutrition on the farm production system). For the first level of analysis, generally simple analytical methods are used. It is important that as many non-treatment effects as possible be removed by statistical analysis.

Finally, economic analyses are conducted by using a partial budgeting procedure to compare treatments. In the case of a forage oxen trial it will be necessary to assess the costs and benefits of this intervention on the whole farm. In the process, conflicts between resources (labor, other crops) will be identified and qualified in economic terms that can be related to the farmer.

GROUP FOUR: MANAGEMENT OF TECHNOLOGY

REPORTED BY: JOHN LICHTE

What management (technical) capabilities does a farmer need to use a technology like animal traction to advantage? What information or training should be provided to help facilitate adoption?

This group focused very strongly on problems at the farm/farmer level. Initially there was a tendency to assume that the technology and project recommendations were all adapted and appropriate and that farmers who did not use the technology as recommended were poor managers. This created a lot of discussion, which caused the group to refocus their presentation and look at the responsibility of projects to adapt a technology so that it responds to the needs and constraints of local farmers. Information must be readily available or training provided in order for farmers to learn to use a technology quickly and well.

Some of the potential solutions to resolve problems of management of technology at the farm level are given below.

ORGANIZATION AND MANAGEMENT OF THE FARM

The group decided that adaptive research and extension at the farm level using the FSR/E approach would be helpful in developing systems which satisfy farmers needs. Farmers need a mix of food and cash crops appropriate to their conditions, both technical and socio-economic as well as agro-climatic. New adopters require several years to learn to use a new technique effectively, whether it be plowing, weeding or using fertilizer. Effective management of a number of techniques combined in a package requires even longer. Farmers who do not have the high technical level necessary to profitably produce a crop like cotton need an alternative cash crop until they obtain the necessary technical skills. The crop mix may also need adjustments to include the production of some forage for dry season feeding. Crop diversification makes it easier for farmers to find the means to meet their own needs.

Certainly the integration of livestock into the farming system can make an important contribution to helping farmers maintain soil fertility. Including crop residues in manure or compost and returning them to the field can have an important impact on soil structure and fertility and reduce the need for purchased fertilizer. In most cases, the use of fertilizer or manure should be considered for a whole rotation, rather than on a per crop basis. A rotation which includes an element which could be plowed under as green manure would be good, but it is difficult technically and socially in West Africa. Cropping patterns may also require adaptation before some animal traction techniques can be used. Monocultures have traditionally been recommended to facilitate the use of animal traction weeding, ridging, etc. Planting intercrops between plants in the row (rather than between rows) will also allow animal traction weeding, without greatly disturbing a useful crop association. Relay cropping can also improve land productivity without impeding the use of animal drawn

equipment. Flexibility is important. Not every crop or field on a given farm has to be weeded and ridged using animal traction in order to reduce a labor bottleneck. Certain crop associations may be worth keeping even if they interfere with animal traction field activities.

The final point raised under general farm management is the need for farmers to replace aging oxen and perhaps equipment. Farmers should be trained to recognize the need to replace animals and equipment, and encouraged to set aside money over time so they have the means to do so.

ANIMAL MANAGEMENT

Farmers need to accept limits on the amount of time oxen work so that the oxen's health is not compromised unnecessarily. A reasonable rule of thumb might be four to five hours a day. This also applies to farmers' groups. One group contacted on the field visits had worked 22 ha over a short period with one pair of oxen. One of the oxen died while working. Projects must look carefully at the relationship between needs and means and be aware of the information needs of farmers with no cattle raising traditions, i.e. potential causes of animal abuse.

On the other hand, many farmers also need to use their oxen more during the non-cropping season. Partial adopters who only plow may use their oxen only two or three weeks a year. Weeding with oxen will extend their use to several months. Carting activities are particularly interesting because they continue all year long. Unless oxen are used regularly throughout the year, they will have to be retrained each rainy seson as field activities commence. Carting may improve the farming system if used to haul crop residues off the fields and manure or compost back to the fields. It can also help reduce the transportation constraint at harvest. Carting will help with other family needs like hauling wood and water. If carts are not numerous in a village or region, carting for others may provide some cash income. In some areas, oxen are be used for activities like irrigating, pumping water or powering grinding mills.

ANIMAL MAINTENANCE

In many areas farmers do not have experience herding and caring for cattle themselves. These farmers in particular need in-depth training on animal health, care and feeding. This should probably be a precondition to adoption. The extent of such training must be related to farmers' experience with livestock. Knowledgeable farmers may also contribute to such training.

FEED MANAGEMENT

Animal feed resources may be available in surplus over much of the year but feed shortages may occur, particularly during the dry season, for three to five months. One method of trying to balance feed availability over the year is to save crop residues for dry season feeding. Usually animals have more than adequate grazing at harvest time so they do not need the crop residues. If left lying in the field much of the crop residues will be trampled and wasted, if not completely consumed by termites, etc. Collecting these crop residues will be difficult unless carts are

available.

Many farmers do not keep crop residues such as cowpeas and groundnut hay until the dry season because of difficulties in preserving them. Often it is still raining when these crops are harvested, so without drying and some form of preservation they will mold unless used quickly. Drying is usually possible even during the rainy season, but simple means of preservation need to be found. In some areas they are piled on top of shelters, but the quality often suffers. Storage in empty huts is effective and requires no investment if one is available. Thatch shelters or shelters covered with grain stalks would offer protection for hay or legume residues. Drying tripods have also been used successfully in some areas. Farmers generally have not adopted pit silos because of storage problems encountered unless the grass is cut quite fine. The high labor requirements of cutting grass preclude adoption of the technology.

Relay planting of legumes for harvest after the rains can also help resolve the problem of preservation.

EQUIPMENT MANAGEMENT

Farmers should have the opportunity to observe the use of different tools. Whenever possible this should be done by observing other farmers in the area who use the different tools well. Potential adopters can then talk with farmers who use the tool effectively to learn more about how it might be useful to them. In this manner they can make up their own mind about what equipment to purchase and use. Equipment which is not used does nothing to improve the farmers productivity and is a useless investment. Projects should focus their efforts on helping farmers decide what equipment to use rather than insisting that they buy a full set of equipment and assuming it will be used.

Project personnel should make sure that farmers know how to use and adjust equipment correctly, once purchased. Any tool needed to adjust equipment must be readily available. Training on the proper use and adjustment should accompany the sale. Extension agents must themselves know how to use and adjust equipment to be of any help to farmers.

MAINTENANCE AND CARE OF EQUIPMENT

Farmers also need to be trained in the proper maintenance and care of equipment. Equipment should be sheltered, particularly during the rainy season, to protect it from rust. Proper cleaning and oiling of equipment should be demonstrated. Farmers should also be trained to recognize when parts need to be replaced, particularly plow and cultivator points. It is much cheaper to replace points on time than have to replace other parts because there were no points to protect them.

GROUP FIVE: MONITORING AND EVALUATION

REPORTED BY: JOHN LICHTE

The charge for group five was to identify evaluation criteria that would be more appropriate than the number of animal traction units placed, and to consider the principle of identifying evaluation criteria as part of on-going project monitoring rather than a priori as part of project design.

VARYING LEVELS OF EVALUATION

This group had great difficulty finding a common starting point acceptable to all members. The group included individuals who are involved in evaluation at three different levels, each wanting to focus on the level appropriate to their work. One was interested in the type of monitoring which would allow the identification of aspects of an ongoing animal traction program which were not functioning effectively so that the program could be re-directed to be more successful. A second was involved in over-all project monitoring and evaluation, where animal traction is one of a number of components. This person wanted to start with project objectives, establish evaluation criteria based on those objectives, and develop a monitoring program which would collect the data necessary to use these evaluation criteria. A third person was involved in evaluating 20 different animal traction projects in a country with the objective of determining what each project is doing concerning animal traction and trying to coordinate and harmonize credit, provisioning of animals and equipment etc. across projects.

The group found it very difficult to agree on a starting point because of the varying needs of these three different levels of evaluation. Finally, it was agreed that the group would begin with the lowest level of analysis, i.e., that which was most directly focused on animal traction programs and the type of monitoring useful to project managers to redirect those programs over time so they would be more effective. The group would then try to build upward toward project evaluation and evaluations across different projects.

SETTING OBJECTIVES

A general objective or purpose for the use of animal traction also had to be agreed on before additional progress could be made. The objective agreed on by the group was: to increase production in a manner that permits repayment of any credits related to the purchase and use of animal traction technology without any decrease in the farm family's standard of living. It was felt that this combined the social objective of increasing production while considering the minimum short-run objectives of the farm family.

BASIS FOR EVALUATION

Turning back to evaluation, it was agreed that the basis of an evaluation must be a comparison with the situation which existed prior to

the introduction of the project or program. This led to a discussion of how to get information on a situation prior to project influence. A number of persons in the group mentioned that no such information had been collected in their project, making evaluation very difficult. It was quickly agreed that traditional baseline studies requiring one or two years of detailed surveys are not an effective means of getting the necessary information. However group participants did not have easy answers to define the alternatives. It was specified that those activities or factors recognized as preconditions for the adoption of animal traction should be monitored. Some of the information group participants agreed it was necessary to know the situation prior to project influence, and which should also be monitored over time included:

1. The availability of family labor
2. The effectiveness of animal health services
3. The availability of arable land and the manner in which it is used
4. The availability of water and feed resources for livestock
5. Technical level, use of: weeding, fertilizer, carting, etc.
6. Marketing of produce
7. Access to production inputs: credit, equipment, spare parts, fertilizer, etc.
8. The effect of animal traction on the environment: physical; social (women, children, intra-household effects)
9. Evaluation of extension service available to farmers and the content of any training provided
10. Regular surveys of production statistics

MONITORING VS. EVALUATION

This combination of factors to be used in both monitoring and evaluation led to some confusion of the two. It was decided that evaluation could be defined as an analysis of the situation or project results at a given moment in time. Monitoring was defined as follow-up on the application of a program or strategy. A precondition for monitoring is establishing a well-defined program or strategy and taking account of the activities necessary for its execution. Monitoring should consist of the systematic collection of data over time, as well as brief studies of a specific program. Such information may be applied either to redirecting a program to make it more effective or to an evaluation of the results from a specific program and its contribution to the project. Information which would be collected on a systematic basis includes:

1. Area cultivated

2. Crops and crop association

3. Yields (recognizing that these are difficult obtain)

4. Revenue and expenditures (recognizing that these are unlikely to be complete and are affected by consumption)

5. Use of production inputs: fertilizer, manure, improved seeds, etc.

This is the type of information that is objectively verifiable in principle. It should be collected by farm type or by farming system, noting the specific need to compare manual farms with farms using animal traction and with motorized farms using tractors. Most members of the group agreed that an evaluation should be based on objectively verifiable results, i.e., analysis of production related statistics and how they have changed over time. It was agreed that in most cases these statistics would have to be collected by the projects, although there was discussion as to whether or not this could be added to the extension agents existing tasks.

Short-term, specific studies are a necessary complement of systematic monitoring. Examples might include a status report on soil structure or interviewing participants in a training program to learn if the training has been effective. The evaluation of animal traction requires both systematic monitoring and short-term specific studies. Evaluation of the adoption of a technology such as animal traction should be done over the long term, i.e. 10 to 15 years.

FSR/E RESERVATIONS

Only one person in the group had participated in a farming systems orientation. The principle of developing evaluation criteria following the identification of problems during the diagnostic phase of FSR/E was presented. The group generally agreed with this principle. In practice, however, most of the group was interested in developing a system of monitoring which would provide the data for evaluations specified *a priori* during the design of their project.

The use of rapid reconnaissance techniques complemented by very specific and restricted formal surveys was also discussed. Most of the group, having no farming systems research experience, found it difficult to understand how these techniques could be used as the basis for an evaluation. They found it difficult to imagine how such procedures could provide the objectively verifiable data they believed necessary for an evaluation.

On-farm systems research was also discussed briefly. Participants from projects were very skeptical of the utility of research on farms until they became convinced that it would be similar to extension with an experimentation component (*recherche d'accompagnement*).