Farming Systems Support Project

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Washington, D.C. 20523

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TASK FORCE REPORT

ON LIVESTOCK IN MIXED

FARMING SYSTEMS

Prepared for:
University of Florida, Management Entity
Farming Systems Support Project

February 1984

UNITED STATES GOVERNMENT

memorandum

DATE: February 28, 1984

REPLY TO ATTN OF: S&T/AGR/EPP, Wendell E. Morse

SUBJECT: Task Force Report on Livestock

TO: See Distribution

Enclosed for your information, review, and comment is the Task Force Report on Livestock prepared for the Farming Systems Support Project which is led by the University of Florida.

The Livestock Task Force has considered appropriate strategies, research methodologies, network development and training needs relative to the role of livestock in farming systems research and extension.

The report defines livestock; their roles or importance in integrated farming systems; the role of disciplines, training, and orientation of specialists in FSR&E; methodologies relating to approaches, project management, extension, institutionalization, policy, models, and case studies, and training needs. The report contains a bibliography of farming system studies dealing with livestock and related topics.

Report recommendations (see pp. 35-36) will be used by the Farming Systems Support Project to guide its work. It is hoped that AID missions and bilateral contractors will find the report useful as they plan and implement their farming systems projects.

Please direct comments to W. Morse, S&T/AGR/EPP, tel. 235-8946.

Enclosure

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REPORT OF TASK FORCE ON LIVESTOCK IN MIXED FARMING SYSTEMS

A. INTRODUCTION

The Livestock Task Force (TF) on Mixed Farming Systems was charged with developing recommendations for the Farming Systems Support Project (FSSP). In preparing these, the TF considered appropriate strategies, research methodologies, communication network development, and training needs relative to the livestock component of farming systems. The TF saw the livestock dimension of Farming Systems Research and Extension (FSR&E) as being extremely important because most farming systems include an animal component. Also, this area has received less attention than crops and has, in general, been neglected in relation to its potential contribution to the total family enterprise. Moreover, the TF recognized the need for a larger cadre of experienced and trained practitioners who can deal with the complexities of crop/animal relationships and the multiple objectives of mixed farm operations.

The Task Force defined its scope of work to include a definition of livestock; their roles or importance in integrated farming systems; the role of disciplines, training, and orientation of specialists in FSR&E; methodologies relating to approaches, project management, extension, institutionalization, policy, models, and case studies; training needs; and recommendations to FSSP management for future action. Additionally, the report contains a bibliography of farming systems studies dealing with livestock and related topics and the identification of collaborating

institutions and program associates within the FSSP network. The TF limited its scope of reference to livestock in crop/animal systems and did not address completely the pastoral systems per se, though reference is made to the agro-pastoral interface which characterizes some systems, especially in Africa

The TF held its first meeting with interested personnel from the Agency for International Development in Washington, D.C., on June 29, 1983. Over thirty individuals participated in a day-long discussion, which resulted in identifying the issues and needs relative to livestock in farming systems, clarifying the definition of livestock as far as this project is concerned, and suggesting strategies and approaches for dealing with the interrelationships of crop/animal systems. Subsequently, the TF conferred with several members of the American Society of Animal Science during its annual meeting in late July at Washington State University, where a portion of the program dealt with livestock development in the Third World. In early August, some members of the TF capitalized on the opportunity to interact with animal and social scientists attending a conference at the University of Florida on "Overcoming Constraints to Livestock Production in Sub-Saharan Africa." Representatives from a number of universities, the International Livestock Center for Africa (ILCA), FSSP, Winrock International, and AID participated in discussions with the TF. The TF had access to the FSSP Task Force report on Family Systems and Household.

Following the conference at KSU on "The Role of Animals in the Farming System: Production, Products, Process," the TF completed the first draft of its report. A second and final draft was submitted to the University of Florida in February, 1984.

1. List of Participants

Task Force:

James W. Oxley, Chairman	Colorado State University
Robert E. McDowell	Cornell University
John D. Wheat	Kansas State University
James B. Henson	Washington State University
A. John DeBoer	Winrock International

Other participants during various meetings of the TF:

Larry Abel	AID,* Washington
Wendell Morse	AID,* Washington
Carol Stengel	AID,* Washington
Phil Warren	AID,* Washington
Hank Fitzhugh	Winrock International
Howard Olson	Southern Illinois University
John Trail	ILCA/Nairobi
Trevor Wilson	ILCA/Addis Ababa
Jim Simpson	University of Florida
Peter Hildebrand	FSSP/Florida
Chris Andrew	FSSP/Florida
Don Ferguson	USDA/OICD

2. Definition of Livestock

For this report, the term livestock includes both ruminants and non-ruminants, including poultry. The definition implies the use of animals for food as well as for non-food purposes, such as traction, transport, fuel, and fertilizer.

ROLES OF LIVESTOCK

Livestock play an equal or more important role than crops in some production systems; while in others, crops dominate. The ability of livestock to make use of resources, such as crop residues, forage, and browse that are not otherwise directly utilizable by humans into usable products, can be an asset toward improving the efficiency of crop/livestock systems on low resource farms. They are also used to lessen risk and as a hedge against inflation.

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*Acknowledgement is accorded a number of other AID employees who participated in the general session of the initial meeting of the Task Force in Washington, D.C.

1. Food

The world population of ruminant species of animals, such as buffalo, camels, cattle, goats, sheep, alpaca, deer, and antelope, that make some contributions of food and non-food uses to humans is nearly 3 billion. In addition, .62 billion pigs and 5.7 billion poultry are kept for food production. Species lesser in number, like the horse, kangaroo, rabbit, capybara, guinea fowl, pigeon, and duck, each contribute more than .5 million kg of animal protein per year. These figures are exclusive of fish and other marine life.

Although more attention has been given to meeting the world's food needs through cereal grains than animal products, the contributions from animals have increased steadily at a rate of 1.2 to 1.8% per annum. As incomes increase slightly in developing countries, there is a disproportionately larger increase in demand for meat and other livestock products compared to food grains and other staple foods. Presently, animal products contribute over 56 million MT of edible protein and over one billion Mcal of energy per annum to world food supplies. Milk and milk products are the largest sources of both protein and energy, followed by beef and fish. The total protein from animal products globally is nearly equivalent to that from corn and wheat and more than half that from all cereals. The energy value is nearly equal to that from wheat and exceeds that from paddy rice.

By western standards, the consumption of livestock products in developing countries is low (milk less than .3 liter per day and meat 10-20 kg per year). Nevertheless, these sources of protein are vital to human survival. For example, consumption of .3 liter of milk, 25 g of meat or one egg per day enables people to consume .7 to 1.4 kg of cereals or tubers. When plant protein such as cowpeas is used, the intake of cereals or tubers must be

reduced 30-40% to maintain adequate protein consumption. Thus, the availability of animal products permits cropping for highest production from land variable in fertility and rainfall.

2. Non-Food Contributions

Throughout the developing countries animals perform a number of social, ritual, and economic functions (Table 1).

Table 1

Classification of Contributions of Livestock to Human Welfare

Classification	Some Contributions
Food	milk, meat, eggs, prepared products
Fiber	wool, hair
Traction	agriculture, cartage, packing, herding, power irrigation pumps, threshing grains, passenger conveyance
Waste	fertilizer, fuel, methane gas, construction, feed, (recycled)
Storage	capital, grains
Conservation	grazing, seed distribution
Pest Control	fallow between crops, plants in waterways
Cultural	exhibition, fighting, hunting, racing, status symbol, religious, barter, ceremonial
Inedible Products	horns, hooves, bones for processing into feed supplements and other products
Income	ready source of cash for daily needs and production inputs

Source: McDowell, 1980 (with modification)

The relative importance of these contributions varies according to ethnic group, country and ecological conditions. In Africa, for example, the estimated annual value of production from livestock is $10 billion, with 50 percent attributed to offtake such as meat, milk, fiber and skins, and 50 percent from services or other benefits such as manure, traction, transport, and barter.

Animals play an increasingly important part of the labor pool in land preparation and related endeavors. Approximately 200 million animals generate 100 million horsepower of energy from animal traction per day. India uses 70 million bullocks, 8 million buffalo, one million camels, and one million horses for land preparation, cartage, packing, threshing of grains, and power for irrigation. Nearly 70% of the farms in Thailand and the Philippines use animals in preparation of lands for crops. Sub-Saharan Africa presently has nearly 15 million draft animals with numbers expanding rapidly. Overall, the use of draft animals for traction is on the increase in almost all developing countries and is contributing significantly to expanding agricultural production and reducing the drudgery of hand labor, especially as costs of other sources of power have substantially increased in recent years.

The majority of farmers in developing countries depend on manure to improve soil fertility. On small farms where cultivation is by hand, farmers prefer manure to chemical fertilizers because it improves soil structure. Crop farmers frequently depend on pastoral herders to graze their livestock at night on land destined for cropping.

More than 200 million MT of manure are used annually as fuel. Currently, India is the largest user with over 80 million MT of buffalo and cattle manure. In several countries, the sale of dung cakes for fuel to urban centers provides more than half the total cash income per family.

Manure serves other useful purposes, such as fertilizer for fish ponds, plastering walls or floors of houses, an adhesive for building blocks, the making of poultices for wound healing, and the production of methane gas. The latter has wide potential, but has met with limited application thus far.

In addition to their value for food and traction, animals play an important role in recreation, religion, and social custom. Cock fighting and fighting between male buffalo or rams are popular. Livestock, especially goats, poultry and sheep, are widely used for celebrations of births, marriages, or religious occasions.

Horns, hooves, skins, and hair are employed in cottage industries; and fat trimmed from carcasses may be used as cooking fuel or in making candles.

As compared to land, livestock are relatively easy to obtain and can be converted into cash. Such conversion is reversible, whereas the loss of land through sale is apt to be irreversible. Animals increase in value through time. This means they have the equivalent of an interest-earning capability which makes them a substitute for cash savings. Animals also provide opportunities for landless families to secure both employment and income.

3. Linkages of Crops and Animals

The production systems which involve crops and animals are numerous. In some systems, crops are the dominant feature and means of income and/or generation of subsistence requirements, while in others livestock dominate with cropping components playing a minor role.

Ten major small holder crop/livestock systems have been identified in both Africa and Asia and four in Latin America (McDowell and Hildebrand,

1980). Most of these systems are designed for intensive use of scarce resources. For these 24 systems, 40-90% of the feed for livestock comes from crop residues, spoiled fruits, tubers or vegetables, and brans from the preparation of grains for human consumption. In many of these systems there is a strong tie between crops selected and the suitability of their residues for use by animals. A major reason for poor acceptance of improved varieties of cereal grains by low resource farmers has been the lowering of quantity of crop residues and a rather marked reduction in nutritional value for livestock due to plant lignification. In some instances the dominant crop and its residues are a major factor in the selection of animal species for the system. An example is the higher density of swine and buffalo in paddy rice areas, buffalo being the best for utilizing rice straw, and swine for the use of rice bran. In essence, the nutrient flow through crop/livestock systems is vital to the operation of limited resource agriculture; hence, crop/animal relationships are critical to its efficiency.

Figure 1 illustrates the close integration of crops and livestock on small farms in the highlands of Ethiopia. The crops provide food, some construction materials, cash income, and feed for livestock. The livestock provide traction for land preparation; transport from field to household and to villages; manure for dung cakes to serve as household fuel, direct application to crops, or adding to residual crop materials for composting; food in the form of milk or meat; income from sales of animals or products; and wool for family needs or production of goods for sale.

In low rainfall areas, food security is extremely important; hence, a high dependence on animals (95%) as illustrated from Mali in Table 2. As rainfall increases (Agropastoral Systems), dependence on animals as a food source may decline; but contribution of other services, such as traction

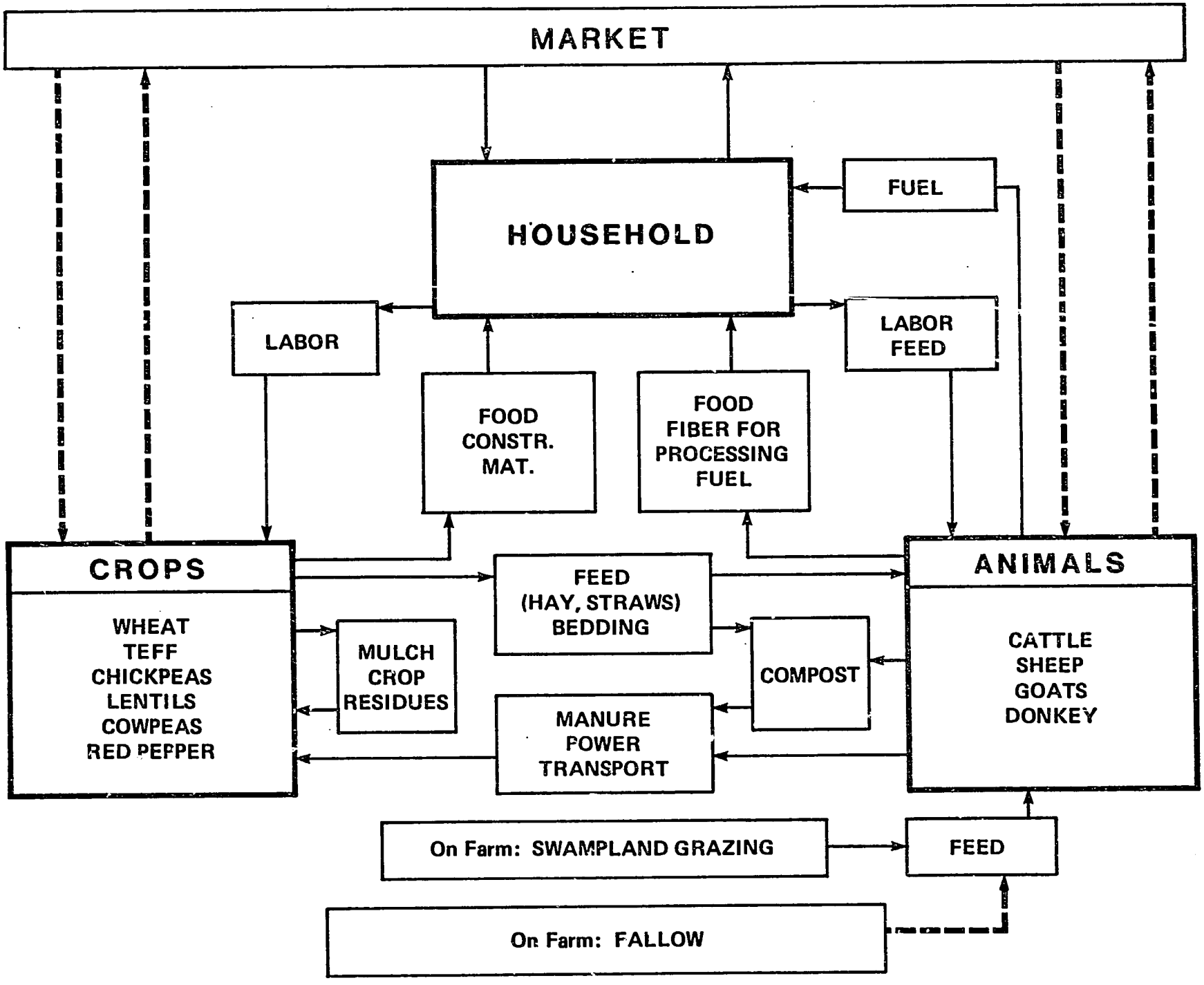


Figure 1. Crop/livestock farm in highlands of Ethiopia, permanent cropping, high-level integration of crops and livestock (Dash lines crops or animals to market shows high reliance on home use crops and livestock). Adapted from McDowell and Hildebrand 1980.

Table 2. Major characteristics of livestock production systems in Mali.

System	Pastoral			Agropastoral		
Subsystem	Pure	Dryland cropping	Flood plain grazing & cropping	Rainfed millet cropping	Irrigated rice cropping	Rainfed cash/ subsistence cropping
Contribution of livestock (% gross revenue)	95	90	60	25	15	10
Rainfall (mm)	<400	300-600	200 (floodplain)	400-800	500 (irrigation)	700-1400
Importance of agriculture	nil to negligible	low	can be quite important	considerable	very important	paramount
Linkage with agriculture	very weak	some cultivation, manure exchanged for stubble grazing	cultivates or arranges to produce crops	cultivates own crops: work oxen important and consumes crop residues		
Current carrying capacity						
a-people	very low	low/medium	high/very high	medium	high	medium/high
b-livestock	low	low/medium	medium/high	low/midium	medium/high	
TLU*/capita	.8-1.6	.4-1.6	1.2-1.6	.4-1.6	.4-1.2	.4-.8
Market production	40% barter, milk/grain	50-60% sale milk/animals	45-50% sale animals/grain	10-50% sale animals	60% (sells rice)	60% (cash crops)
Mobility	high with no fixed base	high with fixed base	high wet season fixed base	low, short distances during cropping season, permanent base		

*Total livestock units

Source: Adopted from Wilson, 1982.

and fertilization, may rise. In these systems there is a strong linkage between pastoralists and agriculturalists. There is a barter system of milk from pastoral herds for grains. Agropastoralists make their crop residues available to herders in exchange for manure.

4. Importance of Livestock to Food Production

In Africa, changes in livestock numbers and in cereal output indicate a significant correlation between the two. Production figures show that each additional animal entering the cattle population is associated with an additional .25 ha of cropland and approximately 200 kg of incremental grain output per year as well as about 30 kg of meat and 38 liters of milk per year. These observations for Africa are evident elsewhere. In India's northwest states where very significant increases in wheat and rice have occurred, there have been corresponding increases in milk output. The reason for the association of livestock production and food grain output are related to several factors. One of these is capital. On low resource farms cash flow is limited, leaving little or no money to invest in fertilizer, better seed, pesticides, or irrigation. In the absence or resistance to the use of credit, increases in food grain production can come about only by finding money to purchase inputs for crop production. More frequently, this is achieved through increased income from the sale of livestock or livestock products.

Another reason for the complimentary relationship between livestock and crop production is the role of animals in providing traction. Recent evidence from Africa shows a marked increase in the crop area cultivated per family as bullock numbers increase. Considerable research has now been initiated to try to improve efficiency in the utilization of animals for traction. This includes improved nutrition, better equipment, and more efficient harnesses for the animals.

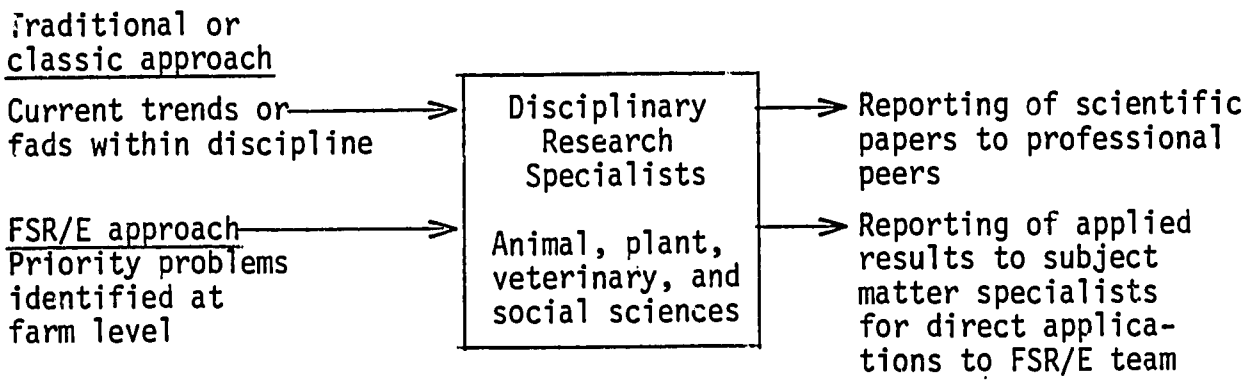
If one accepts the fact that there is an important association between increased food grain and livestock production, the time has come to consider the technical alternatives. This will require efforts to structure technology that will be useful as a part of existing systems or can be used as effective changes for modifications. Even so, for us to capitalize on this association will require a much closer integration among disciplines directing attention to farming systems.

C. ROLE OF DISCIPLINES, TRAINING, AND ORIENTATION IN FARMING SYSTEMS RESEARCH AND EXTENSION (FSR/E)

1. Disciplines

The emphasis on a FSR/E approach in no way diminishes the need for well-trained scientists working under the traditional disciplines in animal science, veterinary medicine, crop sciences, and social sciences. The use of FSR/E for crop-animal system research does imply, however, that a) these scientists need to respond to the findings of the FSR/E descriptive and diagnostic stages in the formulation of their research programs and b) their scientific results must be passed on to the subject matter specialists within the context of how this research is of relevance to the specific farming system in question. Thus, both the inputs into, and the outputs from, the traditional disciplinary research program must be modified. Diagram 1 represents this:

Diagram 1



2. Training

The training and retraining needs are most acute for the members of the FSR team and the subject matter specialists. The needs for disciplinary specialists and problem-solving specialists are more in the area of orientation rather than in retraining. Another area which the TF recommends that high priority be placed is on the role and function of communication specialists within the overall program.

Effective research on crop/livestock systems requires a very high degree of communication, cooperation, and coordination between plant, animal, and social scientists; between disciplines; between researchers and farmers; between farmers, subject matter specialists, and researchers; and between subject matter specialists and problem-solving specialists. Scientists tend not to be particularly skilled at working out these communication needs; and the role of experienced, skilled communication specialists would be crucial in both the design and implementation of the FSR/E approach to mixed crop/livestock systems.

3. Orientation

Orientation is high priority for disciplinary specialists and problem-solving specialists. This is best done by specific courses showing the steps involved in FSR/E approach, use of case studies to show flows of information, and the role of specific disciplines.

D. METHODOLOGIES

Documentation which sets out the conceptual, methodological, and disciplinary aspects of a FSR project applied to animals, delineating the entire research and on-farm testing process is very limited. Most reports referring to methodological and conceptual issues are not put in the context of actual research project and do not grapple with actual problems

of survey design, data processing, research planning and interpretation of research results. Furthermore, much of our documentation dealing with research projects fails to provide the background leading to the initiation of research.

This section is concerned with some of the approaches being employed in livestock/crop oriented FSR projects and discussions of methods of incorporating contributions of livestock into farming systems studies. Bernsten, et al. (1983) enumerates and discusses the typology of livestock systems and lists current farming systems activities with major livestock components underway by various organizations.

1. Approaches

Even though a livestock component has been included in a number of FSR programs (Bernsten et. al, 1983), those with the most definitive projects will be used to illustrate the approaches employed: The International Livestock Centre for Africa (ILCA) with headquarters in Addis Ababa, Ethiopia; Winrock International, Morrilton, Arkansas; and the Centro Tropical de Investicacion y Ensenanaza (CATIE), headquartered at Turrialba, Costa Rica.

Following some preliminary experimentation, all three organizations have adopted the approach recommended for FSR by Norman (1982) in that investigations are conducted in four successive stages: 1) descriptive (diagnostic), 2) design, 3) testing, and 4) extension. Multidisciplinary teams are usually employed with the basic team consisting of an economist, a sociologist or anthropologist, an animal scientist, and agronomist. On occasion other disciplines may be included, such as a range management specialist, a veterinarian, or a human nutritionist. Insofar as possible, the teams remain intact throughout the four stages in order to validate

results as fully as possible. The objectives set for each stage are illustrated in Table 3.

Table 3

Stages of Farming Systems Research Employed by ILCA in Pastoral Systems Research

1.	Descriptive and Diagnostic	Natural, livestock and human resources: production systems constraints, in order of priority; research requirements; assessment of chances of overcoming constraints
2.	Design research managed and executed	Component research; design of improvements through on-station experimentation or from existing knowledge
3.	Testing research managed, producer executed; producer managed, producer executed	Researcher and producer management of improvements; producer acceptance of improvements
4.	Extension	Evaluation of technical and socio-economic impact of improvements

Source: ILCA 1983

The objective of the descriptive stage is to identify constraints to achieving farmer goals and objectives. The process commences with an understanding of the total farming system, including crops and trees as well as assessment of the role and performance of the animals. Constraints to animal production are defined as opportunities for potential change--albeit at the region, family, farm, or enterprise level--which could substantially improve its productivity as defined by farmers. This stage of FSR is accomplished by applying in a sequential manner rapid appraisal methods, single-visit surveys, monitoring typical farms with farm records and case studies.

The design stage involves a systematic process of identifying, evaluating (on paper) and fitting technologies to the existing system that results in a conceptual model of proposed alternatives. A careful blend of inputs and ideas for this task are derived from the current technology and suggestions of farmers and the conduct of component research on an institutionally controlled area and on farms. Usually a high priority by farmers is more and better quality feed for animals which readily involves evaluation of cropping programs.

Testing of alternatives is carried out by introducing changes within the farmer's system in two phases: 1) research managed, producer executed trials; and 2) producer managed, producer executed trials. Between phase 1 and 2, the farmer's management, reactions, and degree of satisfaction usually result in refinements of the original design. Due to the biological nature and socio-economic aspects of animal systems, the testing stage has major implications for the number of replications, the type of changes to be considered, the time frame required for the system to make the transition and for observing some impact, particularly for cattle systems.

Since traditional station methodologies frequently do not integrate and test new technology adequately for small-farm practices, new testing on-station methodologies needs to be developed. To accomplish this, it may be necessary to establish units representative of farmer units on experiment stations with the participation of farmers and farmer advisors. This methodology is being explored by ILCA in conjunction with on-farm testing in Ethiopia and shows much promise for FSR with a livestock component (Gryseels and Anderson, 1983).

The extension stage is to accomplish two major functions: 1) influence administrators or policy makers of domestic institutions and to train extension agents and others concerned with program implementation; and 2) to participate in area-specific development programs using previously demonstrated alternatives. The three institutions are participating effectively in 1), but their policies on phase 2) are unclear. Neither CATIE nor ILCA have a mandate for direct technology transfer to farmers. The same generally holds for Winrock's projects to this time. Since the programs of the three organizations are still working principally in stages 1-3 and phase 1 of stage 4, the extent of involvement or policy on participation in extension has not become a major issue.

Experience will no doubt lead to adjustments in methodology for FSR by ILCA, CATIE, Winrock, and others; but it is gratifying that largely through independent actions the three organizations have arrived at similar objectives and methodologies. Since the projects place heavy emphasis on cropping, closer study of the methodology and the results from CATIE, Winrock, and ILCA may be one solution to the current dilemma of the incorporation of livestock into FSR programs.

The present program of the Animal Production Department of CATIE focuses on cattle, swine, and goat production systems. Winrock has dealt almost exclusively with sheep and goats. ILCA is concerned with camels, cattle, goats, and sheep in both pastoral and agro-pastoral systems.

Experiences to date at CATIE, including some description of methodology, are reported by Avila (1984), Avila, et al. (1982), and CATIE (1978).

A report by Bernsten (1982) gave a framework for approaches to FSR by Winrock International. The recent paper by DeBoer, et al. (1983) on a dual-purpose goat research project in western Kenya is reasonably complete,

but the work has not yet progressed to the stage where specific methodologies have been worked out for the various components to the point that a definite process for technology transfer is defined. In addition to Winrock's involvement with documentation of mixed farming systems (Winrock, 1982) in general and for sheep and goats (Winrock 1983[a]), it has been involved in several studies of the potential for livestock improvement under mixed farm systems employing further testing of methodology (DeBoer 1983[a], Soedjana, et al. 1983, Winrock 1980).

These studies have revealed the importance of research teams to systematically sort through the multiple roles served by animals and the intricate relationship between crops and livestock and focus their research on a limited number of topics which show good promise of having the greatest impact on farmers' welfare. Winrock's approach to an effective FSR program stresses the need to adopt suitable methodology and networks to help in identifying "on the shelf" items of technology appropriate for each situation.

ILCA, too, has a number of reports: a) characterizing the systems approach, e.g. Stewart (1983); b) with emphasis on findings from stage 1 (Table 3), e.g. Nicholson (1983), ILCA (1978), ILCA (1981), Von Kaufmann (1983), and several reports dealing with stages 2 and 3, e.g. Wilson (1982 and 1983), de Leeuw and Peacock (1982), Konandreas, et al. (1983). Among the more advanced studies on FSR with animal emphasis is ILCA Bulletin No. 16 (1983). It describes recommended methodology for stages 1, 2, and 3 and gives results based on experience in five countries (Ethiopia, Kenya, Mali, Niger, and Nigeria). In this report the use of low-flying aircraft surveillance in FSR is described.

ILCA has conducted several workshops on FSR and conducts training courses annually for Africa Nationals.

The prospects for emphasis on a livestock component in FSR are rising. Several U.S. universities, as well as institutions in Europe, are moving in this direction. The Task Force suggests that the FSSP program can serve an important role by monitoring approaches employed in order that more effective evaluation analyses can be made.

2. Project Management

Effective project management in the field is one of the essential ingredients to insure integration of livestock into cropping systems. In this context, management covers a spectrum of activities and qualities including, among others, an effective team leader with both administrative and programmatic skills who also has an appreciation of FSR/E; organization of project activities to promote continual interaction by all disciplines in the team; and orientation and training of team members, both host-country and U.S., who do not have a background in FSR/E.

Both U.S. and host-country scientists must have a general background and understanding of FSR/E and be willing to address a research and development approach that involves such a systems orientation. Failure to incorporate scientists with such a background and interest will insure lack of wholehearted support and ultimately impact negatively on the success of the project. If the group does not have an FSR/E background, then orientation activities need to be carried out. Even if the team has a background in FSR/E, it will be necessary to come to an agreement on the specific approach to be taken, which will require adaptation of FSR/E theory to the existing environment. Project leadership must insure that these matters are addressed. (See the section on the role of disciplines, training, and orientation.)

In order to address the multiplicity of issues associated with both crop and livestock production in the systems approach, there should be at least one social scientist, plant scientist, and animal scientist on each team. As an example, when conducting a diagnostic survey, these three general disciplinary areas should be represented in order to have a holistic view incorporated into the survey. There must also be mechanisms for these individuals to continue to interact, along with the other members of the team, in addressing issues relevant to the program/project. In this regard, there should be a formal mechanism through which the scientists representing all of the disciplines can interact, discuss, review, monitor, and evaluate the ongoing efforts by the team. Proposed activities should be discussed by the group as a whole to insure that all aspects are properly addressed and to allow true interdisciplinary input. Periodic reports should be given to the group by the individual scientist or groups of scientists in order to keep everyone up-to-date on the progress and to insure input from all the disciplines. Seminars, research progress reports, etc., are some of these mechanisms. The management of the team must insure that the necessary environment and mechanisms are in place to foster these interactions.

In order for the above to occur in the most effective way, the project must have good leadership that has an understanding and an interest in incorporating the FSR/E approach involving both crops and livestock. It is sometimes difficult to have project leadership that has a background in both crops and livestock, but the individual in charge must have an appreciation of both in order for them to be appropriately addressed in all aspects of the project undertaking. The Team Leader must have an understanding of team building, must have the respect of the team members, based upon both administrative and programmatic skills and must provide the impetus and support for the host country as well as U.S. staff in order to create an

optimal climate for the conduct of the activities. Project management must also provide the team with the necessary infrastructural and other support requirements in order for the team to be able to carry out their activities. Especially important is the provision of transportation and fuel and the maintenance of vehicles, buildings, and equipment.

In terms of project management relating to the existing administrative and support structures in the host country, it is the usual case that crop activities and livestock activities are based in separate divisions of the Ministry of Agriculture. Therefore, the team should make an effort to incorporate individuals from the relevant existing institutional organizations in such a way that they feel "ownership" of the project and will participate in both the short- and long-term activities.

The project, especially an FSR/E project, must be continually monitored and must change based upon evolving information and ideas that are developed over time. The experiences gained should provide guidance to change the project to make it more effective. Project management is paramount in insuring that such occurs.

3. Extension

For livestock to be successfully incorporated into FSR/E, it is imperative that there be a linkage among the institutions responsible for crops research, livestock research, and the institute responsible for extension programs. This likely will not be easily accomplished since within existing organizations, livestock, range, crop, and extension leaders generally are in different ministries and frequently do not interact. Therefore, efforts must be made to bring these different components together and minimize institutional obstacles to the effective formation of research teams.

Once the linkage exists, extension personnel will likely serve in three major roles. First, in cooperation with the research specialist,

they would convey research findings and needs from local cooperating farmers to the research station for testing under a wider variety of conditions. The second major role would be relaying experiment station results to the local farmers; and the third should be taking results of on-farm and experiment station research to other farmers in the region.

Extension responsibilities to farmers can be carried out through personal visits, seminars, short courses, or field days, such as those held by ILCA in demonstrating the technology of using wooden plows, harness and yoke modified for a single ox used for crop production (Gryseels and Anderson, 1983).

Unless there is active and early extension involvement in FSR/E, the project will fail.

4. Institutionalization

The effective incorporation of livestock into mixed farming systems will depend upon the institutionalization of the FSR/E approach within the existing host country organizations. This is frequently difficult due to the fact that there is a lack of understanding and appreciation of the concept and implementation of FSR/E. As already mentioned, livestock and crop activities are generally administered through different divisions of the Ministry of Agriculture or even different ministries. This separation frequently establishes an environment of competition for limited resources, rather than support for the activities, which results in the livestock and crop-oriented scientists and organizations actually working against each other rather than being mutually supportive. Because of this separation, the career structure for host-country scientists is usually oriented along discipline or commodity lines. Recognition and advancement in rank by the host country scientists is usually determined by a peer system which is

commodity or discipline oriented. This results in a lack of understanding of FSR/E activities and a lack of a reward system for individuals who are directing their efforts into integrated crop-livestock production. Because of this, it is important that the activities of the individual host-country scientist be such that when they carry out FSR/E activities, they are also able to produce publications and other means of recognition within their discipline. Ultimately, it is hoped that the existing organizations and peer scientists will recognize FSR/E as a scientific thrust for which rewards are justified and given. Failure to address these problems will result in host-country scientists who will not wholeheartedly support the FSR/E approach.

As indicated above, most research institutions in developing countries, as well as in the U.S. are oriented along disciplinary and commodity lines. This means that a farming systems approach is unusual, is frequently new, and will not be accepted immediately by the host country institutions and scientists. It is frequently the case that a specific FSR/E project will have more resources at its disposal over the short term as compared to other projects financed by the host country. This may result in an atmosphere of antagonism or defensiveness among host-country scientists. In order to overcome this and other problems, an approach to institutionalizing FSR/E must be based upon interaction, mutual understanding of the activities and involvement of FSR team scientists with those oriented to discipline and commodity activities. One approach is to utilize farming systems as an on-the-ground testing area for feedback to the discipline or commodity groups. Another approach is for the FSR/E group to serve as an on-the-ground implementor for the findings of the discipline or commodity group--in short, to define and implement mutual benefits from FSR/E, commodity, and discipline-related activities as they are mutually supportive. This requires leadership and understanding, especially on the part of the

FSR/E scientists, of the necessity and sensitivity of defining and implementing bridging mechanisms that will benefit not only the systems activities, but the commodity and discipline ones as well. (See section on the role of disciplines, training, and orientation.)

5. Policy Recommendations

Two sets of policy recommendations can be distinguished: a) public policy toward agriculture in general and b) specific policies toward the institutional framework under which farming systems research and development programs are caried out.

a. Public Policies Toward Agriculture. It is commonly recognized that economic policies in developing countries discriminate against the agricultural sector, particularly the smallholder component. Therefore, FSR/E programs must operate under conditions where the client group faces difficult economic conditions. The perceived risk of trying a largely unproven practice generated through the FSR/E program is often too great or the complementary inputs needed to obtain full benefit from the technology cannot be afforded. This is particularly true for livestock, since the animal(s) may represent the largest single non-land asset controlled by the farmer. Where draft power is important, the loss of the use of an animal for even a few weeks may be disastrous.

Another facet which is seldom recognized is that the major economic policies which influence the economic status of the smallholder sector are seldom formulated or implemented by the Ministry of Agriculture or Ministry of Livestock. General economic policies such as exchange rates, money supply, interest rates, taxation, tariff rates, import quotas, export quotas, export taxes, and rationing of foreign exchange are under the control of Ministries of Finance, Economic Planning, or Foreign Trade plus Central Banks. The influence of smallholders is felt even less at

these agencies than at Ministries dealing with agriculture and livestock. The economic planners and decision makers must be made more aware of the national consequences of continuing neglect of the smallholder sector and the agricultural sector in general.

b. Specific Policies Toward Institutional Structures. The pervasive problem is separation of research functions by disciplines and commodities. While this is appropriate for many types of effective research, strict adherence to these lines of authority when a program is trying to improve the flow of technology to farms creates problems. The FSR/E approach constantly labors under bureaucratically imposed constraints. There are short-run and long-run recommendations related to these problems:

(1) Short-run: The approach should be to create effective programs that will illustrate the benefits of the FSR/E approach and will ultimately bring about long-term changes in the bureaucracy. Short-term programs can proceed on the basis of informal groups of scientists, usually requiring donor support, but with a common interest in applying their disciplinary knowledge to small farm problems within the framework of the FSR/E approach. Other short-term programs have been carried out in conjunction with the International Agricultural Research Centers (IARCs) and by universities. The latter often operate under a less restrictive structure than the research agencies of Ministries.

(2) Long-run: The challenge is to bring about effective reorganization of research, extension, and development groups within Ministries to effectively blend their overlapping functions into FSR/E programs. This requires one group to assume overall control of these efforts and sufficient budgetary flexibility to form groups

to work on specific farming systems with clearly stated objectives. There also need to be linkages to local government agencies to insure support at the implementation levels. (See section on institutionalization.)

6. Case Studies and Models

Case studies can be important to the FSR concept in several ways, such as:

i. identifying key elements needed for success in a FSR project

ii. documenting lessons learned from FSR projects

iii. developing and testing materials for the training of practitioners

iv. developing guidelines for the conduct of research on farms

v. developing ways for using evaluation analyses and supporting data to communicate to administrators results and perspectives for FSR

vi. broadening the outlook for those lacking experience in FSR with an animal component; studies from livestock/crop farm FSR can be an especially useful tool in the FSSP.

a. Case Studies. Although case studies can have wide application in FSR, the Livestock Task Force proposes that the initial focus be to develop better means of communication with key personnel in order to have greater impact from research in farming systems.

Administrators need to know what the farming systems approach is and where it fits into the profile of agriculture for their country; finally, they will need information on what administrative arrangements are required to implement the approach. We must assume that these administrators will take a national or at least a regional perspective and that they will weigh the advantages and disadvantages of investment and organization focused on smallholders in comparison to other forms of agriculture. In the past, the claims of smallholders have generally been ignored in favor of commercial

and export agriculture; but on the assumption that the situation is changing, a case must be made in terms that administrators understand, and the case must not be overstated.

Practitioners refer to the relatively few research workers in government ministries, experiment stations, and in the colleges of agriculture, along with extension workers, who are able to view smallholder systems in a holistic fashion and to understand their dynamics with a view to implementing specific innovations. Their efforts will be influenced from decisions made by senior administrators. If these decisions are favorable, the practitioners must be trained to apply the approach in a true multidisciplinary manner.

Administrators and practitioners are central to farming systems for several reasons. Integrated farming systems research will simply not move unless they support it. Second, even if they are favorable, they must integrate FSR into their programs and policies. A third, and probably the most important, is that case studies can be used on groups representing various disciplines as a "neutral focus" for discussions on how they might develop closer collaboration. Normally when either administrators or scientists representing various disciplines get together, there is a tendency to promote the importance of individual disciplines leading to competitiveness rather than objective discussions. Assuming this is a general problem, we must find modes of communication that will stimulate active participation in discussions and lead to multiple linkages among policy groups.

To best serve the above-mentioned audiences, the utilization of case studies will be required at all levels. It is proposed that the FSSP give priority to the selection of one or more institutions to take the lead in preparation of several case studies.

An example of a case study of FSR/E approach applied to livestock improvement has been recently documented (Sambrani, et al 1982). This particular research/extension program was carried out as a collaborative effort between the Small Ruminant Collaborative Research Support Program (SR-CRSP), the Research Institute for Animal Production, and the Directorate General of Livestock Services in West Java, Indonesia. The objective was to establish reasons for the low productivity of intensive small ruminant production systems and to derive specific packages of technology that were feasible under the constraints of these mixed farming systems. Following the initial agro-ecosystem characterization, the group focused on three of the predominant systems found--upland cropping systems with sheep, lowland cropping systems with sheep and goats, and plantation-based systems, also with both species. Because of the seasonal factors involved and the long production cycles involved, the diagnostic stage extended over 18 months. Full-time field assistants were placed in the village to collect information on animal performance, forage production and quality, and socioeconomic factors impinging upon small ruminant production decision making. Much of this work was linked to the central laboratory in Bogor.

Gradually, a pattern began to emerge. First, the lambing/kidding interval was excessively long. Litter sizes and lamb/kid survivability were good. Growth rates of individuals were highly variable, even within pens. The composition of feed offered varied a great deal between seasons, but overall quantities and quality of feed offered did not show large variation between farm and between season. Small ruminants were basically a means of converting excess farm labor into a saleable product. Finally, animals were generally held as a form of savings and not sold at the optimum economic age.

The research team initially did not consider animal health as a serious constraint given the full confinement system under which the animals were kept most of the year. However, the high variability of weight gains observed indicated that parasite load should be considered. Thus, a fourth institution, the Research Institute for Animal Health, was asked to assist. Their research confirmed that routine parasite control would be needed as part of an improvement program.

The packages that are being developed focus on three very specific areas: reduction of lambing/kidding interval, improvement of the protein proportion of the diet on a year-round basis, and a routine animal health treatment focusing on internal parasites. These are being discussed with farmers at a series of monthly meetings, where discussions are lead by a scientist from a specific discipline. Feedback from the farmers about specific problems that may arise has been excellent. Problems such as a shortage of good quality rams/bucks and lack of farmer access to these animals have been discussed as well as farmer problems in detecting heat in the ewes/does. High protein trees and shrubs are being planted and evaluated by the farmers. Control groups for the parasite treatment program are being set up. All this work is being closely monitored by the farmers in conjunction with the village-based staff of the research institute.

A series of 30 working papers describing all aspects of this program are available from Winrock International.

b. Models. Further justification for focusing on the communication aspects is that researchers in different organizations have often identified sets of variables which go beyond the usual farm management models of the previous decade. Often several of the variables are incidental to the focus of the research. This is especially true where there is a strong

focus on animal science technology. The technology may be sound, but usually it has undergone only limited testing on farms; hence, a high dependence on inputs of other disciplines, particularly economics, is warranted to assist in the projection of the economic feasibility of the proposed innovation (Gutierrez, 1983). This would entail development of models for either analysis of data or for projecting the results of applying technology to small farm situations. Models for projected application could become a part of a case study or could be used as another means for communication on the projected contribution of livestock to various farming systems.

In situations where experiment stations have several disciplines working together, small computers could be a very effective means of developing desirable interactions among staff. For example, if after the preliminary analysis of the data, individual scientists were to gather around a computer, projections on the influence of variables could be tested promptly. This would enable the group to interact in a much more precise fashion than in the general discussions. Experience in the past has shown that technicians representing various disciplines will discuss mutual problems and the possibilities of closer linkages, but unfortunately this does not get much beyond the dialogue stage. Objective use of computers would enable much sharper focus on the potential contributions of the various disciplines to a projected change.

Numerous field locations overseas are acquiring small computers. Programs to assist in evaluating data gathered by multidisciplinary teams is a high priority need. Another worthy role for the FSSP is to catalog computer programs which can be useful in processing FSR data. ILCA, for example, views programs for small computers as an urgent need to bring national organizations of Africa into active FSR.

E. TRAINING

1. U.S. Nationals

Training received by U.S. personnel should include an integrated, holistic view of livestock production as well as information relating to farming systems. This training must reflect an appreciation and hopefully experience in a systems approach to research. The leaders must recognize that problems facing livestock-crop interactions are multi-dimensional, and this must be taken into account if educational institutions are to provide relevant training.

Case studies and models for projected applications of FSR/E can be used separately or jointly as means of training those interested in the contribution of livestock to various farming systems.

Short courses, seminars, symposiums and other special meetings can be held at U.S. universities through strengthening and program support grants allowing an exchange of knowledge and experiences. Slide-tape modules are additional aids valuable to training in FSR/E.

These training modules should include at least the following subjects and types of information and are equally applicable to U.S. as well as host country nationals:

a. Introduction--Background to animal agriculture. Source: Fitzhugh, et al.--Role of Ruminants in Support of Man (1978).

b. Roles and functions of animals. Several sources: McDowell (1978); Fitzhugh, et al. (1978); Winrock (1982); and others.

c. Mixed farming systems. Sources: McDowell and Hildebrand (1980), Winrock (1982), various publications by Hart, Bernsten, and others (including ILCA).

d. Conceptualization of research problems dealing with mixed farming systems. Sources: Some of those cited in (b) above. Work at ILCA is also relevant here.

e. Conduct of research. Sources: The Kenya dual purpose goat paper (DeBoer, et al., 1983) and Bernsten's (1982) illustrations of the parallels between crops and livestock. The ILCA work also represents a fairly complete package that could be worked into a module.

f. Research methodologies, especially regarding field testing. Source: several case studies of ILCA, Winrock, and CATIE.

g. Extension programs. A module to develop extension procedures to deal specifically with livestock in mixed farm systems.

h. Maintenance of adequate nutrition for livestock, including a year-round feed supply, effective use of crop residues, etc.

i. Basic livestock management.

j. Improved animal health, including internal and external parasites.

k. Animal traction, including animal care, harness, appropriate implements, and selection and breeding for stronger animals. Source: Gryseels and Anderson (1983).

l. Selecting for increased meat, milk, and/or fiber production.

m. Marketing of livestock and crops.

The Task Force can provide further suggestions for assistance on the above proposed topics for training modules. Also, the pool of program associates of the FSSP network is another available resource for this task.

2. Host Country Nationals

The training received by developing country scientists in the U.S., and in the western world generally, is a mirror image of the westerm educational system and orientation, with limited emphasis on the systems approach. In the case of the crop and livestock disciplines, the integration of the two within the subject matter presented at universities is generally limited or lacking. Therefore, both the host country as well as U.S. individuals who are being trained, generally have had an education that has lacked incorporation of a systems concept. Instead, the training has tended to be quite specialized, focusing on small areas of research, especially for the Ph.D.

Because of the above, individuals who plan to participate in projects on livestock in mixed farming systems should be provided access to courses, seminars, workshops, and other training endeavors that will allow them to become familiar with the FS process. Selected U.S. universities and International Agricultural Research Centers are important and relevant resources for such training. The training should include on-the-ground experience in conducting surveys, in defining domains, etc., so that the individuals have an understanding of not only the theoretical, but the practical application to actual situations. In addition, the research undertaken should be relevant to the host country and should emphasize the combination of both crops and livestock in the systems context.

Whenever possible, research should be conducted in the home country of the trainee. Special courses more relevant to developing country environments and situations should be utilized. An opportunity for the trainee to interact with a functional FSR/E group that incorporates both crops and livestock should be provided. (See previous section for suggested training modules.)

In addition to formal degree and non-degree training in the developed countries, in-country (and regional) workshops, seminars, and conferences on FSR/E are extremely beneficial for project staff, both scientific and support. Such activities can also serve as important mechanisms to inform host-country commodity and discipline-oriented scientists and organizations about FSR/E and the potential benefits from the integration of crops and livestock in a systems approach. The FSSP can make significant contributions to many of the above-listed types of training on a need and demand basis.

F. COMMUNICATION

Communication is essential and should be aimed at acquainting all people involved with the potential opportunities and responsibilities of including livestock in FSR/E. Those included in the in-country communication network are government leaders, including those in the different ministries, research personnel and extension specialists, and the cooperating farmer or farm family. (See FSSP Task Force Report on Family Systems and Household.) A network of institutions such as USAID, universities, ministries, private foundations, and IARCs, should be established to encourage a closer link among the people interested in and working with livestock in FSR/E projects.

In a broad sense, all activities included in extension as well as the other aspects of this task force report pertain to communication. Consequently, the importance of proper and thorough communication must be at the forefront in all planning and implementation stages of FSR/E. The FSSP has a special role it can play in the communication dimension of farming system research and development.

G. RECOMMENDATIONS

The Livestock Task Force strongly draws attention to the fact that animals form an integral and essential part of limited resource farming systems in most of the developing countries and that efforts should be made by FSSP to create awareness of the importance of their integration among training institutions, the IARCs, and government agencies. To that end several recommendations are proposed:

1. That FSSP entertain proposals from one or more universities or institutions, preferably within the FSSP network to develop a series of training modules, as suggested in the section on training. Modules with slides, tapes, or movies should be produced or at least narrated by AV personnel with expertise in this area.

2. That case studies be considered as a means of training and of improving communications and developing policy guidelines.

3. That case studies be developed from those projects that are successful in institutionalizing the FSR/E approach within the existing host country organizations.

4. That FSSP entertain proposals from one or more universities or institutions to develop guidelines for the preparation of case studies to serve the needs of the program.

5. That the FSSP entertain proposals from one or more universities or institutions, preferably within the FSSP network to develop a handbook or set of guidelines on the conceptual, methodological, and disciplinary aspects of FSR/E involving livestock. Materials and information from case studies training modules and other sources can serve as basis for the handbook for use among trainers, planners, evaluators, administrators, and practitioners.

6. That FSSP encourage FSR projects to include a livestock component where it is evident that animals play a role in the farming system.

7. That the FSR/E design and implementation teams be composed of at least a plant, animal, and social scientist.

8. That individuals qualified to become degree candidates be brought to U.S. universities for schooling. These would become the long-term directors of the projects.

9. That individuals who are not degree candidates be brought to the U.S. for brief visits to observe and study some systems-type, crop-livestock operations in the U.S. or sent to appropriate IARCs or other institutions or agencies.

10. That FSSP encourage universities involved in development projects to offer at least one FSR/E course and that the course make reference to livestock in mixed farming systems.

11. That in Africa, research and/or extension personnel be trained in their own working area or sent to ILCA, IITA, or other IARCs to participate in short courses or internship programs.

12. That short courses and special training and orientation meetings be held at local research stations and village centers in developing countries where the FSR/E program is to be conducted. Slide-tape modules developed by FSSP should be used by leaders with FSR/E experience during these training sessions.

13. That the extension component be incorporated at the design state of FSR/E projects.

14. That FSSP sponsor a workshop on research methodologies related to livestock in mixed farming systems.

15. That one of the objectives of the FSSP network be to monitor approaches in FSR and circulate at least annually a bibliography on methodologies employed with the objective of more effective evaluation analyses.

16. That FSSP appoint a task force if and when appropriate to develop recommendations on those farming systems which include water fowl and/or fish.

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PROGRAM ASSOCIATES WITH SIGNED MOA SUPPORT ENTITIES WITH INTEREST OR EXPERIENCE IN LIVESTOCK
(Including Animal Science, Veterinary Medicine, Animal Breeding and Animal Systems) as of 11/23/83

	Program Associate	MOA Entity	Area of Expertise	Geographical Areas (With Years Therein in Parenthesis)
1.	Beran, George	ISU	Vet Microb & Preventive Med	Asia (3+); Africa (10+)
2.	Bernsten, Richard	WI	Ag Economics	Asia (3); Africa (2+); Latin America (?)
3.	Brackelsberg, Paul O.	ISU	Animal Science	Asia (.1); Near East (.1)
4.	Byington, Evert	WI	Range Sci/ Agroforestry	Unknown
5.	Cornelius, Steve	UMN	Animal Science/ Vet Med	Unknown
6.	Coy, Charles	MSU	Vet Med	Africa (2)
7.	Crabo, Bo	UMN	Animal Science/ Vet Med	Asia (.25)
8.	Cuany, Robin	CSU	Agronomy (Forages)	Africa (5) Latin America (3)
9.	Deans, Robert	MSU	Animal Science	Africa (?); Asia (?); Latin America (?); total of 6 years
10.	DeBoer, Alvin J.	WI	Ag Economics	Asia (3+); Africa Latin America
11.	Fitzhugh, Henry A.	WI	Animal Breeding	Latin America, Caribbean, Africa (Total 2 years)
12.	Goodman, Bill	SIU	Animal Industries/ Poultry	Unknown
13.	Hansen, Jorgen	VPI	Vet Med	Unknown
14.	Hart, Robert D.	WI	Agronomy/Crop Ecology	Latin America (6); Africa (?)
15.	Johnson, Harold	UMC	Animal Systems	Unknown

Program Associate	MOA Entity	Area of Expertise	Geographical Areas (With Years Therein in Parenthesis)
16. King, Thomas B.	PSU	Animal Sci/Administration/Extension	Latin America (?)
17. Koch, Berl A.	KSU	Animal Nutrition	Africa (4); Asia (2)
18. Kornegay, E. T.	VPI	Animal Science	Unknown
19. Marsh, Will	UMN	Animal Health Economics/Computers	Unknown
20. McCarthy, F.	VPI	Animal Science	Unknown
21. McDowell, R. E.	CU	Animal Science	Asia (9); Latin America; Africa
22. Mitchell, George	UOK	Animal Science/ Nutrition	Near East (?)
23. Morris, Roger	UMN	Vet Med/ Epidemiology	Africa, Asia, Latin America, Near East
24. Olson, Howard	SIU	Animal Industries	Unknown
25. Oxley, James W.	CSU	Animal Science/ Administration	Asia (2), Africa
26. Perry, Brian	VPI	Vet Medicine	Unknown
27. Schillhorn Van Vern, Tjaart	MSU	Vet Medicine	Africa (8)
28. Sollod, Albert	DAI	Vet Med/ Parasitology	Africa (?)
29. Sutherland, Thomas M.	CSU	Animal Breeding	Africa (2)
30. Thawley, D. G.	UMC	Animal Systems	Unknown
31. Vandepopuliere, Joe.	UMC	Animal Systems	Unknown
32. Vogt, Dale	UMC	Animal Systems	Unknown
33. Ward, Gerald M.	CSU	Animal Science	Asia, Near East
34. Wheat, John D.	KSU	Animal Breeding/ Genetics	Africa (2+); Latin America (.25); Asia (.2)
35. Wilson, Kim J.	MSU	Animal Science (Dairy)	Latin America, Asia (Total 3 years)

Program Associate	MOA Entity	Area of Expertise	Geographical Areas (With Years Therein in Parenthesis)
36. Wilson, Terry	PSU	Vet Med/ Vet Pathology	Latin America (6)
37. Yazman, James	WI	Animal Science	Latin America, Asia

MOA Entities

Non-universities:

1. DAI = Development Alternatives, Inc.
2. IADS = Int'l Agricultural Development Service
3. RTI = Research Triangle Institute
4. WI + Winrock International

Universities:

1. CSU = Colorado State University
2. ISU = Iowa State University
3. KSU = Kansas State University
4. MSU = Michigan State University
5. PSU = Penn State University
6. SIU = Southern Illinois University
7. UOK = University of Kentucky
8. UMN = University of Minnesota
9. UMC = University of Missouri
10. VPI = Virginia Polytechnic Institute
11. CU = Cornell University