

## APPENDIX 1

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## APPENDIX 2

ABBREVIATIONS AND ACRONYMS

AID	Agency for International Development
AIP	Accelerated Impact Program
ANTRAC	Animal Traction
CFA	West and Central African Franc
CAR	Community Organizing Center
CDS	Councils of Development
COCA	Comite d'Etude et d'Orientation du Programme de Culture Attelee
CREAT	Livestock Research Center at Avetonou
DRDR	Direction Regionale de Developpement Rural
DVSA	Direction des Services Veterinaires et de la Sante Animale
ENA	Ecole Nationale d'Agriculture
EORD	Eastern - Organization Rurale de Developpement
FAC	Fonds d'Aide et de Cooperation
FAO	Food and Agriculture Organization
FED	Fonds Europeen de Developpement (European Development Fund)
FSR/E	Farming Systems Research and Extension
FSSP	Farming Systems Support Project
GOT	Government of Togo
GTZ	German (Federal Republic of) Development Assistance Program
ICRISAT	International Crop Research in Semi-arid Tropics
IDA	Second Rural Development Project in Cotton Areas
ILCA	International Livestock Center for Africa
JARC	Catholic Community Organizing for Youth
OAR/Lome	Office of the AID Representative, Lome, Togo
OAU	Organisation Africaine d'Unite
OIC	Opportunities Industrialization Center
PC	Peace Corps
PCA	Projet Culture Attelee
PCV	Peace Corps Volunteer
PRODEBO	Promotion et Developpement d'Elevage Bouvine
PROPTA	Projet de Promotion de la Traction Animale
FVND	Staple Food Crops Project
SAFGRAD	Semi-Arid Food Grain Research and Development
SOTOCO	Societe Togolaise du Cotton
TAT	Togo Animal Traction
UNDP	North Togo Improvement Program
UNIFOCO	Namiele Plain Project
UPROMA	Unite de Production de Materiel Agricole



## APPENDIX 3

CLOSING SPEECH

Delivered by Monsieur Assih S. Passinim, Adjoint Préfet de la KOZAH (Adjunct Magistrate of KOZAH).

Durant une semaine, la Préfecture de la KOZAH en général et la ville de Kara en particulier, ont eu le privilège et l'agréable honneur d'accueillir en son sein des experts et des techniciens venus d'horizons divers, pour échanges d'expériences in matière de culture attelée.

A cet effect, le Commissaire Régional du RPT, Préfet de la KOZAH que je représente et la militante population de la Kozah, par mon canal, remercient du fond du coeur les promoteurs de cette rencontre du donner et du recevoir dans notre ville, et plus particulièrement l'USAID qui a mis tous les moyens logistiques à la disposition des participants, leur permettant ainsi de travailler aisément dans ce cadre idéal de l'Hôtel Kara.

Mmes et MM., notre fierté est aussi grande, parce que ce séminaire-atelier qui tire à sa fin ce soir aura, non seulement apporté un complément d'information, de formation et de sensibilisation aux vaillants techiciens de la culture attelée de nos pays respectifs, mais aussi vient appuyer avec force la politique, d'auto-suffisance alimentaire prônée par notre chef d'Etat, Président-Fondateur du RPT, Le Général Gnassingbe EYADEMA au lendemain de son accession au pouvoir: les centres de dressage de boeufs pour la culture attelée d'Agbassa, dans la Région de la Kara, le Centre de formation de Kamina, dans la Région Centrale, le Projet National de Promotion de la Traction Animal, et d'autres multiples projets à caractère cultural à travers tout le pays en disent long. En effet, pour le PRESIDENT-FONDATEUR du RPT, la santé et la dignité humaines, la paix, sont, entre autres, des maillons solides et indispensables à la stabilité politique dont jouit heureusement son peuple depuis 18 ans. Grâce à cette politique d'auto-suffisance alimentaire, fruits de la culture attelée, les greniers des paysans regroupés ou non ça et là en coopérative, ceux des fonctionnaires regorgent de vivres de toute nature. Bref, grâce à la culture attelée pratiquée par les couches valides togolaises, les vivres abondent sur les places de nos marchés.

Les Togolais doivent leur reconnaissance à cette pratique moderne qu'est la culture attelée initiée par leur Président-Fondateur; aujourd'hui, les Togolais n'ont plus rien à envier aux autres peuples nationaux ou extérieurs. C'est dans le souci d'améliorer davantage la vie de son peuple bien-aimé que l'homme du 13 Janvier, l'ayant exhorté à pratiquer cette méthode culturale peu coûteuse, a fait de nos jours des gens heureux robustes, fiers et n'envient non plus le fonctionnaire du coin. En d'autres termes, le paysan agriculteur pratiquant la culture attelée se suffit largement à tout point de vue.

Mmes et MM., en votre qualité de techniciens en la matière, votre dévouement, à l'issue de ce séminaire-atelier, se manifestera plus tranchant pour encadrer davantage nos laborieux paysans agriculteurs

modernes qui tendent aujourd'hui à se débarrasser entièrement des méthodes ancestrales culturelles, pénibles et peu rentables. C'est par cette assistance, c'est par la vulgarisation des expériences acquises dans ces locaux de l'Hôtel Kara, que vous aiderez nos Chefs d'Etat respectifs à soulager l'Afrique de la sous-alimentation, de la malnutrition de la disette, bref de la misère avilissante. Comme vous l'avez constaté, les heureux lauréats nationaux entourés de soins à Yamoussoukro, en R.C.I., par les Chefs d'Etat membres du Conseil de l'Entente, doivent leur chance à la pratique de la culture attelée. Je suis persuadé que de votre dynamisme renouvelé, de votre sensibilisation, de vos multiples efforts à, tous les niveaux, sortiront les années à venir d'autres lauréats pourvu que le ciel manifeste sa clemence par la régularité de la pluviométrie.

Je ne saurais terminer sans dire aux divers assistants américains, combien l'Afrique en général et nos pays respectifs en particulier, leur sont reconnaissants pour les lourds sacrifices humains et financiers qu'ils ne cessent de consentir pour nos peuples, surtout dans le domaine cultural moderne: à travers eux, nous remercions très sincèrement le Président des Etats-Unis d'Amérique, Son Excellence Ronald Reagan, dont les visées claires rejoignent celles de nos Présidents respectifs pour lesquels, apprendre au peuple à exploiter judicieusement la terre vaut mieux que lui donner des denrées alimentaires importés.

\*Au nom du Commissaire Régional du RPT, Préfet de la Kozah, je souhaite à vous tous un excellent retour dans vos pays respectifs.

- \*Longue Vie au Président Reagan,
- \*Longue Vie aux Chefs d'Etats Africains,
- \*Vivent l'USAID et tous les autres contribuables,
- \*Vive la Culture Attelée.

## APPENDIX 4

CABLE FROM USAID/TOGO TO OTHER AFRICAN MISSIONS AND AID WASHINGTON  
CONCERNING RESULTS OF NETWORKSHOP

1. A Farming Systems Support Project (FSSP) networkshop on "Animal Traction in a Farming Systems Perspective" was held in Kara, Togo, March 3-8, 1985. The thirty participants included representatives from Togo, Ghana, Ivory Coast, Senegal, Gambia, Sierra Leone and Burkina Faso (SAFGRAD/FSU) as well as representatives from USAID, GTZ, ODA, IDRC, Peace Corp, FAC, and ILO.
2. The major conclusion drawn from networkshop presentation discussions in small and plenary groups, field trips and general exchanges between participants was the importance of localized conditions and the constant need to adopt animal traction technology to these conditions, and thereby underlining the need for continuous adaptive research.
3. Small groups worked to identify strategies to deal with five critical areas of concern in animal traction programs: management of technology, preconditions necessary for adoption, animal feed resources, methodologies of adaptive research, and monitoring and evaluation.
4. Highlighted throughout the week was the need for continued exchange of ideas on problem areas and potential solutions through on-going networking activities. Emphasis was placed on the need for networking within countries in order to identify and improve existing information sources and to encourage more internal exchanges of project results. Equal emphasis was placed on the need for more exchanges between countries. Both levels of exchange will help to decrease research overlap and speed up the process of adaptive research for local and regional conditions.
5. Plans for future networking activities under FSSP sponsorship were also formulated during the networkshop:
  - a. Two more annual networkshops on the general theme of animal systems in farming systems will be sponsored by FSSP and held in West Africa.
  - b. Togo networkshop participants' consensus was to focus the 1986 networkshop on four specific themes: 1) animal feeding research for on-station and on-farm; 2) training of trainers in animal traction; 3) design and manufacture of implements; and 4) traditional animal health and husbandry.
  - c. A coordinating committee was selected to plan the next networkshop:

Bai Kanu, Sierra Leone  
Paul Starkey, United Kingdom  
Solomon Owens, Gambia  
Sandra Russo, Gambia  
Kossivi Apetofia, Togo  
Yesso Philidor, Ivory Coast  
Adama Faye, Senegal

Abou Berthe, Mali (nominated but not present at workshop)

- d. Tentative site selection and date for 1986 workshop were made and will be announced following host country approval.
  - e. Several exchanges between teams from different country projects have been proposed for 1985-86, at least under partial FSSP sponsorship, and will be announced upon approval.
  - f. The coordinating committee will meet in The Gambia, November 1985, to plan the agenda for the 1986 workshop, pending country approval. In addition to proposed FSSP sponsored exchanges, tentative arrangements were made for exchanges between technicians and administrators from neighboring countries, for example: Togo - Ghana, Togo-Burkina Faso and Gambia-Senegal.
6. The precipitating impetus for holding the workshop in northern Togo is the Kara-based AID-funded Togo Animal Traction Development Project (693-0218). The project has been designed around the workshop principles of a) drawing on lessons learned by AID, Peace Corps and other donors in the course of previous and current animal traction projects in Togo and elsewhere in West Africa; b) adaptive field testing of extension themes to be tested by farmers according to farming systems procedures.
7. USAID/TOGO would like to bring this particular workshop to USAID Science and Technology Bureau's attention as an example of promoting the common theme network. FSSP has served as an excellent device for linking and backstopping the issue of animal systems within a farming systems perspective. This is especially important with regard to the Agency's policy emphasis on technology generation and transfer on the one hand, and the scientific/technical capacity-building process within West African countries on the other hand.

## APPENDIX 5

## VOICE OF AMERICA NEWS CABLE CONCERNING NETWORKSHOP

## LE CULTURE ATTELEE AU CENTRE DES DEBATS D'UN SEMINAIRE INTERNATIONAL

1. Un séminaire atelier portant sur la culture attelée dans un système d'exploitation agricole s'est tenu du 4 au 8 mars à Kara (deuxième ville du Togo). Il a été organisé par le Farming Systems Support Project (FSSP) de l'Université de Floride (Etats-Unis) que représentait Dr. Susan Poats, Directrice Adjointe du Projet et Coordinatrice du séminaire. Les Travaux ont permis à une trentaine de chercheurs travaillant dans des projets de culture attelée au Burkina-Faso, en Côte d'Ivoire, en Gambie, au Ghana, au Sierra Leone, au Sénégal et au Togo, d'échanger les expériences respectives dans le domaine de la culture attelée.
2. Il s'agit, pendant cinq jours de travaux, de mobiliser autour de la question les avis et résultats obtenus dans les pays où est expérimentée cette forme de culture dans des conditions souvent différentes d'un pays à l'autre de la sous-région Ouest Africaine. En effet, la traction animale se présente à l'heure actuelle comme l'une des formes de mécanisation à la portée des agriculteurs des pays en développement essentiellement pour ce qui concerne le coût de sa gestion. Mais comme l'indique M. John Lichte, second coordinateur de l'atelier et spécialiste de la traction animale, les participants ont surtout mis en relief les problèmes rencontrés sur le terrain, notamment l'adaptation des techniques aux conditions des différents pays, le problème de l'alimentation des animaux souvent perturbée par les effets de la sécheresse, ainsi que la gestion de la technologie. Autant des problèmes autour desquels se sont déroulés les travaux, avec l'apport des expériences de trois autres Américains, un Britannique et un Canadien, chacun spécialiste dans une des branches du développement rural, mais ayant tous opéré dans des projets de développement agricole en Afrique.
3. Le séminaire, la première d'une série de trois prévus pour cette année, mettra ses conclusions à la disposition des projets initiés dans la sous-région, par le canal entre autres du Réseau de Recherche sur l'Exploitation Agricole en Afrique de l'Ouest (WAFSRN), créé en 1982 au Nigéria.
4. Le FSSP, financé par l'Agence Américaine pour le Développement International (USAID) a été créé dans le but de fournir l'appui technique aux projets de développement, à travers l'assistance technique, la formation à court terme, et l'organisation de rencontres pour faciliter la communication entre les hommes de terrain.



## APPENDIX 6

ANIMAL TRACTION PROJECT INVENTORIES

PROJECT NAME: Work Oxen Project

COUNTRY/REGION: Sierra Leone, Northern region initially, expanding to other provinces

TIME FRAME: Open ended; being institutionalized

FUNDING SOURCES: Sierra Leone Government 50%  
British Technical Aid 25%  
French Technical Assistance 25%

PROJECT ACTIVITIES:

- Equipment production and testing
- Training and supervision of extension workers
- Training of farmers and university students
- Animal traction research programs
- Socio-economic and animal health research
- Develop animal traction through village associations
- Participate in agricultural shows
- Monitor and evaluate credit

ANIMAL SPECIES USED AS POWER SOURCE : Cattle

PROBLEMS: Promotion of techniques in non-cattle rearing areas  
Lack of knowledge of the technology  
Unavailability of health services  
Unavailability of implements  
High initial cost and unavailability of subsidies

SUCCESES: Acceptability of the technology by farmers, government officials  
High farmer participation and increase in draft animals  
Equipment production  
Publicity of the technology  
Creation of ox units in the various agricultural projects and institutions  
Creation of village associations for owning oxen and equipment

PROJECT NAME: Farming Systems Unit/SAFGRAD

COUNTRY/REGION: Burkina Faso

TIME FRAME: 1979-1985

FUNDING SOURCES: USAID

PROJECT ACTIVITIES:

Identify socio-economic environmental and technological constraints which limit farm productivity in semi-arid West Africa (Burkina Faso)

ANIMAL SPECIES USED AS POWER SOURCES:

donkeys 75%  
cattle 25%  
horses < 2%

PROBLEMS:

Availability of animal traction  
Condition of animals at beginning of season  
Having proper equipment to effectively utilize animal traction

SUCSESSES:

Cereal yields of animal traction farmers are greater than yeilds of manual cultivating farmers  
Weeding is effected on a more timely basis  
Tied ridges are constructed better by animal traction farmers  
Fertilizer is more thoroughly incorporated with animal traction

PROJECT NAME: Eastern ORD Integrated Rural Development Package

COUNTRY/REGION: Burkina Faso, Eastern region

TIME FRAME: 1974 - 1980

FUNDING SOURCES: USAID and Government of Burkina Faso

PROJECT ACTIVITIES:

- Administrative support and staff training for credit program
- Credit revolving fund for animal traction
- Training extension agents
- Technical assistance for oxen feeding and care
- Socio-economic surveys and monitoring activities
- Regional planning surveys
- Marketing surveys

ANIMAL SPECIES USED AS POWER SOURCES:

- donkeys: about 1000 attelages
- oxen: about 800 attelages
- horses: about 2 attelages

PROBLEMS:

- Size of area
- Inexperience of farmers and extension staff
- Project focus on distribution of package without sufficient emphasis on proper use of equipment
- Low use rates
- Lack of suitable cashcrop to make repayments
- Animals are returned to Fula herders for their training

SUCSESSES:

- Well run credit system
- Animal training at village level using master trainers (bouvier)

PROJECT NAME: Ghanaian - German Agricultural Development Project  
(GGADP)

COUNTRY/REGION: Ghana, Northern region

TIME FRAME: 1970 - 1985, handing over planned for 1985.

FUNDING SOURCES: Governments of Ghana and Federal Republic of Germany  
(through GTZ)

PROJECT ACTIVITIES:

- Agricultural extension in northern region
- Animal traction program
- Support to Ministry of Agriculture in transport,  
communications and information
- Rural dug outs

ANIMAL SPECIES USED AS POWER SOURCE:

- Project trained 2100 pairs of bullocks from 1975-1985.
- Total number of trained pairs in Northern Ghana 10,000
- donkeys - about 1000 used for transport.

PROBLEMS:

- Increased incidence of CBPP, heartwater and penumonia -  
animal health problems
- Lack of capital due to increase in prices of inputs as  
well as after effects of 1983 drought
- Lack of initiative by extension agents due to lack of  
renumeration, discipline and supervision

SUCCESES:

- Training of 2100 farmers and bullock pairs
- Providing 5000 farmers with bullock plows/ridgers
- Self-sustained training of bullocks by farmers in four  
project areas

PROJECT NAME: Mixed Farming Project (MFP/University of Colorado/CID/USAID)

COUNTRY/REGION: The Gambia, entire country

TIME FRAME: 1981 - 1986

FUNDING SOURCES: USAID and Government of The Gambia

PROJECT ACTIVITIES:

- Maize agronomy
- Forage agronomy
- Range improvement and inventory
- Socio-economic surveys
- Farming systems research in crop/livestock systems

ANIMAL SPECIES USED AS POWER SOURCE:

- Oxen for cultivation and transport
- Donkeys for transport and some cultivation
- Horses for transport

PROBLEMS:

- Infrastructure and materials needed to manufacture equipment locally
- Training program needs to be improved in several areas especially in use of equipment, training of oxen, training of trainers
- Oxen lose their training skills over dry season

SUCCESES:

- Village level feeding program has been expanded in 1985 in response to farmer requests.

PROJECT NAME: Farming Systems and Rural Technology Transfer

COUNTRY: Senegal

TIME FRAME: 1983 -1986

FUNDING SOURCES: World Bank, Government of Senegal, FAC

PROJECT ACTIVITIES:

Research in Farming Systems

- a) zonage
- b) farming systems research
- c) technology transfer

ANIMAL SPECIES USED AS POWER SOURCE:

Bovine - NDama, Cross breed	500,000
Equine - horses, donkeys	60,000

PROBLEMS: Not applicable - animal traction existed in the region before the creation of this project

SUCCESES: Not applicable.

PROJECT NAME: Togo Animal Traction Project

COUNTRY/REGION: Togo, Kara and Savannes regions

TIME FRAME: 1983 - 1986

FUNDING SOURCES: USAID, Government of Togo

PROJECT ACTIVITIES:

Animal Traction:

- a) training
- b) demonstration
- c) extension

Agricultural credit: small farmer prefinancing

Evaluation and documentation of draft animal farming

Supply of draft animals

ANIMAL SPECIES USED AS POWER SOURCE:

Taurine, Zebu, Crossbreeds

PROBLEMS: All problems to date relate to the Kara Region:

- a) lack of animals
- b) price of animals is prohibitive
- c) low production increases
- d) lack of available usable land

SUCSESSES:

Farmer and extension agent training

Training of rural development agency extension agents

Training of farmers

PROJECT NAME: Project for the Promotion of Animal Traction (PROPTA)

COUNTRY/REGION: Togo, whole country

TIME FRAME: 1986 - 1987

FUNDING SOURCES: FED, USAID, Government of Togo

PROJECT ACTIVITIES:

- Coordination of animal traction activities in the country emphasizing
  - a) supply of equipment and animals
  - b) coordination of a national animal health program
  - c) training of extension workers

ANIMAL SPECIES USED AS POWER SOURCE:

Bovine - taurine zebu crossbreed

PROBLEMS: Coordination between animal traction projects especially for credit and animal health

SUCCESSIONS: Unification of agricultural material  
Harmonizing training efforts.

PROJECT NAME: Project Vivrier

COUNTRY/REGION: Togo, Kara region

TIME FRAME: 1980 - 1984

FUNDING SOURCES: Entente Fund and USAID

PROJECT ACTIVITIES:

Organizing and training of peasants with the goal of  
their achieving self development knowledge and  
capabilities  
Promotion of food crop development

ANIMAL SPECIES USED AS POWER SOURCE:

Bovine

PROBLEMS: Availability of adapted species of oxen Health Program  
implementation  
Land availability

SUCSESSES: Extension of animal traction  
Replacement of associated farming to monoculture farming

PROJECT NAME: Agricultural Development Project of the Central Region.

COUNTRY/REGION: Togo

TIME FRAME: 1979-1986

FUNDING: GTZ

PROJECT ACTIVITIES:

Introduction of an agro-forestry production system  
adaptable for animal traction

ANIMAL SPECIES USED AS POWER SOURCE:

Taurins, Zebus, Crossbreeds

PROBLEMS:

Low market prices are prohibitive to animal traction  
adoption and restrict repayment of loans  
Poor technical knowledge of maximal animal traction  
operations.  
Poor soil fertility restricts intensive agriculture  
Lack of techniques and technology to improve soil  
fertility.

SUCSESSES:

The creation and implementation of a system for  
introducing animal traction in areas where it and  
animal raising were heretofore unknown.

PROJECT NAME: Southern Mali Farming System Research

COUNTRY/REGION: Mali, southern region, but expect activity will expand to other regions. New project is under consideration.

TIME FRAME: 1977 to present (Dutch AID)  
1979 to present (IDRC)

FUNDING SOURCES: Dutch Aid/Royal Dutch Institute  
IDRC/USAID/Ford Foundation  
Malian Government/Rural Economic Institute

PROJECT ACTIVITIES:  
Farming systems research and pre-extension activities in cooperation with CMDT extension service  
Focus on integration of livestock into farming systems  
Livestock studies and testing  
Socio-economic studies and testing

ANIMAL SPECIES USED AS POWER SOURCE:  
Primarily cattle, donkeys for carting

PROBLEMS: The technical level of new adopters is not usually sufficient to grow cotton profitably. Farmers who haven't adopted can't get into the system.  
Dry season feeding of oxen and family herds: on-farm maintenance as alternative to transhumance  
Alternative crops and revenue sources - diversification  
Maintenance of soil fertility and erosion control  
Access of resource poor to technology and means of production

SUCCESES: Increased forage production using cowpeas as intercrop or relay crop  
Crop and revenue diversification: rapid expansion of upland rice and maize production in research villages  
Erosion control program adapted by CMDT  
Maize program for resource poor farmers extended to pilot project in cooperation with CMDT



## APPENDIX 7

INFORMATION SOURCES ON ANIMAL TRACTION

Prepared by Paul H. Starkey

Several organizations have produced valuable reports relating to animal traction. A summary of some of them is given below in alphabetical order. All these institutions are happy to receive letters in either French or English, although in many cases the replies will be in the official language of the country or the organization. In many cases both English (E) and, French (F) editions of the reports are available. While some organizations charge for their reports, many are prepared to send single copies to research workers, projects or institutions free of charge.

**CDR** Centre for Development Research  
9 NY Kongensgade, DK-1472, Copenhagen K, Denmark.

Publishes mainly socio-economic studies relating to Africa including "Kjaerby, F. 1983, Problems and Contradictions in the Development of Ox-Cultivation in Tanzania" (E).

**CEEMAT** Centre d'Etudes et d'Experimentation du Machinisme Agricole Tropical, Parc de Tourvoie, 92160, Anthony, France

Government sponsored research centre for agricultural engineering, with information and consultancy services available. Publication include "Aide memoire du moniteur de culture attellee" (F).

**CIVM** Centre for Tropical Veterinary Medicine  
Easter Bush, Roslin, Midlothian EH 259RG, Scotland, U.K.

University research centre with an animal traction activities including measurement of nutritional and work requirements for animal traction. Publications include "Draught Animal News" (E,F), "The work Output and Nutritional Requirements of Draught Animals" (E).

**FAO** Food and Agriculture Organization  
Via delle Terme di Caracalla, 00100 Rome, Italy.

United Nations aid agency with FAO/UNDP representatives in all African countries through which publications and information can be obtained. Numerous publications including:  
"Employment of draught animals in Agriculture" (E/F)  
"Animal Energy in Agriculture in Africa and Asia" (E/F)  
"Report of FAO Expert Consultation on Appropriate Use of Animal Energy in Agriculture in Africa and Asia" (E/F)  
"Animal traction in Upper Volta" (E/F) (with filmstrip)  
"AGRIS" - a computer database search service. (E/F).

**GRET** Groupe de Recherche et d'Echanges technologiques.

34 rue Dumont d'Urville, 75016 Paris, France.

Government sponsored information service with many contacts with official and NGO development agencies in the francophone world. Publishes many technical information sheets (F), for example animal powered water pumps, and newsletter "Recherche Developpement" (F).

**GIZ** Deutsche Gesellschaft fur Technische Zusammenarbeit  
Dag-Hammarskjold Weg 1, D-6236 Eschborn, Federal Republic of Germany.

Official bilateral aid agency, with advisory and consultancy services. Derivative organization GATE (German appropriate Technology Exchange) includes expertise on animal powered gears and pumps. Publications include "Munzinger P, 1982, Animal Traction in Africa" (E/F).

**ILCA** International Livestock Centre for Africa  
P.O. Box 5689, Addis Ababa, Ethiopia.

International Research Centre on African Livestock, with research programs in Ethiopia, Kenya, Mali and Nigeria. Specific research interests include animal traction. Comprehensive information search and dissemination service using computer database (E/F). Publications include "Goe, M., and Hailu, M., 1983, Animal Traction a selected bibliography" (E/F), "ILCA Bulletin 14 1981, Animal Traction in Sub-Saharan Africa", "Gryseels, G. et al ., 1984, The use of single oxen for crop cultivation in Ethiopia". (E/F).

**ITDG** Intermediate Technology Development Group  
9 King Street, London WC 1 E 8HN, U.K.

NGO appropriate technology organization with a publications section which sells many useful booklets on animal traction, including some case histories from different countries. Its own publications include a series of technical drawings of animal traction carts and implements, (E) and "Barwell, I., and Ayre M., 1982, The harnessing of draught animals" (E).

**MSU** Michigan State University, Department of Agricultural Economics,  
East Lansing, Michigan 48824, USA.

University department which carried out some valuable evaluations of animal traction in Africa. Publications include "Sargent, M.W., ie Lichte,, J.A. et al ., 1981, An assessment of animal traction in francophone West Africa" (E/F)

**NIAE** National Institute of Agricultural Engineering,  
Wrest Park, Silsoe, Bedford MK45 4HS, U.K.

A government sponsored research centre which has been associated with the development of animal traction in various parts of the

world. Publications include "Matthews M., and Pullen D., 1975, Cultivation trials with ox-drawn implements in The Gambia" (E).

- ODA** Overseas Development Administration  
Eland House, Stag Place, London SW1 E 5DH, U.K.
- Official bilateral aid agency with advisory services.  
Publications include "Mettrick, h., 1978, Oxenization in The Gambia" (E).
- PC-ICE** Peace Corps ICE  
Official bilateral volunteer program. Publications include  
"Watson, P.E., 1981, Animal Traction" (E).
- TSFP** Tillers Small Farm Program  
Nature Centre, 7000 N Westnedge Ave, Kalamazoo, MI 49007, USA.
- NGO appropriate technology centre interested in animal traction.  
Publication "Tillers Report". (E).
- UEA** University of East Anglia,  
School of Development Studies, Norwich, NR4 7TJ, U.K.
- University department with interest in animal traction.  
Publications include "Bartlett J., and Gibbon D., 1984, Animal Draught Technology, An Annotated Bibliography" (E).
- VITA** Volunteers in Technical Assistance  
3706 Rhode Island Avenue, Mt. Rainier, Maryland 20822, USA.
- Information dissemination service providing photocopies of  
numerous animal traction documents (E/F).
- IBRD** World Bank,  
1818H Street NW, Washington, D.C. 20433, USA.
- Official multilateral aid agency. Agricultural research  
department has published documents relating to animal traction  
including "Binswanger H., 1984, Agricultural Mechanization, a  
comparative historical perspective" (e/F) "Binswanger H., and  
Pingali P., 1984, The evolution of farming systems and  
agricultural technology in sub-Saharan Africa" (E/F).
- WN** World Neighbors  
5116 North Portland Avenue, Oklahoma City, Okla 73112, USA.
- NGO aid agency. Publications include "In action : Animal Power"  
with filmstrip (E/F).



## APPENDIX 8

DOCUMENTATION CENTER

One necessary component to any networking activity is the review and exchange of written documents. To encourage such an exchange and to provide an opportunity for workshop participants to review the literature available on animal traction and general livestock production, the FSSP brought a portable documentation center to the workshop. The documents included books, reports, reprints of published articles and copies of unpublished manuscripts. Most of these documents were collected prior to the workshop by means of bibliographic searches and requests to specific documentation centers such as: ILCA, CEEMAT, FAO, USAID, Michigan State University Sahelian Center, Purdue University, ICRISAT, IDRC and national research or extension programs and projects dealing with animal traction or related topics.

An additional set of documents relating specifically to farming systems research and extension were also included. Workshop participants and resource persons brought other documents to add to the collection. Following the workshop, other relevant documents suggested by participants were added to the list. The completed bibliography is found in Appendix 9.

During the course of the workshop, the documentation center was housed in a bungalow near the conference room of the Kara Hotel. It was open at lunch and during evenings. Documents were catalogued and could be loaned out over night. It was not possible to make individual copying requests, but most documents are available free of charge if requested in writing. For most users, the center provided an overview of the range of documents available. There was not enough time to allow thorough reading and most used the collection to gather references for future requests. It is quite likely that a smaller sample of documents would be sufficient for future workshop activities on this subject.

Following the workshop, those documents with duplicate copies at the University of Florida were left behind to be incorporated into the PROPTA Documentation center at Atakpame. As a follow up to the workshop, FSSP is assisting PROPTA in obtaining a large number of the documents from the bibliography to add to the PROPTA documentation center in Atakpame.



## APPENDIX 9

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## APPENDIX 10

PROGRAM  
 ANIMAL TRACTION IN A FARMING SYSTEMS PERSPECTIVE  
 FSSP NETWORKSHOP  
 MARCH 4 - 8, 1985  
 LAMA-KARA, TOGO

Sunday

9:00	Left Lome for Lama-Kara via bus
12:00	Lunch at hotel in Atakpame
4:30	Arrived at Hotel Kara, Lama-Kara
5-6:00	Arranged meeting room
6:30	Words of Welcome
	Introduction of participants
	Cocktail

Monday

8:00	Opening - Mr. Komi Gbeblewoo, Directeur de Statistique Agricole, Ministere de Developpement Rural
8:15	Overview: Housekeeping, procedures, workshop background, What is FSSP? - Susan Poats, FSSP What is FSR/E?, workshop objectives, topics of discussion, workshop schedule, day's objectives - John Lichte, FSSP
10-10:30	BREAK
10:30-12	Keynote address - Hubert Zandstra, IDRC
12-2:00	Lunch
2:00	Overview of animal traction in Africa -Paul Starkey, Work oxen Project, Sierra Leone
3:00	Conceptual framework - John Lichte 1. Agro-climatic zone 2. Livestock traditions 3. Project influences 4. Socio-economic factors
4-4:30	Break
4:30	Placing country experiences in conceptual framework, examples: 1. Sierra Leone 2. Gambia 3. Togo
5:30	Free Period
6:30	Field trip preparations - description of sites,

- logistics, topical focus
1. Management of Technology
  2. Animal Feeding
  3. Preconditions for Adoption

Tuesday

- 8:00 Departure of 4 small groups on separate field trips  
(picnic lunch prepared by hotel and sent with each group)
- 3-5:00 Groups returned from field trips
- 5-6:00 or  
6-7:00 Groups prepared field trip reports

Wednesday

- 8:00 Day's objectives  
Housekeeping
- 8:10 Field trip reports  
Atchangbade - Jacques Delobre  
Kante - Solomon Owens  
Brokou - Bai Kanu  
Landa Pozenda- Adama Faye
- 9:50 Summary of field trip experiences - Vince Barrett
- 10:10-10:40 Break
- 10:40 Remainder of the other topics of discussion  
4. Methodology  
5. Monitoring & evaluation
- 11:05 Field trip experiences related to methodology and  
monitoring & evaluation
- 12-2:00 Lunch
- 2:15 Problems in animal traction programs outside Togo  
1. Sierra Leone - Bai Kanu
- 3-3:30 2. Eastern ORD, Burkina Faso - Vince Barrett
- 3:30-4:00 Break
- 4:00 Problems in animal traction programs outside Togo  
(cont.)  
3. Senegal - Adama Faye
- 4:30 Report on CIMMYT Swaziland workshop - Sandra Russo
- 5-6:30 Free period
- 6:30-7:30 Slide presentations  
1. Paul Starkey, animal traction

2. ILCA slide module, FSSP
3. Adama Faye, Senegal

Thursday

- |           |   |
|-----------|---|
| 8:00      | Day's objectives<br>Identification of small discussion groups   |
| 8:20      | Small group discussion to list and prioritize problems related to group's topic <ol style="list-style-type: none"> <li>1. Management of technology</li> <li>2. Animal feeding</li> <li>3. Preconditions for adoption</li> <li>4. Methodology</li> <li>5. Monitoring and evaluation</li> </ol> |
| 10-10:30  | Break   |
| 10:30     | Small group presentations, problems related to topics 1-3   |
| 12-2:00   | Lunch   |
| 2:30      | Small group presentation, problems related to topics 4 & 5  |
| 3:30-4:00 | Break   |
| 4-6:00    | Small group discussions to propose solutions and strategies related to group's topic  |
| 6-6:30    | Free period   |

Friday

- |             |  |
|-------------|--|
| 8:25        | Day's objectives   |
| 8:30        | Small group presentations, solutions and strategies topics 1-3       |
| 10-10:30    | Break  |
| 10:30-11:50 | Small group presentations, solutions and strategies topics 4&5       |
| 11:50       | Parting comments - Hubert Zandstra                                   |
| 12:05-2:30  | Lunch  |
| 2:30        | Workshop wrap-up - comments by resource people and K. Apetofia, Togo |
| 3:00-3:30   | Verbal and written evaluations                                       |
| 4:00-4:50   | Discussion of follow-on workshop: topics, location and               |

timing  
 Nomination of coordinating committee  
 Sandra Russo           Solomon Owens  
 Paul Starkey           Bai Kanu  
 Kossivi Apetofia      Adama Faye  
 Yessoh Philidor      Abou Berthe (not present)

5-6:00           Break  
 6:00            Official closing  
 6:30            Closing cocktail

### Saturday

Meeting of workshop resource people with personnel involved in the Togo Animal Traction Project:

	Kossivi Apetofia	Vince Barrett
	Pakoubatcho Lekezime	Sandra Russo
	Adjevi Mensah	Susan Poats
	Kossi Loho	John Lichte
	Koffi Tebou	Jim Oxley
	M. Yassim	Paul Starkey
	Joe Howell	
	Tom Remington	
	Art Westneat	
	George Brunei	
	Jim Lewis	
	Craig Kramer	
	Sid Bliss	
8-8:30	Overview of TAT project	
8:30-10:00	Discussion of policy related problems	
10:30-12:00	Discussion of technical problems in small working groups	

## APPENDIX 11

## THE DESIGN AND TESTING OF IMPROVED LIVESTOCK TECHNOLOGY FOR MIXED FARMS 1

HUBERT G. ZANDSTRA<sup>2</sup>

## INTRODUCTION

Farming Systems research was formulated to make available modern production techniques to the complex, poorly endowed mixed farms so predominant in the developing world. First and foremost, Farming Systems Research should have as its objective to generate improved technology that is acceptable to farmers of a defined region, farm type or well-defined production environment. The technologies as such should not be confined to a pre-conceived input, e.g. irrigation, and should consider the balance between farm enterprises (crop, animal, fish pond, etc.) and, therefore, land use as a variable (Zandstra, 1982). This interpretation of FSR sets it apart from a systems approach to research (Norman, 1982), which in itself is highly commendable, and can be applied to by-product use for livestock feed (Berhane et al, 1983) or crop improvement or any other component or sub-system of the farm.

This discussion will emphasize the livestock component of the farm and stress large ruminants. The focus will be on the design and testing of livestock production alternatives, and an attempt will be made to make available experiences from Latin American and Asian researchers. The methodological discussions and examples will refer primarily to a sedentary farm type in which livestock are kept for all or most of the year within farm boundaries. It is hoped that the research approaches discussed will also apply, or can be readily modified to suit farm types in which livestock depends on seasonal access to grazing lands away from the farm unit or in which contractual arrangements exist for livestock management away from the farm for part of the year.

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1. Discussion paper prepared for the network workshop number 1 "Animal Traction in a Farming Systems Perspective; Lana, Kara, Togo, March 4-8, 1985.

2. Director, Agriculture, Food and Nutrition Sciences Division, International Development Research Centre, P.O. Box 8500, Ottawa, Canada K1G 3H9

The opinions expressed are those of the author, and do not necessarily represent those of the International Development Research Centre.

## FRAMEWORK FOR FARMING SYSTEMS RESEARCH

There are numerous presentations of the overall farming systems research framework. All of these recognize the following steps: selection of target area, a diagnostic phase, a design phase, and a technology evaluation phase (Fig. 1). For most of these steps, specific research methodologies and instruments have been developed for the cropping system, in such a way that the type of research conducted at a site is a result of the farm environment that prevails (Zandstra et al, 1981; Shaner et al, 1981). A brief summary of the specific activities, for each of the research phases, is provided in Appendix 1.

For the livestock component, the diagnostic tools developed for more or less rapid appraisal (Cobos and Gongora, 1977; Hildebrand, 1978; Collinson, 1982) can generally be applied to crop-livestock production systems. The simple graphic representations of the mixed farm and the contribution of the sub-enterprises to each other developed by Hart (McDowell & Hildebrandt, 1980; Hart et al 1982) provide an excellent insight into the interaction and limits that operate on the farm.

## INTERACTIONS BETWEEN CROP AND LIVESTOCK ENTERPRISES

There is no need to stress to this audience the important contribution made by animals to the farm enterprise and the extent to which the benefits derived from crop production can depend on livestock. The productivity of labour, considered to be one of the main constraints to the development of African agriculture, can be more than doubled by the introduction of animal traction (see for example Brossier and Jager, 1984). The important contribution of manure is unfortunately best demonstrated by what happens when generations of farms have been forced to use manure as fuel, as is the case in many highly depleted highland areas of Ethiopia (Tinker, 1985).

At times livestock is the only means by which farmers can efficiently benefit from a communal good, such as grazing lands or forests. Livestock also provides an alternative market possibility for crops through the utilization of low quality roughages and poor quality grains. In addition, livestock ownership provides a viable investment that stores reasonably well and produces returns through birth and weight gains. This flexibility for marketing and saving adds to the stability of the farm enterprise and provides protection against natural calamities.

However, the livestock enterprise also competes with food crops for time on the land. Forage crops may occupy land or may be intercropped with food crops, planted in hedgerows, or confined to land types that are difficult to manage. Livestock of course competes for farm labour used in feeding and care of livestock and processing of livestock products (Banta and Frio, 1974).

## MAJOR INTERVENTIONS IN THE LIVESTOCK SYSTEM

The interactions between crop and animal enterprises show that changes in the livestock system of the farm or the introduction of livestock into farms will require substantial modifications in the crop enterprises. The possible

interventions in the animal enterprise are modifications to:

- Feed availability
- Carrying capacity
- Reproductive efficiency
- Animal health
- Animal mix, herd composition
- Animal breed, or type
- Product mix — traction, milk, meat, hides, wool.

By far the most important constraint to increased livestock production is year-round feed availability; therefore, the feeding system receives the most attention in the design of alternative livestock production methods. The low quality of feed available from low input tropical pastures and crop residues leads to limits on digestibility and animal intake. For this reason, it has often been easier to increase the carrying capacity than to increase individual animal performance.

The importance of animal health should not be understated, but the extent to which farming systems research will address animal health beyond the application of existing control techniques is limited. The selection of animal type is generally dictated by the livestock resistance to disease and by climatic and market conditions prevailing in the area. Unless energy intake exceeds maintenance requirements by 180% or more, a strong emphasis on exotic breeds can only be justified on the basis of resistance to disease (De Boer, 1983).

The importance of animal mix and product mix in the consideration of improved livestock technology is often secondary to that of feed availability. It is, however, important for researchers to consider the various expansion paths of the livestock production system and relate this to their understanding of farmers' objectives. Where, for example, animal traction is the initial impetus for the introduction of livestock, an increase in the number of animals may lead to a greater concern for offtake as milk, such as is generally the case in South Asia, or as meat, such as is the case in Batangas, Philippines, e.g. the cattle raisers described by Moog (1980) and in Bali, Indonesia, e.g. the beef enterprise described by Nitis (1983).

#### INTERVENTIONS IN THE CROPPING SYSTEM TO SUPPORT LIVESTOCK

The most common means for increasing feed availability is by the intensification of forage production. Based on Plucknett (1978), the following means can be used to increase feed:

1. Collecting a catch crop after the main crop.
2. Intercropping a minor crop for forage, or to provide additional crop by-products or residues (thinning high density plantings).
3. Use of Cut-and-carry cultivated forages.
4. Use of multiple purposes hedges, fencerows, and fodder trees.
5. Supplementation by tethering or grazing on non-arable land.

6. Modifying the existing cropping systems by
  - a) improvement of amount or feeding value of straw
  - b) treatment of residues and by-products
  - c) protein supplementation to improve digestibility of low quality feed sources.
  - d) increasing yields of the cropping system to produce more forage.

Other crop-based interventions are: to reduce animal traction requirements by minimum or zero tillage (Van der Veen, 1983); to increase post-harvest plowing so that the main animal traction demands take place when livestock is at its peak condition; and to introduce fuelwood plantations at the homestead and in hedgerows and thus replace manure as a source of fuel, and increase fertilization of fields. There are undoubtedly many more interventions in the cropping system that could be listed.

#### THE DESIGN OF ALTERNATIVE PRODUCTION SYSTEMS

The design phase has two distinct but closely related activities: the design of improved production systems, be they farming systems, livestock or cropping systems; and the formulation of the overall research program to be conducted in a certain year. The design of the research program can conveniently be broken down into the experimental design and techniques to be used in the evaluation of alternative production systems, and the research to be conducted on key technological components of these systems. The experimental aspects will be discussed in the testing section.

The design of alternative production systems is a synthetic activity which uses the physical and socio-economic characteristics of the target farms obtained at the diagnostic stage, and combines this with knowledge about the performance of component technology (such as alternative plow designs, supplementation with urea, an improved sorghum variety) to identify improved production systems that are well adapted to the conditions of the target farmers (Fig. 2). Normally, the design of production systems is conducted by an interdisciplinary group thoroughly familiar with the diagnostic information and with experience in the target area. The mix of disciplines will depend on the enterprise or enterprises being considered and on the predominant biological or social constraints which prevail in the existing production systems.

The third workshop of the Latin American Animal Production Systems Research Network is entirely dedicated to an analysis of the techniques used for the design of alternative production systems. Participants also applied the methodology to three well-documented Latin American Livestock production systems (Ruiz and Li Pun, 1983). Most of the following discussion of the design process is based on the results of this workshop.

According to figure 1, the design phase follows neatly after the diagnostic phase, and precedes the testing phase. In reality, the design of alternative production systems overlaps with the diagnostic phase and with the testing activities, and depends substantially on feedback from these activities. For this reason, the design of alternative production systems can

take place simultaneously with diagnostic and testing activities at the farm level.

### 1. Analysis of the Region and the Target Production Systems

Assuming that the target area has already been selected, the design methodology starts with an analysis of historic events, trade pressures from outside and inside the country or region, migratory flows, customs of ethnic groups and consideration of population growth rates and medium and long term development trends. Particular attention is to be paid to the way these factors might interact or conflict with the way existing and evolving production systems may use land.

This analysis is important to arrive at an understanding of the factors that might stimulate or impede future activities required for the improvement of production systems. Understanding the causes and trends which have created certain limitations typical of the region, such as non-availability of credit, lack of roads, undeveloped markets, and a poor level of education, will help identify which of these limiting factors can be readily eliminated by intervention, or will gradually be removed through general development processes. This knowledge of the direction in which the overall system is prone to evolve is particularly important in new settlement areas or regions in which conditions are under rapid change. In such regions, the production systems are unstable and are prone to a series of modifications before an equilibrium is obtained.

### 2. Definition of Development Objectives in the Region

One of the first questions is how important is the production system under study in this region e.g. how important is a sorghum-millet-cowpea food crop system complemented with cotton and groundnut cash crop, with or without animal traction, in this region? This importance can be based on the product value which the system contributes, the frequency of the system and the size of the rural population associated with it, the percentage land use or other indices.

A more in-depth consideration of the system is obtained by an examination of the extent to which the interdisciplinary research team understands the reasons behind the particular form the production system has taken. Too often a diagnostic phase provides only information about the systems' form, land use, prices, percentage produce marketed, number of animals, their use, etc. It often provides very little insight into the reasons for this particular constitution of a production system and its functioning. Certain questions should be posed, such as: "Why has the acreage of groundnuts not expanded beyond what it is, given the tremendous utility farmers obtain from grain and haulms?" or "Why are farmers not using a particular input or approach, even though they are aware of it?" This ensures that the interpretation of the farming system given by the team, on the basis of the diagnostic studies, is internally consistent.

In this descriptive analysis of the system, it is important to take into account the human component, and the objectives, plans and attitudes of the

farm family and the institutional structure within which they operate. The design of alternative production systems begins to take form once the development objectives of the study region are understood. These objectives exist at three levels: objectives of the government and of the national research institution; objectives of the group of researchers responsible for the design and transfer of alternative production systems; and most importantly, the objectives and goals of the producer.

### 3. Analysis of the Production System or Sub-system to be Modified

The analysis of this system starts with the consideration of exogenous factors which have conditioned the system. This often explains certain intrinsic characteristics of the system, such as disease occurrence, genetic potential of livestock, mortality, etc.

The second level of analysis is structural, and refers to an inventory of land uses, structures and equipment. At this level, the areas of crop land, type and size of pasture land, number of animals and structure of the herd, stalls, sheds, and other constructions, equipment and machinery are analyzed.

The third analysis focuses on the way the system functions, and therefore addresses the management of the components of the production system (e.g. sorghum production, pasture production, herd management, veterinary controls, feeding systems, purchase and sales, etc), and interactions between the production system under consideration and other ways in which land, labour and capital are used on the farm. In many cases, the evaluation of the dynamics of the production system will have to be of a qualitative nature. In other cases, sufficient production data and resource allocation information is available to allow effective reconstruction of the actual production system. This is an important capability, as it will also allow a more precise ex ante analysis of alternatives.

### 4. Definition of Adaptation Domains

The objective here is to capture with a minimum of stratifications the greatest percent of the potential target population for the research activity in the region. An important starting point is to take into account ecological factors such as climate and land. Where the variability between regions is smaller than the variability within the region, for example from year to year, there may not be sufficient reason to stratify the adaptation domain. Other factors may be farm size or tenure, distance to markets, or others which will be generally expressed in substantial (structural) changes of the production systems used by farmers. An important method to evaluate if a splitting of adaptation domains is justified is to evaluate if the stratification will mean a difference between the domains in the structure of the production system in terms of crop types or enterprise types (Ruiz, 1983). This consideration is parallel to the differentiation made between readily modifiable and not readily modifiable factors (determinants) which condition cropping systems (Zandstra, 1976). Only the latter were considered acceptable as criteria for stratifying adaptation domains. In effect, the stratification of an adaptation domain means that the research team is convinced that the final recommendation and the research leading up to it for these regions will

be sufficiently different to justify the added research cost and effort.

### 5. Identification of Technical Interventions

At this point, the research team should be able to identify a number of practices or technologies which can produce an increase in farm productivity. The list of possible solutions should be closely related to the production constraints identified previously. The solutions can be compared in terms of their advantages and disadvantages and can be ranked as to the extent of their impact on the performance parameters of the production system.

At this point, it will become obvious that the research team involved in the design of alternatives is in effect working with a preliminary model, and it may be to great advantage to attempt to formalize this model as much as possible in graphic descriptive form (see for example Van der Veen, 1983; or Ruiz and Li Pun 1983, for several examples). An example of the existing, alternative production system for livestock producers in Sona, Panama is presented in Table 1.

### 6. Ex-ante Analysis of Potential Alternatives

The designed alternatives can be specified as a series of proposed changes in components of the existing production systems, such as a change in cropping patterns, supplementation of low quality roughages with high quality leguminous browse, treatment of low quality roughages, improved storage of crop residues or changed plowing time or methods. The ex-ante analysis seeks to evaluate the expected biological and economic impact of these changes. Although the use of ex-ante analysis in cropping systems research has been strongly advocated, the difficulty and risk associated with testing alternative livestock production systems gives greater importance to this methodological step. This analysis will require that the research team be aware of the resource requirements and their costs for the new techniques to be introduced. This will allow the application of partial budgeting techniques to predict the economic viability of each alternative. In addition to this analysis, which is limited to the changes introduced in the sub-system considered (for example the livestock system or only the feeding system), the ex-ante analysis should take into account interactions foreseen with other parts of the farming system. Careful consideration should be given to the demand of proposed alternatives on farm labour, cash inputs or specialized equipment. Other factors to be evaluated should include the returns to labour, net family income, and the production of a minimum amount of subsistence food crops. This type of analysis is greatly facilitated by simple input-output models of the production system under consideration.

The extent to which the ex-ante analysis can be formalized as simple simulation models or linear programming models can reflect in an important way on the type of testing procedures the research team decides on. Where a strong data base exists and ex-ante evaluation allows sensitivity analysis against assumptions on labour and cash input availabilities or assumptions about the biological response of interventions, the ex-ante analysis can be

used in future comparisons with the measured performance of alternatives to further refine the understanding of production constraints and possible solutions.

### 7. Evaluation of an Alternative Production System

The indices calculated in the ex-ante analysis should be compared to similar indices of production systems predominant in the adaptation domain. Where several alternatives are considered, their performance criteria should be compared. In general, the diagnostic phase will allow researchers to become familiar with the acceptable range of production criteria and with the desirability of the direction of change. For example, in systems in which land is not the primary limiting factor, it may be more important to increase productivity of labour, as indicated by returns to family income. Where severe limits on credit exist, reduced input levels and very high returns to cash inputs will be desirable.

The ex-ante analysis should also evaluate the impact of additional changes in the levels of inputs, the management components in the proposed alternatives, the cost and price structure that was used in the analysis. This sensitivity analysis is of great utility to estimate the sensitivity of important performance criteria to selected changes in the designed production system. Great sensitivity to changes in price structures, or to expected productivity changes (for example, of pasture or sorghum straw availability) may be indicative of an unstable production system which carries considerable risk.

### 8. Listing of Assumptions and Requirements for the Alternative Production System

Once a certain system has been selected for field evaluation, it must be described in detail. The demands of the system in terms of input availability and the assumptions made should be listed. These assumptions include the level of institutional support expected. Other assumptions related to the production environment, such as drought or flooding probabilities, are referred to the biological co-efficients used to calculate the performance (impact of fertilization, benefits of reducing calving intervals, relation between weight gain and TDN).

### 9. Identification of Research Priorities

At various points during the design process, the research team will have encountered difficulty in specifying biological relationships, in predicting the performance of alternative management practices, or in agreeing on the interpretation of farmers' behaviour. These information gaps should be listed to arrive at a set of research priorities on component technology or systems description which should be included in the activities of the research team.

## TESTING OF CROP-LIVESTOCK SYSTEMS

The testing phase of farming systems research is the most demanding phase in terms of staff and operational requirements. In this phase, experiments

are used to evaluate the performance of technological alternatives. These alternatives may be single management components -- component technology research -- or a combination of changes which may be a package of crop or animal production techniques or may introduce a completely different production system or land use (better farm resource use).

### 1. Objectives of the Testing Phase

1. To measure the performance of alternative technologies in the farm environment.
2. To compare alternative component technologies and production systems with those presently in use by farmers in terms of biological productivity, farm resource use efficiencies, and farmers' preference.
3. To identify labour, cash, and agricultural input requirements of the alternative technology.
4. To identify resource conflicts at the farm or community level that may be caused by the alternative technology.

### 2. Testing Component Technologies

Adherence to the design. At the design phase, researchers carefully consider the appropriate factor and input level (treatment) to be tested. The management used for other factors should also be specified, and should either adhere to the farmers' management or to that of a designed alternative production system. If, for example, only the effect of dietary supplementation with molasses and urea is to be evaluated, the herd management and the remainder of the feeding system should not be changed from that practiced by the farmer. If, however, this supplementation is to be evaluated as part of a new production system that includes changing animal grazing to a staff-fed system, and that also changes the weaning time of calves, then the nutrition sub-system must be evaluated together with the newly designed animal management methods.

Experimental designs. On-farm testing of component technology for animal production is complicated by the following factors:

- a) The number of animals per farm is small;
- b) animals vary in age, sex, breed, and physiological stage (lactation, pregnancy);
- c) animals move and forage in different areas;
- d) the effects of treatments on animal productivity may take place at a later stage in the animal's life cycle; and
- e) animals may change ownership before the results are in.

These factors make the choice of experimental design very important. In addition to the selection of animals and the allocation of treatments to similar animals across different farms, experimental designs must be chosen such that as many non-treatment effects as possible can be removed by statistical analyses.

Farmers participation. Testing should actively involve farmers, and the farm community. A range of farmer participation can be recognized:

- a) as observer, when the researcher designs and executes a trial on the farmer's land or with his animals, often through a rental agreement;
- b) as executor of a test designed by the researcher, but realized by the farmer, who conducts all operations. The farmer uses his resources and animals, often augmented by production inputs or implements and supervision from the researcher;
- c) as participant in design of the trial and its execution as under b);
- d) as originator of the test, through partial or complete adoption of a recommendation, using his own means to obtain additional inputs that may be required, from a production infra-structure specifically designed for the introduction of the new technology (pilot production program).
- e) as originator of the test without access to special institutional arrangements.

It should be emphasized that only the test situations in d) and e) can provide realistic estimates of the performance of the new technology. Tests b) and c) will reflect the farmers' execution, but results are often strongly influenced by continuous contact with researchers. For research not directly involving animals, such as that on forage crops or forage handling and storage techniques, the experiences obtained in cropping systems research can be directly applied. For treatments to large animals, considerably more care should be taken to avoid risks to the farmers. This is further complicated by the a large number of farmers that will be involved in such trials. The comparison of only 4 diets for buffalo will often involve as many as 30 farmers.

Interpretation of results. Because of the high cost and operational complexities associated with some animal nutrition and management trials, careful and exhaustive analyses are warranted. In addition to establishment of treatment differences, the analyses should simulate the impact of the different treatments on the whole production system. This can be done by tracing the effect of the treatment through the system. Economic analyses are also required. These can be confined to a partial budget analysis strictly comparing treatments, but ideally the costs and benefits should be identified after a careful study (or simulation) of the treatment's impact on the whole production system. For example, the effect of straw treatment will lead to digestibility increases. This is associated with higher consumption and may lead to a need for purchasing straw. It will also lead to increased labour costs for storage and handling. It may even change the rice production methods chosen by the farmer toward rice varieties with lower grain/straw ratios.

#### TESTING DESIGNED ALTERNATIVE CROP-LIVESTOCK SYSTEMS

These systems introduce a number of changes in the farmers' production methods. Changes may be radical, involving alternative crops or animal breeds, but to avoid unnecessary risks, it is best to start with minor

modifications. Table 2 provides an example of the existing and alternative systems from a research project for a dairy/beef production system and the result of a preliminary test of these systems.

The testing of such alternatives involves changes in the crop and livestock components of the farm, and therefore will often require one farm per treatment. To avoid excessive variation and treatment bias, the selection of farms must be made with great care. This selection should be based on a classification of farm types and on a careful selection of those farm types to which the research is directed. There can also be advantages to using pairs of similar farms within the selected farm types to remove variations associated with, for example, farm or herd size, from the treatment effects. Because at least 6 replications are needed, and because data collection requirements are substantial -- covering both crop and animal enterprise and certain whole-farm parameters -- the testing of alternative crop-livestock systems can be very demanding of staff and finances. An example of the whole-farm approach to testing alternative livestock systems is the program of the Panamanian Institute for Agricultural Research (IDIAP), which evaluates one livestock system alternative in each of three regions in which specialized livestock production is dominant (Ruiz and Li Pun, 1983).

Evaluation Criteria. These are similar to those used in cropping systems research and include technical feasibility, economic viability, and social acceptability (Table 3).

#### Problems Unique to Testing Crop-Livestock Systems

Because of the small number of animals on each farm, their higher cost, and the close emotional ties between the farm family and its animals, on-farm experimentation is much more difficult in animal production than in crop production research. Treatment failure leading to a drop in milk production (even in animals adjusting to new feed sources), or loss of weight, listlessness, and diseases will have more serious repercussions for researchers than a reduced grain yield in one of the farm fields. For this reason, the emphasis on ex-ante analysis of the biological and economic feasibility of new production methods should be greater in animal production research than in cropping systems research.

Data requirements for testing by means of simulation techniques depend on whether a biological model or an economic model is used; these two models have very different uses and data requirements. Most of the biological models require detailed information on herd composition, feed supply, etc. Economic models require data on prices, quantity of inputs, etc., which are more readily available. In most cases, partial budgeting techniques suffice for the comparison of alternative systems to those used by farmers.

In the case of modifications to the animal production system, multiple products, and a complex use by the farmer of a difficult-to-cost range of crop by-products, labour, and agricultural inputs, can make for a complex analysis. In mixed farm types, the simultaneous modification of the crop and animal production sub-systems (e.g. introduction of a pre-monsoon forage crop that delays the rice by 20 days and thus reduces its yield by 15%) can lead to

such complexities that ex-ante evaluation of designed technology requires simple whole farm models. These models should be used for sensitivity analysis to determine responsiveness to changes in crop and animal management methods.

There have been suggestions that for large ruminant production systems, researchers should depend primarily on models derived from the descriptive phase of FSR, combined with on-station and on-farm tests of component technology. This would be followed by a thorough ex-ante analysis of alternatives to identify a single alternative that would be validated in a pilot production setting involving a small number of farmers. The validation will allow a comparison between farms with and without the alternative technology and between the predicted and obtained results. This validation process can also employ successive changes in the alternative that is evaluated. In rare cases, it may employ alternatives that use a scheduled introduction of new techniques (e.g. incremental changes in improved pasture to be followed by a change in animal breed).

An alternative approach is to carry the model through to a physical reality, as was done in the modules of CATIE (Avila et al, 1980) for dual purpose milk/beef production and for specialized milk production. A similar module approach is used by the Instituto Veterinario de Investigaciones Tropicales y de Altura (IVITA) in its Amazonian Production Systems program in Peru (Riesgo et al, 1982). These modules have the disadvantage that they are researcher managed, but they do allow tuning and validation of the whole farm models on which they are based. An example of the results obtained in CATIE by comparing monitored farms to a production module is given in Table 4.

The use of unit farms, where a particularly suitable farmer is selected to "allow" his farm to be modified at the researcher's cost, appears more attractive. It keeps the test within the farm environment, and depending on the researcher's willingness to listen, this approach allows continuous input from the farmer or from a farmers' group.

There is a danger in removing the tests from the management constraints that exist on the farm. Researchers would also continuously have to remind themselves that their performance estimate is based on a highly simplified model, and that the "best" alternative mixed production system would still have to be tested on a number of farms to allow a comparison with the system used by the farmer.

Differential Transferability of Technological Components. There is much to be said for the research approach that evaluates individual parts of the mixed system in on-farm testing, and that uses a modelling technique to interpret the performance of the whole system. The effects of changes in animal nutrition or several other animal management components on the animal's performance are much more predictable and transferable than are the effects of changes in the forage or feed production phase. Exploiting this transferability could make the testing phase operationally simpler and would make less demands on experimental designs and data collection protocols.

## CONCLUSION

The testing of crop-livestock systems presents the greatest methodological challenges to farming systems researchers. The small number of animals per farm, their long lifecycles, and differences in age and physiological state introduce a lot of variation. Farmers also are more concerned about something unfortunate happening to their animals than to their crops (you talk to animals, seldom to sorghum).

There will have to be a greater emphasis on ex ante analyses at the design phase that employ simple biological models to conduct sensitivity analyses and that serve as a tool to combine experimental results from several technological components into a measure of their performance in the whole farming system. Such analytical techniques may need to replace part of the research process which, in cropping systems research, is realized by cropping pattern trials.

Experience in on-farm animal production experiments is increasing rapidly, and close communication among scientist in a network context can provide an important stimulus to further methodology development.

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## APPENDIX I:

FARMING SYSTEMS RESEARCH FOR IMPROVED  
SMALL FARM PRODUCTION SYSTEMS

The following is essentially the production systems research framework used by the International Rice Research Institute (IRRI) and the Tropical Agricultural Research and Training Centre (CATIE). It consists of seven research phases, which form a conceptual sequence. In practice however, several research phases may take place at the same time.

1. Selection of the target areas. One or more geographical areas representative of a large homogenous production zone are selected. The area should be a priority area for development by the national government. In this way, when the potential for increased production has been demonstrated, support for production programs will be given.

2. Site description. The first activity of the research is to describe the existing farming systems, the physical environment, the socio-economic environment and constraints to production. The characteristics of the farm environment will decide research priorities at the on-farm research site and at supporting research stations. At this time, the area is also divided in different land types, each of which may require a different production recommendation.

3. Selection of land types or farming systems. The stratification of the target area into land types is based on important environmental traits that are generally reflected in the type of food or forage crops grown and the type of animal feeding system or animal species that predominate. Land types are usually differentiated on the basis of pedological, irrigation, market, climatological or social factors. They should be general enough in occurrence to warrant research expenditures. Because of the staff and funding limitations and to reduce complexity, the research is generally confined to one or two land types and the predominant farm types associated with them. For the selected land types, the predominant farm types are studied in depth over time. This occurs while other research is ongoing and continues through the testing phase. This analysis concentrates on the biological and economic performance of the existing systems and its components. In mixing farming systems, particular attention has to be paid to the competition for farm resources -- cash, labour, land, at certain times of the year --, and to input transfers between subsystems -- crops as feed, manure as fertilizer, animal power, etc. The particular roles that livestock play in the farm enterprise have to be clearly defined.

4. Design of alternative systems. This includes the design of alternative cropping patterns, feeding systems, animal housing and management methods that are well adapted to the area. The design of alternative production methods takes into consideration the physical and socio-economic site characteristics, the performance of the existing production methods and the available component technology for the crops and animals in the farming

system. There are numerous practices which must be specified at the design stage. Many can be specified on the basis of existing knowledge and local methods. Others warrant separate experiments to establish optimal input levels or time and method of application. This component technology research may be conducted in national, regional, and local experiment stations or where possible on the farming systems research sites.

5. Testing of alternative systems. This involves the testing of the designed systems or selected management components in their respective environments on the farm. Farmers participate in the testing by managing the crops and animals according to the designed methods, with frequent advice and constant monitoring of the research staff. Based on the biological and economic performance of designed systems, problems that limit intensification of production can be identified and fed back to discipline or commodity oriented researchers. This scheme helps orientate such research to solve relevant problems of the target farmers. The evaluation of alternative systems involves careful analyses of the performance of each component management change in terms of its contribution to farm productivity. Where possible, a whole-farm analysis has to be used to evaluate the performance of a number of changes in management components that constitute the alternative system under evaluation. Farmers' observations and their tendency to adopt changes in the study area are important means for the evaluation of alternatives.

6. Extrapolation areas. When acceptable production alternatives have been identified, greater benefits from these research results can be achieved by their extrapolation to a wider area. Identification of similar land types and confirmation of the suitability of the new production methods to those environmental homologues is a necessary step prior to extension activities.

7.. Pilot production program. The on-farm testing and the identification of extrapolation areas for the recommendation have at this stage provided substantial information about the performance of the new production methods. A pilot production program is often advisable before embarking on a large scale extension activity. Such a program generally starts off in the original testing area and has the objective of identifying the institutional support and intervention required to assure the successful introduction of the recommendation. If successful, this experience will provide the information needed for the design of a full-fledged production program.

TABLE I

PERFORMANCE OF MILK/BEEF SYSTEMS IN SONA, PANAMA

<u>Criteria</u>	<u>Farmers a)</u>	<u>Experimental a)</u>
U.A/ha/yr	1.3	1.7
Milk l/ha/yr	538	735
Beef kg/ha/yr	49	123
Value of Prod/ha	\$228	\$315
Returns - Var.cost	206	253
Net Family income/ha	\$122	\$182

a) N=3

IDIAP, Panama, 1982

TABLE II

FARMERS AND EXPERIMENTAL PRACTICES EVALUATED  
FOR DUAL PURPOSE CATTLE

<u>Component</u>	<u>Farmers</u>	<u>Experimental</u>
Pasture	<u>H. rufa</u>	<u>H. rufa</u>
U.A/ha/yr	1.1	1.8
Weed control	2, manual	2, chemical
Minerals	Crude salt	Balanced
Internal Parasites	2/year	3-4/year
External parasites	As needed	each 21 days
Grazing:		
- Milking	15-45 days	7-35 days
- dry cows	21-21 days	21-21 days
- calves	continuous	rotational, impr. grass
King Grass	absent	1 ha with 150-55-0/year
Dry season supplement	absent	King Grass Molasses-urea

IDIAP, Panama 1982, average for 3 locations

TABLE III

Types of evaluation criteria for on-farm Experimentation.

Type of evaluation	Criteria
1. Technical feasibility	a) Ecological balance b) Bio-physical compatibility with existing systems. c) Yield d) Sustainability of crop yields e) Efficiency in use of inputs
2. Economic viability	a) Profitability b) Stability of returns c) Release of resources d) Compatibility with resource base e) Compatibility with existing support services.
3. Social acceptability	a) Farmers' assessment or reactions b) Adoption rate c) Social benefits d) Compatibility with short and long term societal goals e) National priorities

Source: Ngambeki, D.S., and G.F. Wilson. 1982. On-farm Experimentation in Farming Systems Research, IITA, Ibadan, Nigeria.

**TABLE IV**  
  
COMPARISON  
FARMER'S DUAL PURPOSE PRODUCTION SYSTEM  
TO THE IMPROVED SYSTEM

Criteria	Farmers (N=17)	Module
Use of concentrates, kg/cow.day	0.45 (47)*	0
Use of molasses, kg/cow.day	0.44 (59)	1.5
Carrying capacity, cow units/ha	1.8	4.0
Birth rate, %	52	57
Death rate, %	10	4
Milk production, l/cow.year	431	1,150
Total cost 1	\$ 387	999
Variable cost	\$ 189	600
Labour (days)	\$ 167	345
Investment in:		
constructions	\$ 211	535
machinery, equipment, tools	\$ 20	60
Milk Production, l/ha pastures	652	3,068
Meat Production kg/ha pastures	192	307
Product value	\$270	1,241
Net returns	\$ -117	242
Family income (FI)	\$ 155	617
FI/labour days 2	\$ 6.17	10.88

1. All monetary values are in Costa Rican currency

2. Minimum wage was \$5.45/day.

(FROM: AVILA ET AL , 1980).

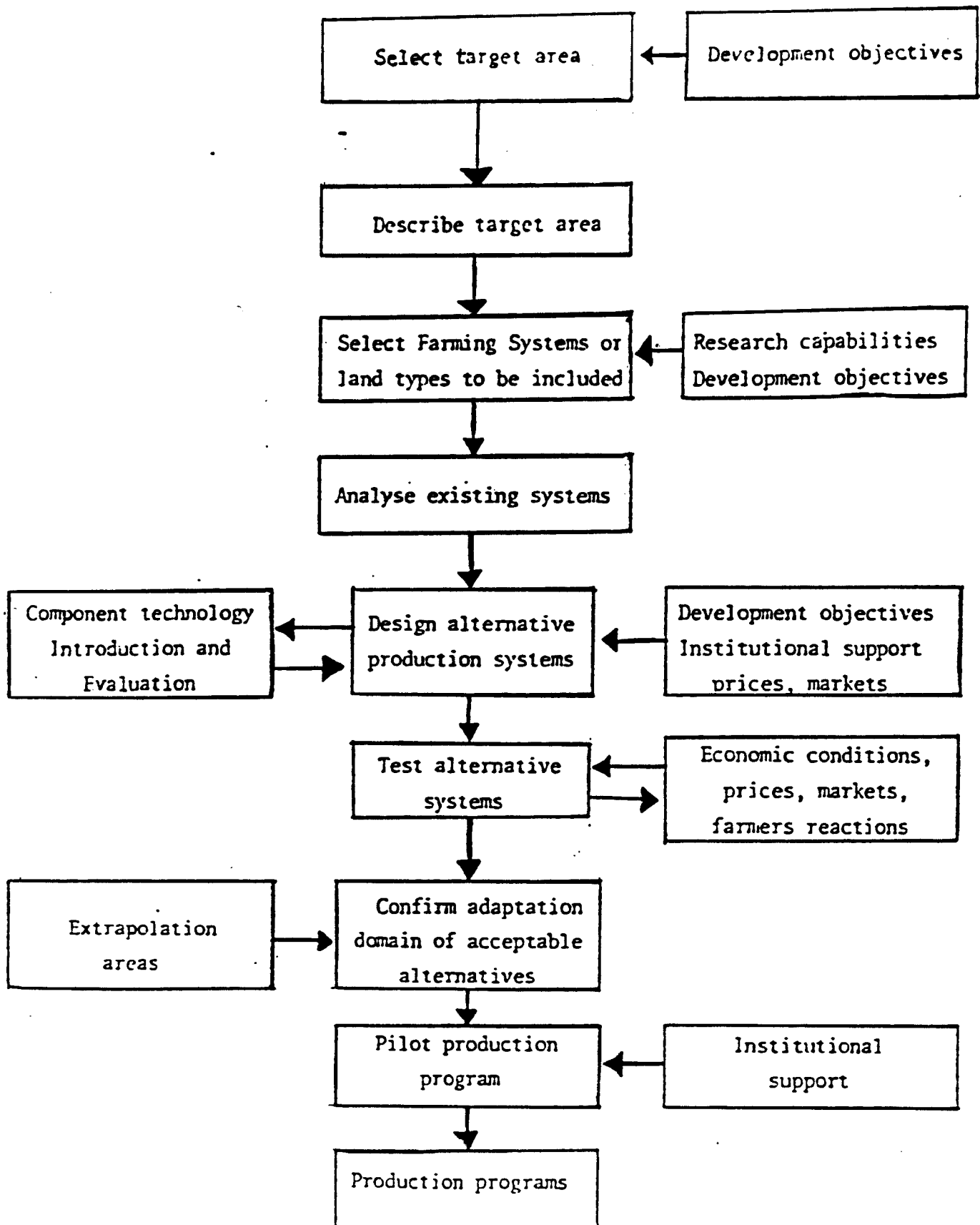


Fig. 1. Conceptual flow of activities in research and development of mixed farming systems.

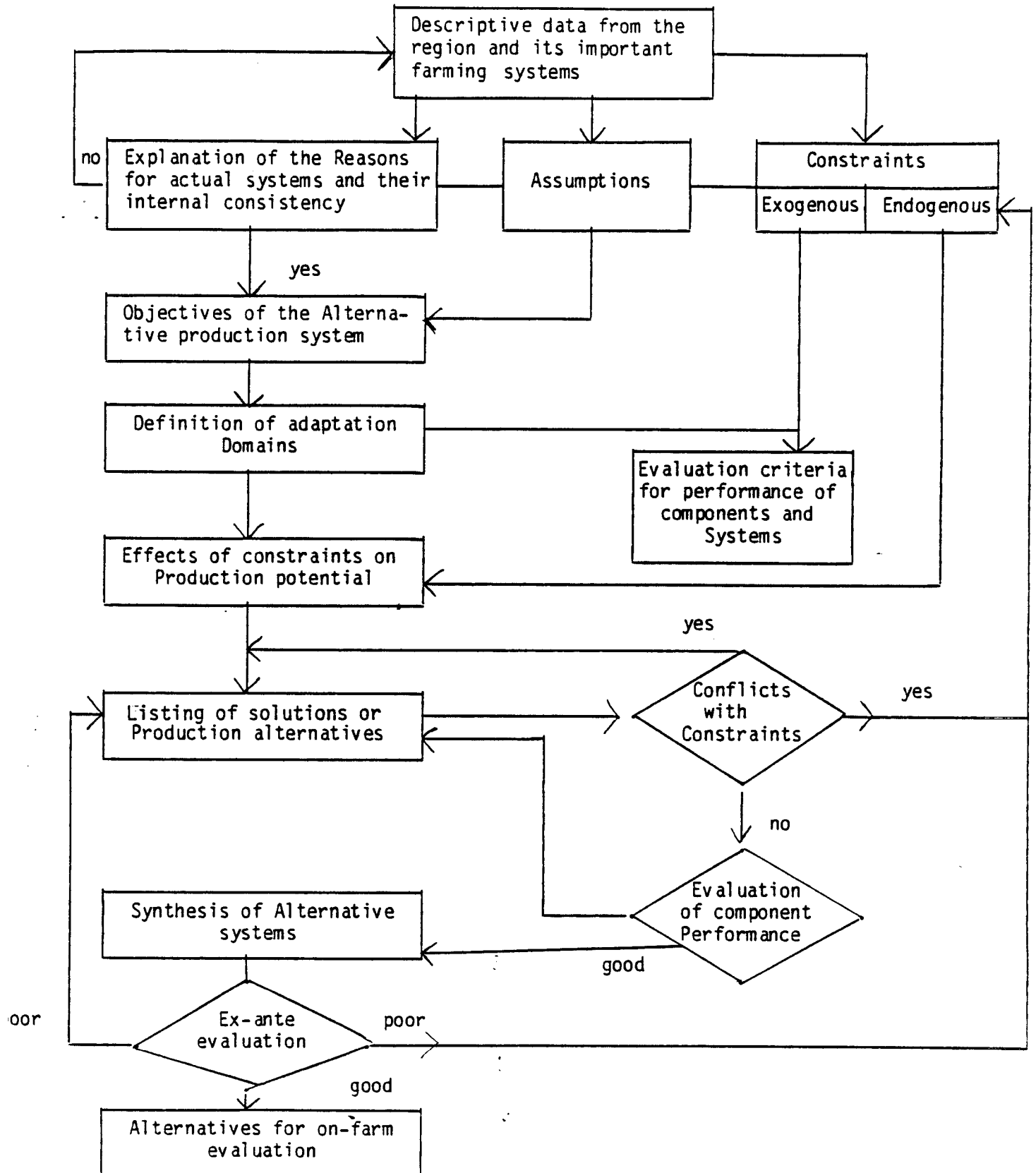


Fig. 2. The design process for alternative production Systems.

Source: Ruiz and Li Pun (1983)

