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Pasture Improvement Research in Eastern and Southern Africa

Proceedings of a workshop held in Harare, Zimbabwe, 17–21 September 1984

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Pasture Improvement Research in Eastern and Southern Africa

Proceedings of a workshop held in Harare, Zimbabwe, 17–21 September 1984

Editor: Jackson A. Kategile

Cosponsored by the
Southern African Development Coordination Committee, Gaborone, Botswana,
and the
International Development Research Centre, Ottawa, Canada

Abstract: The proceedings contains reviews by national scientists on pasture research done primarily in Eastern and Southern Africa (Ethiopia, Kenya, Tanzania, Burundi, Zambia, Zimbabwe, Swaziland, Lesotho, Botswana, Mozambique, and Madagascar). The application of the results obtained and lessons learned are highlighted and used in setting of national priorities for research areas for the future. Critical reviews on current pasture research methodologies are included in the proceedings. The research methods discussed are germ-plasm collection, storage, and dissemination; and germ-plasm introduction and evaluation, nutritive evaluation of pastures, grazing experiments, and range monitoring. Specific guidelines on methodologies are outlined and these are useful to pasture agronomists, animal nutritionists, and range-management scientists.

Two case studies of pasture-research regional networks in Asia and Latin America were presented and discussed. A strategy for future pasture research coordinated through a regional Pastures Network for Eastern and Southern Africa (PANESA) was discussed and agreed upon.

Résumé: Dans les actes ci-joints, des scientifiques de divers pays analysent la recherche entreprise sur les pâturages en Afrique orientale et australe (Éthiopie, Kenya, Tanzanie, Burundi, Zambie, Zimbabwe, Lesotho, Botswana, Mozambique et Madagascar). L'utilisation des résultats obtenus et les connaissances acquises sont mises en lumière, puis utilisées pour établir les priorités nationales en matière de recherche. Les actes comportent une analyse critique des méthodes de recherche actuelles sur les pâturages : rassemblement, entreposage et diffusion du matériel génétique; mise à l'essai et évaluation de ce matériel; expériences de pâturage; évaluation nutritive des pâturages et exploitation rationnelle de ceux-ci. On présente des lignes directrices précises sur les méthodes à suivre, qui seront utilies aux agronomes en charge des pâturages, aux spécialistes de la nutrition animale et aux scientifiques responsables de la gestion des pâturages.

Deux études de cas ont fait l'objet d'une présentation suivie d'une discussion : il s'agit des réseaux régionaux de recherche sur les pâturages en Asie et en Amérique latine. Après discussion, on a convenu d'une stratégie de la recherche sur les pâturages, dans les années à venir; la coordination de cette stratégie sera assurée par une section régionale du Pastures Network for Eastern and Southern Africa (PANESA).

Resumen: En las actas se recogen ponencias presentadas por científicos de diferentes países sobre las investigaciones en pastos que se han realizado principalmente en el Africa oriental y meridional (Etiopía, Kenia, Tanzania, Burundi, Zambia, Zimbabwe, Suazilandia, Lesotho, Botswana, Mozambique y Madagascar). Se destaca la aplicación de los resultados y experiencias obtenidos, muy útiles para determinar las prioridades de las investigaciones futuras en las diferentes naciones. En las actas se recogen también ponencias críticas sobre las metodologías empleadas actualmente en las investigaciones sobre pastos. Se analizan los siguientes métodos de investigación: recogida, almacenamiento, diseminación, introducción y evaluación de germoplasma; evaluación del valor nutricional de los pastos; experimentos de pastoreo; y control de dehesas. Se resumen directrices y metodologías específicas de gran utilidad para agrónomos especializados en pastos, expertos en nutrición animal y científicos especializados en gestión de dehesas.

Se presentan y analizan dos estudios de casos de las redes regionales de investigación en Asia y Latinoamérica. Se discutió y aprobó una estrategia para realizar investigaciones sobre pastos en el futuro que serán coordinadas por la Red de Investigaciones sobre Pastos para Africa Oriental y Meridional (RIPAOM).

CONTENTS

NETWORK APPROACH IN PASTURE RESEARCH: TROPICAL AMERICAN EXPERIENCE

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Abstract *Animal production and productivity are A slow in tropical America in spite of its large number of cattle. The main constraint for animal production is the availability and quality of pastures. Considerable efforts have been spent on pastures research. However, its impact has been rare. Pasture research is a long and costly endeavour. At the same time, resources for research are becoming more scarce. Faster and more economical ways have to be found to solve these problems. The network approach and the orientation of national pasture research programs could provide alternatives. The paper presents an overview of pastures research experiences, the activities of the International Tropical Pastures Network in Latin America and a scheme for an applied pasture research program.*

Animal production and productivity in the tropical areas of Latin America are low compared to what is found in temperate areas (Table 1). As a result, large deficits of beef and milk are found in most of the region. The difference between the growth rates of beef demand and production for tropical America in the last 10 years has been 3.1%/year. Surpluses, however, occur in some temperate American countries (Table 2).

Vast areas of acid infertile soils (oxisols and ultisols) account for 40-50% of the total land resources. In these regions, current stocking rates are as low as

Table 1. Livestock population and animal productivity in the USA and selected countries of Latin America, 1981.

Region/country	Population (10^6 cattle)	Productivity (kg/animal/year)
United States	114	90
Tropical America	199	24
Brazil	93	24
Colombia	24	24
Venezuela	11	31
Temperate Latin America	69	52
Latin America	267	31

Source: CIAT (1983).

Table 2. Beef: annual growth rates of demand and production in Latin American countries.

	Growth rates (%)	
Region/country	Demand	Production
Tropical America	5.3	2.2
Bolivia	4.9	4.9
Brazil	6.1	1.5
Colombia	4.9	3.5
Dominican Republic	6.0	3.4
Ecuador	8.9	5.3
Mexico	4.4	3.3
Paraguay	4.4	-1.1
Peru	3.0	-1.3
Venezuela	4.2	5.4
Central America	4.0	3.3
Caribbean	3.2	2.0
Temperate Latin America	1.7	3.2

Source: CIAT (1983).

0.12 animals/ha. These areas have great potential for agricultural production, because they receive ample solar radiation and, in general, have good physical soil properties and extended growing seasons. On these soils, low quality and quantity of available forage are the most important constraints for beef and milk production.

In some cases, dry matter availability (quantity) is not as limiting as it is in the extensive grasslands in the subhumid savannas (llanos of Colombia and Venezuela and cerrados of Brazil), where grasses grow rapidly and profusely after burning. Although cattle graze the young regrowth for 2-3 months, the available forage soon becomes unpalatable and accumulates as fuel for the next burn. Farmers traditionally burn different areas in a sequential pattern utilizing the same area every 18-24 months.

In contrast, under the much more intensive resource utilization (land, animals, feeds, etc.) that occurs in dual-purpose cattle production systems under the more humid environments of tropical America, both quality and quantity are extremely important. Land is more expensive and higher costs (land clearing) are required for establishment of crops or pastures. Maintenance costs are also expensive due to the need to control weed invasion and amendments and fertilizers required to maintain productivity. Often pasture degradation occurs rapidly while the farmer's herd naturally grows. This creates unbalanced situations where dry matter availability and higher carrying capacity of pastures become more important.

These two contrasting situations obviously require different and very specific research approaches. In the first case, grasses and legumes under minimum management should maintain quality and productivity for cattle in a relatively low-stocking rate farming system. In the second case, in the humid tropics dual-purpose system, improved grasses and legumes and better options for management should make higher stocking rates and controlled weed competition possible, thus providing better distribution of forage throughout the year.

In addition to the farming systems, pasture components (grasses and legumes) should be expected to

be different under the variable complexes of soil, climate, diseases, and pest pressures that occur in different environments. The use of available (commercial) pasture species in different environments commonly results in a failure at the adoption level. These differences occur across countries, across regions within countries, as well as across farms in the same region.

Considerable resources and effort are being spent on pasture research. However, quite often the impact of the utilization of research results has been rare. Contributing factors to this situation have been lack of definition of target agroecosystems, lack of representativity of research station locations, fragmentary research efforts, lack of farmers' involvement, inadequate links between research, and transfer of technology.

Resources for research in the developing world are becoming increasingly limited, and pressure for obtaining rapid answers to animal production systems problems is also increasing. The need to find more economical and faster ways in pasture research utilizing local and regional expertise is most necessary. The network approach can provide an alternative for the integration and complementing of national pasture program efforts, thus reducing costs and time and, at the same time, improving the coverage of the extremely complex combinations of environmental and farming system situations.

This paper presents an overview of pasture research experiences in tropical America, a description of the Latin American Tropical Pastures Network, and some suggestions for research schemes in national pastures research programs.

PASTURE RESEARCH EXPERIENCES IN TROPICAL AMERICA

To evaluate the emphasis and volume of research on tropical pastures in tropical America, a computerized catalogue of the 3,170 summaries (CIAT 1979, 1980, 1981, 1982, 1983) was done. This is a specialized publication including most scientific and monographic

articles about tropical pastures published in English, Spanish, and Portuguese.

Publications of Latin American scientists are not very well known in the international scientific community. One of the reasons for this is language; most publications in the region are in Spanish or Portuguese. However, their prolificacy and contribution to the subject of tropical pastures are quite substantial with 1,034 articles from countries of tropical America (Brazil, Colombia, Venezuela, Peru, Cuba, etc.), compared with 161 from the USA, and 516 from Australia and New Zealand, and 1,459 from other countries.

Comparing the number of papers by research subject in the total vs. tropical America (Table 3), it is important to note that although the proportion of papers on soil microbiology and pasture management and productivity is about the same in the region as in the total, in tropical America, there is less research emphasis on plant physiology, animal nutrition, pasture quality and productivity, farming systems, and economics research. However, there is a major research emphasis on the subjects of germ plasm and genetics, plant protection, agronomy, soils, and fertilization, as well as on seed production.

This tropical American major emphasis on agronomic work perhaps depicts the excessive concentration of pasture research in small plot evaluations under cutting that occurs normally in less-advanced or incipient pasture research groups. However, the emphasis on fertilization trials and on plant protection seems well justified by the needs of research on the predominantly acid infertile soils and on the high pressures of pests (Cigarrinha, Mion or Salivazo),[1] as well, as diseases (anthracnose in Stylosanthes spp., rhizoctonia, bacteriosis, and cercospora in Centrosema spp., etc.) that occur in tropical America.

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[1] Sucking Homoptera of the genera Zulia, Aneolamia, Mahanarva, etc., that severely affect grasses, especially Brachiaria spp.

Table 3. Publications in different fields of tropical pastures research.

Field	Total		Tropical America	
	No.	%	No.	%
Germ plasm and genetics	242	7.6	95	9.2
Plant physiology	130	4.1	31	3.0
Plant protection	146	4.6	76	7.4
Agronomy	324	10.2	138	13.3
Soil fertility	509	16.1	222	21.5
Soil microbiology	179	5.6	53	5.0
Pasture establishment	110	3.5	51	4.9
Animal nutrition	458	14.4	99	9.6
Pasture quality and productivity	416	13.1	39	3.8
Pasture management and productivity	327	10.3	105	10.2
Seed production	223	7.0	106	10.3
Farming systems and economics	106	3.3	19	1.8

In the same way, Table 4 shows the contribution of tropical America and that of the total based on monographic publications on small plots under clipping and those on grazing and pasture animal-production work. Although the monographic contribution of tropical America is about the same as the total, very clearly the proportion of research publications on small plots under clipping increases at the expense of publications on grazing and pasture-animal production work for the case of tropical America.

Table 5 shows the distribution of published work in tropical pastures according to type of cattle enterprise. It is evident that most published work has been conducted on beef production; a lower proportion on milk production and a minor one on dairy-beef dual-purpose production. These proportions contrast with the predominance of the dual-purpose farming system, and the importance of milk production in a region where most countries are importers of that commodity. This clearly indicates the degree of initial development of

Table 4. Publications by different levels of tropical pasture research.

Level of evaluation	Total		Tropical America	
	No	%	No	%
Monographs	451	14.2	139	13.4
Agronomic small plots under clipping	2055	64.8	828	80.0
Grazing effect	197	6.2	49	4.7
Pasture-animal productivity	359	11.3	13	1.3
Use of supplement feeds	108	3.4	5	0.4

Table 5. Published data on tropical pasture evaluation under grazing according to animal production systems.

Country and regions	Animal production systems		
	Beef	Milk	Dual purpose
Brazil	79	7	1
Colombia	49	5	-
Cuba	28	44	1
Peru	4	-	-
United States	18	2	-
Venezuela	4	3	1
Rest of America	76	13	7
Other countries	66	6	1
America with acid soils	163	59	3
New Zealand and Australia	99	15	1

tropical pastures research activities in tropical America, as well as the lack of experience of researchers and adequate funding from Latin American research organizations to undertake grazing work at early evaluation stages.

INTERNATIONAL TROPICAL PASTURES EVALUATION NETWORK (RIEPT)

In cooperation with national pasture research programs in tropical America, in 1978, the Tropical Pastures Program of the Centro Internacional de Agricultura Tropical (CIAT) was the catalyst in the formation and organization of RIEPT, with the following main objectives: (a) germ-plasm introduction and evaluation, (b) development of appropriate and simple methodologies for pasture research, (c) exchange of information, and (d) training. In 1979, as a result of the first meeting (workshop) of collaborating institutions (Table 6), there was agreement on the basis of organization of the network (Toledo 1982) as well as on the methodological evaluation sequence to mobilize effectively new germ plasm (from national program sources and CIAT) throughout the region and from the initial introduction gardens to grazing trials and farming systems.

The common failure of commercially available cultivars (selected under different environments) in the highly acid infertile soils and under high disease and pest pressures that predominate in tropical America was clearly recognized. The diversity of ecosystems and farming systems requiring new improved pastures was also very clear.

Sequential Methodology of Evaluation

Based on the common interest of testing new germ-plasm options, four types of multilocational trials were conceived. First, regional trial A (RT-A) to evaluate survival of a large number of entries (100-150) in a few highly representative sites in major ecosystems and, second, regional trial B (RT-B) established in as many sites as possible to measure seasonal dry matter productivity of a reduced number of promising entries (20-30) selected from RT-A and major screening sites of national programs and CIAT. These first two types of regional trials are agronomic, utilizing uniform methodologies (Toledo and Schultze-Kraft 1982) to allow comparisons of germ-plasm performance across locations to study the range of adaptation to basic environmental parameters (soils, climate, and biotic factors).

Table 6. List of institutions by countries participating in the first workshop of the RIEPT (October 1979).

Country	Institution
Australia	CSIRO
Bolivia	Centro de Investigación Agricola Tropical
Brazil	CEPLAC-Bahía CIAT/CPAC-Brasilia EMAPA-Maranhao EMBRAPA-Brasilia EMBRAPA/CENARGEN-Brasilia EMBRAPA/CNPGC-Mato Grosso EMBRAPA/CNPGL-Minas Gerais EMBRAPA/CPAC-Brasilia EMBRAPA/CPATU-Pará EMGOPA-Goiás EPAMIG-Minas Gerais FAO/UEPAE-Teresina, Piaui IAPAR-Paraná
Colombia	CENICAFE CIAT Fondo Ganadero del Putumayo ICA
Cuba	Instituto de Ciencia Animal Ministerio de Agricultura
Ecuador	Escuela Superior Politécnica de Chimborazo INIAP
Guyana	Livestock Development Co. Ltd. Ministry of Agriculture
Jamaica	Ministry of Agriculture
Mexico	INIA
Nicaragua	INTA (MIDINRA)

(continued)

Table 6. Concluded.

Country	Institution
Peru	COPERHOLTA-Tarapoto
	INIA/CTA-Tarapoto
	INIA/NCSU-Yurimaguas
	IVITA-Pucallpa
	Universidad Agraria "La Molina"-Tarapoto
Surinam	Ministry of Agriculture
Trinidad	Ministry of Agriculture
Venezuela	Centro Nacional de Investigaciones Agropecuarias
	FONAIAP
	FUSAGRI
	Universidad Central de Venezuela
	Universidad de Oriente
	Universidad del Zulia

Third, regional trial C (RT-C) to evaluate under grazing a further reduced number of accessions (about 10) assembed in grass-legume mixtures. The purpose of these trials is to assess the dynamics of the sward in terms of productivity (carrying capacity of dry matter on offer), and botanical composition (proportion and survival of grass and legume), under different intensities and frequencies of grazing. Regional trial Cs in small plots under grazing are conducted with different designs only at relatively few sites of the network because most of the generated information in terms of grass-legume compatibility and effect of trampling may be considered as highly dependent on the genetic characteristic of the plants and could be extrapolated to animal productivity trials (Paladines and Lascano 1983).

Fourth, regional trial D (RT-D) assesses pasture productivity and persistence in terms of animal products (animal body weight gains, milk production, etc.) of the best new pastures compared with the best traditional pastures used in the region. It is expected that

the management commonly used in the prevailing farming system should be incorporated in the treatments and design of these trials. Consequently, it is expected that RT-Ds will be conducted using independent methodologies and in as many locations as possible because they must aim to improve existing pastures in the predominant farming systems of the area of influence of each location.

Figure 1 shows the organizational scheme of RIEPT, where germ plasm is sequentially passed through the different regional trials in the different ecosystems. The information generated (Pizarro 1983) is shared by all members of the Network by means of direct communication, meetings, workshops, the Tropical Pastures Bulletin (published 3 times a year), and by direct consultation with the central data base of the network located in CIAT. The sequence in several locations is being reduced to the steps RT-B and RT-D, using information of the full sequence generated by other more-developed pasture research groups in locations within the same ecosystem. In a parallel fashion, all national programs are also working with the resulting promising selected materials, especially to study and adjust fertilizer and Rhizobium requirements, to develop establishment techniques, and to optimize their performance under the specific soil conditions of the location.

To support this cooperative effort, the Tropical Pasture Program of CIAT, with financial aid from the International Development Research Centre (IDRC), is conducting supportive methodological research especially to modify available techniques and develop new techniques more suited to the conditions (technical and economical resources) of national programs in the region.

The rapid expansion of RIEPT between 1978 and 1983 is shown in Table 7. In 1983, 84% of the trials were at the agronomic level (RT-A and RT-B), and 16% were evaluations under grazing (RT-C and RT-D). At present, several new grazing trials are being proposed and established. Some of these trials are partially financed by IDRC, especially for national programs with less resources. To date, RIEPT has been most instrumental in catalyzing the research activities on

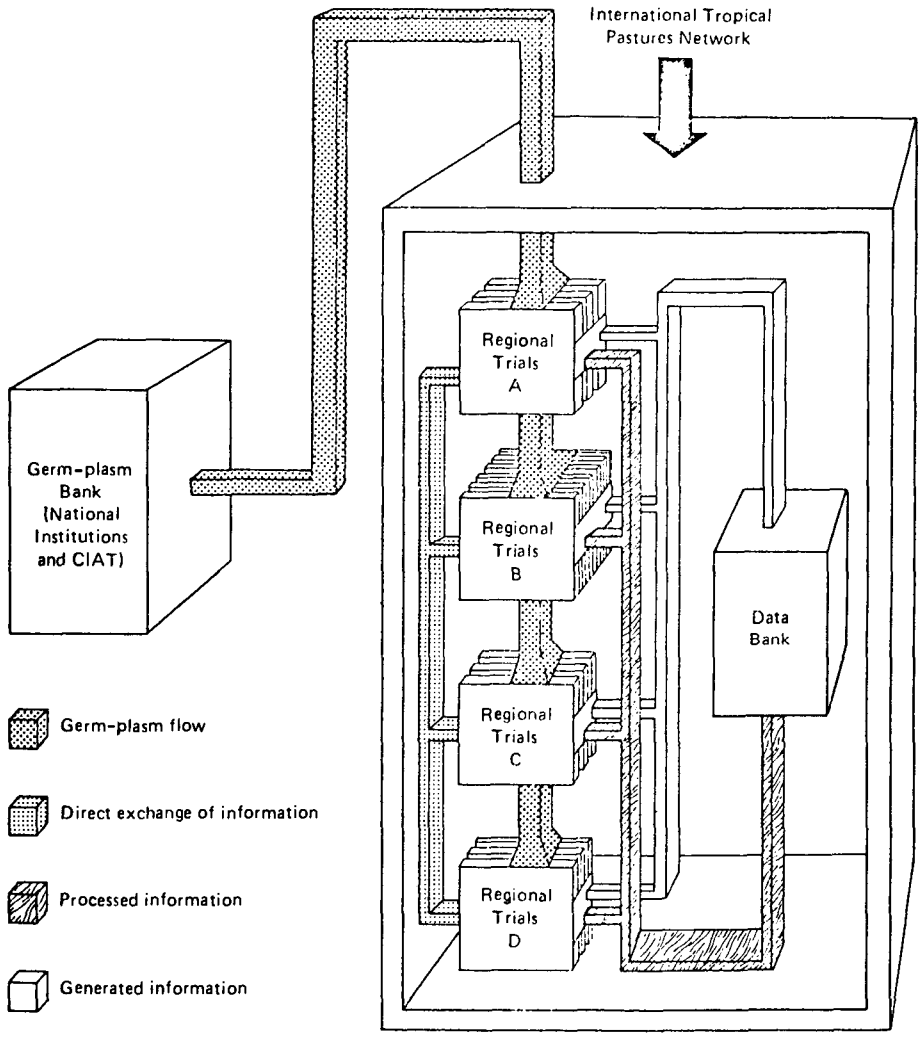

Fig. 1. Organization of the International Tropical Pasture Network.

Table 7. Active[a] regional trials between 1978 and 1983 by countries.

Countries	1978	1979	1980	1981	1982	1983
Bolivia	1	1	1	2	2	2
Brazil	1	8	12	9	9	16
Colombia	3	5	12	11	13	13
Costa Rica	-	-	1	1	1	2
Cuba	1	1	-	-	1	1
Ecuador	2	2	3	3	4	6
Guyana	-	-	2	1	1	-
Hawaii	-	-	1	1	1	-
Honduras	-	-	-	-	-	1
Mexico	-	-	-	1	1	7
Nicaragua	-	-	2	3	3	3
Panama	-	-	3	3	3	10
Paraguay	-	-	-	1	1	-
Peru	3	3	5	7	11	13
Dominican Republic	-	-	-	-	-	4
Trinidad	-	-	1	1	1	-
Venezuela	4	4	5	5	5	-
Total	15	24	48	49	57	78

[a] Active = sown trials reporting information.

tropical pastures in national programs in tropical America and is strongly helping them to advance into grazing evaluation on-station as well as on farms. In this sense, two new initiatives are being undertaken. First, the on-farm evaluation of improved pastures in animal production systems (RT-E) and second, the support to national programs to organized seed-production activities.

SCHEME FOR EFFECTIVE APPLIED RESEARCH ON PASTURES

Commonly, the organization of agricultural research is based on the specialization of the person responsible for its design. Often there is a lack of a comprehensive scheme that will thoroughly incorporate the activities of applied research as well as the participants and their relationships with basic research components in addition

to global incorporation within the framework of the target area.

When a research program is set up, often the organizers emphasize disciplinary work: breeding, fertilization, animal nutrition, mechanization, etc., in a scheme of "applied research" that commonly does not give enough attention or consideration to farmers. However, although not as frequently as in the past but certainly more so in recent years, some research programs are organized to emphasize research in farmers' fields strongly, very often only describing and documenting farmers' practices. Nevertheless, the alternatives to solve the basic problems of productivity in rural areas are lacking.

In addition, historically, research and extension have been disconnected, especially in the developing countries. Despite the very elaborate and often very comprehensive diagrams and organigrams put to paper to link these two very important activities for rural development, in reality the link is at most tenuous.

The results (of this comprehension) often produce frustration for researchers and extensionists, new technologies with little potential of adoption by farmers, political discredit of research and extension activities, and reduction of economic support that often destroys or reduces the activities of a program. In this way, large amounts of money, resources, and time could be spent while farmers remain the same with their traditional techniques, low productivity, and poor standard of living.

Scheme for Effective Applied Research

One way to approach the applied research activities more effectively is to consider them as comprehensively as possible, where the activities of researchers, extensionists, farmers, developers, etc., are consolidated in a flow of research activities and information toward more productivity and a better standard of living for farmers.

Figure 2 represents our suggested view of the activities involved in applied research. The basic, natural (soil, climate, and biotic), and socioeconomic

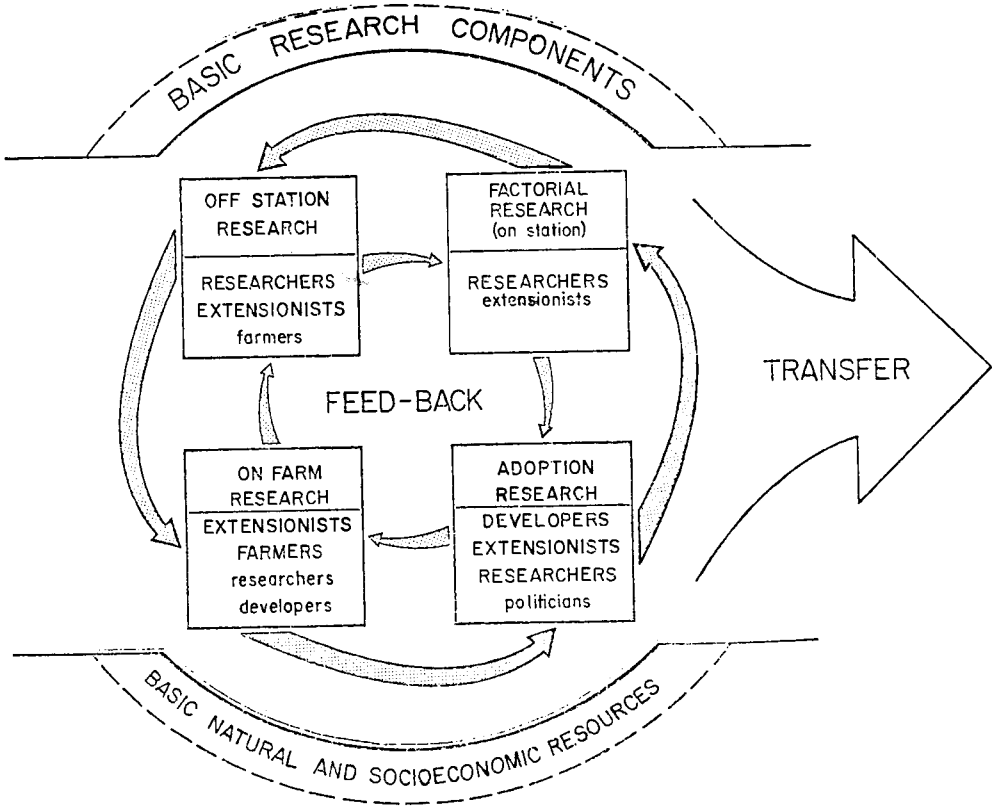

Fig. 2. Organization, participants, and flow of information in an applied research program.

(farming system, anthropologic, economic, etc.) resources (BNSR) have to be evaluated and described at the macrolevel to set the bases for understanding the target area, to set research priorities, etc. Understanding of the ecosystems and prevailing farming and animal production systems is basic for the definition of the applied research programs. Knowledge of the ecosystems in terms of soils, climates, topography, etc., helps in the definition of environmental constraints and the adaptation domains, i.e., confines, (limits for the technology). Farming systems characterization will help in defining the resources (land, animals, crops, type of pastures), management (fertilization, rotations, etc.), products and productivity (milk, beef yields, birth rates, etc.), and all relevant interactions of farm components in the target area. They provide an idea of the production constraints. These research activities are represented at the bottom of Fig. 2 to emphasize information that should be regarded as basic. In the top of the scheme, the basic research components (BRC) are included to emphasize the other available information and resources for applied research. These BRCs are germ plasm, fertilizer sources, means for plant protection, tools, machinery, etc., and normally are developed by other specialized research and/or production organizations. The applied research should consider them basic for the development and assembly of new technology.

For the BRC and the BNSR, the applied research takes place with the objective of combining resources from the two kinds available to optimize and/or modify (positively) the existing production techniques in the prevailing ecosystem and farming system. The applied research covers a range of research activities that includes (a) factorial research (on station), (b) off-station research, (c) on-farm research, and (d) adoption research.

Factorial Research

Factorial research is usually conducted in experimental fields (minor research stations). Its role is very important in selecting from the BRCs the components that suit the needs for the research toward the prevailing farming systems (e.g., major screening of germ plasm, characterization of the performance of

performance of promising selections, breeding, management and its interaction with the nonlocation-specific responses of selected materials, use of alternative sources of fertilizers and chemicals).

Other important roles of on-station research are methodological adjustment and development as well as coordinating and centralizing the activities of the whole applied research endeavour. The participants of the factorial research traditionally are only the researchers. However, the coparticipation of researchers and extensionist leaders is of great importance.

Off-Station Research

Commonly, the research station represents only limited and quite often the best[2] conditions of its target area. Off-station research is very important in any applied research program. Its objective is to validate and adjust selected components to different environments (e.g., minor screening of germ plasm (RT-B and RT-C), fertilizer dosage, mineral requirements, management trials and their interactions with location specific responses). In addition to the researchers and extensionists, the participation of at least leading farmers is very important for this multilocational research activity.

On-Farm Research

The specific components and techniques adjusted for the several environmnents of the target area should be validated at the farm level. Usually on a farm, several micro-environmental conditions occur. In addition, each farmer has different experiences, preferences, skills, resources, etc. Consequently, the exposure of the newly generated technology to farmers' management and adaptation is a very important research activity for the final selection of adoptable technology.

The objective of on-farm research is to validate new technologies at the farmer level, evaluating their performance, as well as the modifications and adapta-

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[2] Frequently, research stations are found in the best locations in terms of soils and resources.

tions done by farmers (e.g., evaluation of the biological performance of the technology gap between experimental and farmers' yields, labour requirements, resource requirements, cost-benefit analyses). The most important factors in this on-farm research should be the extensionists and the leading farmer. Also, the researchers' participation is important, mainly in the evaluation activities and, especially, in methodological development and in the definition of measurement techniques to obtain reliable information. At this level of research, the participation of developers[3] is also critical to incorporate their inputs and viewpoints as well as make them aware of new technological advances.

Adoptive Research

After evaluating the performance of the new technology at the microlevel in the farmer's fields, the released[4] technology may or may not move rapidly in a zone, region or, country. This is strongly affected by the characteristics of the technology in question (superiority of new technology in productivity, availability of resources required for its implementation, cost-benefit advantage, range of technology, adoptability, etc.), as well as by the characteristics of the socioeconomic environment (farmers' choice, infrastructure, marketing, politically determined economic incentives, etc.).

At this macrolevel, the research should be mainly a joint effort of developers, extensionists, and researchers. The politicians should also play an important role in this type of research. They should be aware of the potential of the new technology, as well as the requirements in terms of the political decisions for the better achievement of development. The transfer of technology is a natural result of this integrated approach and its effectiveness only depends on the effective participation and communication (forward and feedback) of politi-

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[3] Developers: officers of developing organizations (developing banks, farmers associations, cooperatives, etc.).

[4] Superior technological components and techniques made commercially available to farmers at different levels of applied research activities.

cians, developers, farmers, extensionists, and researchers.

Network Approach

The apparently simple scheme for applied research (Fig. 2) is not so easy to implement in pasture research, especially when traditionally researchers, extensionists, and farmers are not together in the same development program. In addition, to incorporate the developers and politicians in the applied research process is certainly even more difficult. One way to facilitate the implementation of an effective pasture research program within this integrated approach is to organize and implement a network to suit the needs of coverage (ecosystems and farming systems), and at the same time gaining time and economics of scale.

The network approach as suggested in Fig. 3, should be expected to cover major off-station as well as on-farm applied research activities. This coverage should be done through defined sequential trials to provide a backbone to advance the research activities with new selected germ-plasm to reach the farmers appropriately.

After major germ-plasm screening that is part of the factorial research, minor screening (RT-A), adaptation trials (RT-B), management trials (RT-C), and animal productivity trials (RT-D), as described earlier are linked to the on-farm trials, regional trial E (RT-E), that is part of the adoption research. The full sequence of regional trials could take 12-17 years (Table 8). Flexibilities should be included for participants in network activities to advance more rapidly by avoiding some of the steps in this sequence. The soundness of these faster routes will depend strongly on the experience accumulated in networking, especially in the germ-plasm/environmental and germ-plasm/management interactions, as well as in the effective characterization of soil/plant/animal relationships at the station level and the appropriate recognition of farmers' needs and requirements. Data processing, information, and feedback also play a critical role. Contrasted with the longest route (Fig. 3), passing after major screening to RT-A, RT-B, RT-C, RT-D, and RT-E, which probably is logical for the more advanced institutions, the

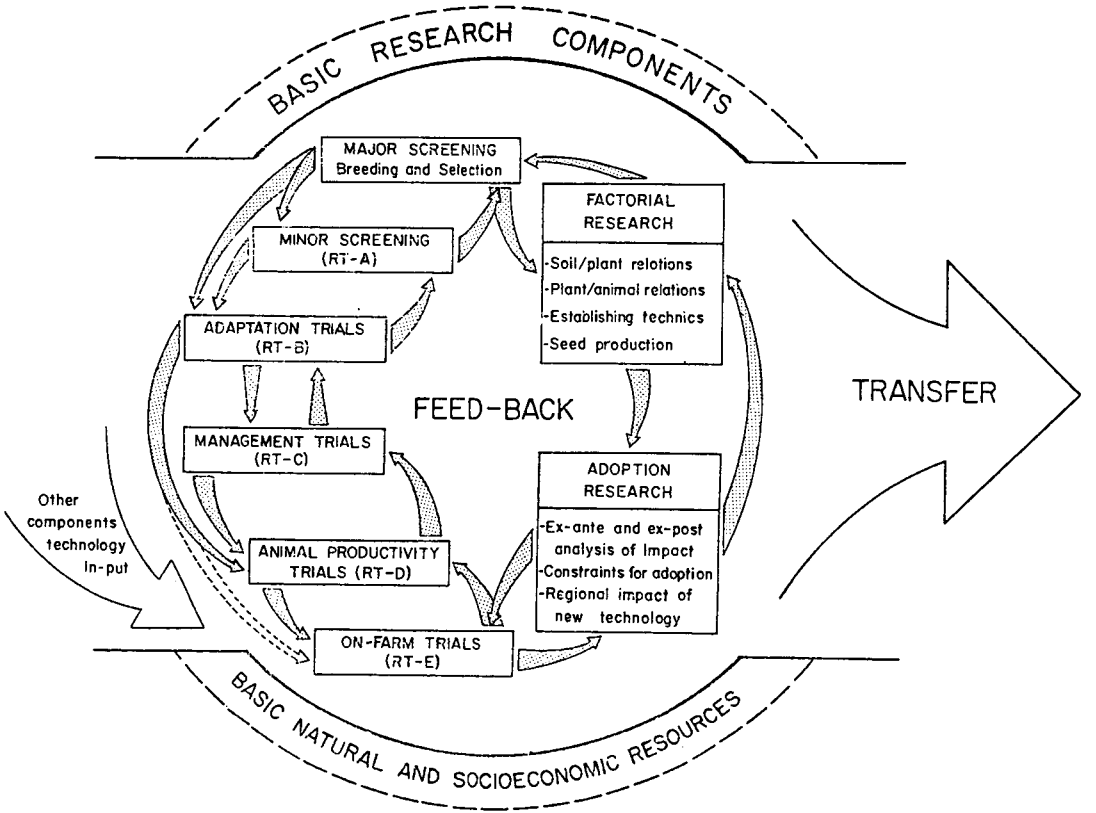

Fig. 3. The Network activities in a pasture applied research program.

Table 8. Time needed to conduct the different steps of pasture evaluation.

Type of trial	Time (years)
RTA = Introduction	2
RTB = Agronomic measurements	2
RTC = Pasture persistance	2-3
RTD = Animal production trials	3-5
RTE = On-farm evaluation of animal production systems	3-5

the shorter route will start with RT-B, passing to RT-D and/or RT-E saving in one specific location both time and resources.

Another way to visualize the organization of the Network in an applied pasture research program is to use the flow diagrams as shown in Fig. 4, where after diagnosis and characterization of the target area, constraints are defined and research strategies set. This scheme combines the well known steps of the farming systems research methodology and the steps and methodology followed in RIEPT (Li Pun and Zandstra 1982; Mateo and Li Pun 1983). The sequential trials within the network (RT-A to RT-E) provide a means of coverage of the applied research toward the integration of the new improved technology in farming systems.

In addition to the appropriate coverage of the target area, several benefits and economies of scale could be reached by applying the network approach: (a) effective exchange of information, (b) adjustment of methodologies to common resources, (c) catalysis of the reearch activities in a region or country, (d) capacity for extrapolation of results, and (e) more complete understanding of the environment/plant/animal/farmer complex.

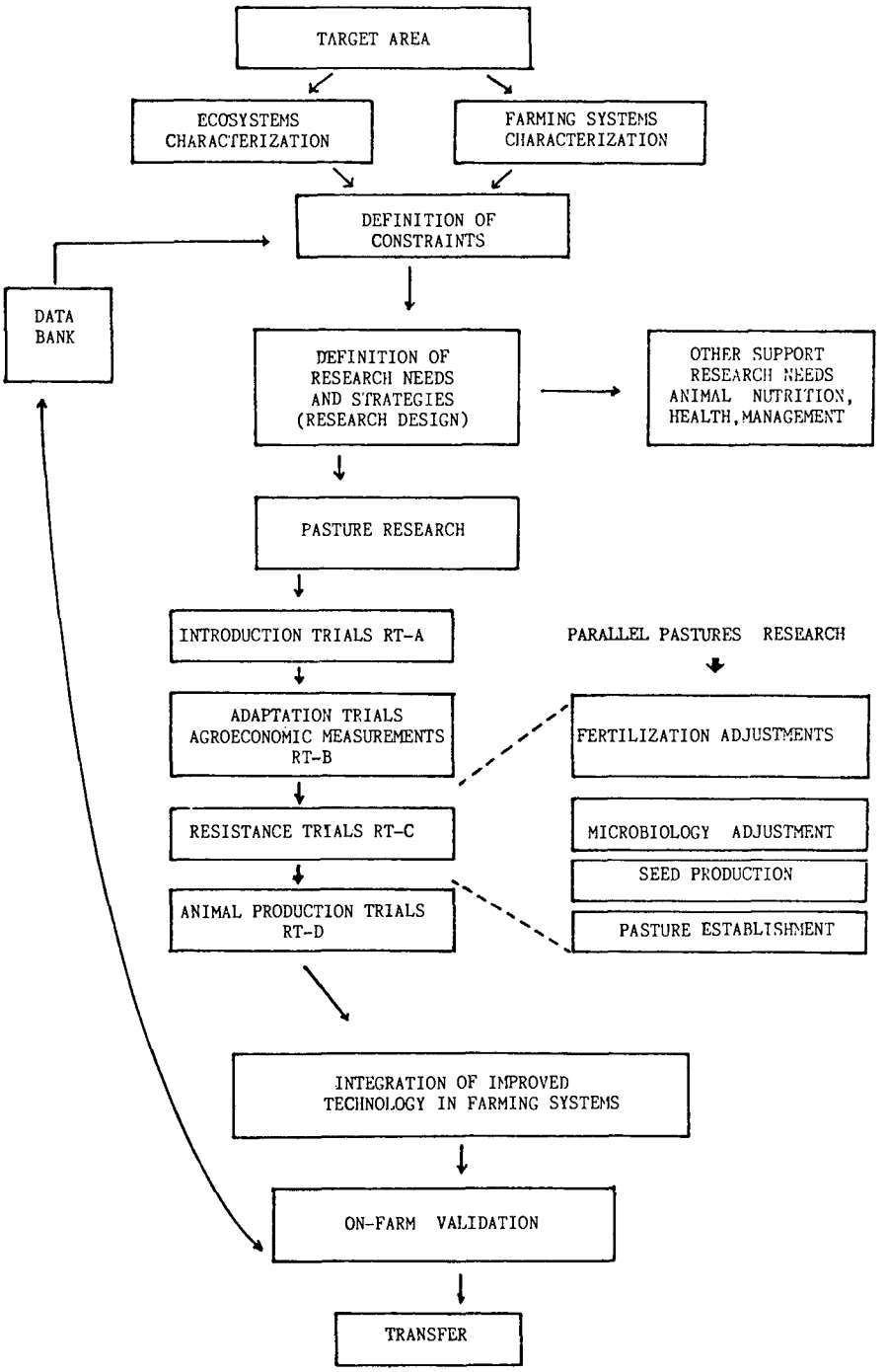

Fig. 4. Scheme for a national program for applied research on pastures.

In conclusion, networks are in fashion these days. In a recent consultation meeting at CIAT, some of the Latin American national program directors expressed their worries about networks. In particular, it was felt that they only have the name and not the organization for effective action on subjects of common interest and that so many networks are being developed in name only that their organizations and researchers are in danger of becoming entangled in a profuse web of ineffective networks. Effective networks require (a) a common interest and a defined research problem, (b) sources of basic research in components, (c) understanding of the diversity of natural and socioeconomic resources, (d) effective coordination and organization based on consultation with participants, (e) continuity of activities, and (f) effective exchange of information.

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