-PN-ABS-842 ISN 90123

FODDER CROPS RESEARCH IN PAKISTAN:

A Review

by

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April, 1988

Sponsored by:

PARC / USAID / NART - WINROCK

PN-ABS-842
isn 90723

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A

A REVIEW OF PAKISTAN FODDER CROPS RESEARCH PROGRAM

EXECUTIVE SUMMARY

1. The vast amount of on-station research data that has been accumulated since 1975 clearly shows that fodder crop production can be increased 50 to 100%. Despite this storehouse of information, Pakistan livestock farmers still experiece two traditional stress periods of fodder/forage shortage, namely May/June and October/November. Thus, livestock achieve only about 75 to 80% of their inherent productive capacity. With proper packaging and dissemination of this technology to livestock farmers and commercial fodder growers there could be a "Fodder Crops Revolution" in Pakistan.

2. As a preliminary step, it is suggested that the fodder crops research programs be critically reviewed by a small Pakistan Task Force. This exercise will allow:

a) A state-of-the-arts summary.
b) Preparation of fact sheets about presently used fodder crops and promising types, these to be compiled into loose leaf notebook as guidelines for cultural practices and utilization.
c) Choice of one or two outstanding varieties of the more important fodder crop types for Basic seed increase.
d) A basis for future research planning and development.

3. Another benefit of the critical review will be the opportunity to formulate simplified packages of technology for on-farm testing and transfer of information to livestock farmers and commercial fodder crops growers. Any of the fodder researchers can put together such packages but it is suggested that the above-noted Task Force assume responsibility as a beginning. The packages must be kept simple and understandable by farmers, for example adjacent fields of berseen using high quality seeds and farmer-saved seeds. An added variation might be berseem plus ryegrass or plus oats. Similar combinations can be developed for summer (Kharif) fodder crops.

Note: Development of packages and attempt to transfer technology to farmers will be of little benefit or value unless quality seeds are available.

4. A very serious constraint that continuously hampers improved and increased fodder production is lack of seed availability of superior high yielding varieties and the poor quality of farmer-saved seeds sold on the local market. Only a few private and small seedsmen produce and sell fodder crop seeds of improved quality. The multinational seed corporations can provide seeds of

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maize, sorghum (jowar-single cut), and sorghum-sudan grass hybrid (multicut). These are usually proprietary brands. At present they have no interest in seeds of berseem and Persian (Shafcal) clovers, lucerne, oats, ryegrass, single or multicut millet (bajara), multicut sorghum and cowpeas.

a. It is proposed that a Village Contract Seed Multiplication Scheme be launched, using government support and financial backing by the Agricultural Development Bank of Pakistan to support small seedsmen entrepreneures in mobilizing village growers, providing technical know-how, needed inputs, supervision in all aspects of seed production and harvest -- all on credit from the seedmen, repayment with seed delivery.

Note: Seed grower supervisors employed by the seedsmen and seed agronomists (provincial employees) will be needed.

At present there are only large, centralized seed cleaning and processing plants in Pakistan. For efficient operation in production of fodder crops smaller, more widely dispersed plants will probably be more effective.

b. Basic (Foundation) seed will be needed and can be supplied by the breeder/sponsoring institution or in some instances by contract growers.

c. A seed consultant will be needed (with repeat visits) to assist in organizing and implementing the scheme, training of seed grower supervisors and and seed agronomists.

4. Movement of technology on to farmers would normally be carried out by Farming Systems Research (FSR-sometimes FSR/E when extension is involved). An active FSR is a in place in Pakistan but as yet has included fodder crops only to limited extent. Since FSR has a projected program with other crops, it is proposed that a Village Task Force for Transfer of Fodder Technology be formed as an adjunct to FSR. It would be multidisciplinary, composed of a Fodder Agronomist, Livestock Management Officer, Adaptive Research Officer and two Extension staff. This team should receive training from FSR staff of the Fodder Crops Research Program, Livestock Management and Animal Nutrition Programs. These units can provide guidance in formulating simplified technology fodder/feed packages. FSR should assist in the location site so as to focus in a specific area. From this beginning other Task Forces could be organized for expansion into other areas.

Note: The Task Force must have support of the staff in their respective units, financial backing, mobility, and a source of quality seeds.

5. In addition to the above-noted modifications in the Fodder Crops Research Program the following suggestions are offered for adjustments and prioritization:

a) Focus and concentrate on the species and varieties presently used and those which already show promise.

b) Include plans for more on-farm research which will provide farmer feedback and enhance work on farmer-related problems.

c) Limit the introduction of exotic materials; no more than 10% of activities devoted to this part of the program.

d) Increase collaboration and integration with the livestock sector in evaluation of forage nutritive value and animal performance.

i) Location of livestock unit on the Fodder Research Institute Sargodha.

ii) Establishment of a Fodder Research Institute at the Bahadurnagar Livestock Production Institute with Fodder Agronomists seconded to selected Livestock Research Stations.

iii) Seeds of varieties chosen for seed increase provided to livestock stations and animal scientists for further animal evaluation.

e) Close the gap of fodder shortages by examining practices to extend the productive interval of fodder crops, also using crop residues, conservation of hay and silage (again collaboration with the livestock sector).

f) Concentrate breeding and varietal improvement on sorghum - sudangrass hybrids, multicut millet and sorghum, and mazenta (maize-teosinte cross).

g) Initiate studies with fodder trees and shrubs to obtain forage production, seasonal availability, and nutritive value.

Note: More detail for specific crops is given in the text

6. For continued strengthening and expansion of the Fodder Crops Research Programs there is need for additional staff and advanced training of staff. These items are covered in the text. All of this, of course, requires financial and administrative support.

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a. One means of broadening the vision of staff members is by increased linkages with International Agricultural Research Institutes and National Programs. This has been disucssed in the text.

7. To further enhance collaboration and integration of various institutes and units with an interest in fodder crops, forages/pastures and to further the exchange of information and ideas it is proposed that a Pakistan Fodder and Forage/Pasture Network be organized, established, and implemented. A model is submitted for consideration.

8. The writer did not have an opportunity to become acquainted with the National Forage and Pasture Program (which also includes range management). It is suggested that a short-term consultant with experience and background in grazing-and rangelands spend time reviewing and evaluating this program.

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A REVIEW OF PAKISTAN FODDER CROPS RESEARCH PROGRAMMES

Preamble:

The writer was inivited by the Pakistan Agricutlural Research Council (PARC), Government of Pakistan, and USAID/MART/Winrock to: 1) review and evaluate the status of fodder crop research in Pakistan and 2) make suggestions regarding future planning and direction. This took placing during Mar. 17-Apr. 15, 1988 at the time when cool/cold (rabi) season fodder crops were near their peak production of forage.

The review encompassed 1) travel by road in Southern Sind (Karachi-Hyderabad-Jhuddo), Islamabad Capital Territory, Punjab (Attock City, Chakwal, Sargodha, Faisalabad and environs, Bahadurnagar, Lahore and environs), Baluchistan (Quetta and environs), and Northwest Frontier Province (Rawalpindi, Peshawar and environs, north to Mingora in Swat District, east to Besham, south to Mansehra, return to Islamabad), 2) visits to various Agricultural and Livestock Research Institutes, Agricultural Universities, 3) interviews with a number of fodder crop, forage/pasture and livestock researchers, university staff members, officials of the National Agriculture Research Center (NARC), Provincial Governments, USAID, MART/Winrock, and 4) on-farm visitations.

The writer wishes to express sincere thanks and appreciation as follows:

1. To PARC Chairman, Dr. Amir Muhammed and Member Crops Sciences Dr. M. Yousaf Chaudhri for their time during final briefings.

2. To various NARC officials for interviews, discussions and field visits; especially Mr. M. Banaras Bhatti for his cooperation and assistance at NARC and during travel to Faisalabad.

3. To provincial Government officials for interviews, background information; espeically to Dr. Zafar Altaf, Secretary Department of Agriculture, Punjab for attention and suggestions.

4. To the many staff members of various Agricultural and Livestock Research Institutes and agricutlural Universities for their cooperation in explanations of research, sharing of knowledge, and review of background information; especially to Dr. A.R. Chaudhry, Director, Fodder Research Institute, Sargodha for research review, discussions and suggestions.

5. To USAID/ARD for support and assistance.

6. To the staff members of MART/Winrock for assistance; particularly Dr. Bill Wright for his cooperaiton and to Dr. Takumi Izuno for coordination of the review, time spent in travel, many discussions and suggestions.

1. Introduction-Fodder/Forage Situation and Improvement Achieve

If livestock numbers were equally distributed every Pakistani who can walk or crawl would be able to lead and claim ownership to one of the following: a cow/bull, buffalo, sheep, goat, horse, mule, donkey, or camel. The 1986 preliminary livestock population of 18.3 million cattle, 16.8 buffalo, 24.8 sheep, 30.9 goats, and over 4.5 others very nearly equals the estimated human population. This parallel situation has essentially existed since founding of the nation. By the year 2000 a projected livestock population for the major species will total 19.2 million cattle, 24.8 buffalo, 36.6 sheep, and 56.8 goats (2). These burgeoning animal numbers will require a 51% increase over the present feed supply. As such, this implies that the future generation of livestock will be as ill-fed and undernourished as in 1988, or more so since greater genetic potential is anticipated through animal breeding and upgrading. Even today, present feed resources permit animals to achieve only 75 to 80% of their inherent productive capacity.

A. Fodder and Feed Supply.

The total digestible nutrients (TDN) and digestible protein (DP) from different sources and available for livestock was recently estimated by the Ministry of Food Agriculture, and Cooperatives (Livestock Division) to be 36.77 and 23.22 million tonnes annually with requirements standing at 47.45 and 36.50 million tonnes, respectively (2). Thus, an annual deficit of 29 and 56.5% of TDN and DP existed. This is readily observed by viewing the condition of animals across all of Pakistan, but especially in the hill land and rangeland regions. The livestock feedstuffs are derived from fodder crops, trees and shrubs, rangelands, pastures, herbaceous plants on non-cultivated areas and wastelands, crop residues and weeds, industrial wastes and by-products. The major feed resources in Pakistan's distributed as follows:

Type of Feed	% of Total
Crop residues	50.70
Fodder, forage/grazing	37.85
Cereal/legume seeds and by-products	6.10
Oilcakes, meals, animal proteins	2.35
Others (e.g. after harvest grazing, food wastes, etc)	3.00

Crop residues are largely comprised of wheat straw and rice straw as well as stalks of maize, sorghum (jowar) and millet (bajara), coraling about 35.85 million tons 5.5 million tonnes, along with 1.0 million tons of molasses. All other crop residues (haulms, vines and stalks of pulses, cowpeas, groundnuts, rape, cotton, etc.) supply around 5.5 million tons. Fodder crops are classified as cut-and-carry herbage from berseem, oats, rape and sometimes wheat and burley during the winter (rabi) season and maize, sorghum, millet and sometimes rice in the summer (kharif

season). Forage crops are those grazed in the rain-fed (barani) hill land and rangeland areas. In addition, weeds, grasses and other herbaceous plants are collected as fodder or grazed whenever available from roadways, pathways, field boundaries, canals, bunds, non-cultivated areas and waste places. Fodder trees and shrubs add considerably to the overall feed supply but no data are available as to their production. Throughout Pakistan all plant and waste vegetable materials edible by livestock are cut, grazed, browsed or scavanged.

Of the total cropped area in Pakistan from 16 to 19% is planted to fodder crops on an annual basis. From the 2.77 million ha area about 53 million tons of dry fodder are produced, giving a national average of 19.1 tonnes/ha. Thus yield per unit area of land are low due primarily to poor inputs at the farmer level. On-station fodder fields from high yielding varieties (HYVs) more than double those from farmer fields. Nonetheless and traditionally, a shortage of feedstuffs occur during May/June after the flush of berseem and Persian clovers and before summer fodder crops reach a productive stage. A second scarcity prevails during October/ November before the winter season types are ready for cutting.

B. A Fodder Revolution.

The above noted situation has been reported and repeated in many discussions, forums and publications. It can now be changed with Government of Pakistan (GOP) support for transfer of present fodder crop technology to local farmer/livestock keepers. This technology can already be found within the information and data existing in the National Fodder Crops Programme and collaborating Province Research Institutes.

Note: The fact is that more in-country research data and information about fodder crops exists today than was available at the time of the wheat revolution began.

With Proper packaging and dissemination of such knowledge there can be a veritable "Green/Fodder Revolution" comparable to that of wheat in the mid 1960s and early 1970s. Had previous recommendations been implemented (5,7) the Fodder Revolution would already be a reality.

C. **Recommendation**: To achieve a Fodder Revolution in Pakistan will require mobilization of manpower and supporting resources, logistical planning, financial backing, and a notable policy change to elevate fodder crops to a prestigious level comparable to that of wheat. Furthermore, it will require a Fodder Spokesman--just as Dr. Norman Borlaug was the Wheat Spokesman -- is knowledgeable and a propoment of fodder crops in Pakistan, has ready access to and confidence of the Minister of Agriculture, Chairman of the Pakistan Agricultural Research Council (PARC), Provincial Secretaries of Agriculture and other policy makers, has repect of and is held in high esteem by

his colleagues and all Pakistanis. Also needed will be a means of technology transfer onto farmer fields.

D. Plan to Achieve a Fodder Revolution.

The following is offered as a plan to promulgate a Fodder Revolution in Pakistan:

1) Assessment of present research with compilation, summarization and publication of information, giving particular reference to providing a year-round fodder/feed programme.

2) Development of a massive seed multiplication programme of selected HYVs of fodder crops.

3) Formulation of simplified packages of technology for on-farm validation with options for farmer choice of practices applicable to local conditions.

4) Movement of fodder crop technology onto farmer fields via FSR or Village Fodder-Feed-Livestock Technology Transfer Program under the guidance of FSR.

Then for continued enhancement of a Fodder Revolution there is need for:

5) Modification, adjustment and prioritization of on-station research activities based on feedback from farmers.

6) Organization and implementation of a Pakistan Fodder and Forage/Pasture Network to enhance integration and collaboration of fodder, forage/pasture (range management), livestock production and animal nutrition researchers.

II. Organizational Structure of Fodder and Forage/Pasture Programmes -- Past, Present and Proposed

A. Evaluation of the National Fodder Programme.

As compared to other agricultural crops, fodder and forage research in Pakistan was essentially neglected prior to 1975. Several Fodder Botanists and general Agronomists had evaluated local and introduced species and carried out agronomic studies at various institutions, including the Punjab Agricultural Institute at Lyallpur (now Ayub Agricultural Institute, Faisalabad), Forage Research Station, Sargodha, Punjab University of Agriculture at Lyallpur (now Agricultural University, Faisalabad), Northwest Frontier Province Institute at Tarnab, Sind Agricultural University at Tandojam, Agricultural Research Institute at Sariab (Quetta), Forest Institute Range Management at Peshawar, Range Management Branch of Pakistan Forest Institute in the Maslakh Project area of Baluchistan, and Jaba Sheep Farm at Mansehra. In many instances these studies were of short duration with no effort of national coordination (7).

In 1974 a "Working Group" of fodder and forage researchers convened in Islamabad to review a State-of-the-Arts and make recommendations regarding future activities. At that meeting Dr. M. Anwar Khan set forth the conceptual framework within which the National Forage and Fodder Research Programme was developed. A detailed proposal with objectives, suggested areas of research, lists of buildings and equipment, staff requirements and their training, along with budgeting for the period 1975-1980 was presented and adapted. The programme was implemented in July, 1975 with Dr. Khan as Coordinator. The coordinated fodder research programme was to be undertaken at Islamabad, Agricultural Research Institutes at Lyallpur (Punjab), Tarnab (NWFP) and Sariab (Baluchistan), Agriculture Universities at Lyallpur and Tandojam (Sind), Livestock Production Research Institute at Bahadurnagar, and Livestock Experiment Station, Qadirabad (Punjab). The range/forage research was to be carried out at research stations in the following ecological regions: tropical maritime (Dhobyi, Sind), tropical plains sandy (Thal, Punjab), subtropical (Islamabad and Pakistan Forest Institute, Peshawar), Mediterranean (Hazar Gunje, Quetta in Baluchistan), Himalayan subtropical (Juba, NWFP), Himalayan temperate (Dirkot, Azad Kashmir). Because of limited funding the proposed research was not supported at all locations. Nonetheless commendable efforts, activities and results should be especially noted for work at NARC (Islamabad), Fodder Research Institute, (Sargodha), Ayub Research Institute (Faisalabad), Livestock Research Institute (Bahadurnagar) with supplemental information from ARI, Sariab (Quetta), Tandojam (Sind), Tarnab (Peshawar).

In 1985 , the National Forage and Fodder Research Programme was separated to form different divisions as follows:

1) National Cooperative Fodder Research Programme with Mr. Mohammad Banares Bhatti as Coordinator, located at NARC, Isalamabad, and under the auspicies of the Crop Sciences Division.

2) National Forage and Pasture Programme with Dr. Noor Mohammad as Corrdinator, located at NARC, Islamabad, and under the auspicies of the Natural Sciences Division.

This separation appeared logical because of the diversity in production areas, as well as definition of fodder crops and utilization of pasture and forage crops. Fodder crops in Pakistan comprise all crops that are used as cut-and-carry livestock feed. Pasture and forages in Pakistan include all vegetation grazed and browsed by livestock, with particular reference to rainfed flat lands, hill lands and rangelands. There is no clearly defined responsibilities for fodder trees and shrubs which are lopped for feeding or browsing.

B. National Cooperative Fodder Research Programme (NARC)

This programme has the direct responsibility of conducting research to meet the needs of the Barani farmers within a 70 km

radius of Islamabad and Rawalpindi(1). In addition, the coordinator has been assigned the role of integrating and coordinating fodder crops research at the following eight cooperating units:

1) Ayub Agricultural Research Institute, (AARI) Faisalabad, including the Fodder Research Institute, Sargodha, where the major research programme is located and in actuality has fodder staff seconded to AARI.

2) University of Agriculture, Faisalabad (UAF), Unit "A" (Plant Breeding and Genetics).

3) University of Agriculture (UAF), Faisalabad Unit "B" (Chemical analysis).

4) Livestock Production Research Institute (LPRI), Bahadurnagar.

5) Agriculture Research Insitute, Sariab (Quetta).

6) Agricultural Research Institute, Tarnab (Peshawar).

7) Agricultural Research Institute, Tandojam (Sind).

C. Staffing and Organizational Pattern

1) The present staff positions are diagrammed in Figure 1. (not all positions are filled at Islamabad).

Figure 1. Staff positions in the national fodder programme and collaborating units.

NARC - Coordinator (Islamabad)

- Sr. Scientific Officer
- Scientific Officer (2)
- Junior Scientific Officer

Fodder Research Institute (Sargodha)
- Director
- Fodder Botanist
- Agriculture and Research Officers (20+)

AARI
- Fodder Botanist
- Agriculture Research Officer (2)
- Guar Botanist (Bahawalpur)

UAF (Faisalabad))

Unit "A"
- Plant Breeder

Unit "B"
- Animal Nutritionist

LPRI (Bahadurnagar)
- Research Officer (Fodder Crops)
- Agriculture Research Officer (2)
- Agriculture Officer (1)

ARI (Sariab)
- Agronomist
- Assistant Agronomist

ARI (Tarnab)
- Principal Investigator
- Assistant Scientific Officer

ARI (Tandojam)
- Agronomist
- Assistant Research Officers (2)

2) **Summary:**

The National Coordinated Fodder Programme is based on a sound and well-designed organizational structure. Additional staffing and funding will be needed to meet future demands for higher production of quality fodder/feed as the livestock population expands and places greater need for increased total digestible nutrients, metabolizable energy, and digestible protein from reduced land area. The concurrent need for additional and more highly trained staff must be anticipated and should be given immediate attention with selection among present staff and/or promising M.Sc. graduates, for Masters and Ph.D. training. Staff replacement for those on study leave are a necessity with provision made for additional positions created to assure and retain the cadre of trained personnel

D. Recommendation:

Proposed staffing pattern of the NARC Fodder program and collaborators:

NARC: In addition to the Coordinator, two PhDs -- Plant breeder and one agronomist, three MScs--one agronomist, one fodder tree specialist, one statistician, two B.Sc -- one soil chemist one in plant protection, one MSc as subject matter specialist (SMS fodder crops) to liase with the Farming Systems Research Program (FSR) and with Adaptive Research/Extension Division. The SMS will need in-service FSR training as well as international experience at an IARC (e.g. CIAT).

AARI and Fodder Research Institute: Among the present staff from 3 to 5 MSC selected for Ph.D training, at least one in plant breeding, the others in agronomy and related disciplines. An animal nutrition unit to be established at the Fodder Research Institute with facilities to carry out invitro and invivo studies in the laboratory and with ruminants. A subject matter specialists (fodder crops) assigned the Fodder Research Institute to liase with FSR and Extension.

UAF: A fodder agronomist position in Unit "A" to collaborate in national varietal evaluation and cultural practice trials as well as the Departments of Animal nutrition, Livestock Management and FSR.

LPRI: Establishment of a Fodder Research Institute at Bahadurnagar as an adjunct to the present Livestock Production Research Institute, under the auspices of the Livestock Department and Director General. At Bahadurnagar would be a Director of the Institute, two Agricultural Research Officers and two Agriculture Officers. In addition five Research Officer (attached to the Fodder Institute) would be located at five of the major livestock institutes in the Punjab Province.

The present and successful working relationship between the Research Officer (Fodder Crops) and the Animal Nutritionist at LPRI will serve as a model for those five out-posted as Fodder Research Officers. A subject-matter specialist (SMS Fodder Crops) to be attached to the Fodder Research Institute to liase with the five provincial Livestock Institutes with FSR Extension. Two or three of the Fodder Research Institute Staff selected for PhD training in fodder agronomy.

Note: This scheme has already been elaborated and proposed to the Secretary of Agriculture, Punjab. It should be implemented in 1989.

ARI Tandojam: At present there is an Agronomist who has heavy administrative responsibilities and two Assistant Research Officers who carryout research with all crops, having limited time to spend on fodder crops.

Note: Before notable advance will be realized it is absolutely essential that a fodder agronomist post be created and filled with a MSc, one who has full responsibility for research with the NARC Coordinator. Furthermore, in the near future, the Provincial Department of Agriculture should create a post of fodder agronomist to be located at a major livestock Research Farm (Institute) to work closely with the Livestock Personnel (using the Bahadurnagar LPRI) model) and collaborate with the Coordinator of the National Fodder Crops Research Program (NARC).

ARI (Sariab): The same situation exists as at Tandojam, except that one assistant agronomist works with all crops. Thus, one full time fodder agronomist will need to be posted at Sariab. In addition the Baluchistan Provincial Department of Agriculture should create a post of fodder agronomist to be located at a major Livestock Research Farm with responsibilities as noted above.

ARI (Tarnab): Again, there is one Assistant Agronomist and one Agricultural Research Officer who are responsible for a number of crops. There is urgent need for a full time fodder agronomist and closer cooperation will the NARC Coordinator. As noted above, the NWFP should create at least two posts of fodder agronomists to be located at Livestock Research Farms one in the Peshawar Valley, the other in the hill country.

Also the NWFP Agriculture University should immediately create a position of fodder agronomist to work closely with the TIPAN Livestock and Extension Personnel and to liase with the Coordinator of the National Fodder Crops Program (NARC). Hopefully, the TIPAN Project will create an agronomist position, someone with experience

to work with the NWFP Agricultural University Fodder agronomist.

III. Assessment of Research Results, Summarization and Publication of Achievements.

A. Achievements to Date.

A vast amount of on-station data and information has been accumulated by the various institutions engaged in fodder crops research. Those responsible for past and present accomplishments are to be complimented. Annual reports have been duly prepared and a Position Paper on Fodders (4) provides background information and suggestion for continued research.

Salient achievements todate were noted as follows (taken from the NARC Mater Research Plan on Fodder with present writer interpretations):

1. From evaluations of introduced and indigenous, species HYVs such as berseem, lucerne, oats, sorghum, millet and maize developed.

2. Multicut types such as B.N. Hybrid (Bajara-Napier, i.e. Pennisetum hybrid), SS hybrid (sorghum-sudan), elephant grass, lucerne and oats available and some popularized.

3. Production technology for improved cultivars standardized (i.e seeding rates and time, cultural practices and expected yields of green fodder).

4. Quality determinations through proximate analysis.

5. Green and dry matter production potentials determined for major fodder crops.

6. Dissemination of production technology for improved cultivars through demonstration and zonal trials in farmers fields in the ICT-Rawalpindi area and Punjab.

7. Prebasic seeds of HYVs produced at the Fodder Research Institute (Sargodha) and NARC.

8. Comparative trials of farmer yields and improved (research) production technology (showing on-station yields to be more than double).

Note: Despite these notable results a tour of the countryside reveals that farmer practices still prevail and the two stress periods in May/June and October/November continues to seriously hamper animal output.

B. Constraints:

These have been reviewed (3,4) and can be summarized as follows (present writer's interpretations):

1. Fodder crops considered a minor crop and thus do not receive the priority give to food and fiber crops.

2. Inadequate funding for on-station and on-farm research.

3. Lack of information regarding improved practices at the farmer level.

4. Insufficient (at some institutions non-existence) fodder crop-livestock collaboration.

5. Shortage of information about fodder preservation.

6. No organized scheme for seed multiplication and distribution.

7. Limited linkage with IARCs and other national fodder programs.

8. Little market incentive for additional out-put of animal product.

C. **Recommendations**: Critical Review of Fodder Research, condensed summary and publication of findings.

Even though background findings are available among fodder research workers and a Master Research Plan was elaborated with a view towards Year 2000, the work plans and objectives appear to be closely allied with those of past studies. With the undertaking of future planning it seems that this an appropriate time for an indepth and critical review of the cooperative fodder research programs -- a State-of-the-Arts report. A small Task Force of 3 to 5 fodder researchers under Chairmanship of the National Coordinator could assemble annual reports and other pertinent information for review and critique. The summarization might be in the form of simplified fact sheets based on findings and recommendations for individual fodder crops. Attention should be given to planting date, sequential dates for some types (e.g. maize) and interval of production, with the aim of combinations to provide year-round feed (see Chaudhry's Position Paper on Fodder as a fact sheet model). Wherever possible, response to agro-ecological differences should be noted. These fact sheets should be published and compiled in a loose-leaf booklet for easy subsequent modification, additions as new species or types have been identified and evaluated, or removal if the occasion arisen. Undoubtedly, such a booklet will be of value and use for researchers, FSR staff, training and visitation (T&V) personnel and other extension workers, as well as various interested people.

This exercise will also be of benefit and value in the present and future planning, modification, and fine-tuning of the national and provincial research activities.

D. Literature Review

The present writer had great difficulty in locating published information regarding fodder and forage crops in Pakistan prior to and after nation separation. Recent annual reports from various institutions were located (1) but apparently have not been accumulated in an central archive. Random probing led to several publications, one even dating to 1891(8). Undoubtedly, references exist that contain valuable information, particularly concerning past introductions and evaluations (6). A survey of such publications probably would reduce the massive introduction of countless genera and species and allow selection of certain species, their varieties, cultivars and accessions to be evaluated.

Recommendations: That a complete survey of literature of fodder and pasture crops, as well as rangelands, be initiated and updated. In fact, this would provide the basis for one ore more MSc thesis dissertation. It will be most helpful to solicit and use studies from East Punjab.

IV. Development of a Massive Seed Multiplication Program

A. The Present Situation

The first, foremost, and immediately serious constraint of on-farm fodder improvement and production in Pakistan is the lack of quality seeds of presently used varieties and a scheme for increase and production of improved and superior HYVs. In general, farmers do not have access to fodder crop seeds of high germinability. Thus, they save their own seeds or purchase them locally, the source usually being farmer produced seeds of low quality. Farmer-saved and local supplier contain a high percentage of immature shrivled seeds that do not germinate or else produce seedlings which are weak and non-competetive with weeds. In addition, there are many intermixed weed seeds, thus adding to and perpetuating the presence and competition of undersiable plants which usually have lower nutritive value than those of the fodder crop. In some instances, limited amount of imported seeds and those produced by local seedsman can be purchased. This applies particularly to seeds of maize, Sadabahar (the recently popularized sorghum-sudan or SS hybrid), sorghum to a limited extent, berseem (imported from Egypt), and an even more limited supply of lucerne.

There are limited numbers of specialized seed growers and most are under contract to multinational or national corporations such as Cargill Pakistan Seeds Ltd. and Rafhan Maize Products (the latter producing registered seeds). These growers produce seeds of maize, sorghum and SS hybrids. There has been some interest by

other seed corporations such as Pacific Seed, Pioneer and Dekalb. Now that importation of sorghum seeds, which includes SS hybrids, has been declared tax-free by GOP, there will be an increased importation of these types. With the recent advent of a so-called fodder type maize there will also be interest among some corporations to provide their named brands. These seed companies are not interested in producing, nor supplying, seeds of berseem, lucerne, oats, ryegrass, and cowpeas.

Two examples show that farmers will accept improved fodder types and purchase quality seeds.

1) It was reliably reported that 10% of farmer fields (largely commerical producers of fodder) within a 10 mile radius of Lahore were comprised of the S.S.hybrid during the 1986 kharif season and about 50% during the 1987 season. Cargill Pakistan Seeds Ltd. expects to readily sell 90 to 100 tonnes of this hybrid seed for the same area of production during the 1988 season. It should be noted that sale of these seeds was accompanied by a leaflet giving complete recommendations for planting, agronomic practices, pest control, and management practices for multiple harvest.

2) A commercial (local) seedman in Faisalabad reported that he quickly sold 20 tonnes of lucerne seeds (his selection) for the 1987 fall planting. These were locally produced seed from a second-year stand that produced about 400 kg/acre of processed seeds. A farmer incentive was the seedsman's guarantee of at least a 3-year stand persistancy, if managed according to his recommendations.

It is likely that the multinational seed corporations could meet the demands for S.S. hybrids and sorghum single-cut hybrids. That of a fodder type maize is debatable unless demand increases and they can develop and market a proprietary hybrid. An interest in a multicut pearl millet will no doubt be forthcoming among farmers/commercial fodder producers, particularly for early planting since it is not damaged by the shoot-fly. Again seed production by multinationals will depend on the demand of marketable hybrids. If farmer demands for seeds of these types are not met by seed corporations, they can then be produced under the following schemes.

B. Proposed Village - Contract Seed Multiplication Scheme.

The major fodder crops not likely to be produced or imported by multinational and national seed corporations include mostly the rabi crops of berseem and Persian clovers, oats, ryegrass, lucerne and possibly the kharif crops of fodder maize, pearl millet and cowpeas. If found to fit into cropping schemes, Lablab purpureus (lablab) is a future possibility.

The Village-Contract Seed Multiplications Scheme can be organized within the private sector along with government support. It is suggested that the scheme be established in the Punjab and if

successful then expanded into other provinces.

1) Success of the scheme will depend to a great extent upon collaboration of local seed merchants who already have experience and expertise in seed multiplication, processing and marketing of various types of seeds. In fact, they may be seed producers and/or have local contracts for multiplication of selected crops such as various vegetables.

Mobilization of selected local seedsmen should be initiated by the Secretary of Agriculture. In some instances it may be necessary to provide financial bakcing or loan support to set the seed multiplication scheme in motion. The Agricultural Development Bank of Pakistan seldom, if ever, makes loans directly to small farmers. In the Village Contract Seed Multiplication Scheme, however, loans would be made to the commercial seedsmen who in turn provide inputs on a credit basis to the village seed growers.

2) Another essential component will be seed grower supervisors who will select village farmers as seed growers and provide guidance in all aspects of production, i.e. land preparation, planting, required inputs, agronomic practices irrigations, pest control, field roguing, harvesting, and threshing.

3. A seed agronomist(s) will be needed to coordinate the seed supervisor activities, assist in farmer training and guidance, field inspections, etc.

4. Village seed growers will be provided a contract with the following agreements:

a) Prescribed acreage of a given fodder crop.
b) Promise to follow instructions as outlined in the contract
c) Seeds provided by the seed grower supervisor alongwith inputs on credit, to be repaid from value of the harvested seed crop.
d) Technical know-how for growing seeds that free of weeds and off-type plants, harvest and care of the seeds, etc.
e) A guaranteed price for the seeds.
f) Repayment of credit when seeds are turned over to the seedsman.

Note: It should be recognized that more contractual detail will be required as formulated by the seedmen, seed grower supervisors, and seed agronomists.

Once the harvested seeds have been collected from the seed grower they will be assembled at a central location for cleaning and processing. At present there are only large, centrally located seed cleaning and processing plants (e.g. Punjab Seed Corporation) for wheat, rice, maize, cotton, but which could also

handle fodder crops seeds provided there is sufficient volume. In the long run, a greater number of smaller seed processing plants, strategically located, will be more effective for fodder crops seeds. After processing, samples will be extracted for purity and germination tests. Results from these tests are provided by the seedsman as a display of guaranty to the seed buyers (farmers).

C. Basic (Foundation) Seed Stocks.

The seedsmen and seed grower supervisor must have access to a supply of Basic or Foundation seeds to assure that grower seeds conform to genetic purity and agronomic description of the improved variety (cultivar). It will be the responsibility of the fodder crop plant breeder or the sponsoring institution (e.g. Fodder Research Institute, Sargodha; NARC, Islamabad; the proposed Fodder Research Institute, Bahadurnagar (LPRI) to produce and provide pre-basic (Breeders) Seed. In some instances the sponsoring agent will also produce Basic (Foundation) seed. In others Basic seed might be produced by contract growers, following the model for increase of cotton seed.

Note: A Word of Caution: In the beginning years of establishing the Village-Contract Seed Multiplication Scheme the number of varieties (cultivars) of any one fodder crop should be limited. At a later time cultivars for specified agro-ecological regions can be introduced.

Furthermore, it may be necessary to select specific sites for seed production, i.e. areas where high yields of quality seeds can be obtained, for example, it is already known that seed production of lucerne is best adapted to more arid areas with irrigation.

D. Fodder Crops Seed Consultant and Training of Nationals.

To assist in organization and implementation of the Village-Contract Seed Multiplication Scheme it is recommended that a seed specialist spend time as a consultant (2 to 3 months, perhaps with repeated visits) to provide ideas, organizational planning, production, harvesting, processing procedures, etc. A suggested consultant is Mr. Johnson Douglas who has such experience in several countries. Another source of expertise is Mississipi State University: Dr. James Delouche, State Seed Lab., Mississipi State Univeristy, Mississipi State MS 39762. Of underlying importance will be training of Seed Agronomists who should have short-term experience at Mississipi and/or California. Furthermore, it is suggested that one or more Seed Agronomists be selected for advanced training at the Master's or Ph D level.

V. Packages of Fodder Crop Technology.

A. The present situation.

As previously noted a mass of on-station fodder crop data and information exists but little on-farm testing has been

undertaken. The Annual Technical Report for 1986-87 from the Fodder Research Institute, Sargodha noted zonal observational fodder tials of berseem varieties at 7 locations and green fodder yield trials of oat varieties at 6 locations. These were placed on government farms in the Punjab Province.

An objective set forth in the NARC Master Research Plan on Fodder Crops (3) stated "To develop an out-reach program through on-farm testing of improved varieties and production/management technology". The same report noted the demonstration of improved fodder crop varieties and their production technology on farmer's field in irrigated areas of the Punjab, IRDP Centres in the ICT area of Islamabad and Rawalpindi under an out reach program. As a result and impact of these trials more than 100 tonnes of seed of different improved fodder crop varieties from Fodder Research Institute, Sargodha, and 25 tonnes seed of improved oat varieties from NARC were produced and distributed to interested growers during 1986-87. The farmers urged that more seeds be made available as they were convinced of the technology.

In reality, these are not on-farm trials as usually defined. To expedite the transfer of fodder crop technology, however, it might be of greater farmer benefit at the present to by-pass conventional on-farm trials supervised by the researcher and to collaborate directly with FSR and other farmer related institutions in dissemination of information. Two examples will illustrate and substantiate this approach.

1. At the Proka Livestock Production farm near Faisalabad, and a part of the Faculty of Animal Husbandry (AUF), a clear-cut on-farm demonstration (validation) was observed as carried out under the FSR program. In adjacent canal fields was a) An excellent stand, relatively weed free and highly productive planting of berseem using high-quality seeds and b) a very poor irregular stand, excessively weedy and much less productive planting of berseem using low-quality farmer seed. This simple comparision has effectively convinced local farmers of the value of improved seeds, but the problem is availability of such seeds at the present time.

2. In the Hala vicinity of the Pattoki Livestock Production Project a number of demonstration plots of improved practices were located on farmer fields, e.g. berseem planting using high-quality seed, ryegrass+berseem mixtures, early planted Afgoyee fodder type maize, improved oat varieties. These are used for farmer field days. Unfortunately, the farmer practice was not a comparative part of the demonstration but there were nearby fields under farmer conditions.

A further and encouraging collaborative FSR-Fodder crops plan has been discussed for the 1988 kharif season using cowpeas as a fodder "catch crop" after wheat in the Islamabad area (personal communications, Coordinator, National Fodder Crop Program).

B. Formulation of Fodder Crops Technology Packages.

Many simplified validation trials can be put together using on-station information already available.

> **Note**: It is essential that these trials (plans) be kept very simple -- a comparision of two treatments, if one or more additons then kept so as to be easily and readily understood by farmers and commercial fodder growers.

For example, a comparision might be berseem alone (quality seed), berseem+ryegrass, and the local farmer practice. An additional treatment could be 1/2 of the berseem+ryegrass topdressed with N and 1/2 not top-dressed or ryegrass alone, or berseem+oats, etc. Similar, combinations can be put together for kharif crops.

Any of the fodder researchers can develop such packages of technology but a coordinated and systematic approach will be more fruitful. It is suggested that the Task Force for review of research, summarization of data, and preparation of fact sheets (see section III-B) assume the initial responsibility. They must do so judiciously and with wisdom so as to keep packages simple, pertinent, and to a minimum. They should consult with FSR personnel and the Subject Matter Specialsits in developing packages for local areas.

C. Development of Year-round Feed Programs

The formulation of technology packages aims at transfer of improved practices, use of higher quality seeds, utilization of superior varieties, and introduction of new fodder species or types. They can also be an effective means of developing and demonstrting year-round fodder/feed programs. There is sufficient information presently available to show that a full 12 month fodder/feed supply is possible.

A calendar for production and supply of year-round green fodder was formulated using combinations and/or sequential plantings of maize or maize+cowpeas (single cut), S.S.hybrid (multi-cut) berseem+ryegrass (multicut) and ryegrass alone (multi-cut) at the Bahadurnagar Livestock Production Research Institute (personal communication. R.O. Bahadurnagar).

A similar calendar was developed using combinations and/or sequential plantings of maize or maize+cowpeas (single cut), sorghum+guar (single cut), berseem+oats (multicut), and oats alone (single or double cut). These calendars and other have application on government and large farmers.

In a similar manner, the agronomist at the Pattoki Livestock Production Institute put together a year-round scheme using combinations of maize+cowpea, sorghum, S.S.hybrid, sugarcane tops, berseem+ryegrass, and oats. These were verified on small farms, but as yet not adopted by livestock farmers nor commerical fodder growers.

Likewise, a year round shcme for use of fodders (maize, sorghum, S.S.hybrid, pearl millet, mazenta -- an experimental maize x teosinte cross, but no seed available at present -- cowpea, guar, berseem, oats, lucerne) on 24 acres in a three-year rotation was proposed (4). This plan was based in part on information from Bahadurnagar Livestock Production and Research Institute.

All of these year-round calendar are too complex for small farmers. They are based on production of green fodder and do not include crops residues, especially wheat and rice straw. The latter provide more than 40% of the present feed supply in Pakistan and will continue to be used by small livestock keepers for year to come. Nonetheless, year-round feed programs can be devised using green fodder production of presently available types along with the widely used crop residues (mainly bhusa treated with the urea, buffalo dung as noted in Section IX A8). These will need to be validated by on-farm trials then disseminated by FSR. It should be emphasized that such trials and demonstrations must be kept to simple combinations.

VI. Movement of Fodder Crops Technology onto Farms.

A. FSR Approach

Once fodder crops technology has been packaged, FSR and adaptive research usually assume responsibility for location of contact farmers, establishment, management and utilization of the demonstrations (validations). FSR is well established within selected target areas, working primarily with wheat, rice, maize, cotton cropping patterns. As yet very little fodder crop technology has been incorporated into on-going programmes, but information is ready for packaging and dissemination. A beginning is underway and hopefully will increase as fodder crops receive more prominent and national recognition.

As fodder technology is moved into the FSR programme it must become a part of the on-going progamme and the present or projected target areas. It is essential that the fodder researcher be involved in the in-service training programmes. Furthermore, he should visit the demonstration sites whenever possible, participate in field days and farmer meetings. This allows him to gain first-hand information about the performance of the fodder crops on farmer fields, farmer responses and their feedback. In this way on-station research becomes more farm-problem oriented.

The Subject Matter Specialist will also be directly involved in the inservice-training and movement of packages onto the farm. In addition he will participate in field days and provide farmer feedback to the researcher.

As the FSR programmes develop, activities will eventually expand into an array of agro-climatological regions and ecologic sub-regions. This, then, permits further evaluation of fodder crops under different environmental conditions and

enhances refinement of the research programme.

B. Recommendation: Village Task Force for Transfer of Fodder Technology.

Since FSR has a planned program at present, it is suggested that a Task Force be formed to be composed of a Fodder Agronomist, Livestock Management Officer, Adaptive Research Officer (in essence a Subject Matter Specialist) and extension two staff members. The Task Force members would be selected from their respective units and receive in-service training from FSR, Fodder Crops Research Programme, Livestock Management and Animal Nutrition Programmes.

They will assist in developing simplified packages of technology, combining fodder production and use of feedstuffs (crop residues, bhusa, silage, hay), aspects of animal health for movement onto farmers.

> **Note:** The FSR demonstrations at the Proka Livestock Farm, AUF (near Faisalabad) will serve as a model.

FSR will assist in locating an area covered by several villages in which the Task Force will concentrate and focus by locating demonstrations on contact farmer fields. From this beginning, other task forces can be organized for an expanded village programme.

> **Note:** The task force must have support of researchers in their respective units, financial backing, mobility, and a source of quality seeds for on-farm demonstrations and subsequently for farmer distribution.

VII. Modification, Adjustment and Prioritization of Fodder Crops Research.

A. The present situation.

A critical review of the fodder crops programmes will reveal that portions of the on-going research is somewhat repetitive of past trials and studies. Areas of questionable research include on-station trials with different levels of N and P where land has previously bEen fertilized, use of radiation or neutron treatment of fodder crops for increased herbage production, height and frequency of cutting as well as leaf number and area of different varieties of commonly used fodder crops, continued evaluation of the 35-year old BN hybrid which is seldom used by farmers, varietal testing of berseem when past trials have shown no significant yield differences. These examples are by no means unique to Pakistan but are noted to illustrate that too often research is carried out for the benefit of researchers and/or administrators and not based on farmer problems and needs.

Having noted these examples of redundant research, it will, of course, be necessary to conduct trials of agronomic practices

with fodder crops not commonly grown at present, e.g. SS hybrid (multicut) millet (multicut), cowpea intersown with maize and sorghum, and new varieties (cultivars) of fodder crops. Such studies should be taken to on-farm trials for validation after one or two seasons of on-station testing.

B. Goal, plant of work and research activities.

Although not clearly stated in the Master Research Plan : Year 2000 (3), the goal of the fodder crops research programme might be summarized as follows: To use information obtained from all collaborating units in developing economical and practical year-round fodder/feed programmes and to collaborate in their transfer to livestock farmers and commercial fodder growers with options applicable and adaptable to different ecological regions.

An aim of the national fodder research programme is to develop an integrated system whereby each cooperating research institution constitutes a vital component, with NARC as a nucleus institution to provide fodder crops information. The plans of work and research activities as adopted in 1985 for each institution are outlined in Table 1. They were based on objectives set forth in the 1975-1980 programme. Essentially these research activities represent present objectives of the on-going programmes (1,3).

Table 1. Plan of work NARC and Collaborating Units.

Research activities	NARC	Fodder Res Ins.	AARI	UAF"A"	UAF"B"	LPRI	Sariab	Tarnab	Tandojam
1. Evaluation of fodder species and varieties.	x	x	x	x	x	x	x	x	x
2. Breeding and selecting superior type.	x	x				x			
3. National uniform varietal testing	x	x	x			x	x	x	x
4. Agronomic and cultural practices.	x	x	x			x	x	x	x
5. Chemical (proximate) analysis.					x				
6. Livestock evaluation trials of fodder.						x			
7. Development of year-round feed programmes.	x	x				x			
8. Seed multiplication of HYVs and distribution.	x	x	x			x	x	x	
9. On-farm demonstrations and outreach.	x	x	x						
10. FSR collaboration.	x								

x: location of research activity.

The Rearch strategies and objectives set forth in the Master Plan : Year 2000 include the above research activities and will also 1) emphasize crop-livestock oriented research with an efficient farming systems thrust, 2) develop suitable technologies of fodder preservation for barani and mountaineous areas, 3) develop dual purpose fodder types e.g. pearl millet lablab, cowpea etc., 4) give attention and evaluate the use of fodder trees as livestock feed, 5) strengthen linkages with International Agricultural Research Centres (IARCs), 6) provide in-service training for fodder researchers.

Note: These goals, aims, objectives and plans of work are suitable for present activities and future projects with certain linkages with the livestock sector and FSR.

C. Adjustments and Priorities

The following suggestions are guidelines for consideration of future activities. More details for specific crops and other areas of research are discussed in Section IX and X.

1. Based on a critical review of present and past research, choose one or two superior selections or varieties for production of Basic seeds, if not already underway. The crops should include those not available, or not likely to be available from multinational corporations, namely berseem, shaftal, oats, ryegrass, multicut sorghum and pearl millet, cowpeas, possibly lucerne. Consultation should be made with multinational representatives to confirm these choices and determine whether SS hybrids, single-cut sorghum and forage-type maize can be provided through their sales.

   a) Cooperate in a scheme to multiply these seeds through the proposed Village Contract Seed Multiplication Scheme (Section IVB), independent seedsmen, and/or government farms.

2. Formulate simplified fodder/feed packages of technology (Section VB) and collaborate in their movement onto farmer fields (Section VI).

3. Concentrate on those species and varieties of crops presently used and/or shown by preliminary data to be promising; more on-farm testing of these.

   a) Limit introduction of exotic mateirals; no more than 10% of activities.

4. Collaboration and integration with the livestock sector in evaluation of nutritive value and animal performance; provide seeds of the chosen superior varieties to the

livestock farms and animal scientists in the universities for their evaluations.

5. Close the gap of fodder shortages by examining practices to extend the productive interval of fodder crops, forage conservation, and use of crop residues (again collaboration with the Livestock Sector.

6. Concentrate breeding and improvement on SS hybrids, multicut pearl millet, sorghum and mazenta; continue upgrading of seed quality of the chosen fodder crop varieties.

7. Initiate studies with fodder trees and shrubs.

Note: It is realized that not all of these suggestions nor recommendations in Section IX and X can be implemented, simultaenously and will, in fact, occur over several years. Furthermore, the success of these modifications and adjustments as well as any activities of the National Fodder Research Program and Collaborating Units will be dependent upon budget, trained personnel, facilities, and logistical support.

VIII. Proposed Pakistan Fodder and Forage/Pasture Network.

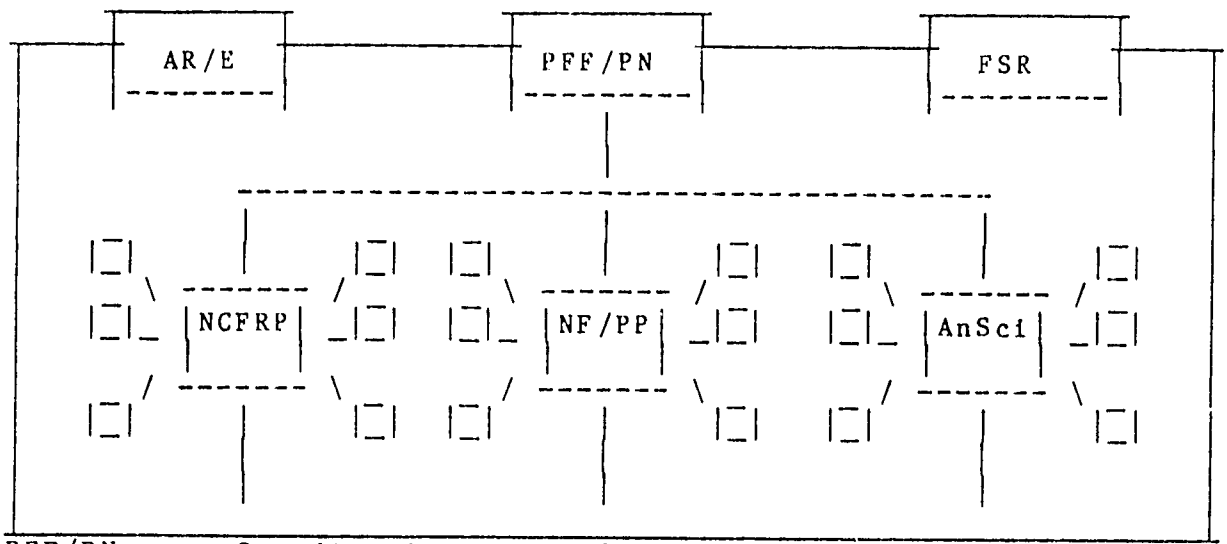
With the 1985 separation of the National Forage and Fodder Research Programme into two components 1)National Cooperative Fodder Research Programme and 2) National Forage and Pasture Research Programme, there has been little integration and cooperation between or among researchers of the two entities. Furthermore, there is limited collaboration of either programmes with the livestock sector--animal nutrition and livestock production/management (the exception being Bahadurnagar LPRI). As a further anamoly, there is restricted contact between the fodder, forage/pasture, livestock researchers, FSR, and extension personnel(including the Adaptive Research Unit).For effective and well-structured fodder and forage/pasture (including range management) programmes there must be integration with the livestock units. Researchers in each entity should not only be cognizant of the others activities but must be involved in and allied with certain aspects of cooperative projects. For dissemination of findings and mavement of research results onto the farms it is essential that fodder and forage/pasture researchers have close contact and work with FSR and extension personnel.

The organization and implementation of a National Fodder and Forage/Pasture Network provides a common meeting ground for all of these units. The network can be defined as an association of individuals with common interests, in this case animal feedstuffs. It is a mechanism to link participants for enhancement of research and extension capabilities, dissemination of information and germplasm, and formation of groups to solve problems effectively. On-going activities are presented and

discussed at annual or predetermined meetings and through publication of a newsletter. New ideas can be introduced by formal and informal training given by outside consultants and peer groups within the network. Opportunities are usually created for critical examination of individual and institutional activities. Coordination of research is encouraged, complementation enhanced, duplication reduced, and the value of multilocation testing strengthened. Transfer of technology becomes more effective and efficient. Networks have activities as annual meetings, workshops, group monitoring, training and coordinated efforts of research, on-farm demonstrations, T&V, etc.

A number of models exist (9,12) but the following organizational scheme is proposed for Pakistan. Membership would be solicited from among the listed organizations, institutes and units.

Figure 2: Organizational scheme for a Pakistan fodder and Forage/Pasture Network.



PFF/PN -----Coordinating unit of the network.

NCFRP - National Cooperative Fodder Research Project and collaborating units.

NF/PP - National Forage/Pasture Project (including range management) project and collaborating units.

An.Sci. - Animal Nutrition and Animal Production/Management and other livestock sector units.

FSR - Farming Systems Research Programme.

AR/E - Adaptive Research and Extension personnel.

Critical factors for success of the network:

1) Coordination by one person for the day-to-day responsibilities and operation of the network. A committee provides general guidance, but success of the network is largely dependent on the coordinator. He must possess leadership ability, broad experience, keen interest to advance the career of others, be well organized and a sound office manager, have writing skills, prepared to spend time travelling, tactful and understanding of others.

The coordinator will be located at NARC with a qualified office staff, be responsible for record keeping, collecting information from member units and participants, preparing a monthly or quarterly newsletter and have access for its printing, as well as funds for distribution.

2) A newsletter is an important component of the network. It should be published regularly to create and maintain a link among members of the network as well as outsiders. It should be of reasonable quality, simple in format, contain a mixture of opinions, news, scientific and practical articles written by members, and widely distributed.

3) The network should have broad goals, a flexible approach, a strong emphasis on farming systems, and be based on widely shared problems that are clearly defined with options for solutions.

The aims of the network are 1) to increase the effectives of research and transfer of technology by providing support and encouragement and 2) to help overcome communication problems.

Goals include 1) improve research planning, 2) encourage research in areas of mutual interest to participants, 3) strength technological capacity within participating units, 4) enhance the in-country information base, 5) assist in transfer of technology and extension of research developments, and 6) develop a network base for long-term contacts both in- and out-of-country.

The network activities are planned by the coordinator and a steering committee composed of elected officers and representatives of participating units. An annual general meeting is an important activity for election of officers, review of research results, FSR and extension activities, discussion of plans for the coming year, and prepared talks on various fodder-related topics.

Outside funding is necessary in the organization, establishment and functioning of the network, to supplement in-country funds so that acquisition of foreign exchange is not a problem. Networks are attractive to funding agencies as research and development tools because of their 1) effective use of established personnel and institutions, 2) flexibility in start-up and alteration in planning, and 3) minimal requirement in the

way of formal agreements. The International Development Research Centre of Canada (IDRC) has been active in promoting and supporting networks. USAID has also expressed interest in supporting networks in some countries.

IX. Strengthening Linkages with IARCs and National Programme.

As a means of 1) keeping updated and abreast of on-going research elsewhere, 2) stimulating and motivating researchers, and 3) enhancing in-country research, linkages must be established with related IARCs and various national programmes. This can be accomplished by 1) correspondence -- primarily names placed on mailing lists to regularly receive newsletters and publications (e.g. CSIRO, CIAT, ILCA, PANESA, ICARDA, ICRISAT, Indian Fodder and Research Centre, Jhansi, U.P., and various institutions in the USA), 2) attending and participating in training programmes and workshops, 3) inviting staff from these institutions as consultants and workshop leaders, 4) visitation to these institutions, and 5) exchange of germplasm.

An example of the benefits obtained from such a linkage was the field workshop organized and carried out in cooperation with Department of Scientific and Industrial Research Crops Division, (DSIR) New Zealand. Participants not only received instructional expertise from a New Zealand researcher but also entered into and were a part of establishing field trials and demonstrations. In fact, information and data are still being obtained from the field trials.

The writer strongly favors a plan to support travel for a group of fodder researchers to selected universities and institutions. The list of Pakistan nationals might include 1) Coordinator, National Forage Research Program, 2) Director Fodder Research Institute, (Sargodha) 3) R.O. Fodder Crops, Bahadurnagar LPRI and 4) Three Agronomists working with fodder crops at the Agricultural Research Institutes located at Tandojam (Sind), Quetta (Baluchistan), and Tarnab (NWFP).

Travel plans might include the following:

1) University of Florida, Gainsville, 2) Coastal Plains Agricultural Experiment Station, Tifton, Georgia, 3) Texas A&M University, College Station, 4) University of California, Davis, 5) University of Hawaii, Honolulu, and 6) CSIRO Pasture and Forage Research, Brisbane. Contact persons at these institutions could asist with interveiews and local travel.

X. Fodder Crops Species and Types -- General Information, Utilization and Research

A. Rabi (Winter) Fodders.

1. Berseem syn. Egyptian clover (Trifolium alexandrum). This annual species provides the major rabi season fodder, being grown from the lower Sind northward into the lower vallies of Swat

district. It frequently is sown with sarsoon (brassica), sometimes with oats, and occasionaly with wheat (upper Peshawar valley). Recent studies are underway in mixture with annual ryegrass. Six to eight kg/ac of seeds may be sown from mid-September through the month of October. The first cut is ready 50 to 60 days after sowing, about 40 days in winter (but longer in the north), and 25 to 30 days in the spring. Yields are highly variable, being 20 (plus) tonnes/ac on farmer fields and over 50 tonnes (fresh weight) with improved practices (on-station), from 4 to 6 cuts. Forage often contains no more than 10% dry matter. If seeds are to be harvested the final cutting is late March. Agaiti and Pachaiti varieties are somewhat superior to the old variety Mescavi and ecotypes which exist after years of farmer-saved seeds. Studies have shown little no difference among varieties and ectopes when high quality seed is used for sowing.

Suggested Research:

a) Continued seed purification by mass selection of superior types, increase of basic seed, on-farm demonstrations compared to farmer-saved seed; eliminate breeding by radiation and neutron treatment.

b) Agronomic trials in mixture with annual ryegrass (using seeds from the Bahadurnagar selection) in different agro-ecological zones and on-farm trials.

c) Agronomic trials with various oat varieties, particularly an early selection to supplement the winter decline of berseem.

2. Persian clover syn. shaftal (*Trifolium resupinatum*) -- an annual which replaces berseem, particularly under barani conditions and at higher elevations. Only farmer-saved seeds are available and may be of poor quality. Seeds are much smaller than berseem, 2 to 3 kg/ac being sufficient. Shaftal is sown alone or and sometimes mixed with wheat, occasionally with oats. When sown alone, and poor a stand occurs, volunteer weeds, indigenous Medicagos and Vicias, along with brassica will be found. Forage yields are lower than berseem but plants are more leafy. Research has been neglected, primarily due to the attention given to berseem but shaftal is still an important fodder crop in many parts of Pakistan.

Suggested Research:

a) Collect seeds from different agro-ecological areas with evaluation at NARC and Tarnab, possibly NWFP Research Station at Mingora; varietal (cultiver) purification of superior ecotypes production of basic seed for further multiplication.

b) Agronomic trails alone, in mixture with annual ryegrass, with oats, and with wheat; on-farm trials compared to farmer practices.

3. Lucerne (Medicago sativa) -- This valuable legume has been known in Pakistan for many years. One reference to Baluchistan in 1891 noted 4 or 5 cuts per annum and up to 200 mounds/ac fresh weight where irrigated and manured (8). Lucerne is still a prominent fodder crop in the higher elevations of this province, being commonly grown in orchards. The highest yielding variety (local ecotype) is Kandahara, having good cold tolerance. Lucerne is not widely used in the hill lands of NWFP, but recent trials at the Jabba Sheep Farm (Mansehra District) have demonstrated its potential without irrigation.

In the lower elevations lucerne stands are less persistant and most small armers use it as an annual. On-station trials, however, show that it will persist three or more years, producing up to 50 tonnes/ac fresh weight in the first year. Plant growth and yields decline in mid-summer due to the heat. Some farmers relate reduced milk production during this time with an adverse affect of lucerne. In actuality, this depression is a climatic effect on the animal, but the lucerne may also be more highly dignified because of reduced growth and leaf shatter.

Reportedly two types exist in the Punjab, namely an annual form and persisting varieties. It is suspected that harvest of seeds in April and May has caused selection towards the annual which is available in local markets, but this has not been verified. Varietal tests at the Fodder Research Institute, Sargodha, and other locations have shown some yield differences. A blend of so-called Types 8 and 9 appears to have advantage and the percentage composition is being examined. Until a scheme for commercial production is available, however, the value of a blend will soon be lost with farmer-saved seed.

A practical view of lucerne production in Pakistan suggests that lucerne holds little or no advantage for the small farmer in irrigated areas where land is at a premium. A perennating crop, such as lucerne, produces less biomass per unit area than a sequence of annual crops. Its use and value on government and large private farms, howver, can be justified, particularly in view of high quality forage. In fact, if very large areas were available for high tonnage output there might exist the possibility of exporting a pelleted product.

Suggested Research:

a) Continued varietal testing, especially in different agro-ecological areas, using a broader spectrum of varieties and cultivars to include materials from the northern and southern USA as well as proprietary material from multinational seed corporations. It is likely that different varieties are needed for the warmer and cooler climatic conditions. Furthermore, it is likely that a multinational brand-named variety can be more readily available than in-country produced seed. Eliminate the use of radiation and neutron treatment as a breeding technique.

b) Collect genetic material (ecotypes or various seed sources) of the so-called annual type and evaluate at different locations; determine if the annual form is Medicago sativa or another species; examine the benefits of an annual type as a means of closing the gap of stress periods, alone and in combination with oats and ryegrass.

c) Agronomic studies in on-farm trials.

d) Determine areas best adapted for seed production; conduct agronomic and seed production trials in these areas.

e) Reduce number of proximate analysis: no need for all plots.

4. Red clover (Trifolium pratense) -- This is a biennial species being evaluated at limited sites in the hill lands. Preliminary results look promising but plant longevity may be a deterrent to its use where land area is limited.

Suggested Research:

a) Observational plots of a larger number of varieties from northern USA in a number of agro-ecological areas.

Note: This should not be given high research priority.

5 Birdsfoot trefoil (Lotus corniculatus) -- This perennial species was collected in Baluchistan in the late 1800s (8) and occurs in some parts of the NWFP. It might have limited value as an escape species or intersown with indigenous grasses.

Suggested Research:

a) Observational plots of a few varieties from New York State, USA, not a high priority item.

6 White clover (Trifolium repens) -- This species has become naturalized in the cooler regions of Pakistan and regenerates from shattered seeds. It occurs spontaneously and provides fodder when other mixed species are cut, as well as grazing. It is unlikely that other introductions will be as productive as the above mentioned species.

7. Oats (Avena sativa) -- This species has been used as a fodder crop over a long period of time in Pakistan, being second to berseem in total country winter feed production. It is highly regarded as a commercial crop around cities and larger villages, being cut and carried by humans and transported by animal drawn and motor-driven vehicles. A higher percentage of oats is single-cut but in mixture with berseem and shaftal can be double-cut. Time of planting from late September to mid-December extends the season of fodder availability. Yields are highly variable but often exceed 50 tonnes/ac of fresh material. Local selections

have a wide leaf: stem ratio and are susceptible to various diseases. Improved varieties are more leafy, possess disease resistance or tolerance, and produce more biomass. Varieties are being screened for early, medium, and late types but much overlapping exists in regard to maturity classification. Selection should probably be based on clearly distinguishable early and late types. On government farms oats is sometimes used alone or in mixture with berseem as silage, quality being determined by fine-chopping and extent of packing. It could also be used for hay, perhaps taking a double-cut then left for hay or seed, saving the straw for later feeding.

Suggested Research:

a) Continued selection of early and late types with leafiness and disease resistance, the late type tested for multi-cut; intercrossing of lines as needed.

b) Limited on-station varietal and agronomic testing and more nationally organized on-farm trials. Fertilizer trials on-station where land has been continuously fertilized has little or no on-farm value.

c) Continued production of basic seed stock but more effort directed toward seed production for farmer use (Section IV).

8. Wheat -- Not only is this the most important food crops in Pakistan but it serves a dual purpose role in livestock production, namely fresh-cut fodder and straw (bhusa, when chaffed) What is more widely used as a fodder crop than indicated in published material. In the hill lands and mountains of N.W.F.P and Baluchistan it is more important than oats when grown alone and in orchards, mixed with berseem or shaftal as on-farm and commercial fodder. When cut early, plants regenerate new tillers for a second cut or grain production. In these and other barani areas brassica is often intersown with wheat, being pulled as fodder when needed.

In the higher elevations of the NWFP wheat straw is not shredded but stocked for later feeding. Elsewhere, bhusa is saved in mounds. It is estimated that 50% or more of livestock TDN comes from bhusa, being higher for some dry animals. The organic matter digestibility of wheat straw is about 43%. A number of physical, chemical and biological methods have been attempted to improve intake and digestibility. The most simple, cheapest and successful is urea ammonia treatment as developed by the Division of Animal Nutrition, NARC. As bhusa is stored in the normal manner an aqueous solution of 5kg urea plus 10 kg cattle or buffalo dung is sprinkled over each 100 kg of straw. The treatment process is completed in 4 to 6 weeks. This procedure increases intake by about 80% and digestibility by 50%.

Note: This simple procedure is ready for immediate movement onto farms. Simple technology packages of fodder crops (rabi

and kharif) in combination with treated bhusa should be developed for on-farm demonstrations (Section VI B).

Suggested Research:

a) Obtain seeds of recommended varieties from Wheat Research Institute plus selection (varieties) that are leafy, for fodder yield trials in different agro-ecological areas; planted alone, in mixture with berseem and with shaftal; used as single-cut and multicut; effect of cutting on grain production.

b) Limited agronomic studies may be needed, but probably will be comparable to recommendations for oats.

9. **Barley** -- At one time grown as a food crop in Pakistan, barley now has limited use in the brewery industry. It is still planted as a fodder crop in some areas, particularly Baluchistan and the NWFP. Generally, it is sown alone but also in mixture with berseem and shaftal. No fodder yield data were encountered. Barley possesses notable tolerance to saline and drought soils, more so than other cereals. In the barley breeding program at the Ayub Research Institute one variety can be double cut, then produce an acceptable grain yield.

Suggested Research

a) Obtain several varieties from the barley breeder at Ayub Research Institute for fodder yield trials in a number of locations; planted alone, in mixture with berseem and shaftal, used as single-cut and multi-cut; effect of cutting for fodder or grain production.

10. Triticale -- This crop has been evaluated as a potential fodder crop and found to be lower yielding than oats. Furthermore, it is more stemmy and less leafy. Thus, it should be abandoned as a fodder crop until more promising types are developed.

11. Ryegrass (*Lolium multiflorum* - annual and *L.perenne* - perennial) -- Both types have been evaluated at several locations, the annual form being more productive for fodder. One variety from Australia has been grown in various trials at the Bahadurnagar Livestock Production Research Institute since 1976. In 1986-87 a 10 ha block was cut twice then left for seeds producing 400 kg/ac. This is being repeated in 1987-88. Undoubtedly, natural selection has occurred so that a well adopted and highly productive type has evolved.

Note: Seeds from the field should be harvested as a source of Basic (Foundation) seeds for further multiplication, evaluation at other institutes, and on-farm trials (demonstrations). This selection should be given a local name for specific identity. Repeated sowings should be made each year in an isolation block (to prevent intercrossing),

plants cut two or three times before seed production and thus maintained as a source of Basic seed. Seeds of this selection can be included in the village-contract seed multiplication scheme (section IV) and/or provided to local seedsman for increase.

Fodder production trials at LPRI showed that ryegrass alone or in mixture with berseem possessed a higher dry matter content, yielded more total dry matter and crude protein during winter and early spring than berseem alone. Other advantages of ryegrass include growth compatibility with berseem, filling in spaces not occupied by berseem, provision of more digestible energy, and extending the growing season when repeatedly cut and not left for seed. The ryegrass-berseem mixture with repeated cuttings has been successfully demonstrated in farmer fields by the Pattoki Livestock Production Institute.

Suggested Research:

a) Seeds of this newly named variety should be made available through the national fodder crops program for extensive agronomic trials, alone and in mixture with berseem and shaftal, at collaborating units, provincial experiment stations and livestock farms; placed on farmers fields via FSR, the Village Task Force (section VI B), extension.

b) Additional annual type varieties should be obtained for cooperative trials, particularly varieties from California for evaluation at lower elevations and from Oregon for higher elevations.

Note: The tetraploid type will probably be of little value in Pakistan since it is more stemmy and less leafy. Furthermore, it readily crosses with the commonly used diploid varieties, thus producing triploid seeds and sterile F plants.

12. Brassica -- This oil crop is frequently sown with berseem, providing increased fodder from the first cut. It is also mixed with wheat and pulled along with weeds as fodder. Volunteer plants appear with wheat, oats, barley, and in non-cultivated areas, being pulled or cut for livestock feed.

B. Kharif (summer) Fodder.

1. Maize -- When used as a grain crop the stalks and leaves of maize are kept as stover. Maize also provides green fodder, being planted alone or in mixture with guar and cowpeas, sometimes with millet. When sown as fodder, 40 kg/ac of seeds are broadcast, with cutting begun at the time of barley flowering. Even as a grain crop, the sowing rate may be increased, plants being pulled as fodder until an appropriate stand is attained for grain. Staggered dates of sowing permit sequential harvests. If planted too early in the spring, however, plants suffer from shoot fly

attack. In some irrigated areas maize is sown at 100 kg/ac, cut at early flowering, and sold as a commercial fodder crop. The agoyee variety is being popularized as a fodder maize, producing higher yields than the older Akbar variety. This has become a common practice around Karachi where transport by trucks exceeds 200 miles from the city. Yields may surpass 20 tonnes/ac fresh weight at each harvest. Maize provides excellent silage when harvested in the soft-dough stage, chopped finely (pieces of one inch) and firmly packed to exclude air. On government and large farms it is stored in pit or bunker silos. Small farms very seldom make silage.

Suggested Research:

a) Obtain potential fodder types from the CIMMYT collection for comparison with Afgoyee, Akbar and other local varieties, including commercial types from multinational seed companies. These trials need not be located at more than two or three sites.

b) Basic seed increase for further multiplication.

2. Sorghum syn.jowar (*Sorghum bicolor*) -- This species is used for both grain and fodder, usually a single cut but multicut varieties are being evaluated. A number of varieties are available for barani and irrigated areas. Some have sweet stalks but others are non-sweet, some more disease resistant than others, but all are susceptible to the shoot fly. Under irrigation sorghum can be sown between March and August, in the barani areas with the onset of rains. If sown as fodder, 32 kg/ac are used and for grain only 8 kg. When a grain crop is taken the stalks are used as fodder if still green or saved as stovers for later feeding. As a single-cut crop, fresh weight averages about 20 tonnes/ac but multicut types under experimental conditions approach 50 tonnes (15 to 20% dry matter).

Suggested Research

a) Continued maintenance of germplasm and varietal testing, including commercial hybrids; limited on-station and more on-farm trials.

b) Breeding efforts directed towards a multicut fodder type; pre-Basic and Basic seed increase for further multiplication.

3. Millet syn. bajra (*Penninsetum ameriancum*) -- This is an important dual-purpose fodder and grain crop in the lower elevations, especially in rain-fed areas. For fodder it is grown as a monocrop or mixed with maize and sorghum. Seeds may be sown from April to August under irrigation and just before summer rains in barani areas, using 5 to 6 kg/ac. For years only one cut was made for fodder or grain (stover saved for later feeding). Even though a fodder type was introduced some 20 years ago it, too, was used for single-cut until 1987. At the Fodder Research

Institute this variety was planted early in a multi-cut trial, three cuts as fodder in a vegetative stage then left for seed. Fodder yields approached 20 tonnes/ac, not too different than single-cut.

Suggested Research:

a) Continued germplasm evaluation of the dual-purpose type.

b) Additional introduction of multicut type, especially from Tifton, Georgia; breeding efforts placed on the mulcicut type.

c) Continued seed purification of the present (old) variety and development of a composite.

d) Extended testing of the multicut varieties on-station and on-farm; also farmer demonstrations.

e) Seed multiplication of the multicut varieties.

4. Sorghum-Sudan grass hybrid -- The interspecific cross has been used in various countries for a number of years. In fact, the first Pakistan release was made from the Maize and Millet Research Insticute, Yusufwala in 1972. Unfortunately, because of seed production problems it was not distributed to the public. Interest was renewed in recent years with realization of the value of repeated cuttings, high fodder yields, and good quality forage when cut in a vegetative stage of growth. A problem of hybrid seed production exists within the country, primarily due to non-synchronization of the parental lines. This has been overcome by some seed producers and at various institutions by using compatible parents and techniques to obtain timely pollen production. Even with increased in-country seed production, there are also present supplies of hybrid seed from multinational corporations. With farmer demand, they probably can supply the major seed request.

The S.S. hybrids can be planted early (about 8 kg/ac from mid-February in some localities) but are subject to shoot-fly and borer damage. Nonetheless, the later the sowing the fewer cuts and less fodder. In general, sowing will be made after wheat harvest. The first cutting is ready in about 60 days and thereafter at 45 to 60 day intervals, cut in the vegetative growth stage, with variable fodder yields that can exceed 50 tonnes/ac fresh weight. Farmers are accustomed to allowing later maturity for increased tonnage and must, therefore, be enlightened as to more frequent cutting and value of quality forage. In fact, the final cut can be prolonged, plants cut and bundled, stacked upright in shocks (bundles in a tepee form) for drying and later use. Farmer should not save seeds because a fodder yield decrease of about 20% will be experienced due to F2 plant segregants. A fact sheet and verbal explanation of S.S. hybrid use will be of benefitproduction, proximate analysis, and

nutritive value of the more prominent species found in irrigated land and barani cropland areas.

Suggested Research:

a) Determination of fodder production and proximate analysis of selected species; seasonal availability of fodder; nutritive value in collaboration with the livestock sector.

Note: To carry out this activity will require a full-time fodder Agronomist. It will be necessary for him to locate trees of various ages on public or private property, arrange for their long-term use (in some instances pay a rental fee); collect data as noted above; in some instances return the herbage to the owner and in others accumulate sufficient amounts for animal digestibility and performance studies.

1. Leucaena leucocephala (commonly referred to as leucaena, sometimes ipil-ipil which is the Philippine designation) -- This multi-purpose leguminous tree is given attention in this report because an effort is underway to popularize its use as fire wood and soil enrichment (nitrogen fixation) when properly inoculated.

The species is indigenous to tropical America and the time of introduction into Pakistan has not been established. It is listed by Khan () as Leucaena glanca, "cultivated in both wings of Pakistan but fodder value not recognized". Single trees and small plantings occur throughout the lowland areas of Pakistan where moisture is sufficient for establishment, but the herbage is still not used as livestock feed. Apparently, the roots become nodulated by bacteria (observed) which vegetates in the soil, but this may not be the most effective strain of Rhizobium for enhanced nitrogen fixation.

The forage may not be used in Pakistan because of mimosine content. This proteineous compound causes serious disorders in both monogastric and ruminant animals. In some countries, however, ruminants possess in their microflora a bacterium which degrades the mimosine and permits a high-leucaena diet (up to 100%) without damage to the animal. This bacterium may not exist within the microflora of Pakistan ruminants. If not, it can be introduced by having a source of rumen and adding it to the foodstuff of those lacking this organism. Furthermore, it is passed among animals that feed from the same trough.

The seed coat of leucaena is extremely hard but readily scarified by pouring boiling water over the seeds (in a container), leaving the seeds covered for one minute, then draining and cooling them in the shade. Seedling growth is slow and they must be protected for about six months, especially from grazing animals and particularly goats. The place for leucaena has not been agreed upon but it probably fits best on the inside of bunds, along roadways and pathways, field boundaries, etc. In some countries alley cropping is practiced, i.e. leucaena plants closely spaced in rows placed 10 to 15 feet apart with cropping

between rows. As yet it has not been determined that alley cropping is appropriate for Pakistan.

A wide array of germplasm is available within Pakistan but there is no organized scheme for evaluation. Leucaena suffers from cool weather and frost damage, losing its leaves but recuperating with warm temperature.

Suggested Research and Activities:

a) The Coordinator of the National Fodder Research Program assume responsibility for assembling germplasm, obtaining sufficient seeds, and organizing uniform trials in various locations to determine forage productivity and seasonal availability, under different cutting and spacing regimes.

b) Importation of specific and effective *Rhizobium* for comparative studies with the local strain; in cooperation with a soils microbiologist.

c) Obtain seeds of *Leucaena pulverulenta* for trials in cooler areas (from Texas A&I).

d) Establish nurseries for seed production.

e) Participate in on-farm trials and prepare an instructional fact sheet to accompany seed distribution.

f) Collaborate with animal nutritionist and bacteriologist to determine if the mimosine bacterium exists among the microflora of ruminants in Pakistan (procedural information from CSIRO, Brisbane.)

XI. Forage and Fodder Conservation

A. Hay Making

Conservation of hay is not common practice in most of Pakistan, except in the higher elevations where the native grasses are cut after maturing and drying in situ, then stored for winter feeding. This is not a quality product. At the lower elevations, many farmers need the forage when drying conditions prevail during April and May. Then, when forage is again available in June and July rains are likely.

Haymaking on government, military and large farms should be no more difficult in Pakistan than in other countries. Crops such as lucerne, ryegrass alone and in mixture with berseem, oats and multicut millet are suitable for hay. Berseem alone will be more difficult because of lush growth. These crops lend themselves to mechanized hay making, using appropriate equipment for cutting, windrowing and baling. The Engineering Section of NARC can no doubt, provide advice for import of needed items and plans for their manufacture within the country.

On small farms haymaking will be more difficult because of operation size, use of hand labor (possibly labor shortage), shortage of forage and lack of appropriate technology (know-how). It can be done on a small scale, however. Crops such as oats, ryegrass alone or mixed with berseem and multicult millet thickly sown for production of small stems and cut just before headings are suitable for hay. They should be cut, swathed, and allow to dry until very little juice extrudes when a handful of the plants are twisted, not allowed to dry until they break. The ryegrass alone or with berseem will need to be turned on the second day after cutting. These can then be collected at the end of the second day or on the third day and placed on hay cocks -- poles about 6 feet long constructed as a triangle with the base pole longer and some 2 feet from the triangle base, two such triangles placed together on a slant, tops tied or made to interlock, two other poles laid across the base poles. The oats should be cut in the milk or soft dough stage and can be bundled after one or two days drying time. Then bundles are set upright, heads touching, some 10 to 12 bundles in a single hay cock. The millet can also be bundled probably requiring one more drying day, and placed in a stack similar to oats for complete drying.

B. Silage making

Silage is made on some livestock research stations and government farms using maize, sorghum and oats. Elephant grass, the Pennisetum hybrids, S.S.hybrids, and millet can also be used. Pit or bunker type silo are most common. Some "good" silage results but some is not so "good", with much spoilage occurring. Stage of plant development when harvested is important, but for the most part, there is a need for an appropriate cutter and chopper. Fine chopping is a necessity -- pieces no more than one inch in length. Packing with compaction is a must. The bunker or pit silo should be so constructed to allow packing with a tractor. It should be open, at least on one end for the pit type, to allow easy access for packing, drainage, and entry for feeding. Adequate coverage with plastic and soil, maize stalks, etc. is needed for further exclusion of air.

On small farms, silage making will be more difficult. Small pit silos were observed but poor quality silage was noted because of large-cut stalks, inadequate packing and exclusion of air. The same crops mentioned above are suitable. A small pit-type silo is adequate, preferably plastic-lined with holes in the bottom for drainage. The most important features are proper stage of crop harvest, fine chopping, packing and compaction, secure covering to exclude air. An above ground type, small silo should also be servicable. This requires a plastic bag (10 mil or more) some 5 feet in diameter and 8 to 10 feet long. A circular structure must be built, for example poles lashed together, with the bag fitted inside and the tops draped outward over the poles, some holes in the bottom of the bag. The material to be ensiled is placed in the bag after proper cutting, assured firm compaction as filling is accomplished. This packing, as well as that in the pit silo

can be performed with a farm-made tool for tamping. It is easily constructed using a piece of a log, approximately one foot in diameter and one foot in length, with two small (5-foot lengths) attached upright on opposite sides of the wooden block, used as handles in compacting the ensiled material. After filling, the base, the open end (top) is firmly tied and the small stack well covered.

> **Note**: These simple techniques for hay-and silage making on small farms can be evaluated and modified at NARC or one of the Collaborating Research Units; a fact sheet (guideline) prepared. They can readily and easily be demonstrated on-farm.

XII. National Forage and Pasture Program

The writer did not have the opportunity to become acquainted with this program but suggested that a short-term consultant spend time reviewing and evaluating the past and present research then assist in formulating guidelines for the future. This person should have long-time experience with grazing-rangelands in arid conditions, hopefully in several countries.

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Itinerary and Schedule -- Fodder Crop Consultant (1988)

March 15 - 16	: Travel Gainsville, Florida - Karachi
March 17	: Arrive Karachi
March 18	: Karachi/Hyderabad Farm visit to Jhudo, Mirpurkhas District.
March 19	: Hyderabad/Tandojam Sind Agriculture University Agriculture Research Institute
March 20	: Hyderabad/Tandojam/Islamabad Atomic Energy Agriculture Research Centre
March 21	: Islamabad USAID/ARD and USAID/MART National Agricultural Research Centre Barani Agricultural Research and Development (BARD PROJECT)
March 23	: Islamabad/Sargodha Barani Livestock Research Institute Kheri Murat (Attock District) Barani Agriculture Research Institute Chakwal (Jhelum District) Fodder Research Institute Sargodha (Sargodha District)
March 24	: Sargodha/Faisalabad
March 25	: Faisalabad -- USAID Guest House
March 26	: Faisalabad Farming Systems/Command Water Mgt. Proj. Shahkot Proka Livestock Centre, Faculty of Animal Sci. University of Agriculture, Faisalabad.
March 27	: Faisalabad Ayub Agricultural Research Institute
March 28	: Faisalabad Nuclear Institute of Agriculture and Biology (NIAB) University of Agriculture Faisalabad
March 29	: Bahadurnagar Livestock Production and Research Institute Bahadurnagar
March 30	: Hala, Punjab Pattoki Livestock Project Project (GTZ)
March 31	: Lahore Visit Punjab Government officials, Gargill Pakistan, Milk Pak.
April 1	: Lahore
April 2	: Visit with Agricultural Journalists and former Minister of Agriculture.
April 3	: Travel Lahore-Quetta

April 4	: Quetta USAID/MART Project, Arid Zone Research Institute, ICARDA, Agricultural Research Institute, Sariab, Livestock Department Headquarters, Baluchistan Forestry Department Headquarters, Baluchistan
April 5	: Travel Quetta-Islamabad USAID/Winrock Forestry Project
April 6	: Peshawar Agricultural Research Institute, Tarnab Northwest Frontier Province Agricultural University, Pakistan Forest Institute, Peshawar
April 7	: Peshawar - Mingora (Swat District) NWFP Agriculture University
April 8	: Mingora - Mansehra - Islamabad NWFP Agricultural Research Station, Mingora (Swat District) Jabba Sheep Farm (Mansehra District)
April 9-15	: Islamabad Preparation of Report Review of Findings - NARC Coordinator National Fodder Research Program. Briefings - PARC Chairman, Member Crops Sciences, USAID/ARD, COP MART/Winrock.
April 16-17	: Travel Islamabad-London-Atlanta-Gainesville.

Chonological Order of Interviews and Discussions
Fodder Crop Consultant (1988)

Sind Agriculture University

Dr. A.Q. Ansari, Vice Chancellor
Dr. Sahmsuddin Tagar, Dean Faculty Crop Production
Mr. Ghulam Nabi Kalwar, Assoc. Prof. Agronomy
Dr. Umed Ali Buriro, Asst. Prof. Agronomy
Dr. Kazi Suleman Memon, Assoc. Prof. Soils
Dr. Ghulam Hussan Soomro, Chair. Livestock Management

Sind Agriculture Research Institute

Mr. Altaf Hussain Chaudhry, Director
Mr. Mohammad Khurshid Rajput, Agronomist

Atomic Energy Research Centre

Dr. A. R. Azmi, Director

Islamabad: USAID/ARD

Dr. H. Patrick Peterson, Chief
Mr. Richard H. Goldman, Deputy Chief
Mr. Harry Dickherber, Agric. Program Officer
Dr. Curtis Nissly, Project Officer MART
Dr. Abdul Wahid, Program Specialist

MART(Winrock)

Dr. Bill C. Wright, Chief of Party
Dr. Takumi Izuno, Research Operations
Dr. Murray Dawson, Farming Systems
Dr. J. Cordell Hatch, AV Communications
Dr. Ted Buila, Training

National Agricultural Research Centre (NARC)

Dr. Abdus Salam Akhtar, Director General and
Member Animal Sciences (PARC)
Dr. Mumtaz Ahmad, Project Director, Barani Agric. Res. Dev. Project
Mr. M. Banaras Bhatti, Coordinator, Fodder Research Program
Dr. Noor Mohammad, Coordinator, Pasture and Forage Program
Dr. Amanat Ali, Coordinator, Animal Nutrition
Dr. William Pringle - Barani Agric. Res. Dev. Project

USAID/Winrock Forestry Planning and Development Project

Dr. Eugene Ostmark, Chief of Party
Dr. Michael R. Dove, Project Anthropologist

Barani Livestock Research Institute, Chakwal

Mr. Gulzar Ahmed, Agricultural Chemist

Fodder Research Institute, Sargodha

Dr. A. R. Chaudhry, Director
Mr. Mukhtar Ali Mukhtar - Fodder Botanist

Farming Systems/Command Water Management Project Field Day, Shahko

Dr. Abdul Majid - FSR Coordinator
Mr. Mohammad Arshad - FSR Site Coordinator Shahkot
Dr. Shahid Ahmed, Director Land and Water Resources (PARC)

Ayub Agricultural Research Institute, Faisalabad

Dr. Muhammad Hussain Chaudhry, Director Wheat Research
Dr. Asghar Jalees, Director Agronomy
Dr. Tufail Ahmed, Director Pulses
Mr. Abdul Ghafoor Asi, Fodder Botanist
Mr. Anwar Zafar, Maize Botanist
Mr. Mohammad Shafi Quari, Barley Breeder

Nuclear Institute of Agriculture and Biology, Faisalabad

Dr. Kausar A. Malik, Head Division of Soil Biology

University of Agriculture, Faisalabad

Dr. Manzur Uddin Ahmed, Dean, Faculty of Animal Husbandry
Dr. Abrar Hussain Gilani, Director of Research
Dr. Munawar Ahmed Lial, Prof. Animal Nutrition
Dr. Sadaqat Hayat Hanjra, Assoc. Prof. Livestock Management
Mr. Mohammad Tufai, Asst. Prof. Fodder Agronomy.

Livestock Production and Research Institute, Bahadurnagar

Dr. Yaqoob Lala, Director
Sheikh Abdul Waheed, Research Officer, Fodder Crops
Mr. Chaudhry Abdul Hameed, Agric. Research Officer.

Pattoki Livestock Production Project

Dr. Hubert Krischke, Agronomist
Mr. Tariq Mahmood, Counterpart (Agronomist)

Lahore

Dr. Zafar Altaf, Secretary Agriculture Punjab
Mr. Javed Qureshi, Secretary Livestock and Dairy Development
Dr. Aslam Yousaf, Research Manager, Cargill (Pak) Ltd.
Mr. Yawar Ali Manager, Milk Pak
Mr. Sadiq Qureshi, Agricultural Journalist
Mr. Malik Khuda Bakhsh Bucha-Former Agriculture Minister

Quetta

Dr. Dyno Keatinge, Chief of Party, ICARDA (Arid Zone Res.Inst)
Dr. Asghar Ali, Scientific Officer, ICARDA (Germplasm)
Mr. Rana Asghar, Scientific Officer Range Management
Mr. Nazar H. Khiliji, Asstt. Agronomist, ARI, Sariab
Mr. Yunus Khan, Secretary Livestock Department Baluchistan
Mr. Faqir Mohammad, Director Research Baluchistan
Mr. Durrani, Secretary, Forestry Department, Baluchistan
Mr. Ghias, Conservator of Forest

Peshawar

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Syed Muslim Shah, Asst. Agronomist, ARI (Tarnab)
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Dr. William Seiders, Extension TIPAN (Univ. Ill)
Dr. Kenneth L. McNabb, USAID/Winrock Forestry Project
Prof. M. Hanif Qazi, Chairman, Plant Breeding, NWFP Agri. Univ.
Dr. M. Bashir, Director Livestock Res. Instt. Surezai (Peshawar)

Mansehra

Dr. Jamshed Khan Jadoon, Deputy Director NWFP Livestock Research Station (Jabba Research Farm)

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Dr. Amir Muhammed, Chairman, Pakistan Agricultural Research Council (PARC).

Dr. M. Yousaf Chaudhri, Member (Crop Sciences) PARC