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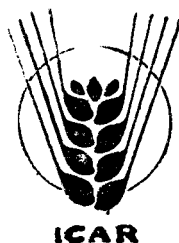
annual report

1974

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
INDIAN GRASSLAND AND FODDER RESEARCH INSTITUTE

JHANSI - 284003

INDIAN COUNCIL OF AGRICULTURAL RESEARCH



**annual
report
1974**

**INDIAN GRASSLAND AND FODDER
RESEARCH INSTITUTE**

JHANSI - 284003 (INDIA)

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INTRODUCTION

The importance of grasses, grasslands and fodder crops in feeding the livestock and in the agricultural economy of the country, the increasing gap between the supply and demand of forage, the limitations of earlier studies and the diversity and complexity of the problems, led to the establishment of the Indian Grassland and Fodder Research Institute at Jhansi towards the end of the Third Five Year Plan during 1962 by the Government of India and administered from April, 1966 by the Indian Council of Agricultural Research, New Delhi.

OBJECTIVES

The Institute has following *seven-fold* major objectives :

1. To carry out research, both of basic and applied nature, on grasses, grasslands and fodder crops as related to sustained production of high quality fodder for efficient animal production, maintenance of soil fertility and crop production.
2. To evolve high yielding, fertilizer-responsive, disease and pest-resistant and superior quality forage and fodder crops suited for different agro-climatic regions of the country by the use of modern techniques of plant breeding and through the application of research in other cognate disciplines,
3. To study all aspects of the problems of weeds in cultivated fodder and grasslands and evolve economic measures of their control.
4. To design and fabricate efficient, low cost labour saving farm machinery implements from indigenous materials to meet the diverse needs, with special reference to forage cultivation in small farm holdings.
5. To conduct basic and applied researches on all aspects of seed production techniques as well as to devise suitable control measures for protecting seed under storage from diseases and pests.

6. To collect, co-ordinate and callaborate research work on the subject in the country by centralising direction / operation and superintendence.
7. To disseminate knowledge on the subject through organised training programme and conduct large scale forage demonstrations at national level.

ORGANIZATION

The Institute is currently organized into *EIGHT SCIENTIFIC DIVISIONS* viz., (i) Plant Improvement, (ii) Soil Science & Agronomy, (iii) Grassland Management, (iv) Weed Ecology & Control, (v) Plant Animal Relationship, (vi) Seed Technology, (vii) Agricultural Engineering, and (viii) Extension & Economics (including Statistics) and *TEN SECTIONS* viz., (i) Cartography, (ii) Technical Information, (iii) Laboratory Services, (iv) Instrumentation, (v) Photography & Art, (vi) Farm, (vii) Library, (viii) Administration, (ix) Audit & Accounts, and (x) Estate Management. A medical unit has also been provided and is headed by a Junior Medical Officer. The Cartography & Art Sections have been put under the Division of Extension and Economics for administrative purposes. Similarly, the Estate Management Section is placed alongwith the administration section.

For the conducting of researches for the higher altitude temperate-alpine and hilly regions extending over the State of J & K, Himachal Pradesh, Uttar Pradesh, West Bengal and North-eastern regions of the country, the Institute has established its regional station at Manasbal, Safapora, J & K.

During the year the Institute has utilized a budget of Rs. 25.98 lakhs of which Rs. 8.76 lakhs was under plan and Rs. 17.21 lakhs was under non-plan. The capital expenditure was to the tune of Rs. 4.20 lakhs, wholly under plan and the revenue expenditure was Rs. 21.78 lakhs. A revenue of about Rs 1.04 lakhs was realised through the sale of farm produce and feeds and fodders surpluses.

ALL-INDIA CO-ORDINATED PROJECTS

The Institute is the Head-quarters for two major All India Co-ordinated Research Projects in the fields of Forage Crops and

Economics of Milk Production with their main and sub-centres located in various parts of the country. The Co-ordinating units and the two Project Co-ordinators for these two projects as also one of the research centres of the latter project are located at the Institute. Besides these, the Institute also houses research centres of three other All India Co-ordinated Research Projects viz., on Dryland Agriculture on Agronomic experiments and on fodder and grain sorghum.

STAFF PATTERN

The Director is the technical and administrative head of the Institute. He is assisted by Heads of Divisions for technical matters, by Administrative Officer for the purposes of Administration and Senior Accounts Officer for budget and accounts. The main Institute including its regional station and the units of different co-ordinating projects functioning at the Institute has a sanctioned strength of 177 scientific and specialised personnel, 25 technical staff, 69 administrative and 78 supporting and watch and ward staff. During the year under report the staff position in various Divisions/Sections/Schemes is summarised below upto the Research Assistants and equivalent level.

<i>Designation</i>	<i>Name</i>	<i>Date of joining</i>
Director	Dr. M. L. Magoon	10.6.1970 (upto 26.9.1974)
P. A. to Director	Shri O. P. Dubey	25.1.1971

PLANT IMPROVEMENT DIVISION

Head of Division	Dr. K. L. Mehra	15.4.1967
Botanist	Vacant	
Plant Breeder (Legumes)	Shri Amar Singh	15.5.1969
Cytogeneticist	Vacant	
Plant Breeder (Grasses)	Dr. R. Krishnan	12.10.1970
Geneticist (Grasses)	Vacant	
Junior Plant Pathologist	Dr. S. T. Ahmed	6.2.1970
Junior Breeder (Grasses)	Vacant	
Junior Entomologist	Shri Shri Ram	4.5.1970
Junior Breeder (Legumes)	Vacant	
Junior Plant Physiologist	Dr. R. B. R. Yadava	28.8.1972
Junior Cytogeneticist	Vacant	

Junor Botanist	Vacant	
Asstt. Plant Improvement Officer (Legumes)	Shri C. B. Singh	11.7.1968
Asstt. Plant Improvement Officer (Grasses)	Vacant	
Asstt. Systematic Botanist	Dr. S. R. Gupta	21.1.1970
Senior Research Asstt.	Shri M. S. Yadav	22.2.1969
Senior Research Asstt.	Shri K. S. Kohli	9.5.1972
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Research Assistant	Shri Devendra Singh	1.1.1968
Research Assistant	Shri J. N. Gupta	18.9.1969
Research Assistant	Shri U. S. Misra	17.7.1973
Research Assistant	Shri Daya Nand Singh	7.1.1974
Research Assistant	Shri U. P. Singh	12.12.1973

SOIL SCIENCE & AGRONOMY DIVISION

Head of Division	Vacant	
Fodder Agronomist (Crop Husbandry)	Vacant	
Agronomist (Soil & Water Management)	Vacant	
Agronomist (Dryland)	Vacant	
Soil Scientist	Dr. N. D. Mannikar	1.9.1969
Junior Agronomist (Drainage)	Vacant	
Asstt. Agronomist (S. W. M.)	Shri N. P. Shukla	10.8.1972
Asstt. Soil Scientist	Dr. Dashrath Singh	7.9.1972
Asstt. Agronomist (Crop Husbandry)	Vacant	
Senior Research Asstt.	Shri S. N. Tripathi	5.8.1972
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Research Assistant	Shri N. C. Srivas	17.7.1973
Research Assistant	Shri C. L. Yadav	17.7.1973
Research Assistant	Shri D. C. Saxena	10.12.1973(A/n)

Research Assistant Shri Ram Asray Singh 10.1.1974

GRASSLAND MANAGEMENT DIVISION

Head of Division Dr. K. A. Shankarnarayan 21.9.1974
(A/n)

Ecologist Dr. K. A. Shankarnarayan 3.1.1964
(upto 21.9.1974)

Ecologist (GM) Shri K. C. Kanodia 22.9.1967

Ecologist (FG) Shri R. Deb Roy 5.5.1970

Assistant Ecologist Dr. Vinod Shankar 31.7.1967

Assistant Ecologist Dr. P. S. Pathak 24.12.1969

Assistant Ecologist Dr. P. K. Jayan 25.2.1971

Senior Research Asstt. Shri K. C. Velayudhan 10.5.1972

Senior Research Asstt. Shri Prasadhi Rai 21.10.1974

Senior Research Asstt. Dr. C. M. Misra 18.11.1974

Research Assistant Shri Prasadhi Rai 17.7.1973
(upto 20.10.1974)

Research Assistant Shri B. K. Trivedi 11.8.1969

Research Assistant Shri Ravi Kumar 22.9.1969
(upto 1.8.1974)

WEED ECOLOGY & CONTROL DIVISION

Head of Division Dr. T. R. Dutta 13 12.1967

Agronomist (W.C.) Vacant

Assistant Agronomist Shri R. K. Pandey 28.5.1968

Assistant Chemist Vacant

Assistant Plant Physiologist Dr. Ch. Narasingarao 2.2.1973

Senior Research Asstt. Smt. N. P. Kaur 18.11.1974

Senior Research Asstt. Vacant

Senior Research Asstt. Vacant

Research Assistant Shri O. P. S. Verma 17.12.1973

Research Assistant Shri S. D. Gupta 17.7.1973

PLANT ANIMAL RELATIONSHIP DIVISION

Head of Division Dr. A. Rekib 10.4.1972

Livestock Specialist Vacant

Animal Nutritionist Dr. Indra Kumar 26.8.1974

Analytical Chemist
(Trace Elements) Vacant

Organic Chemist	Dr. R. K. Gupta	31.5.1969
Junior Analytical Chemist	Shri S. C. Gupta	21.11.1970
Junior Animal Nutritionist	Dr. V. C. Pachauri	28.12.1974
Junior Chemist (Bio-assay)	Shri A. P. Singh	22.10.1974
Junior Instrumentalist	Vacant	
Veterinary Officer	Shri J. Prasad	17.3.1972
Assistant Analytical Chemist	Vacant	
Assistant Livestock Officer	Shri V. S. Upadhyay	21.2.1972
Assistant Biochemist	Shri A. P. Singh	9.5.1972
		(upto 21.10.1974)
Senior Research Asstt.	Shri N. C. Verma	21.10.1974
Senior Research Asstt.	Shri A. B. Majumdar	7.11.1974
Senior Research Asstt.	Shri O. P. S. Panwar	27.11.1969
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Research Assistant	Shri B. K. Bhadoria	14.12.1973
Research Assistant	Shri L. K. Karnani	12.12.1973
Research Assistant	Shri Charan Singh	1.1.1974
		(A/n)
Livestock Assistant	Shri S. V. Joshi	25.5.1974

SEED TECHNOLOGY DIVISION

Seed Production Officer	Vacant	
Geneticist (Seed Production)	Vacant	
Seed Physiologist	Vacant	
Plant Pathologist	Vacant	
Entomologist	Vacant	
Senior Research Asstt.	Dr. S. N. Singh	28.11.1974
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	

AGRICULTURAL ENGINEERING DIVISION

Senior Research Engineer	Vacant	
Agricultural Engineer	Shri Jai Singh	16.12.1969
Assistant Agricultural Engineer	Shri R. B. Varshne	2.6.1972
Land Surveyor	Shri H. B. Dhingra	11.10.1971

Senior Research Asstt.	Shri J. P. Neema	1.11.1974
Senior Research Asstt.	Shri M. P. Singh	28.11.1974

EXTENSION & ECONOMICS DIVISION

Senior Agronomist (Extension)	Vacant	
Statistician	Shri P. R. Sreenath	8.5.1968
Extension Agronomist	Vacant	
Junior Agronomist (Demonstrations)	Vacant	
Assistant Agricultural Economist	Shri H. H. Datta	18.1.1968
Senior Statistical Investigator	Vacant	
Senior Research Asstt. (Extension)	Vacant	
Senior Research Asstt. (Extension)	Vacant	
Senior Research Asstt. (Economics)	Shri I. P. S. Yadav	28.11.1974
Senior Research Asstt. (Economics)	Shri S. N. Sankhwar	16.12.1974
Research Assistant (Economics)	Shri Ram Prakash	4.11.1969 (upto 19.8.1974)

CARTOGRAPHY SECTION

Junior Cartographer	Vacant
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TECHNICAL INFORMATION SECTION

Junior Scientific Officer	Vacant
Senior Technical Asstt.	Vacant

PHOTOGRAPHY & ART SECTION

Photographer-cum-Artist	Shri C. B. Misra	28.4.1974
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FARM SECTION

Farm Manager	Vacant	
Farm Superintendent	Shri S. P. Marwaha	15.2.1967

Farm Assistant	Vacant
Farm Assistant	Vacant

LIBRARY SECTION

Assistant Librarian	Vacant	
Senior Library Assistant	Shri M. M. Rastogy	1.5.1967

ADMINISTRATIVE SECTION

Administrative officer	Shri H. C. Tewari	22.8.1972
Office Superintendent	Shri A. S. Bhati	3.11.1966
Store Officer	Shri A. Krishna	21.8.1972
Head Clerk	Shri H. C. Saxena	3.12.1969

AUDIT & ACCOUNT SECTION

Senior Accounts Officer	Shri T. R. Reejonia	19.12.1973
Accounts Officer	Shri M. G. Hayaran	26.5.1973
Junior Accountant	Shri J. N. Parashar	16.3.1971
Junior Accountant	Vacant	
Junior Accountant	Vacant	

ESTATE & MANAGEMENT SECTION

Estate Officer	Vacant
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MEDICAL UNIT

Junior Medical Officer	Vacant
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ALL INDIA CO-ORDINATED PROJECT ON FORAGE CROPS

Project Co-ordinator	Dr. B. D. Patil	9.8.1971 (upto 21.8.1974)
Junior Statistician	Shri J. A. Sastry	28.6.1972
Senior Rerearch Asstt.	Shri O. P. Dixit	9.5.1972

**ALL INDIA CO-ORDINATED PROJECT ON ECONOMICS
OF MILK PRODUCTION**

Co-ordinating Unit :	
Project Co-ordinator	Vacant

Junior Statistician	Shri D. P. Handa	10.11.1972
Research Unit :		
Junior Agronomist	Shri J. T. Karnani	24.2.1972
Veterinary Officer	Vacant	
Senior Research Asstt.	Shri N. C. Verma	9.5.1972 (upto 20.10.1974)

ALL INDIA CO-ORDINATED AGRONOMIC EXPERIMENTS

Junior Agronomist	Dr. D. N. Singh	4.10.1972
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ALL INDIA CO-ORDINATED PROJECT ON DRYLAND AGRICULTURE

Agronomist	Vacant	
Junior Engineer	Shri J. P. Saxena	10.4.1972
Junior Soil Physicist	Dr. C. R. Hazra	5.7.1972
Senior Research Asstt.	Shri M. D. Singh	14.8.1972
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	
Senior Research Asstt.	Vacant	

ALL INDIA CO-ORDINATED PROJECT ON SORGHUM

Junior Agronomist	Shri A. S. Gill	12.5.1972
Junior Breeder	Vacant	
Research Assistant	Shri S. K. Gupta	24.12.1972
Research Assistant	Shri K. P. Niranjana	11.12.1973

SUB-STATION AT MANASBAL (J & K)

Agrostologist	Vacant	
Senior Research Asstt.	Shri B. K. Misri	30.10.1974

FACILITIES

Experimental Farm : The Institute has about 575 hectares of experimental farm situated at a distance of about 8 km from the town of Jhansi on the Jhansi-Gwalior Road. The farm is located in the transitional zone with contrasting soil types and varying topography. About 356 haectres are under natural grasslands and about 135 hectares have been

brought under cultivated fodders adopting suitable soil reclamation and coservation measures. The farm has a good potential for irrigation and supplementary source for irrigation water. There is also a well-equipped meteorological observatory, located in the centre of farm to provide data on weather conditions. It also has an adequate farm buildings.

Library : The accessions of books and periodicals to the library continued to show an upward trend. Thus during the year the library had a total of 2950 technical books, 58 Indian journals and 106 foreign journals for the benefit of scientists. Besides, the library has been enriched by the addition of 95 reprints of scientific papers and technical publication encompassing different disciplines from within the country and abroad.

Museum : The Institute has a good museum upto dated with a number of large size photographs, charts and diagrams, etc. depicting the research activities and achievements of the Institute. In the museum the specimen seed of various important forage crop high yielding varieties developed by the Institute are maintained along with models of low cost farm implements designed and fabricated at the Institute.

RESEARCH COLLABORATION AT NATIONAL LEVEL

The Institute collaborated actively with the Institute of Agricultural Research Statistics, New Delhi in chemical analysis of fodder samples collected from cultivated fields under their pilot survey scheme for the estimation of production of cultivated fodders in Meerut District. The Institute had also collaborations with U. P. State Department of Agriculture/Animal Husbandary in the conduct of trials on forage crops and exchange of herbage materials.

EXTENSION AND EDUCATION

Advisory Services : The facilities developed at the Institute were fully utilized in maintaining liaison between the cultivators, extension workers and research workers and rendering advisory services to interested agriculturists. Information on matters of technical and general nature on different aspects of cultivation of grasses and fodder crops was given to various parties which included farmers, private individuals, Block Development Officers, Students, State/Central Governments, Universities, Colleges and Research Institutes. The necessary advice was also provided

to farmers and cultivators by visiting the different areas during the different phases of crop growth.

Technical publications and Mass communications : About 80 research papers and articles of general interest were written up for publication in appropriate journals/presentation in the all India Seminars/Conferences to disseminate the results of research. Besides, invited lectures on various aspects of forage production and utilization in Agricultural colleges and Research Institutions as also popular talks through All India Radio for the benefit of interested growers/agricultural graduates were undertaken by the Institute.

A special issue of Indian farming on Forage Crops was brought out by the Indian Council of Agricultural Research containing research articles in popular language bringing to the notice of farmers and extension workers. Various research findings of practical utility obtained at the Institute, in particular, and other places inside and outside the country, in general, on different aspects of forage production and utilization were incorporated in this issue.

Seed supply : The Institute arranged to supply varying quantities of seeds of range grasses, pasture legumes and cultivated fodder crops to several State/Central agencies and private organisations during the year.

National Demonstrations : During the year, 1974, the Institute conducted three National Demonstrations in the state of Uttar Pradesh. Two crop Fodder-Fodder rotations were planned. However, due to heavy and continuous rains the kharif fodder crop demonstration was not possible and only the demonstration of berseem crop was taken up for Rabi. Except for one of the trials, the other trials have shown economic returns from this crop and the targetted 60 tons of green fodder/ha/year was also achieved with the single crop.

Weed control extension and demonstration trials were carried out at (i) Regional Agricultural Research Station, Etawah (U. P.), (ii) Dry-land Project, Fatehpur-Sikri, Agra (U. P.), (iii) submerged aquatic weed control at Bull-Paddock, Samthar (U. P.) and at several centres of the All India Co-ordinated (Forage Crops) Project. Besides, several advisory Services were rendered against specific enquiries/requests from interested beneficiaries of weed control research.

Kisan Goshti : A Kisan Goshti on the Forage Production and its utilization was organised with the collaboration of the Commissioner, Jhansi Division. The deliberations were held during 29-30th, October, 1974 in which besides the progressive farmers from each districts of the Bundelkhand region, District Magistrates, District Planning Officers, District Forest Officers, District Agriculture Officers, District Livestock Officers, Farm Managers also took part. Further the invitation was extended to Deputy Secretary (Agriculture), Government of U. P., Conservator of forest, Directors and Joint-Directors of Agriculture & Animal Husbandry of Government of U. P. and Deputy Development Commissioner and Deputy Director of Agriculture, Animal Husbandry and Soil Conservation.

The scientists of the Institute delivered lectures on the general situation of the fodder crop production and availability, Grassland Management, Forage Plant Improvement, Forage Production, Livestock Improvement, Plant Protection, Engineering and Extension. The lectures were followed by discussions and formulation. of programmes.

As a follow-up action of the Goshti the Institute has laid out demonstration trials on graminaceous and leguminous fodder crops at different locations in the Bundelkhand Division.

Exhibitions : The Institute will be participating in a 'Vikas Pradarshini' being organized at Jhansi by the Zilla Parishad Jhansi, sometime during January, 1975. At this Exhibition it is proposed to put up a stall of the Institute and depict through Visual aids and models the research achievements of practical value obtained at the Institute for the benefit of the visitors to the exhibition who will include farmers, general public, officials, school children, etc.

WORKSHOPS/CONFERENCES/SYMPOSIA

The scientific and technical staff of the Institute attended the following workshops/conferences/symposia during the year, 1974:

1. First annual conference of Agricultural Research Statisticians
and
27th Annual Conference of the Indian Society of Agricultural Statistics - Jointly organized at the Institute of Agricultural Research Statistics, New Delhi from 25th to 28th April, 1974.

2. Forage sorghum group meeting (A.I.C.S.I.P.)-Organized at I.A.R.I, New Delhi from 15-16th April, 1974.
3. Sorghum workshop of A.I.C.S.I.P. - Organized at Hyderabad from 21-23rd March, 1974.
4. Annual Convention of Indian Society of Agricultural Engineers -Organized at Allahabad.
5. Annual Workshop of ICAR on Farm Machinery Research-Organized at Punjab Agricultural University, Ludhiana.

FINANCE

The Institute was provided with adequate budget in proportion to its current stage of development. The actual expenditure incurred from January to December, 1974, is as follows :

	Revenue Expenditure	Capital Expenditure	Total
Plan	Rs. 4,56,678.24	4,19,620.00	8,76,298.24
Non-Plan	Rs. 17,21,277.55	—	17,21,277.55
Total	Rs. 21,77,955.79	4,19,620.00	25,97,575.79

After meeting the feed and fodder requirements of the livestock strength at our farm, the total receipts from the sale of farm produce amounted to Rs. 1,03,780.94.

VISITORS

The Institute was honoured by the visit of a large number of persons including eminent scientists, important dignitaries and distinguished persons. In addition, officer trainees, groups of students, officials, groups of farmers, extension workers and progressive farmers visited the laboratories and the research farm of the Institute. Only a small list of distinguished visitors is given below :

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Dr. B. S. Jogi
Director of Agriculture,
Himachal Pradesh, Simla | <ol style="list-style-type: none"> 3. Dr. B. A. Krantz
Agronomist, I.C.R.I.S.A.T.,
Hyderabad. |
| <ol style="list-style-type: none"> 2. Dr. G. S. Negi
Director of Animal Husbandry,
Himachal Pradesh, Simla. | <ol style="list-style-type: none"> 4. Dr. Kampen
I.C.R.I.S.A.T.,
Hyderabad. |

5. Dr. M. S. Swaminathan
Director General,
I.C.A.R., New Delhi.
6. Shri F. C. Gera,
Consultant,
Indian Institute of Public
Opinion,
New Delhi.
7. Dr. Eric Da Costa
Director
Indian Institute of Public
Opinion,
New Delhi.
8. Mr. S. J. Maxwell,
Assistant Resident Representa-
tive of U.N.D.P.,
New Delhi.
9. Mr. E. Rawitz
I.A.E.A./U.N.D.P.
Soil Physicist.
10. Mr. J. de Waard,
U.N.D.P.
11. Shri M. S. Choudhari
Additional Chief Secretary,
Government of M. P.
12. Shri A. K. Pandya
Special Secretary (Agriculture),
Government of M. P.
13. Mr. Ballard Wallain
Technical Advisory Committee,
Sheep and Cattle Project,
Australian High Commission,
New Delhi.
14. Mr. Mcellister
Technical Advisory Committee,
Sheep and Cattle Project,
Australian High Commission,
New Delhi.
15. Dr. E. M. Hutton
Chief of the Division of
Tropical Agronomy,
The Cunningham Laboratory,
C.S.I.R.O.,
Australia.
16. Capt. D. V. Panse
Panse Agro-Industries
Corporation, Poona.
17. Dr. M. L. Agarwal
Director,
Sugarcane Research Institute,
Shaharanpur.
18. Dr. R. G. Singh
Cane Physiologist,
Sugarcane Research Institute,
Shaharanpur.
19. Shri D. N. Gupta
Agronomist,
Sugarcane Research Institute,
Shaharanpur.
20. Shri S. R. Srivastava,
Farm Management Officer,
Jhansi
21. Shri Ajit Sanga,
Meteorological Office,
Poona-6.
22. Hon'ble Shri Shiv Charan Mathur
Minister for Food & Agriculture
Rajasthan.
23. Prof. E. K. Woodford
Director, Grassland Research
Institute,
Hurley, Maidenhead, SL6 5 LR.
24. Dr. D. J. F. Burton
Assistant Education Adviser
(Science)-II,
British High Commissioner
British Council Division,
21 Jor Bagh, New Delhi-3

WEATHER CONDITION AND CROP PROSPECTS

The year, 1974 was comparatively an abnormal year. About 84% rainfall was received only in July and August. The total annual rainfall was 875.4 mm which is the normal rainfall of this area, but due to its ill distribution crops like jowar suffered due to lack of moisture at the time of flowering. There was almost daily rainfall from 10th July to 24th August, after that a drought spell of one month (25th August to 22nd September) was observed. From January to 5th June, the rainfall was not received except 1 mm rain on 28th May and again from 15th October there was no rainfall. Rabi crops were otherwise normal as no climatological hazard (hailstorm or frost) occurred during this period.

Weekly mean maximum temperature for the year ranged from 20.7°C to 44.1°C. The maximum temperature of 44.9°C was recorded on 10th and 11th May.

The relative humidity was lower upto the last week of June and thereafter the whole monsoon period was humid.

PROGRESS OF RESEARCH

The research projects relating to forage production and utilization recommended by the Staff Research Council and approved by the Indian Council of Agricultural Research were implemented *pari-passu* to the facilities and built up staff strength available. The technical programme for the year, 1974 along with salient features of research and their details are given below :

TECHNICAL PROGRAMME 1974

Plant Improvement Division :

- PI-1.1 Survey, collection and maintenance of germplasm.
- PI-2.1 (A) Screening of germplasm collection of pasture grass.
(B) Evaluation of germplasm collections of selected range grasses.
- PI-2.2 Screening of germplasm collection of range legumes
- PI-2.3 Screening of germplasm collection of cultivated legumes.
- PI-3.1 Breeding improved varieties for high fodder yield and quality in cowpeas.
- PI-3.2 Variety synthesis for high fodder yield, seed yield and quality in lucerne.
- PI-3.3 Variety construction for high yield quality and early maturity in velvet beans.
- PI-3.5 Variety building in horse gram.
- PI-4.1 Varietal construction for yield and disease resistance in field bean.
- PI-6.1 Evaluation of fodder sorghum germplasm.
- PI-6.2 Evaluation of fodder oat germplasm.
- PI-6.3 Production and quality breeding in fodder sorghum and oats.
- PI-8 Entomological investigations on forage crops during the year, 1974.
- PI-8.1 Determination of efficacy and residues of different dosage of promising and safer insecticides in the control of insect-pests of lucerne and cowpea.
- PI-9.1 Assessment of relationship between insect-pests incidence and cultural practices such as dates of sowing and levels of fertilization in lucerne and cowpea.

- PI-10.1 Effect of growth regulators on seed setting of fodder crops.
- PI-12.1 Prevalence, distribution and control of plant diseases their effect on forage yield and quality.
- PI-12.2 Analysis of resistance in selected forage crops against some important diseases.

Soil Science and Agronomy Division :

- SA-1 Evaluation of genotypic response of fodder crops-
 - (a) Response of guar varieties to different levels of phosphate.
- SA-2 Cultural management and fertilizer use of fodder crops-
 - (a) Cultural-cum-manurial trial on turnip.
 - (b) Neem cake coated urea on fodder sorghum (M. P. chari).
 - (c) Neem cake coated urea on forage oat.
 - (d) Effect of N application and cutting intervals on the fodder yield of oat (Kent).
- SA-4 Seed production in fodder crops-
 - (a) Effect of supplemental irrigation on seed yield of M. P. chari and cowpea sown pure and as mixed.
 - (b) Impact of cultural management and phosphorus application on seed production of guar.
- SA-5 Soil water management of fodder crops-
 - (a) Effect of soil moisture stress at different stages of growth on seed yield of berseem.
 - (b) Water use efficiency of overlapping and relay cropping for year-round green fodder production.
- SA-6 Availability and uptake of nutrients.
- SA-6.1 Micronutrients and secondary elements in forage crop nutrition—
 - (a) Influence of micronutrients on forage production of M. P. chari under rainfed condition.
- SA-6.1-1 Sulphur status of forage and sulphur availability in soils of intensive forage growing areas.
- SA-6.3 Fertility evaluation of Bundelkhand forest soils as influenced by closure of forest.
- SA-6.4 Phosphate fertilizer value of indigenous rock-phosphates for

grasses and fodder crops.

SA-6.5 Rapid tissue testing in fodder crops.

SA-6.6 Quantification of nitrogen fixed by different legumes for the use of subsequent graminaceous fodders.

Grassland Management Division :

GM-1 Grassland productivity.

GM-1.2-5 Relative efficiency and economics of various sources of nitrogenous fertilizers on the quality and quantity of herbage on *Sehima-Heteropogon* grasslands.

GM-1.2-6 Effect of different percentage of Neem cake coated urea, different levels of nitrogen and time of application on quality and quantity of herbage on *Sehima-Heteropogon* grasslands.

GM-2 Grassland improvement.

GM-2.1 Studies on suitable techniques for establishment of promising legumes in natural grasslands.

GM-2.2 Comparative performance of grass-legume mixture.

GM-3 Grassland utilization.

GM-3.2 Comparative study of continuous versus deferred rotational grazing on *Sehima* grasslands.

GM-3.3-2 The effect of intensity and interval of cutting-cum-manuring on the regeneration, quality and quantity of herbage in *Chrysopogon fulvas* (Mhow).

GM-3.4 Studies on the comparative merits of natural grasslands subjected to improved management practices and cultivated pastures in animal production.

GM-4 Range ecology.

GM-4.3 Plant succession on out crop in *Sehima-Dichanthium* cover.

GM-4.4-1 Detailed study of *Heteropogon contortus* and seed testing of fodder trees, legumes and grasses.

GM-4.4-2 Autecology of grassland species; studies on *Leucaena Leucocephala* (Lam.) De wit.

GM-4.5-1 Effect of frequency of burning with or without grazing on the changes in the botanical composition in *Sehima* grasslands.

GM-4.5-2 Effect of phosphate on root growth of principal grass of *Sehima-Dichanthium* cover.

GM-5 Forest grazing appraisal, production and utilization.

GM-5.2-1 Silvi-pastoral studies on fodder-cum-fuel trees.

GM-5.2-2 Studies on the establishment and growth of plantation species in an integrated land use pattern.

Weed Ecology and Control Division :

- WE-1.1 Autecology of weeds.
- WE-1.2 Survey and collection of weeds.
- WE-1.3 Crop weed interaction.
- WE-2 Preliminary evaluation of herbicides for forage cropping systems.
- WE-4 Fate of herbicides in plants and their interaction.
- WE-7 Weed control in forage crop systems.
- WE-7.1 Turnip.
- WE-7.2 Oat.
- WE-7.3 Chicory control in berseem.
- WE-7.4 Wheat-guar.
- WE-7.5 Sunflower-oat.
- WE-7.9 Groundnut-oat.
- WE-7.11 Soybean-linseed.
- WE-7.12 Guar-linseed.
- WE-7.14 Moong-oat.
- WE-7.15 Bajra-peas.
- WE-8 Physiological studies with herbicides on fodder crops-
 - (a) Effect of herbicides on transpiration in fodder crops
 - (b) Effect of triazine herbicides on N content in sorghum.

Plant Animal Relationship Division :

- PAR-1 Evaluation of forage crops in relation to livestock production.
- PAR-1.1 Studies on the chemical evaluation of forage crops for nutrient yield.
- PAR-1.2 *In vitro* studies on digestibility of important fodder and forage crops.
- PAR-1.3 Studies on the nutritive value of important fodders and forage crops for buffalo, cattle and goat.
- PAR-2 Studies on the economic use of fodder for increased livestock production.
- PAR-2.1 Studies on the production potential of different forages in terms of quantity and quality of goat meat.

- PAR-2.2 Studies on the effect of feeding fodder based ration on the growth rate, sexual maturity and first lactation milk yield of buffalo heifers.
- PAR-3 Studies on the conservation of fodder and forage crops.
- PAR-3.1 Conservation of green forages into quality silage and hay.
- PAR-3.2 Fortification of low grade roughages.
- PAR-5.1 Studies on anorexia syndrome in sheep and goat.
- PAR-5.2 Clinical studies on the intra-ruminal use of antibiotics in the management of bloat.
- PAR-6.1 Chemical evaluation of physiologically active constituents of forage plants.
- PAR-6.3 Forage poisoning in livestock.

Extension and Economics Division :

- AES-1 Study on cost of cultivation of crops at Central Research Farm, Jhansi.
- AES-2 Socio-economic Survey in Ambabai Village.
- AES-3 Studies in Economics of Livestock Products (Milk Production).
- AES-4 Allied studies in the Central Research Farm—
(a) Bullock maintenance cost.
(b) Cost of tractor operation.

Agricultural Engineering Section :

- AE-1 Design, development and evaluation of forage harvesting, seed collecting and processing machinery.
- AE-2 Further development and evaluation of irrigation channel-cum-bund former, country plough mounted seed drill, smoke screen former and grass seed collector.
- AE-3 Design, development and evaluation of hay conditioner and rake for quality hay-making.
- AE-4 Influence of Engineering practices on moisture conservation and forage production in range grasses of *Sehima-Dichanthium* cover.

PLANT IMPROVEMENT DIVISION

Salient feature

The germplasm bank of forage crops was further enriched with exotic and indigenous collections of legume and grasses thus bringing the total to 4562 in legumes, 4158 in grasses and 15 in other forage crops.

In *Cenchrus ciliaris*, based on the cumulative green fodder yields in two separate trials in sixth and fourth year of evaluation, varieties 3813, 3108, 3501 and 59-1 were found superior to Pusa Giant Anjan (control).

Genetic variability was studied in berseem, cowpea, soyabean, *Pennisetum pedicellatum* and *Cenchrus ciliaris*. Varietal evaluation trials were conducted in moth, guar, field bean, *Clitoria ternatea* and *Atylosia scarabaeoides*.

In cowpea, 832 collections screened for vigour, growth habit, and flowering, 100 promising segregants of five intervarietal crosses were selected for economic characters.

In local and multilocation yield trials besides IGFRI-S-978, 985 and 457, three other selections IGFRI-S-998, 143 and 515 were found superior in green fodder yield.

In the lucerne varietal evaluation trial, Syn-4 and Syn-5 gave higher green fodder yield in two cuts as against Sirsa-9.

In Velvet bean and horse gram high yielding cultivars were selected.

In fodder sorghum, 23-33% increase in green fodder yields over M. P. Chari (control) were recorded in advanced generations hybrid derivation of crosses and two selections. Promising selections were isolated based on evaluation of germplasm.

In oats intrapopulation selection could be successfully practiced for fodder and seed yields. Selection viz. IGFRI-S-2672, S-2636 and 2680 were found to be promising with comparable cumulative (two cuts) green fodder yields as S-3021 recommended for pre-release multip-

lication; the physic-morphic characteristics underlying fodder yield superiority of dropping plant types among the three plant types studies were indentified.

In lucerne a dose of 1.5 kg/ha of dipterex, endosulfan and malathion was efficacious in checking incidence of leaf hopper, lucerne weevil and aphid. On the other hand, in cowpea, soil application of carbofuran (even @ 1.0 kg/ha) was quite effective in checking the incidence of leaf hopper and flea beetle as compared to 1.0, 1.5 and 2.0 kg/ha application of endosulfan and malathion. However, foliar formulations of all three chemicals were effective in checking insect pests of cowpea.

Application of groth regulators (GA, Phosfon-D, Ascorbic acid, B-nine and CCC) increased fodder and seed yields in cowpea, berseem and lucerne.

Vitavex and Dithane M-45 were found to be superior in controlling rust of lucerne. Rust resident F₂ generation plants were isolated in oats.

RESEARCH WORK DONE

Plant Introduction

PI-1.1 : SURVEY COLLECTION AND MAINTENANCE OF GERMPASM.

(S. R. Gupta and J. N Gupta)

Seventy two new collections of exotic legumes and 15 grasses were added to the germplasm pool of the Institute, thus bringing its total to 4562 in legumes, 4158 in grasses and 15 in miscellaneous forage crops. The new collections included 49 of uar, 20 of moth, 15 of local collect ions of spear grass, 7 of *Stylosanthes* species, 3 of *Leucaena leucocephala* and one of *Atriplex* sp.

An extensive survey of C. R. Farm and grassland areas in and around Jhansi, revealed the possiblity of wide diversity in *Sehima nervosum* (Edaphic ecotypes) in different soil types and habitats. Seeds from plants indicating morphological variations in tillering, inflorescence length, leaf colour, period and duration of flowering, and growth habit have been collected. Twenty-six germplasm collections from local area

and five selections from material already in nursery have been made.

Two selections in *Bracharia brizantha* differing in growth habits i. e., prostrate and spreading and, semierect with small leaves have been isolated for studying the persistence of these characters under identical conditions of soil and irrigation.

PI-2.1 (A) : SCREENING OF GERMPASM COLLECTION OF
PASTURE GRASS
(M. S. Yadav)

Cenchrus ciliaris

Performance of *C. ciliaris* strains were assessed in two trials. One trial comprising of 26 strains is running for the 6th year and the other trial comprising of 28 strains (including best five entries of 1st trial) is running in 4th year. For the first trial only one cutting could be recorded where as the trial running in its 4th year gave two cuttings of green fodder. Based on yield data of both the trials, it was found that selection No. 3108, 3801-1, 3802, 3133, 3132, 3813-1, 59-1, 8-2-5, 103, 25, 54 and 3105 give higher cumulative green fodder yields than the rest. The top varieties viz. 3813, 3808, 3801-1 and 59-1 gave 271, 267, 262 and 244 q/ha green fodder yield respectively where as Pusa giant Anjan produced only 181 q/ha of green fodder. Both the trials were continued for recording data in subsequent years.

Analysis of genetic variability

Heritability, genetic advance and correlations among nine fodder yield contributing characters were worked out using in 28 varieties of *C. ciliaris*. Leaf number, leaf breadth and involucl number showed high heritability and high genetic advance indicating that straight selection is likely to improve them. The plant height, leaf breadth, spike length and fodder yield were significantly and positively correlated with each other in all combinations at the genotypic and phenotypic levels. Thus, it suggested that the breeder should select tall plants bearing broad leaves and long spikes having many involucels to develop high fodder and seed yielding type of *C. ciliaris*.

Cenchrus setigerus

A varietal evaluation trial with 16 varieties was planted in 1971. During the 4th year, IGFRI-3126-1, 79-1, 4858-1, 2758-1 and 28-1

gave higher fodder yield i. e. 139, 137, 129, 125 and 123 q/ha. respectively than the rest.

Dichanthium annulatum

A trial with 18 varieties is running in its 4th year. After the third year, all the varieties showed decline in fodder yield, therefore, the trial is being discontinued. Yield performance of superior varieties along with that of control in different years is given below.

Year	No. of cuts	Fodder yield of IGFRI selection numbers in q/ha			
		495-1	3995-1	495-5	Control (Marvel - 8)
1971	one	87	70	85	50
1972	three	264	242	221	146
1973	two	239	227	223	148
1974	one	135	131	114	95
TOTAL	Seven	725	670	643	439
Percent increase over control		64.23	52.61	64.46	—

Morphological data on germplasm collection of thin napier and *Andropogon gynus* were also recorded. In thin napier (*Pennisetum polystachyon*) IGFRI-S-15, gave 700 q/ha green fodder under two cuts. It was more leafy than the rest collections. In *Andropogon gynus* IGFRI-S-3804 gave leafy green fodder (300 q/ha) during winter month i. e. November-December.

Factor analysis in *Pennisetum pedicellatum* :

The sources of common variation of eight components of fodder yield were studied using centroid method of factor analysis. Three factors together accounted for most of the inter-correlation of the character studied. The factor-1 affected positively the tiller number, leaf number, stem girth, and fodder yield, the factor-2 affected negatively the tiller number and positively the leaf width and primary branches

and the factor —3 affected positively the tiller number and leaf width.

PI-2.1 (B) : EVALUATION OF GERMPLASM COLLECTIONS OF SELECTED RANGE GRASSES.

(J. N. Gupta and S. R. Gupta)

On the basis of experiment conducted using 20 varieties of *Pennisetum pedicellatum* to study differential growth responses under purely rainfed condition in red gravelly soils, it was found that three varieties i. e., 3808, 2771 and 864 were promising with respect to relative growth rate, tillering per unit time, tussock diameter, dry matter production at preflowering and maturation stages. There also appear to exist possibility of intravarietal selection in the varieties 2771 and 864. The regeneration after cutting at pre-flowering stage was only through sprouting of lateral buds in 2771 variety.

PI-2.2 : SCREENING OF GERMPLASM COLLECTION OF RANGE LEGUMES.

(U. P. Singh and M. S. Yadav)

Clitoria ternatea

Varietal evaluation trial comprising 15 varieties was laid out in a R.B.D. Selection No. ILO 23-1, 173, 11, 12-1, 160, and 13-1, gave higher cumulative green fodder yield (two cuttings) of 199, 196, 191, 180, 175 and 169 q/ha respectively.

Atylosia scarabaeoides

20 varieties were grown in a replicated trial in R.B.D. Selection No. ILO 1-8, ILO-4006, ILO-1, ILO-1-10, ILO-167 and ILO-83 gave higher fodder yields of 60, 58, 57, 50, 49 and 47 q/ha respectively under one cutting.

Desmodium

Seven collection of *Desmodium* spp. were grown in rows for seed multiplication.

Stylo

13 promising collections of different sp. were raised for seed multiplication.

PI-2.3 SCREENING OF GERmplasm COLLECTIONS OF CULTIVATED LEGUMES.

(K. L. Mehra, M. S. Yadav and U. P. Singh)

Berseem

Based on two years data (1971-72 and 1972-73) of berseem progeny row trial, 16 high yielding varieties were isolated and they were put in a replicated trial. Varieties did not differ significantly with each other in respect of fodder yield. Fodder yield under three cuts ranged from 315.5 to 384.9 q/ha. Superior selections 105-1, 102-1, 99-1, 107-1, 104-1 and 2531 gave 384.9, 384.7, 380.3, 370.7, 367.9 and 365.2 q/ha green fodder yield respectively.

Analysis of genetic variability

Genotypic and phenotypic variability of 10 characters was studied in 45 collections of Berseem. The fodder yield, primary branch length and tiller number exhibited wide range of variability. Both genotypic and phenotypic coefficients of variation were comparatively moderate for the secondary branches. The heritability values were high for the secondary branches, fodder yield, primary branches, primary branch length and tiller number. High heritability accompanied high genetic advance for secondary branches while fodder yield, primary branch length and tiller number exhibited high heritability but moderate genetic advance indicating the possibility of securing success in the selection of these traits.

Guar

100 collections of guar were tested in a replicated trial. Data on plant height, node number, stem thickness, branch number, branch length leaf length, leaf width, and fodder yield were recorded on randomly selected plants in each varietal plot. Selection No. 1535-1, 212, 1538-1, 31-1, 8432/P2, 163-1, 1539-1, 8978/P2, 8781, 8929/P2, 5694/73-1, 97-1, 9016, 8968, 2381-1, 5491, 32/P2-2 gave higher green fodder yield of 363, 361, 358, 355, 322, 305, 300, 286, 286, 285, 278, 276, 275, 275, 256, 255, and 253 q/ha respectively than the rest.

Moth

25 collections were grown in a replicated trial. Data on various forage attributes were recorded at 50% flowering stage. Varietal defere-

nces for green fodder yield were found significant. Selection No. 85-1, 87-1, 1568-1, and 70-1 gave 189, 163, 155 and 137 q/ha green fodder yield respectively.

Analysis of genetic variability

Soybean

Heritability, genetic advance and simple correlations among nine fodder yield components were studied in 36 fodder type collections of soybean. Leaf area and branch length exhibited high coefficient of variation, high heritability and high genetic advance. Days to flower showed high heritability and moderate genetic advance. Based on the data obtained on the heritability estimates and the correlation coefficients it was suggested that the selection for late flowering, tall plants with long branches and broad leaves is more likely to produce high fodder yielding soybean types.

PI-3.1 : BREEDING IMPROVED VARIETIES FOR HIGH FODDER YIELD AND QUALITY IN COWPEAS.

(M. L. Magoon, Amar Singh, C. B. Singh and K. S. Kohli)

Evaluation of gene pool

A part of the gene pool comprising 832 cultivars including the fresh cultivars were grown in two row plots. Observations on flowering time, vigour of plant, growth habit (erect, decumbant and prostrate) and twining habit were recorded. Based on these characters, 20 promising cultivars were identified for conducting large scale trials.

Inter-varietal hybridization and selection.

Intervarietal hybrids originating from five parental crosses viz. S-998×143, S-1545×1300, 2523×1300, 143×998, 1407×1300 were sown for selection of superior segregates in F₃ generation. Observations on the general vigour of the plants, growth habit, leaf size, days to flowering, flower colour, etc., were recorded. Wide variability was observed in the segregating population for the different economic characters. 100 promising segregants, based on these characters, have been identified.

New crosses

New crosses between the three distinct botanical forms or sub

species viz., *V. sinensis* (mainly for grain), *V. sesquipedalis* (for vegetable pods), and *V. cylindrica* (for fodder) have been successfully made with a view to select dual purpose types. Eleven successful hybrids have been secured.

Relationships of genetic parameters in cowpea

The nature and extent of 28 phenotypic and environmental correlations coefficients between the different fodder yielding components in 154 cultivars of cowpea belonging to the five regions of the world namely, for East India Middle East Africa and America, were studied. Out of 28 phenotypic correlations, 24 were homogenous and their average correlations were also significant. The remaining four correlations were found to be heterogenous, indicating thereby the operation of different types of genetic systems with regard to these character associations. Inter regional comparisons in the five regions for 28 environmental correlation coefficients revealed that 16 of them were heterogenous indicating the differential influence of environment on the growth parameters involved in such correlations. High environmental influence would pose limitations for good response to selection for a specific character, since inter environmental genetic slippage would be of considerable magnitude between the different generations of selections and evaluation. These investigations, thus, reveal that more emphasis need to be placed in the improvement of the main branch length and the number of leaves as compared to other characters.

In the local and multilocation yield trials conducted during the year, besides the selections IGFRI-S-978, IGFRI-S-985 and IGFRI-S-457 other promising selections that proved superior were IGFRI-S-998, IGFRI-143, IGFRI-515 and yielded 255, 300 and 325 q/ha of green fodder respectively.

PI-3.2 VARIETY SYNTHESIS FOR HIGH FODDER YIELD, SEED YIELD AND QUALITY IN LUCERNE

(K. L. Mehra, K. S. Kohli and D. N. Singh)

Gene pool evaluation and screening

250 cultivars of lucerne including the indigenous and exotic species viz. *M. denticulata*, *M. orbicularis*, *M. tribuloides* and *M. scutellala* were grown for maintenance and screening. The plant material was screened for drought hardiness, growth habit, general vigour, leafiness

and seed setting ability. Amongst the *Medicago Sativa* cultivars, 10 promising types based on the growth habit and seed yielding attributes have been selected for large scale trial.

Amongst the four species tried, *M. denticulata* and *M. scutellata* exhibited superior growth. The former showed a complete prostrate growth habit and very high seed setting while the latter was decumbent to prostrate in growth and good seed setting habit.

Due to the low population of Insect pollinators, selection was exercised for higher number of pod set per inflorescence amongst the clones of polycross nursery and the gene pool. Based on the pod setting, the cultivars, were grouped into high, medium, and low pod setting types. In all 16 cultivars with high pod setting habit were isolated.

Varietal evaluation trial

A replicated yield trial with 20 promising selections was conducted. In the two cuts obtained for fodder, Syn-4 and Syn-5 developed at this Institute proved promising and outyielded the others but they were not significantly superior to the control variety S'rsa-9, their fodder yields were 251 q/ha (Syn-4) and 212 q/ha (Syn-5) in two cuts.

An All India co-ordinated yield trial with seven varieties was laid out. In the two cuts taken before March, entry No. 5 was found superior in the first cut and entry No.2 and 3 in the second cutting, with a yield of 283 q/ha (No. 2), 286 q/ha (No. 3), and 288 q/ha (No. 5) green fodder respectively.

Breeders seed production in isolation was undertaken in the improved selection IGFRI-244, recommended for release. This selection possesses broad leaves, greater ability to recover after each cut and higher pod set and seed production as compared to the other types.

PI-3.3 VARIETY CONSTRUCTION FOR HIGH YIELD QUALITY AND EARLY MATURITY IN VELVET BEANS.

(Amar Singh and K. S. Kohli)

Germplasm screening

The available germplasm of 40 cultivars of the species *S. nivenum* and *S. deeringianum* was screened for different growth character espes-

ially aggressiveness, leaf size, quicker growth and early maturity. It was observed that although the flowering takes place in September-October but the pods being succulent, fleshy and thick take considerable time for maturity. Six promising selections have been indentified for large scale trial.

Comparative yield trial

In a replicated fodder yield trial conducted with eight promising selections, no significant differences in the fodder yields were observed. However, the selections, IGFRI-2284-1 (early flowering type) and IGFRI-S-2276-5 also exhibited a potential for use as a double cut strain.

In addition, it was also observed that tremendous flower shedding after anthesis takes place in all the cultivars. It may be due to the early abscission of flowers. It was also observed that the plants which happen to climb on the field boards exhibited a high number of pod set per cluster as compared to the others.

PI-3.4 VARIETY BUILDING IN HORSE GRAM (D. N. Singh and C. B. Singh)

Horse gram being a dual purpose, drought resistant legume, a breeding programme was initiated this year, with a gene pool composed of 30 cultivars. In a yield trial conducted with these cultivars, higher fodder yields were recorded in types from Maharashtra but the dry matter content was high in IL-18679 followed by PLKU-41, IL-9626 and 10939. In respect of leafiness, the latter two cultivars were found superior to the rest. Based on the seed colours, it was observed that these cultivars were showing segregation for this character.

PI-4.1 VARIETAL CONSTRUCTION FOR YIELD AND DISEASE RESISTANCE IN FIELD BEAN (M. L. Magoon, Amar Singh and D. N. Singh)

Germplasm screening

The gene pool composed of 40 cultivars was grown in single rows of 3 metre length and assessed for general vigour, flowering initiation, growth habit, response to defoliation and their reaction to mosaic virus. It was observed that the broad leaf types with erect to decumbent growth had slower rate of regrowth as compared to the types with pros-

trate or trailing habit. It was also observed that the incidence of mosaic virus was more prominent in the aftermatch growth rather than the primary growth when it was found that all the cultivars were comparatively free. The cultivars with prostrate growth habit and possessing pigmented vines and flowers were comparatively free from the disease under field conditions.

Varietal performance

23 promising selections were evaluated in a replicated yield trial. Maximum green and dry matter yield were recorded in IGFRI-S-2218-I (280 q/ha) and IGFRI-S-2230-III (220 q/ha) in a single cut taken at the flowering stage.

Studies on genetic parameters governing fodder yields

Data on nine plant characters in a gene pool composed of 30 cultivars was recorded at two stages of plant growth, i. e. 45 and 75 days of sowing. The heritability values for leaf length and width were generally high in both the cuttings and moderate for green fodder yield at the time of early cut and for branch number at the time of normal cut. Heritability values for green and dry matter content of leaf and stems along with green fodder yield were either low or very low.

Out of 38 phenotypic correlations studied only a few were found to be significant. In the early cut leaf length, leaf width and green fodder yield were highly significantly correlated. Green weight of leaf showed a significant negative correlation with green and dry weight of the stem besides showing a moderate and positive correlation with the dry weight of leaf. Dry weight of leaf and stem were also strongly correlated. Most of the significant correlations obtained in the early cut were comparable to those obtained in the normal cut. Correlations of green fodder yield with leaf length and width were very low.

PI-6.1 EVALUATION OF FODDER SORGHUM GERMPLASM (D. S. Katiyar, R. Krishnan and U. S. Misra)

About 250 fodder sorghum collections were sown for evaluation and/or multiplication. In a replicated trial of fodder sorghum plant height, leaf number, leaf length, leaf breadth and stem girth in 22 cultures ranged from 142 to 291 cm, 8 to 12, 45 to 67 cm, 4 to 8 cm, and 0.6 to 1.6 cm, respectively. Over 200 cultures were screened for days taken to bloom, stem girth and general vigour. Forty-one promising cultures were selected for evaluation.

PI-6.2 EVALUATION OF FODDER OAT GERMPLASM
(U. S. MISRA, D. S. Katiyar and R. Krishnan)

About 168 cultures of oats were sown in a replicated trial in November 1974 alongwith Kent, 3021 and 2688 as control for evaluation.

PI-6.3 PRODUCTION AND QUALITY BREEDING IN FODDER SORGHUM AND OATS
(R. Krishnan, M. L. Magoon, K. L. Mehra, D. S. Katiyar and U. S. Misra)

Breeding through selection and/or hybridization

SORGHUM

Evaluation : Three advanced generation (F₇) hybrid derivatives, F₃ of a exotic sorghum-sudan grass hybrid and five selections were evaluated alongwith M. P. Chari (as control) for their yield performance when cut at 50 percent flowering stage. Besides green fodder yield, data on days to reach 50% bloom, plant height, leaf number, leaf length, leaf width and stem girth were recorded. All the entries reached 50% bloom stage between 60 and 65 days. The advanced generation hybrid derivatives of crosses 248 × 699 (257.1 q/ha) and 309 × 762 (238.6 q/ha) and selections 491 (250.0 q/ha), 309 (235.7 q/ha) and 702 (225.7 q/ha) gave 33, 24, 30, 23 and 17 percent more green fodder yields over control variety M. P. Chari (191.4).

Advancing hybrid generation : Selected lines of hybrid derivatives emanating from single plant selections in four crosses were advanced to F₆ and F₇ generations. Variations in respect of plant height, leaf number, leaf length, leaf width and stem girth were observed.

OAT

Intra-population selection in cv. Kent : Thirty one single plant progenies of cv. Kent were grown in replicated rows and were evaluated for fodder and seed yields as well as component characters. Variability circumscribed within these single plant selections were found to be significant for most of the characters studied, namely, days to 100% bloom, plant height, leaf number, leaf length, leaf breadth, stem thickness, tiller number/25 cm, leaf stem ratio (dry weight basis), green

fodder yield, dry matter percent and seed yield. Character association studies revealed significant positive association between fodder yield (green as well as dry) and seed yield, thereby portending possibility of selecting lines combining desirable expression in these cardinal traits.

Evaluation : Eight promising selections of oats were evaluated along with S-2688 and S-3021 (varieties recommended for pre-release multiplication) for their yield performance under multicut management system. Fodder oat selections, IGFRI-S-2672, S-2636 and S-2660 were among the highest yielders and gave cumulative green fodder yields of 306, 299 and 299 q/ha respectively. They were *at par* with variety S-3021.

Advancing of hybrid generation :

F₁ hybrids of diallel cross involving five parents (without reciprocals) along with parents were studied for fodder attributes and seed yield. Parental combinations manifesting heterotic vigour for fodder characters were identified. In F₁ hybrids of three biparental crosses and their parents fodder components and seed yield were studied.

F₂ generation of a biparental cross and of nine crosses from an incomplete diallel involving five parents were grown along with parents in replicated trial. They were screened for fodder attributes namely ; plant height, leaf number, leaf length, leaf width, stem girth, tiller number, days to bloom and leafiness. F₂ plants combining desirable expression of these characters were selected from these populations. F₃ generation of 76 selected plants of two crosses, F₄ generation of six crosses grown in replicated rows and F₅ of seven crosses were advanced.

Seed multiplication

Multiplication of breeder's seed of the two Oat selections, IGFRI-S-2688 and IGFRI-S-3021 recommended for prerelease multiplication and promising advanced generation hybrid derivatives of sorghum were undertaken.

Plant types in fodder oats

Three plant types viz. 'erect', 'spreading' and 'drooping' were recognized in F₄ generation hybrid derivatives of six crosses in fodder

oats. The inter-relationships of physio-morphic characters such as leaf area index stomata frequency, specific leaf weight, net assimilation rate, plant height and tiller number with fodder yield at bloom stage were studied. Intrinsic differences among the three types in respects of physiological characters contributing to fodder yield were observed. 'Dropping' plant types were found to be superior in fodder yields.

Interspecific hybridization - *Avena sativa* x *A. fatua*

The F₂ and F₃ populations of *A. sativa* cv. kent x *A. fatua* alongwith parents were screened for fodder and contrasting exomorphic characters of parents. Because of the low germination in F₂ about 29 percent of sown seed established into adult plants. Considerable variations were secured among F₂ plants and F₃ plant progenies. Recombinants of contrasting parental traits were observed.

PI-8.1 DETERMINATION OF EFFICACY AND RESIDUES OF DIFFERENT DOSAGES OF PROMISING AND SAFER INSECTICIDES IN THE CONTROL OF INSECT PESTS OF LUCERNE AND COWPEA (Shri Ram)

A : LUCERNE CROP

The experiment was carried out for the first year in randomised block design with three promising granular systemic insecticides, viz., dipterex endosulfan and malathion each @ 1.0, 1.5 and 2.0 kg/ha applied after mixing with soil in seed furrows to avoid the direct contact of insecticide and seeds alongwith a control treatment. The subsequent application of insecticides was done as side dressing after each cut of the crop. The results revealed that the medium dose (1.5 kg/ha) of dipterex, endosulfan and malathion was most efficacious as compared to other dosages in checking the incidence of leaf hopper, lucerne weevil and aphid. The maximum per cent (36, 43 and 41) increase of green fodder yield was obtained with the plots treated with dipterex, endosulfan and malathion respectively at this dose.

A trial was conducted in randomised block design replicated thrice with three dosages each of malathion (0.025, 0.05 and 0.075%) carbaryl (0.05, 0.075 and 0.1%) and endosulfan (0.04, 0.06 and 0.08%) applied as foliar spray 20 days before 1st cut and 20 days after 2nd and 3rd cut for the control of leaf hopper, lucerne weevil and aphid. The

results revealed that the medium dose of each insecticide was as good as higher dose in checking the incidences of pests. However, the insecticide malathion was most effective for leaf hopper and aphid while endosulfan for lucerne weevil. The percent increase in green fodder yield was 49 with malathion, 34 with carbaryl and 53 with endosulfan.

B : COWPEA

The experiment was conducted for the first year in randomised block design replicated thrice with three promising systemic granular insecticides, viz. carbofuran endosulfan and malathion each @ 1.0, 1.5 and 2.0 kg/ha applied after mixing with soil in seeds furrows to avoid direct contact of insecticides with seeds alongwith a control treatment. The results revealed that even the lowest dose of carbofuran was quite effective in checking the incidence of leaf hopper and flea beetle as compared to other dosages of endosulfan and malathion, moreover endosulfan and malathion retarded the growth of the crop. The per cent increase in green fodder yield was 20, 32, and 34 from plots treated with carbofuran 1.0, 1.5 and 2.0 kg/ha respectively as compared to control.

The experiment was conducted for the first year with spray formulations of malathions (0.025, 0.05 and 0.075%), carbaryl (0.05, 0.075 and 0.1%) and endosulfon (0.04, 0.06 and 0.08%) applied as foliar spray for the control of leaf hopper and flea beetle alongwith a control treatment. The results indicated that the medium doses of malathion, carbaryl and endosulfan were as good as their higher doses in checking the incidence of insect pests. The percent increase in green fodder yield was 46, 39 and 40 from plots treated with malathion, carbaryl and endosulfan respectively at their medium doses.

PI-9.1 ASSESSMENT OF RELATIONSHIP BETWEEN INSECT PESTS INCIDENCE AND CULTURAL PRACTICES SUCH AS DATES OF SOWING AND LEVELS OF FERTILIZATION IN LUCERNE AND COWPEA.

(Shri Ram)

A : LUCERNE

An experiment was laid out using a randomised block design with four replications. The variety Sirsa-9 was sown on five different dates viz., last week of October, 1st and 3rd week of November and

1st and 3rd weeks of December. Observations were recorded at 15 day intervals on the incidence of leaf hopper, lucerne weevil and aphid. The results indicated that the early sowing of this crop is better as compared to late sown both in respect of incidence of pests and fodder yield.

B : COWPEA

The trial was laid out in a randomised block design replicated four times. Four dates of sowing i. e. 1st and 3rd weeks of July and 1st and 3rd weeks of August in combination with three levels of fertilizer i. e. (i) 10 Kg N+20kg P₂O₅ (ii) 20 kg N+40kgP₂O₅, (iii) 20 kg N+80 kgP₂O₅ were included in the study. The results revealed that early sowing with 20 KgN+40 kg P₂O₅ was best both in respect of incidence and yield.

General incidence of insect pests of lucerne and cowpea at the farm

General incidence of insect pests was recorded in lucerne and cowpea crops during the season. Observations on the incidence of pests were recorded at 15 days intervals in general fields of the farm.

In lucerne : The incidence of leaf hopper, lucerne weevil and aphid started as early as last week of December, 4th week of January and 2nd week of February respectively and reached their peaks during 4th week of February, 2nd week of February and 4th week of March respectively and thereafter there was a declining trend in each case.

Cowpea : The data on incidences of insect pests of cowpea indicated that leaf hopper and flea beetle appeared as early as 1st week of July and reached their peak period of damage during 4th week of September.

PI-10.1 EFFECT OF GROWTH REGULATORS ON SEED SETTING OF FODDER CROPS. (R. B. R. Yadva)

Cowpea

The experiment was conducted for the 2nd year in randomized block design with three replications. Plant population per plot was maintained keeping the distance between row to row as 25 cm and plant to plant as 15 cm. The crop was sprayed with different concentrations of

GA (10, 25 ppm), Phosfon-D (50, 100 ppm), Ascorbic acid (25, 50 ppm), B-nine (500, 1000 ppm) and CCC (500, 1000 ppm) at 35 days from sowing and 2nd spraying at the stage of flower initiation and one plot kept as control (water spray). Further, all the treatments received normal doses of fertilizers and inter cultural operations at regular intervals.

The results indicated that plant height, branch number, leaf number/plant, dry matter content and fresh weight of shoot were significantly affected by the spraying of these chemicals. The maximum grain yield (4.17 q/ha) was obtained with 1000 ppm B-nine treatment followed by 100 ppm of Phosfon-D (3.79 q/ha) and 50 ppm of Ascorbic acid (3.74 q/ha) respectively where as the lowest yield (2.12 q/ha) was recorded in the control plots. The maturity period was also reduced by 3 to 12 days as against the control.

Berseem and lucerne

Two separate field trials one on berseem and other on lucerne were carried out for the 2nd year in randomized block design with 4 replicates. And the same concentration of chemicals as in the case of cowpea were sprayed at 40 days from sowing, and the second spraying at the time of flower initiation. All the treatments received normal doses of fertilizers and inter cultural operations at regular intervals.

Green fodder and seed yield were affected greatly by the foliar spray treatments of growth regulating substances over control. The maximum herbage yield of 295.7 q/ha was obtained by the application of CCC (500 ppm) followed by 265.2 q/ha by of Phoston (100 ppm) and the lowest fodder yield 209.3 q/ha was obtained in GA (10 ppm). However, green fodder yield varied from 6.1% to 38.5% increase in various treatment over control. Similarly the seed yield was also influenced markedly by the application of these substances. The highest seed yield 4.78 q/ha followed by 4.41 q/ha were obtained in 500 ppm of B-nine and 500 ppm of CCC treatments respectively, whereas only 2.4 q/ha was obtained in control plants. In general, the seed yield increases varied from 22.9% to 95.9% under the different treatments over control. However, in general, poor yields were obtained due to late sowing of crop and heavy infestation with weeds.

The results of lucerne crop showed that the green fodder varied from 135.5 q/ha for control to 172.53 q/ha for 100 ppm phosfon

treatments and the percentage increase over control ranged from 13.2% to 27.4%. The maximum seed yield was obtained in 500 ppm of B-nine (8.1 q/ha) followed by 100 ppm of Phosfon (7.2 q/ha) and 500 ppm of CCC (6.9 q/ha). These chemicals also affected other morphological characters of plant growth but the effects were not proportional to the concentrations applied. The percentage increase in the grain yield over that of the control under different treatments ranged from 6.2% to 80.8 percent.

Miscellaneous works

During the period, stimulation in seed germination of fodder crops through retardants were examined in the laboratory. The results have clearly brought out that the seeds of cowpea (*Vigna unguiculata* L.) and M. P. Charı (*sorghum bicolor* L.) soaked in 100 ppm of chlormequat (CCC) for 1 hr would give the maximum germination of 93.2% and 84.4% respectively. Berseem (*Trifolium alexandrinum* L.) seed soaked for 4 hr in 100 ppm of B-nine gave maximum germination (95.3%) followed by 4 hr soaking period in 100 ppm. Phosfon (95.4%). Seeds of Vetch (*Vicia sativa* L.) also gave maximum germination of 96.0% when soaked for 1 hr in 100 ppm of B-nine.

On the other hand, a number of cultivated and non-cultivated oat varieties grown at this Institute were screened for drought resistance based on chlorophyll stability index (CSI). It was found that IG. 3021 (*Avena sativa* L.) has been the best to withstand high temperature suited for drought condition. Among the non-cultivated oat (*A. barbata*) found lower value of CSI.

PI-12.1 PREVALENCE, DISTRIBUTION AND CONTROL OF PLANT DISEASES THEIR EFFECT ON FORAGE YIELD AND QUALITY.

(S. T. Ahmad)

Incidence of plant diseases were recorded through periodic surveys mostly at Central Research Farm, Jhansi and few at Kashmir. As a result of these surveys the following diseases were found in the various forage crops. Leaf blight, leaf blotch, virus on oats, leaf spot and rust on species of *Sehima*, *Dichanthium*, *Heteropogon*, *Iselema*, & *Vulpia*; Leaf spot, mildews, rust bacterial leaf spot on lucerne; leaf spot, stem rot on berseem; leaf spot, mildew, bacterial leaf spot virus on sem; mildew, bacterial leaf spot and virus on pea; rust, leaf spot on velvet

bean; leaf spot, virus on arhar; leaf spot; bacterial blight, virus on guar; rust, bacterial pustules, virus on soyabean; leaf spots, leaf blight on jowar and leaf spot, rust on bajra were recorded.

Several chemicals viz. Agrimycin, Dithane M.45, Agrosan and Vitavex were tried to control the foliar diseases on two varieties (diploid and tetraploid) of methi and Syn-1, Syn-6, Syn-8, of lucerne grown in replicated randomised block design. None of the chemicals could significantly control the mildews. However, Vitavex and Dithane M-45 were far superior in controlling the rust of lucerne. Agrimycin showed some promise in suppressing the leaf spots of lucerne as compared to other chemicals. During kharif season, two varieties of guar (IL-67-196 and IL 67-219) were grown in replicated randomised block design. These were subjected to 5 treatments (Vitavex 0.02%, 0.04%, Agrison 0.2%, 0.4% and unsprayed control) to observe the effect on the occurrence and spread of the leaf spots. It was observed that Vitavex at higher concentration suppressed the percentage of leaf spot as compared to other treatments. There were differential varietal response in the above treatments. In another experiment, 2 varieties each of velvet bean, sem, cowpea and soyabean were grown in similar fashion and were subjected to 5 treatments viz. Vitavex, Dithane M-45, Streptocyclin, Agrimycin and control in order to note their effect of foliar disease control and on yield. It was found that intensity of leaf diseases, was low on all the treatments. The fodder yield of cowpea was increased between 30 to 50 percent, the highest being with the antibiotic. There was no such effect on soyabean. The experiment will be repeated to work out other details.

Several cultivars of oats, wheat, lucerne, and sarson grown at C. R. farm were screened for resistance to various plant diseases. Resistant cultivars in each case were identified. In wheat about 75 cultivars received from IARI, New Delhi were grown separately to record the incidence of rusts, smuts, mildews, leaf spots and leaf blights.

PI-12.2 ANALYSIS OF RESISTANCE IN SELECTED FORAGE CROPS AGAINST SOME IMPORTANT DISEASES.

(S. T. Ahmad)

Several collections of oats belonging to diploid, tetraploid and

hexaploid oats were raised at two different locations. These were used to attempt crosses for rust resistance and high yield, besides evaluating them for disease reactions. Second filial generations of over 20 crosses, comprising of over thousand plants were grown, and were screened for resistance to crown and stem rusts, through artificially created epiphytotic conditions, and for other desirable characters. Single plant selections were made out of resistant plants for further studies. Few resistant plants were again back crossed with either of the parents.

SOIL SCIENCE AND AGRONOMY DIVISION

Salient features

The Division continued to work on finding out suitable fodder crops, varieties, and cropping patterns, their cultural, manurial and irrigation requirements for increased fodder and seed production. The highlights of the work under report are as follows :

Maximum yield (544 q/ha green fodder-8.69 q/ha D. M.) of oats (Knet) was obtained at 120 kg N/ha applied basal at sowing. Application of nitrogen all as basal at sowing was superior to application of the same dose split as 2/3 at sowing and 1/3 after first cut.

Guar crop gave significantly higher seed yield (8.88 q/ha) when the crop was cut for fodder at 69 days and left for seed (3.69 q/ha).

The application of two irrigations (15 and 30 days after third cutting of berseem) produced the seed yield at par with the yield of three or four irrigations applied at different stages, indicating thereby the possibility of economising water for seed production without affecting the seed yields of berseem.

Though micronutrient treatments to rainfed M. P. chari did not show significant effect, Zn and Mn applications to soil increased fodder yield.

Sulphur deficiency appears to be common in above 65 percent of soils of intensive forage growing areas of Bundelkhand, on the basis of 10 ppm heat soluble sulphur as critical limit. S deficiency was generally found in light-textured soils which were under natural grasslands for several years.

Lucerne (*Medicago sativa*) and Bankulthi (*Phaseolus atropurpureus*) legume fodder and oats (*Avena stiva*) have N : S ratio of 15, 22 and 38 respectively indicating thereby that they are not balanced from animal nutrition point of view (N : S ratio of 10 : 1 of forages is considered optimum for ruminants).

Closure of Bundelkhand forests resulted in improvement in soil

fertility which improved further with its duration.

In a soil of ph 6.8, the percentage efficiency of Mussoorie, Laccadive end Udaipur rockphosphates as compared to superphosphate was 78, 62 and 54 percent respectively on the basis of fodder yield of lucerne in pot culture studies.

Bray's method was found better than Hoffer's method for spot tissue testing of fodder crops.

RESEARCH WORK DONE

SA-1 : EVALUATION OF GENOTYPIC RESPONSE OF FODDER CROPS

Response of guar varieties to different levels of phosphate (R. A. Singh)

It was the second year of the experiment. The trial was modified this year and consisted of three new varieties of guar evolved at Indian Grassland and Fodder Research Institute (2376, 2402 and 2403) compared at four levels (0, 30, 60 and 90 kg P_2O_5 /ha) of phosphate. The crop was sown on 12th July, 1974 and harvested on 25th September, 1974 i. e. 75 days after planting. The results revealed that neither varieties nor phosphate levels had any significant effect on forage yield of guar. On an average the fodder yields ranged from 156.5 to 181.5 q/ha for varieties and 143.2 to 181.3 q/ha for phosphate levels.

SA-2 : CULTURAL MANAGEMENT AND FERTILIZER USE OF FODDER CROPS

Cultural cum manurial trial on turnip (R. A. Singh and S. N. Tripathi)

The experiment was continued for the second year. The effect of three methods of sowing of turnip (broadcast, line and ridge sowing), three seed rates (3, 5 and 7 kg/ha) and four fertilizer levels (60 kg N, 60 kg N + 30 kg P_2O_5 , 60 kg N + 30 kg K_2O and 60 kg N + 30 kg P_2O_5 + 30 kg K_2O /ha) was studied on the forage yield of turnip. The crop was sown on 26th October, 1973 and harvested on 11th, 12th and 13th January, 1974. Unlike last year, this year broadcast sowing gave

significantly higher forage yield (317.7 q/ha) over line sowing (253.3 q/ha) and ridge sowing (242.4 q/ha). Among the seed rates lowest seed rate of 3 kg/ha gave increased yield of fodder (318.5 q/ha) over 5 kg (265.7 q/ha) and 7 kg (239.4 q/ha) seed rates. Application of phosphorus and potash did not prove advantageous in increasing yield of turnip.

Neem cake coated urea on fodder Sorghum (M. P. chari)

(R. A. Singh and N. D. Mannikar)

The experiment was started this year. Four levels of urea viz., 120 kg N/ha basal, 80 kg N/ha basal plus 40 kg N/ha after 1st cut, 90 kg N/ha basal and 60 kg N/ha basal plus 30 kg N/ha after 1st cut were combined with four levels (0, 10, 20 and 30 percent by weight) of neem cake to evaluate its efficiency in increasing the forage yield of M. P. chari by reducing the pace of nitrification of nitrogen and thus ensuring the availability of the applied nitrogen to the crop over a long period. Two control (without nitrogen and neem cake) treatments were also included in the study for the purpose of comparison.

The crop was sown on 12th July, 1974. There was almost continuous rain from 13th July, 1974 to 22nd August, 1974. Due to ceaseless rains over a long period, the germination of the crop was badly affected and no interculture operation could be done to control the heavy infestation of weeds because of adverse soil condition. The yield of the forage was, therefore, low due to poor germination and growth of the crop. First cutting was taken 60 days after sowing of the crop and the second cut 56 days after the 1st cut. Application of nitrogen increased the green fodder yield from 31 to 115 percent over control (60.6 q/ha). Neem cake coating had no effect on the forage yield of M. P. chari. The treatments exhibited the same trend in respect of dry matter yield also.

Neem cake coated urea on forage oat

(N. D. Mannikar, R. A. Singh and S. N. Tripathi)

It was the 1st year of the experiment. Urea with and without neem cake coating was tested on forage oat. The treatments consisted of all combination of four levels of nitrogen as Urea (120 kg N basal, 80 kg N basal + 40 kg N after 1st cut, 90 kg N basal and 60 kg N basal + 30 kg N/ha after 1st cut) and four levels (0, 10, 20 and 30 percent by weight of urea) of neem cake. Two controls (without nitrogen and neem

cake) were also included. The oat variety Kent was sown on 19th November, 1973. First cut was taken 87 days after sowing and the 2nd cut 64 days after 1st cut.

Results indicated that nitrogen increased the yield. On an average 120 kg N/ha applied basal at sowing increased the green fodder yield by 442 q/ha (68.6 q/ha dry matter) over control (102.5 q/ha green fodder and 18.3 q/ha dry matter) and 66.8 q/ha (4.7 q/ha dry matter) over 90 kg N/ha applied basal at the time of sowing (477.4 q/ha green fodder and 82.2 q/ha Dry matter). It was further observed that application of entire quantity of nitrogen at the sowing time was significantly superior to the treatments where 2/3 nitrogen was applied at sowing and 1/3 after 1st cut. Thus the entire quantity of 120 kg N applied at the sowing time gave 79.8 q/ha more yield of green fodder (12.2 q/ha dry matter) over that of 80 kg N applied basal and 40 kg topdressed after 1st cutting. Similarly 90 kg N/ha applied basal gave higher green fodder yield by 64.6 q/ha (13.2 q/ha dry matter) over the split application of the same i. e. 60 kg N basal and 30 kg N after 1st cut. Coating of neem cake over urea did not give any definite trend with regard to either green fodder or dry matter yield.

Effect of N application and cutting intervals on the fodder yield of oat (Kent)

(A. S. Gill and K. P. Niranjana)

The trial was conducted during *rabi* season. Variables comprised of sixteen N levels ranging from 0 to 150 kg N/ha as basal as well as split (main plot) and two cutting management treatments, C₁ : single cut at 50% flowering and C₂ : 2 cuts – first at boot stage and second at 50% flowering (sub-plot). The design of the experiment was split plot with three replications. The trial was sown on 29th October, 1973 using a seed rate of 100 kg/ha and a row spacing of 25 cm. The dates of cuttings are as below :

C₁ : 20.2.74; C₂ : I cut – 23.1.74; C₂ : II cut – 8.3.74

Split application of N (top dressing) was done just after taking the first cut in C₂ treatment and also the same time in C₁ treatment. Green fodder and dry matter yields were recorded.

The effect of N application on green fodder yield was found to be significant. The yield increased with increasing levels of N upto 120

kg/ha irrespective whether applied as basal or split. Significant increase in yield was obtained upto 120 kg N/ha applied as basal or in 2 : 1 ratio of 120 kg total N/ha. The yields for 120 kg N/ha basal, and that applied in the ratio of 2 : 1 were 315.4 and 316.1 q/ha respectively.

Cutting management treatments did not show any significant effect on the green fodder yield, however, more yield was obtained in C₂ treatment. The average yields for C₁ and C₂ treatments were 268.5 and 273.1 q/ha respectively.

The effect of N application on the dry matter yield was also found significant but the significant response was restricted only upto 90 kg N/ha applied in the ratio of 2 : 1 or 3 : 1.

Significant differences were observed in the dry matter yield with cutting management treatments. Single cut (C₁ - 80.99 q/ha) recorded significant increase in yield over two cuts (C₂ - 67.7 q/ha).

Interaction was found to be nonsignificant for green fodder as well as for dry matter yields.

SA-4 : SEED PRODUCTION IN FODDER CROPS

(D. C. Saxena and N. P. Shukla)

Effect of supplemental irrigation on seed yield of M. P. chari and cowpea sown pure and as mixed

The trial was laid out for the first year. Three levels of soil moisture (control i. e. rainfed (I₁), 50% ASM (I₂) and 75% ASM (I₃) and three crop mixtures (M. P. chari pure, Cowpea pure and M. P. chari + Cowpea in alternate two rows each) were tried in randomized block design. Sowing was done on 11.7.1974 in rows of 25cm apart. Harvesting was done on 30th October 1974. Continuous rainfall at early stages of crop growth affected the yields adversely. There was drought spell of 30 days from 25th August to 23rd September. Two supplemental irrigations in I₃ treatment and one irrigation in I₂ treatment were applied.

Results indicated that the seed yields of M. P. chari increased linearly with the increased application of irrigation water. The maximum seed yield of M. P. chari (13.3 q/ha) was obtained at 75% ASM. Among the different crops, M. P. chari pure had given the average seed yield of 9.1 q/ha, cowpea 1.1 q/ha and mixture of M. P. chari + Cowpea 7.5

q/ha (0.8 q of cowpea + 6.7 q of M. P. chari per hectare). It clearly indicates that sowing of mixture of M. P. chari + Cowpea gives 47% higher seed yield of M. P. chari and 31% higher seed yield of cowpea in comparison of M. P. chari and cowpea as pure sown.

Impact of cultural management and phosphorus application on seed production of guar

The trial was laid out for the first year. Two sowing dates (middle of July and end of July), two levels of cutting management (no cutting, one cutting) and four phosphate levels (0, 30, 60 and 90 kg P₂O₅/ha) were tried in split plot design, keeping the sowing dates and cutting management in main plots and phosphate levels in sub-plots. Sowing was done on 13th and 28th July, 1974 and harvesting for seed was done on 7th December, 1974. Due to continuous rainfall in early period, the crop growth and subsequently seed yields were very poor.

Results indicated that the crop which was left only for seed had given significantly higher yield (8.88 q/ha) than the crop which was cut for fodder at pod formation stage (69 and 54 days after sowing in respective treatments) and then left for seed (3.69 q/ha). The sowing dates and phosphate levels did not show any significant effect on seed production.

In the treatment for one cutting, the green fodder yield for mid July sowing (47.8 q/ha) was significantly more than that of July end sowing (29.9 q/ha).

SA-5 : SOIL WATER MANAGEMENT OF FODDER CROPS (N. P. Shukla and D. C. Saxena)

Effect of soil moisture stress at different stages of growth on seed yield of berseem

The trial was repeated for the third year. The crop was sown on 5th November, 1973. Upto the third cutting for fodder, all plots received irrigation at optimum level (75% ASM). The crop was left for seed setting after three cuts. The stress treatments were imposed after the third cut by withholding irrigation at different stages of crop growth and the seed yields were compared with control (no stress at any stages after third cut i. e, 4 irrigations at 15 days interval).

The results revealed that the seed yield was significantly affected by stress treatments. The seed yield of 5.58 q/ha and 5.42 q/ha were obtained by the application of three irrigations (just after, 15 and 30 days after third cutting or just after, 30 and 45 days after third cutting). The seed yield of 4.61 q/ha was obtained in case of four irrigations applied at 15 days interval. All the treatments receiving one irrigation at any of the growth stages produced significantly lower yield over control.

However, it is seen that the application of two irrigations (15 and 30 days after third cutting) produced the seed yield *at par* with the yield of three or four irrigations applied at different stages, indicating thereby the possibility of economising water for seed production without affecting the seed yields.

Water use efficiency of overlapping and relay cropping for year round green fodder production

Trial was continued for third year. Like previous years, three cropping patterns (berseem + sarson — napier + cowpea; berseem + sarson — M. P. chari + cowpea; and oats — M. P. chari + cowpea) were planned to be tested, but due to lack of irrigation facility during summer, the summer crops could not be taken and the cropping patterns were changed as berseem + sarson — napier + cowpea (from July to October only); berseem + sarson — M. P. chari + cowpea (from July to October only); and oats — M. P. chari + cowpea. Three soil moisture regimes (irrigations at 25, 50 and 75% ASM) were maintained in rabi season and after third week of August in kharif season.

The results indicated that the green fodder yields increased significantly from 944 and 1003 q/ha for irrigation at 25% and 50% ASM respectively to 1165 q/ha for 75% ASM. The yield difference between 25% and 50% ASM was, however, not significant.

Overlapping cropping of berseem + sarson — napier + cowpea had given significantly higher yield (1080 q/ha green fodder) than relay cropping of oats — M. P. chari + cowpea (885 q/ha green fodder). The green fodder yields of overlapping cropping and relay cropping of berseem + sarson — M. P. chari + cowpea were *at par*, because the yield of napier, generally a major contributing crop component of overlapping system, was very poor.

SA-6 : AVAILABILITY AND UPTAKE OF NUTRIENTS.

6.1 : Micronutrients and secondary elements in forage crop nutrition

(N. D. Mannikar and D. C. Saxena)

Influence of micronutrients on forage production of M. P. chari under rainfed condition

The trial was repeated for the second season with the treatments comprising of 3, 6 and 9 kg each of Zn, Cu, Mn and Fe/ha along the two control treatments. The sowing was done on 3rd August, 1974 in lines at 25 cm row to row distance. The harvesting of green fodder was done on 4th October, 1974.

The results showed that the green fodder yields varied from 215.8 q/ha for control to 229.2 q/ha for 9 kg Zn/ha treatment. Zn and Mn treatments showed an increasing trend in yield, while Cu treatments showed a decreasing trend with the increasing levels of application of this element. None of the treatment was, however, statistically significant over the control treatment.

6.1-1 : Sulphur status of forage and sulphur availability in soils of intensive forage growing areas

(Dhashrath Singh)

Available sulphur status of surface soils of intensive forage growing areas of Central Research Farm, I. G. F. R. I., Jhansi, have been estimated in order to assess sulphur supplying ability of these soils, as sulphur is an important nutrient in animal nutrition. In view of the importance of sulphur in utilization of nitrogen by animals, sulphur and nitrogen content of most common forages has also been assessed. Forages were harvested at proper stage of harvesting for fodder for analysis

It has been observed that as much as 65% soils of intensive forage growing areas are deficient in sulphur taking 10 ppm heat soluble sulphur as critical limit. The available sulphur content varies from 8.25 to 24 ppm S. Most of the soils deficient in sulphur are light in texture and have been under natural grasslands for years.

Considering N : S ratio of 10 : 1 of forages as optimum for

ruminants as much as 30 percent of the 23 commonly grown forages are deficient in sulphur from animal nutrition point of view, i. e. they have N : S ratio wider than 10 : 1. The range of N : S ratio varies from 2.42 to 37.66. One of the most striking feature is that grasses inspite of being grown on soils deficient in sulphur, have narrow N : S ratio (3.29 to 8.33) which indicates their ability to utilize even difficultly available sulphur than what is extracted as heat soluble sulphur.

Lucerne (*Medicago sativa*) and Bankulthi (*Phaseolus atropurpureus*) legume fodders and oats (*Avena sativa*) have N : S ratio of 15, 22 and 38 respectively which are of higher order amongst the forages grown in this part of the country. In these forage crops specified earlier, wider N : S ratio is mainly because of their being rich in nitrogen and poor in sulphur.

These investigations indicate that whereas grasses are adapted to grow on soils poor in sulphur but sulphur nutrition of fodder legumes must be carefully attended to because of legumes being relatively rich in nitrogen.

6.3 : Fertility evaluation of Bundelkhand forest soils as influenced by closure of forests

(Dashrath Singh, N. D. Mannikar and N. C. Srivas)

Soil fertility of Bundelkhand forest soils (0-15 cm) with respect to available nitrogen, phosphorus and potash were studied in relation to period of closure of forest after main felling. Closure of forests after main felling is an important silvicultural management practice.

The studies revealed that the Bundelkhand forest soils are slightly acidic in reaction, pH ranging from 5.6 to 6.8 which is quite favourable for nutrients availability. Out of the six studies, increase in organic carbon (an index of available nitrogen after a period of three years has been 140 percent for Dhaurisagar, 22% each for Haraspur and Dudhai, 26% for Birda and 28% for Thangana sites. The basal (after 1.5 years of closure) organic carbon contents of Dhaurisagar, Haraspur, Dudhai, Birda and Thangana sites were 1.31, 0.88, 1.11, 1.35 and 0.88 percent, respectively. Therefore, Bundelkhand forest soils, already rich in nitrogen fertility, showed further enhancement in N status due to closure of these forest coupes.

There has been considerable improvement in phosphorus soil fertility as a result of closure. Increase in available phosphorus as a result of closure in Dhaurisagar and Thangana sites being as high as six fold over a period of three years. The initial (basal) P content of both Dhaurisagar and Thangana sites, being 11.2 kg P/ha as measured by Olsen's extractant.

Soils of Bundelkhand forests can be rated as medium to high in available potassium (347 to 560 kg K/ha). As a result of closure of these forests, the values of available potassium tended to increase with the progressive increase in the closure period after main felling of the forest.

Thus, closure of these forests resulted in improvement in soil fertility which improved further with its duration.

6.4 : Phosphate fertilizer value of indigenous rockphosphates for grasses and fodder crops

(Dashrath Singh, N. D. Mannikar and N. C. Srivas)

Second stage evaluation of treatments screened out of laboratory incubation studies was carried out in pot-culture experiments taking lucerne for direct effect and guar for residual effect as test crops. Fertilizer value of Udaipur, Mussoorie and Laccadive phosphate deposits taking single superphosphate as standard has been evaluated. Each of these phosphate sources were applied at 60, 120 and 180 kg P_2O_5 per hectare levels. FYM added @ 60 tonnes/ha as per the treatment.

It has been observed that the availability coefficient ratio (ACR) of these rockphosphates compared to superphosphate on this soil (pH 6.8) to lucerne has been 0.60 for Udaipur, 0.75 for Mussoorie and 0.21 for Laccadive phosphate at 60 kg P_2O_5 /ha level. In case of Laccadive phosphate earths the highest ACR of 1.30 was observed when this phosphate carrier was applied @ 180 kg P_2O_5 /ha, whereas in other two phosphate rocks, availability coefficient ratio tended to decline with increasing levels of phosphate application. Whereas response to added P in Mussoorie rockphosphate declined with increasing levels of phosphate application, in Laccadive phosphate earths it continued to increase with each level of P application in a soil of 50 kg P_2O_5 /ha as Olsen's extractable P. In Udaipur rockphosphate maximum response was observed at

60 kg P_2O_5 /ha level, this level being 120 kg P_2O_5 /ha for superphosphate and 180 kg P_2O_5 /ha for Laccadive phosphate. The percentage efficiency of Mussoorie, Laccadive and Udaipur rockphosphates as compared to superphosphate was 78, 62 and 54 respectively, taking fodder yield of lucerne as a criterion.

On evaluation using ACR, FYM application together with the phosphate carriers have not been beneficial but taking fodder yield and crop quality (with respect to phosphorus) of both lucerne and guar crops FYM application along with phosphate carriers proved promising.

The residual fertilizer value of rockphosphates was 93 to 94 percent to that of super when adjudged from fodder yield of guar.

6.5 : Rapid tissue testing in fodder crops (Dashrath Singh and N. D. Mannikar)

In the second-year oats and rape were grown on graded nitrogen levels (0, 25, 50, 75, 100 and 125 kg N/ha). The stem and leaf of fodder rape and oats were tested after 60 days of growth and that of oats again after 90 days of growth with Bray's and Hoffer's tissue testing procedures. Nitrogen in plants and soil at the time of tissue testing was also determined adopting usual methods.

The results of green fodder yield of oats indicate that there was significant increase in yield of oats up to 50 kg N/ha level and again at the highest level (125 kg N/ha). Green fodder yield of oats was 203, 244, 385, 391, 398 and 448 q/ha at 0, 25, 50, 75, 100 and 125 kg N/ha levels respectively.

In fodder rape every additional increment of nitrogen application has yielded significant increase in green fodder. Green fodder yield of fodder rape was 154, 263, 320, 349, 362 and 412 q/ha at 0, 25, 50, 75, 100 and 125 kg N/ha levels respectively.

Amongst the two rapid tissue testing methods tried, Bray's method was found to be better suited for on the spot testing. Nitrogen content in both these crops and soil increased with increasing levels of nitrogen application as evident from rapid tissue tests and soil and plant analysis. Taking crop response and production efficiency as indices, application of 50 kg N/ha for fodder oats and 25 kg N/ha for fodder

rape was found to be economic optimum nitrogen level for soils of medium nitrogen fertility.

6.6 : Quantification of nitrogen fixed by different legumes for the use of subsequent germinaceous fodders
(N. D. Mannikar and R. A. Singh)

This was the first year of the trial. Three forage legumes guar, cowpea and mucuna were compared at 30 and 60 kg P_2O_5 /ha to evaluate their capacity for nitrogen fixation. The kharif legumes were sown on 7.8.1974. Guar and cowpea were harvested on 3.10.1974, and mucuna on 21.10.1974. Phosphate was found to have no effect on the yield of different leguminous fodder crops. The green fodder yield of mucuna was the highest (106.8 q/ha) followed by cowpea (84.2 q/ha) and guar (41.7 q/ha) It may be pointed out that low yields were obtained due to late sowing. Late sowing became necessary due to rain for longer duration in the month of July. The effect of residual nitrogen (fixed by legumes) will be seen in subsequent rabi season on oat fodder crop.

Research contemplated

The following new researches will be undertaken in addition to the technical programme of 1973 already underway.

1. Response of varieties of *Pennisetum pedicellatum* to different plant densities and nitrogen application.
2. Intercropping of forage legumes in jowar grown for seed.
3. Effect of soil moisture regimes and nitrogen on fodder and seed yield of triticale.
4. Comparison of different crops under soil moisture levels for fodder production.
5. Comparison of different fodder crops (legumes and graminaceous) under rainfed conditions.
6. Soil test fertilizer response studies in common fodder crop rotation.

GRASSLAND MANAGEMENT DIVISION

Salient features

Studies on application of fertilizer on natural *Sehima Hetropogon* grasslands showed that the highest dry forage yield (79.2 q/ha) was obtained when ammonium sulphate was applied as a source of nitrogen @ 60 kg N/ha as compared to other sources like Calcium ammonium nitrate (75.4 q/ha), urea (72.69 q/ha) and farm yard manure (60.6 q/ha).

The neem cake coated urea did not show any effect on the forage production but its time of application (mid July) was found superior for the first cut (49.3 q/ha).

During the fifth year of experiment on the merit of continuous versus deferred-rotational grazing system in *Sehima* grassland. The former provided 1602 grazing days while the latter 2136 days to the Haryana heifers. However, the average body weight gain under the continuous system was greater (412 g/heifer/day) as compared to 362 g/heifer/day under deferred grazing system.

Studies on the performance of Mandya sheep in the *Sehima* grasslands subjected to improved management practices versus mixed pasture of *Cenchrus ciliaris*, *C. setigerus* and Siratro showed that sheep (ten in each treatment) increased in their body weight from July to November. Thus in this period the group weight gain was highest 37.5 kg in *Cenchrus*+Siratro pasture as compared to 24.7 kg in *Sehima*+*Stylosanthes*, 21.9 kg in *Sehima* control and 14.5 kg in *Sehima*+Nitrogen treatments. It was further observed that treatment involving *Cenchrus*+Siratro pasture provided the highest 1818 grazing days as against 1776 in *Sehima*+Stylo pasture, 1662 in *Sehima*+60 kg N/ha and 989 in *Sehima* (control).

Studies on the effect of burning with or without grazing on changes in botanical composition of *Sehima* grasslands showed lowest population (6.5%) of *Sehima* in annually burnt and ungrazed plots while in such plots the percentage of *Hetropogon contortus* increased

(38.5%). The growth of *Heteropogon contortus* plants was more vigorous in biennially burnt and grazed plots.

The effect of phosphate on root growth of *Heteropogon contortus* revealed that during the second year the highest root number (814) and fresh weight (500.56 gm/tussock) were found in the treatment combination of N₆₀P₄₀. Similar trend was also observed in *Shima nervosum* during its first year of establishment.

Studies on the establishment of pasture legumes in natural grasslands have indicated the suitability of broadcasting in premonsoon and line sowing in monsoon with 20 kg P₂O₅ for best germination and establishment of *Stylosanthes humilis* and *Glycine javanica*.

Studies on the comparative performance of grass-legume mixture and their pure swards with 3 varieties of *Cenchrus ciliaris* var. Molopo sustained highest mortality (44.4%) when transplanted in *Stylosanthes humilis* followed by *C. ciliaris* var. 3108 (40.1%) and var. Pusa Giant Anjan (33.8%) when transplanted in *Macroptelium atropurpureum* (Siratro) and *Clitoria ternatea* respectively.

The seed health and germinability of *Heteropogon contortus* were influenced by the plant type and management practices. The heaviest seed with longer viability was associated with the Giant plant types and the seed from 20 kg P plots.

Leucaena leucocephala sown in between the lines of grasses like *Setaria sphacelata*, *Chrysopogon fulvus*, *Cenchrus ciliaris* (3108) and *Heteropogon contortus* gave maximum survival in *Chrysopogon fulvus* plots (80.4%) followed by *S. sphacelata* (75.4%).

Silvi-pastoral studies on *Acacia tortilis* and *Leucaena leucocephala* continued to show better growth of the former species when grown with *Cenchrus ciliaris*, which also gave the highest forage production.

RESEARCH WORK DONE

GM-1 : GRASSLAND PRODUCTIVITY

- 1.2-5 Relative efficiency and economics of various sources of nitrogenous fertilizers on the quantity and quality of herbage on Schima-Heteropogon grasslands
(Prasidhi Rai, K. A. Shankarnarayan and K. C. Velayudhan)

The trial was repeated for the second year with four sources of nitrogenous fertilizers (ammonium sulphate, urea, calcium ammonium

nitrate and Farm Yard Manure) and five levels of nitrogen (0, 30, 60, 90 and 120 kg N/ha) to find out an efficacious and economic nitrogenous fertilizer that would provide maximised forage production from *Sehima-Heteropogon* natural grasslands.

Result showed that highest dry matter yield of 79.2 q/ha was obtained in two cuttings when nitrogen was applied at 60 kg N/ha through the source of ammonium sulphate. The application of nitrogen through urea and calcium ammonium nitrate gave maximum dry matter yields of 72.6 and 75.4 q/ha only when applied at 120 kg/ha with farm yard manure as the source. The maximum dry matter yield of 60.6 q/ha was recorded with an application of 90 kg N/ha. The control yield was only 39.7 q/ha dry forage.

Regarding the quality of herbage, it was found that there were no significant differences among the different sources of nitrogen in their effect on the percentage content of crude protein.

1.2-6 : Effect of different percentage of neem cake coated urea, different levels of nitrogen and time of application on quantity and quality of herbage on Sehima-Heteropogon grasslands

(Prasidhi Rai, K. A. Shankarnarayan and K. C. Velayudhan)

The trial was undertaken for the second year with four levels of blending of neem cake with urea (0, 5, 10 and 15%), three levels of nitrogen (30, 60 and 90 kg N/ha) and three times of application (16th July, 10th August and 4th September) to find out the optimum level of blending of neem cake with urea, level of nitrogen and time of application of urea for maximising forage production besides a prolonged vegetative growth of herbage *pari-passu* with slow release of nitrogen.

It was found that neem cake coated urea applied to *Sehima-Heteropogon* grasslands at 5, 10 and 15% compound did not show any beneficial effect either in the first cut (13th September) or in the second cut (16th November).

The maximum dry forage yield of 55.4 q/ha was recorded in two cuttings when nitrogen was applied at the rate of 60 kg N/ha. It was also noticed that mid-July application of urea/neem cake coated urea was superior in the first cut with highest dry matter yield of 49.3 q/ha

whereas first week of September fertilizer application recorded the highest dry matter yield (10.4 q/ha) in the second cut only.

Quality of the herbage was observed to be unaffected due to the blending of neem cake with urea as judged by the crude protein content.

GM-2 : GRASSLAND IMPROVEMENT

2.1 : To find out suitable techniques for the establishment of promising legumes in natural grasslands

Stylosanthes humilis, an annual exotic legume for the second year and *Glycine javanica* a perennial exotic legume for the first year were taken up for investigation during the year under report. Out of seven cultural treatments comprising three pre-monsoon ones and four monsoon ones tried to introduce these legumes into the protected natural grasslands dominated by *Sehima nervosum* and *Heteropogon contortus*, broadcasting in pre-monsoon and line sowing in monsoon + 20 kg P₂O₅/ha recorded the highest germination counts (96250 and 49333 plants/ha) for *Stylosanthes humilis* and *Glycine javanica* respectively followed by dibbling in pre-monsoon (79583 plants/ha) for *Stylosanthes humilis* and line sowing in monsoon (43333 plants/ha) for *Glycine javanica*.

Observation were also made on the establishment of *S. humilis* under various treatments. The highest establishment (85410 plants/ha) was registered with respect to broadcasting in pre-monsoon.

2.2 : Comparative performance of grass/legume mixture (K. C. Velayudhan, Vinod Shankar and Prasadhi Rai)

Three improved strains of *Cenchrus ciliaris* viz. varieties Molopo, 3108, Pusa Gaint Anjan and three species of tropical pasture legumes viz. *Clitoria ternatea*, *Macroptilium atropurpureum* (Siratro) and *Stylosanthes humilis* were undertaken for studies. Treatments comprised of all nine possible combinations of these strains of grass and legume and also the six pure swards of grass and legume strains.

During the establishment year, results showed the following trends. *C. ciliaris* var. Molopo showed highest mortality percentage (44.37%) when transplanted in the plots of *Stylosanthes humilis*, followed by *C. ciliaris* var. 3108 (40.06%) and *C. ciliaris* var. Pusa giant (33.75%) when

transplanted in the plots of Siratro and *Clitoria ternatea* respectively. Least mortality (15%) was noticed in the case of Pusa giant.

Out of the three varieties of *Cenchrus ciliaris* var. Molopo grown with Siratro attained maximum height (97.46 cms) as compared to var. 3108 and var. Pusa giant grown alone or as mixture with legumes. This was followed by *C. ciliaris* var. 3108 which attained 73.62 cm when grown with *Stylosanthes humilis*. Maximum tiller number (17) was recorded in the case of var. 3108 when grown alone. With regard to tussock size var. 3108 attained the largest tussock (5.2/4.2 cm) as compared to two other varieties.

Observation on establishment of legumes revealed that *Clitoria ternatea* gave the highest plant counts in pure as well as in mixed sward as compared to other ones. Siratro was far superior to the other two legumes displaying better growth and vigour.

GM-3 : GRASSLAND UTILIZATION

3.2 : Comparative study of continuous versus deferred-rotational grazing on Sehima grasslands

(K. A. Shankarnarayan and Prasadhi Rai)

The data for the monthwise grazing days, during the fifth year of experiment on the merit of continuous versus deferred-rotational grazing system in the *Sehima* grasslands, are given in Table 1. It will be seen that the number of grazing days for heifers recorded a slight increase from August to September and was same in October in the continuous grazing system which recorded a total of 1602 grazing animal (heifer) days in an area of 4 ha block. The trends were similar in deferred rotational grazing although the total number of grazing animal (heifer) days was far superior (2136). The botanical composition will be assessed next year.

Table 1 : Monthwise grazing days in two grazing systems in an area of 4 ha block each

Month	Continuous grazing	Deferred-rotational grazing
August	522	696
September	540	720
October	540	720
Total	1602	2136

A significant observation in this connection is the fact that weight gains per heifer/day was greater in continuous grazing system (412 g/heifer/day) compared with deferred-rotational grazing system (362 g/heifer/day).

In view of the fact that deferred-rotational grazing provided maximum grazing days and considering the large cattle population, it is preferable to adopt the deferred-rotational system for efficient management of *Sehima* grasslands.

3.3-2 The effect of intensity and interval of cutting cum manuring on the regeneration, quality and quantity of herbage in *Chrysopogon fulvus* (Mhow)

(K. C. Kanodia, K. A. Shankarnarayan and Prasadhi Rai)

The experiment was continued for the third year with treatments consisting of four intervals of cutting (10, 20, 30 and 60 days), three intensities of cutting (5, 10 and 15 cm height) and three levels of nitrogen (0, 30 and 60 kg N/ha) and their combinations.

Results showed that both interval of cutting and application of nitrogen significantly increased the dry matter production which increased as the period between cutting interval was raised. The Maximum dry matter yield of 28.93 q/ha was obtained at 60 days cutting interval. Application of 30 and 60 kg N/ha increased the average forage production from 9.18 q/ha in control to 14.31 and 17.81 q/ha respectively. The intensity of cutting did not affect the forage yield significantly. However, the maximum average dry matter production of 14.45 q/ha was obtained when cut at the height of 10 cm.

3.4 Studies on the comparative merits of natural grassland subjected to improved management practices and cultivated pastures in animal production

(K. A. Shankarnarayan and Prasadhi Rai)

Studies on the performance of Mandya sheep was repeated for the second year with four treatments viz., *Sehima* grasslands (control), *Sehima* grasslands + 60 kg N/ha, *Sehima* grasslands + Stylo and a cultivated pasture of *Cenchrus ciliaris* + *C. setigerus* + Siratro. The results are summarised below :

Dry forage production in open

The monthwise dry forage yield from 24.7.74 to 1.11.74 for each treatments showed that the dry matter yield varied not only among the treatments but also within the periods. Thus the maximum forage yield (47.0, 76.1 and 78.9 q/ha) was recorded in *Sehima* + nitrogen in second and fourth weeks of August and first week of October whereas control showed maximum dry forage yield (15.7, 67.3, 63.8 and 13.2 q/ha) in July, 1st and 3rd weeks of September and later half of October. From mid October there was a sharp decline in production in all cases. Although, the level of dry forage yield in *Sehima* + Stylo was of a low order in general, it showed maximum forage production of 13.8 q/ha in first week of November. Since November represents a period of lean forage supply, the maximum yield shown by *Sehima* + Stylo in this period appears of great significance for providing better grazing to animals.

In the case of mixed *Cenchrus* + Siratro pasture, the forage yields gradually increased from July through August and attained a peak production on 20th September. Here again *Cenchrus* + Siratro pasture top dressed with trace elements Molybdenum and Cobalt, recorded maximum dry matter yield (110.9 q/ha). The dry matter production showed sharp decline from 18th October onwards, as in the case of *Sehima* grasslands.

Comparative study of forage production among the four treatments showed beyond doubt that *Cenchrus* + Siratro outyielded either grasslands of *Sehima* (control) or *Sehima* subjected to improved management practices.

It will be observed in general, that higher forage yields were shown upto 23rd August in *Sehima* grasslands compared to others. Therefore, from the view point of management, it is suggested that *Sehima* grasslands may be utilized for grazing in the early periods of growth upto August whereas *Cenchrus* + Siratro pasture can be utilised for animal grazing beyond August.

The forage production under cages

The data on forage production in the cages represents the growth and production of herbage in the intervening period under grazing. It has been seen that among *Sehima* treatments, the maximum dry matter yield was generally recorded in *Sehima* + Nitrogen treatments attaining

a peak production of 187 q/ha on 4th October. From November the production declined markedly.

The mixed pasture of *Cenchrus*+*Siratro* on the other hand, showed a gradual increase in production from July to mid-October. Here again *Cenchrus*+*Siratro* treatment along with addition of trace elements Molybdenum and Cobalt recorded the maximum dry forage production (251 q/ha) in 3rd week of October.

The body weight trends in sheep

The data on group weight of Mandya sheep in various treatments revealed that the group weight gain was maximum in *Cenchrus*+*Siratro* pasture (37.5 kg) upto 15-11-74 followed by *Sehima*+*Stylo* treatment (24.7 kg). The lowest gain in the same period was recorded in *Sehima*+nitrogen treatment (14.5 kg)

The total number of grazing days with sheep in a period of 115 showed that *Cenchrus*+*Siratro* pasture has given maximum grazing days/ha of 1818 followed by 1776 in *Sehima*+*Stylo*, 1662 in *Sehima*+nitrogen and 982 in *Sehima* control.

Behaviour studies in Mandya sheep

Information on behaviour of sheep under grazing conditions, would be important from the view point of animal management in grazing ecology studies. Therefore, during the year under report, a record of behaviour of Mandya sheep was carried out in three treatments viz. *Cenchrus*+*Siratro*, *Sehima*+*Stylo* and *Sehima*+60 kg N treatments in a period of eleven hours (6 A.M. to 5 P.M.).

It has been observed that in *Cenchrus*+*Siratro* pasture, out of 660 minutes, greater part was devoted to grazing (575 minutes) followed by about 64 minutes on idling. Almost 17 minutes were involved for salt licking whereas least time was devoted to either cudling or drinking water. The number of bites/minutes, an index of grazing efficiency, was 37.5.

In *Sehima*+nitrogen treatment, maximum time (579 mts.) was devoted to grazing followed by cudling (48 mts.). Unlike *Cenchrus*+*Siratro* pasture, only 25 minutes were devoted to idling. The number of bites/minute recorded in this case was 42.5.

Examining the behaviour of animals in *Sehima*+Stylo treatment, it was discerned that 490 mts. were involved in grazing, 132 mts. in idling and relatively little time was spent on cudling, drinking water or licking salt. The number of bites/minute was 38. The lower value in terms of number of bites/minute in *Cenchrus*+Siratro pasture is attributed to the fact, that while grazing Siratro, the whole plants with stolons came above ground and time lag occurred in separating the leaves from the stem.

The nutritive value of forage in various periods as affected by treatments

The herbage samples collected in various periods during the conduct of experiment in 1973, were analysed during 1974 to give an idea of the nutritive value of herbage in terms of neutral detergent fibre (NDF) *in vitro* true dry matter digestibility and crude protein.

It has been observed that the maximum NDF value of 80.6% in *Sehima* control was on first week of October whereas the *in vitro* true dry matter digestibility of 72.1% was greatest in mid-November. In *Sehima*+Nitrogen and *Sehima*+Stylo treatments maximum NDF value of 81.0 and 82.0% was recorded in mid-September and *in vitro* digestibility of 77.3 and 70.9% was highest at the end of October and mid-november respectively.

Regarding crude protein it has been seen that in all treatments, the crude protein was maximum in August and progressively decreased by December. As was to be expected, *Sehima* (control) recorded the lowest crude protein content. In *Sehima*+nitrogen treatment, the position was slightly better although the trend was similar. But in the case of *Sehima*+Siratro there was great improvement in crude protein content of forage which was nearly 7% till August and about 5% as late as December.

Referring to mixed pasture of *Cenchrus*+Siratro the NDF value (80.9%) was maximum in the end of October. While the *in vitro* digestibility (72.6%) was maximum in mid-November. It has been seen that while *in vitro* true dry matter digestibility was more or less maximum in mid-November in both *Sehima* grasslands as well as *Cenchrus*+Siratro pasture, the NDF values which was maximum in mid-September in *Sehima* and late October in *Cenchrus*+Siratro.

It was also observed that *Cenchrus* + Siratro pasture recorded the maximum crude protein content and therefore superior compared with *Sehima* treatments. The level of C. P. in early August was about 8% and it remained at about 7% level even upto end of October. In other words, *Cenchrus* + Siratro pasture has the potentiality to provide maintenance requirement of animals upto late October and supplemental feeding would appear necessary only beyond mid-November.

GM-4 RANGE ECOLOGY

4.3 Study of plant succession in grassland on rocky substratum in SEHIMA community

(B. K. Trivedi, Vinod Shankar and K. C. Kanodia)

The data on listing and counting of species in permanent list and denuded quadrats and profile diagrams of the crevices revealed the following results.

In certain quadrats at base and top flats of the rock outcrop the vegetation is still in developmental phase and the quadrats are in higher stage of plant succession than the initial stage at which these were fixed in the year 1968, while in other the vegetation has attained the pre-climax stage i. e. *Heteropogon contortus* and *Sehima nervosum* stage. The increase was recorded in the population of *Chrysopogon fulvus* and *Tephrosia villosa* but no invader was observed in the crevices.

4.4-1 Detailed study of HETROPOGON CONTORTUS and seed testing of fodder trees, and grasses

(P. S. Pathak and R. Deb Roy)

Seeds of *Heteropogon contortus* types (Himachal, Prostrate, Decumbent, Erect giant, medium and dwarf) were sown in the nursery beds during July. After germination one plant each at a distance of 50 cm from plant to plant and row to row were maintained, weeding out the rest.

During December the final growth performance was observed. The maximum plant height was found in medium type (82 cm) and the dwarf showed minimum. The tussock diameter was maximum in Prostrate type. Dwarf type showed maximum number of tillers (116) while the minimum were in medium type. The fresh and dry weight produced was

maximum by the decumbent populations while the minimum was contributed by the dwarf type. Dwarf type gave maximum number of seeds/plants but the seed test weight was highest for the Himachal population.

When the one month old seedlings of these types were transplanted, establishment was 100 percent in the prostrate and decumbent types. The dwarf type has poor establishment. The final plant height was not significantly affected but the tussock diameter, tiller number, flowering and the other plant characters were totally reduced. The seed production was again maximum in the dwarf type. Test weight of seeds followed the same pattern as above but the weight in all the cases was reduced. Thus transplanting produced weak plants and very reduced dry matter in all the populations.

The seeds of most of the grasses, legumes and fodder trees tested during the previous years were again tested once and confirmed the previous results.

Seeds of *Hetropogon contortus* were collected from various experimental plots of the C. R. Farm and studied for their health and germinability. Out of the 5 populations collected from the natural grasslands, heaviest seeds were produced by decumbent plants (1.5314 g/1000) followed by the prostrate ones. The dwarf population produced very light seeds (0.7891 g/1000). The germination also was quite different in different populations. After September the germinability reduced in all the cases but the maximum was in decumbent population.

Seeds collected from fertilizer experiments also showed a good response of 20 kg P associated with 60 kg N. In absence of fertilizer P poor quality of seeds were obtained.

Seeds from grazing experiments also showed variation. The maximum test weight was from Paddock I and maximum from the Paddock III. But the maximum germinability was in seeds from Paddock II at all times of testing.

Seeds from burning experiments varied in their test weight and the maximum was by the seeds from grazing plots. Alternate year burning followed by grazing gave the lightest seeds. The germinability in all the cases was reduced due to burning or grazing.

In order to assess the seed production parameters of *Cenchrus ciliaris* varieties grown in the seed production block and the nursery the plants were observed at maturity stage for various characters. Out of 8 varieties the maximum green forage produced was by Buffel variety (210 q/ha). Maximum percentage of fertile tillers were in 3133 variety and minimum in Buffel. The spikelet number and spike length varied independently in all the varieties. Maximum number of spikelets were observed in Buffel. The test weight of the spikelets was also taken and the harvest spikelets were in Pusa Giant variety. Further studies on the various parameters of these seeds are in progress.

4.4-2 Autecology of grassland species : Studies on *Leucaena leucocephala* (Lem.) De wit.

(P. S. Pathak and R. Deb Roy)

(a) As in the previous year no cutting was possible during January and February of this year owing to low temperatures during the last week of January due to very low temperatures for 4 days there was appreciable frost damage to all the tender branches and leaves which could recover only after 15 days but all the plants survived after the attack.

In spite of better rainfall (total and monthly) distribution during the year the green forage yields for all the treatments was lower than for the previous year (1973). This appeared mainly owing to the loss in vigour of the plants after 2 years of continuous cutting. Maximum forage yield was obtained at higher plant density (10046.8 kg/ha) while the minimum in the low density plots (1826.6 kg/ha)

At high density 120 days interval and 10 cm cutting height gave the highest forage yield and the lowest was by 60 days interval and 20 cm cutting height. 40 days cutting interval was the second highest of all the treatment combinations while at all the other plant densities maximum was under 40 days interval. This maximum production was associated with the high leafiness and tender and palatable branches also. This year weed infestation was also a problem in all the plots.

(b) Seven populations of this plant were sown in June 1974 in the nursery beds and its germination, establishment and plant growth in terms of height, diameter and branching was recorded every subsequent

month. The plant phenology and fruit setting was also noted. The growth under this condition was compared with the populations already growing under natural grassland conditions and on the loamy soils under proper management.

Seedling emergence under coarse gravelly red soil in the nursery was very poor in all the plots. In the month of December the maximum height growth was in the plants from Dehradun population followed by the Australian ones, but the latter recorded maximum diameter growth. In the nursery condition owing to optimum moisture level there was no leaf fall or slow growth during November and December in any of the populations. Branching was maximum in Banaras populations (47 branches/plant).

Under grassland conditions the plants were exposed to termite attack and the rabbit grazing problems. Yet in the third year maximum basal diameter was attained in Australian populations. During winter months all the populations showed leaf fall and pod ripening. Heavy gum formation was observed in all the populations at all the sites. The populations showed wide variations in their flowering time and pod setting. Studies on their other characters are in progress.

(c) *L. leucocephala* was sown in between the lines of grasses planted during July in the nursery. The grasses *Setaria sphacelata*, *Chrysopogon fulvus*, *Cenchrus ciliaris* (3108) along with *Heteropogon contortus* as control were sown in 17×5 meters plots in two replications. The germination was observed and more than one seedling from a place were weeded out. During December the survival and other plant characters were noted. Maximum seedling survival was in *Chrysopogon fulvus* plots (80.4%) followed by *S. sphacelata* (75.4%) and the minimum in *C. ciliaris*. Similar pattern in plant height and basal diameter growth was observed but the second maximum was in *Heteropogon contortus* plots.

(d) Seeds scarified for 9 minutes with concentrated sulphuric acid were sown from March upto August 1974 at monthly intervals and their emergence rate and establishment were watched under nursery conditions. Soil temperature at 5 and 15 cm depths were also recorded during the germination period every month. Seedling growth has been studied by harvesting five plants at weekly intervals upto 3 months age

in all the conditions. The data are being analysed for various growth attributes.

4.5-1 Effect of frequency of burning with or without grazing on the changes in the botanical composition in Sehima grasslands
(B. K. Trivedi, Vinod Shankar and K. C. Kanodia)

After imposing the burning in required plots in the 3rd week of January the number of tussocks of *Heteropogon contortus* and *Sehima nervosum* and forage yield for spring growth were recorded during March. The botanical composition through 10 metres permanent line transects, forage yield and plant vigour of *H. contortus* and *S. nervosum* were recorded in the month of September. On recording the above data the animals were introduced for grazing. The results in brief are given below :

In *S. nervosum* the maximum percentage cover, dominance and composition were recorded (9.6, 49.2 and 14.1 respectively) in grazed plots, while minimum percentage values for cover and dominance were 5.2 and 25.7 respectively in biennial burnt without grazed plots. Percentage composition (6.5) was found very low in annually burnt without grazed plots.

In the case of *H. contortus* the minimum values for cover (2.9%), dominance (14.3%) and composition (9.1%) were observed under the grazing treatment and maximum percentage cover (6.8) and percentage dominance (33.5) were found in ungrazed triennially burnt plots. A remarkable increase in its population (38.5%) was noted in only annually burnt treatment.

Maximum plant height and spike length of *S. nervosum* was 161.2 cm and 16.7 cm respectively in grazed plots. The vigour of *H. contortus* was observed better in control and biennially burnt with grazing treatment. Maximum yield (3410.6 kg/ha) was recorded from grazing plots while the minimum was 1851.4 kg/ha for annually burnt plots.

4.5-2 Effect of phosphate on root growth of principal grasses of Sehima-Dichanthium cover. (a) *Heteropogon contortus*, (b) *Sehima nervosum*
(K. C. Kanodia and Dashrath Singh)

(a) *Heteropogon contortus*

During the second year of experiment in 1974 results showed that application of phosphate at the rate of 40 kg P₂O₅/ha increased not

only the root number (from 356 in control to 714 roots per tussock), but also increased the fresh weight of roots from 231.78 gms. in control to 416.05 gms. Application of nitrogen also expressed increase in the root number and root weight but the magnitude of increase was smaller as compared to that due to phosphate application. The highest root number (814) and fresh weight (500.56 gms.) was recorded in the treatment combination of $N_{60}P_{40}$. The observations were recorded by Augar method.

It is also interesting to note that by root box (1 cu. ft.) method the highest root number (5568) and fresh weight of roots (244.31 gms.) were found for the treatment combination of $N_{60}P_{40}$.

Soil indicator : In the second year of experiment with fertilizer application of various combinations of Nitrogen 0 and 60 kg N/ha and Phosphorus 0, 20 and 40 kg P_2O_5 /ha similar to the first year indicated that improvement in soil fertility with respect to nitrogen was observed only where nitrogen was added in combination with phosphorus in the soil. The highest P availability in soil was observed where phosphate was applied at P_{40} level with or without nitrogen. Stability index of aggregates in this poorly aggregated soil indicated that with the application of Nitrogen alone this soil has become aggregated to some extent. Phosphate application did not show any response on aggregation. The nitrogen and phosphorus analysis of forage from this *Heteropogon* pasture indicated that nitrogen was high wherever nitrogen application was reported irrespective of phosphate levels added. Phosphorus status of *Heteropogon* forage was high only at 20 kg P_2O_5 /ha level.

(b) *Schima nervosum*

The results obtained during the establishment year (1974) indicate that the application of phosphate 40 kg P_2O_5 /ha increased the root number from 160 in control to 218 roots per tussock by Augar method. It is also interesting to note that the highest root number (796) and fresh weight of roots (35.2 gms.) were found in the treatment combination of $N_{60}P_{40}$.

Soil indicator : In the first year of this experiment comprising of combinations of N at 0 and 60 kg N/ha and P at 0, 20 and 40 kg

P_2O_5 /ha, it was observed that build up in nitrogen fertility of soil was highest at $N_{60}P_{40}$ fertilizer treatment. Build up in phosphate fertility of this soil was highest where phosphate was applied at 40 kg P_2O_5 /ha level either with or without nitrogen. Degree of aggregate stability improved with the application of nitrogen only and sometimes where both nitrogen and phosphate were applied in combination.

Nitrogen status of *Sehima* forage was the highest in N_{60} treatment. Phosphate application did not affect nitrogen composition of this crop. Phosphate status of *Sehima* forage was the maximum in treatment where P was added @ 40 kg P_2O_5 /ha level.

GM-5 : FOREST GRAZING APPRAISAL PRODUCTION, AND UTILIZATION

5.2-1 Silvipastoral studies on fodder-cum-fuel trees (R. Deb Roy and P. S. Pathak)

Silvipastoral studies on two fodder cum fuel trees viz., *Acacia tortilis* and *Leucaena leucocephala* with two grass species namely *Cenchrus ciliaris* and *Cenchrus setigerus* were initiated during 1971 with a view to study the establishment and growth of fodder-cum-fuel trees and to find out a suitable tree grass combination for optimum production and stock carrying capacity.

Both the grass species were harvested in the last week of October. *Cenchrus ciliaris* in general recorded higher forage production compared to *Cenchrus setigerus* in all the treatments. Similar observation was recorded during 1972 and 1973 also. Highest forage production of 53.4 q/ha was recorded when *Cenchrus ciliaris* was grown in the space between the two lines of *Leucaena leucocephala* spaced 4m×4m. The second highest forage production of 40.20 q/ha was recorded by *Cenchrus ciliaris* when grown with *Acacia tortilis* at a spacing of 4m×4m. Lowest forage production of 26.3 q/ha was recorded by *Cenchrus setigerus* when grown with *Acacia tortilis* at a spacing of 4m×6m. Forage production in general was higher with spacing treatment of 4m×4m compared to that of 4m×6m.

Out of the two fodder-cum-fuel trees *Acacia tortilis* continued to

exhibit better growth performance compared to *Leucaena leucocephala*. Highest annual increment 77.1 cm was recorded by *Acacia tortilis* with the spacing treatment of 4m×6m and with no grass treatment whereas highest annual increment in collar diameter of 1.84 cm as also the second highest annual increment of 67.0 cm was recorded at the same spacing treatment but when grown with *Cenchrus ciliaris*.

Due to grazing and also because of heavy termite attack large number of plants of *Leucaena leucocephala* have died and as such proper assessment regarding the growth of the species could not be ascertained.

The forage production as affected by the different treatment combination are presented in table 1.

Table 1 : Forage production in q/ha under silvipastoral studies

Grass species	<i>Leucaena leucocephala</i>		<i>Acacia tortilis</i>	
	4m×4m	4m×6m	4m×4m	4m×6m
<i>Cenchrus ciliaris</i>	53.41	40.20	40.20	29.52
<i>Cenchrus setigerus</i>	21.49	32.23	26.26	26.26

5.2-2 Studies on the establishment and growth of plantation species in an integrated land use pattern

This is in continuation of the studies initiated last year with a view to study the establishment and growth of fodder trees with grasses and to find out a suitable tree-grass combination for increasing forage production and stock carrying capacity in forest plantation.

The grass species viz. mixture of *Sehima nervosum* and *Chrysopogon fulvus* and *Cenchrus ciliaris* were established during the year under report. The establishment of the grasses was quite patchy. Grasses were harvested during November. The forage production in general was higher with *Cenchrus ciliaris* compared to mixture of *Sehima nervosum* and *Chrysopogon fulvus*. Highest forage production of 55.7 q/ha was recorded by *Cenchrus ciliaris* with the treatment combination of *Hardwickia binata* planted at a spacing of 4m×6m. The second best forage production of 33.57 q/ha was also that of *Cenchrus ciliaris* but with the treatment combination of *Albizzia amara* planted at a spacing of 4m×4m.

Both the tree species exhibited more than 90 percent survival. The

average annual height increment were higher in *Albizzia amara* compared to *Hardwickia binata* whereas average annual increments in collar diameter were higher in the latter species compared to former. Highest annual increment in height and collar diameter in *Albizzia amara* was 89.9 cm and 1.30 cm respectively recorded in the spacing treatment of 4m×6m with no grass treatment while that of *Hardwickia binata* was 65.6 cm and 1.38 cm respectively observed in the spacing treatment of 4m×4m with no grass treatment. The growth in height and collar diameter under different treatment combinations are presented in the table below :

Table : Growth of tree species in cm. as affected by the spacing and grass treatment

	<i>Hardwickia binata</i>				<i>Albizzia amara</i>			
	4m×4m		4m×6m		4m×4m		4m×6m	
	Height	C.D.	Height	C.D.	Height	C.D.	Height	C.D.
No grass (control)	87.6	1.86	83.7	1.96	129.5	1.72	154.4	2.25
<i>Cenchrus ciliaris</i>	54.3	1.16	82.1	1.48	123.7	1.64	134.7	1.76
<i>Sehima nervosum</i> / <i>Chrysopogon fulvus</i>	52.6	1.04	80.1	1.83	111.5	1.42	120.7	1.62

Silvicultural studies

Out of the fodder trees introduced during 1971 only two species viz. *Acacia tortilis* and *Albizzia amara* continued to exhibit cent percent survival. The next in order of merit are *Hardwickia binata*, *Azadirachta indica*, *Acacia arabica*, *Leucaena leucocephala* and *Dalbergia sissoo* with 84.6 percent, 83.3 percent, 77.0 percent and 77 percent survival respectively. *Acacia tortilis* exhibited maximum height growth of 398.5 cm followed by 344 cm, 275 cm and 239.5 cm respectively in *Albizzia amara*, *Acacia arabica* and *Dalbergia sissoo* respectively. Maximum growth in collar diameter of 7.82 cm was recorded by *Albizzia amara* followed by *Acacia tortilis* (7.36 cm), *Dalbergia sissoo* (5.63 cm), *Acacia arabica* (5.03 cm) and *Hardwickia binata* (4.96 cm) respectively. Highest annual height increment of 95.7 cm was observed in *Acacia tortilis* followed by *Hardwickia binata* (83.5 cm), *Albizzia amara* (60.0 cm), *Dalbergia sissoo* (59.9 cm) and *Acacia arabica* (39.9 cm) respectively.

Out of the fodder trees introduced during 1973 *Dichrostachy glomerata* exhibited 83.3 percent survival followed by *Albizzia richardiana*, *Dichrostachy nutans* and *Terminolia arjuna* with 80, 78.5 and 70 percent survival respectively. *Terminolia arjuna* showed maximum height growth of 198.7 cm followed by 147.9 cm, 115.2 and 110.3 cm respectively in *Albizzia richardiana*, *Dichrostachys nutans* and *Dichrostachys glomerata* respectively.

Research contemplated

In addition to the technical programme for 1974, the following research programme will be undertaken :

1. Effect of nitrogen and phosphorus on quantity and quality of herbage in *Chrysopogon fulvus*.
2. Effect of population density on forage and seed production of *Cenchrus ciliaris* (var. 3108.)
3. Effect of phosphate fertilization and cutting management on growth and production of pasture legumes.
4. Effect of utilization frequency and intensity on quantity and quality of forage in *Dichanthium annulatum*.
5. Studies on establishment and growth of *Leucaena leucocephala* in the natural grasslands.

WEED ECOLOGY AND CONTROL DIVISION

Salient features

Autecological studies on *Scchharum spontaneum* indicated sprouting was more on buds lying at upper zone of the soil profile. The bud dormancy could be broken by alternating high and low temperatures (40°C and 10°C, 7 hrs each) or 100 ppm GA₃ or 3.5% ascorbic acid. Moisture stress induced early flowering. During *rabi*, crop yield losses of lucerne due to weed infestation were 11.7% and in oats 8.3%. Evaluation trials with new compounds indicated that bentazone @ 1-3 kg/ha and benefin @ 0.5-1.5 kg were selective for both cereal and leguminous fodders. *Rabi* screening trials indicated that dicamba @ 0.5 to 1.0 kg/ha was selective for germinaceous crops. Methabenzehiazuron @ 2, 3 and 4 kg/ha gave excellent control of weeds for three months with good selectivity to wheat, barley, oat and lentil.

Twelve herbicide analogues using/3-amino-benzotrifluoride and corboxylic acids were synthesised. Evaluation of these analogues for crop-weed selectivity is in progress.

Agronomic studies on weed control indicated that pre-planting trifluralin @ 1-2 kg for fodder turnip, pre-em. linuron @ 0.5 kg for fodder oat @ 1 kg for wheat, pre-em. chlorbomuron or linuron @ 1.5 kg for sunflower, pre-pl. nitratin @ 1.5 kg for groundnut and guar, @ 2 kg for mung, pre-em. atrazine @ 0.5 kg for pearl millet and pre-em. alachlor @ 2.5 kg for soybean were found to be promising in selective weed control and increasing the fodder yields.

Laboratory studies pointed that by herbicide induced stomatal closure, transpiration could be reduced upto 40% when oat seedlings were sprayed with minute sub-lethal doses of herbicides viz. diuron or atrazine at 10⁻³M.

RESEARCH WORK DONE

WE-1.1 : AUTECOLOGY OF WEEDS

(S. R. Gupta and J. N. Gupta)

Autecological studies on *Sachharum spontaneum* indicated that

the buds and their sprouting were more numerous on upper horizon of soil profile than at greater depths. Bud dormancy could be broken by exposure to alternating high and low temperature (i. e.) 40–36°C for 7 hrs followed by 5–10°C for 7 hrs. or by soaking in 3.5% ascorbic acid or 100 ppm GA₃. Water-logging was injurious for bud sprouting. Water stress induced early flowering. Increased soil organic matter delayed flowering and induced profuse bud development. Sprouting of buds was more in cases where bud moisture and soil moisture differences were less.

WE-1.2 : SURVEY AND COLLECTION OF WEEDS

(S. R. Gupta and J. N. Gupta)

Accession register for collected weeds was prepared. Determined weed species were mounted and arranged family wise according to the model system followed by the Central National Herbarium.

WE-1.3 : CROP WEED INTERACTION

(J. N. Gupta and S. R. Gupta)

Studies on the crop losses in lucerne due to weeds were continued. Weed emergence and competition were less this year. The calculated loss due to the weed growth in *rabi* of second year was only 11.7%. The chief weeds were *Asphodelus tenuifolius*, *Melilotus alba*, *Chenopodium album* and *Convolvulus arvensis*.

Experiment on the estimation of crop losses due to weed growth in fodder oats was conducted during *rabi* 1974. Magnitude of weed infestation were noted and weed population were analysed for their important value indices. Crop growth was surpassed by the weed growth even in the early growth stage. The chief weeds were *Chenopodium album*, *Melilotus alba*, *Cyperus rotundus*, *Convolvulus arvensis* and *Asphodelus tenuifolius*. The calculated losses due to weed growth in fodder oats was only 8.3%.

WE-2 : PRELIMINARY EVALUATION OF HERBICIDES FOR FORAGE CROPPING SYSTEMS

(T. R. Dutta, C. N. Rao and O.P.S. Verma)

(a) Herbicidal screening trial :

During *kharif* 1974, five new herbicides viz. benefin, dicamba, fluchloralin, bentazon and bromxynil were evaluated for their physio-

logical activities and selectivity in two legumes (guar and moong) and three cereal fodder crops viz. Sorghum (cv. M. P. Chari), teosinte and pearl millet. Fodder sunflower was also included. Bentazon pre-em. @ 1, 2 and 3 kg/ha and benefin @ 0.5–1.5 kg/ha were selective for all the leguminous and graminaceous fodders. Dicamba pre-em. between 0.5 to 1.0 kg/ha showed selectivity to graminaceous fodder viz. sorghum (M. P. Chari), teosinte and pearl millet. They inhibited the growth of all the legumes and sunflower.

Similar trials during *rabi* 1974 with eight herbicides viz. benefin, buturon, methabenzehiazuron, dicamba, fluchloralin, bentazon, methachlorphenprop and bromoxynil were conducted for wheat, barley, oat, linseed, berseem, pea and chickpea. Dicamba @ 0.5 to 1.0 kg/ha applied as pre-em. as well as post-em. was selective to graminaceous crops. Methabenzehiazuron @ 2, 3 and 4 kg/ha gave excellent control of weeds for three months with good selectivity to wheat, barley, oat and lentil, but retarded the growth of legumes like pea and chickpea. Bentazon at all doses and Bromoxynil at 0.5 to 1.0 kg/ha as post-em. were selective to graminaceous crops and lentil.

(b) Ammonium sulfamate as stump treatment for control of brush species in natural grasslands gave promising results for eradication of *Zizyphus*, *Carissa*, *Lantana*, *Butea* and *Acacia*.

WE-4 : FATE OF HERBICIDES IN PLANTS AND THEIR INTERACTION (R. K. Gupta)

Oat samples both untreated control and linuron treated were analysed for *B*-carotene, soluble carbohydrates, ash, Ca, N, P, and ether extractives. Further analyses are in progress.

Twelve herbicides analogues using *B*-aminobenzotri-fluorides and carboxylic acids were prepared. These compounds were crystallised, purified and further work to evaluate their biological properties is under progress.

WE-7 : WEED CONTROL IN FORAGE CROP SYSTEMS (R. K. Pandey and S. D. Gupta)

WE-7.1 : Turnip

This trial was repeated for second year on sandy loam soil. The

treatments were pre-pl. nitratin and trifluralin each @ 1 and 2 kg a. i./ha, pre-em. nitrofen @ 1.5 and 3 kg a. i./ha, propachlor @ 3 and 6 kg a. i./ha, hand-weeding and weedy check. Pre-pl. trifluralin ranging from 1-2 kg a. i./ha reduced the population of broadleaved weeds, upto 91.5% at higher level. The next best treatment was propachlor at 6 kg a. i./ha. Trifluralin @ 1 kg/ha increased the dry weight of roots by 5 q/ha over no weeding. Trifluralin and nitratin were markedly toxic for subsequent oat crop.

WE-7.2 : Oat

In a spacing, nitrogen and herbicidal trial on medium soil, the herbicide treatments were untreated control, pre-em. linuron @ 0.5 and 1.0 kg a.i./ha and MCPA @ 0.75 kg a. i./ha (post-em.). The nitrogen levels were 60 and 120 kg N/ha and row to row spacings were 15 and 25 cm. Pre-em. linuron @ 0.5 kg a. i./ha reduced the weed infestation by 80% and increased fodder yield by 58.7% over no weeding (61.3 q/ha). This treatment was safe for crop at both N levels. Post-em. MCPA @ 0.75 kg/ha was not as efficient as linuron, which might be due to its later application. Weed intensity and fodder yield were not affected at variable spacing. Nitrogen at 120 kg/ha gave better yield than 60 kg N/ha. Pre-em. linuron @ 0.5 kg a. i./ha produced maximum yield of 103.6 q/ha with 120 kg N/ha. Linuron @ 1 kg a.i./ha reduced crop stand.

WE-7.3 : Chicory control in berseem

The effect of post-em. MCPB at 0.25 to 1 kg a.i./ha in relation to time of application was evaluated with no weeding treatment. Post-em MCPB @ 0.75 and 1.0 kg/ha applied at 40 day crop stage appeared to be better than other treatments for reducing chicory weed after first cut. These treatments appeared harmful to the crop lowering the yield in first cut.

WE-7.4 : Wheat-Guar

The experiment was repeated for the 2nd year on sandy loam soil. Four variable moisture levels imposed by flow irrigation at 2 and 3-week-crop stages with and without sprinkler irrigation applied 5 days after crop sowing formed the main plots. The sub plot treatments of weed control consisted of control, pre-em. chlorbromuron and linuron

each at 0.5 and 1.0 kg a.i./ha. Pre-em. linuron @ 1.0 kg/ha showed 94.9% weed control and grain yield was raised significantly from 15.0 (weedy check) to 32.7 q/ha. This treatment was followed by chlorbromuron and linuron @ 1.0 and 0.5 kg/ha, respectively. Interaction of irrigations and herbicides did not influence crop yield. Linuron and chlorbromuron did not affect the plant stand of rotational crop of fodder guar adversely.

WE-7.5 : Sunflower-oat

This experiment was repeated for the second year on medium black soil. The treatment consisted of pre-em. chlorbromuron, ametryne and linuron each at 0.75 and 1.5 kg. a.i./ha and alachlor @ 1.5 and 3.0 kg a.i./ha. With 96.5% weed control in early phase of crop growth, chlorbromuron at 1.5 kg/ha gave maximum yield of 36.8 q/ha while yield under weedy check was 13.8 q/ha (d.m.). This treatment was followed by Linuron at 1.5 and alachlor at 3 kg a.i./ha. These treatments were safe for subsequent crop of oats in first year.

WE-7.9 : Groundnut-oat

On medium soil, pre-plant nitratin, pre-em. alachlor and dichloromate (each at two levels) with hand weeding and no weeding as main plot with 50 and 100 kg P_2O_5 /ha in sub plot in groundnut and no weeding and post-em. MCPA @ 0.75 kg a.i./ha as sub-sub plots in the subsequent crop of oat were repeatedly applied in the second year to study the cumulative effect of treatments on crop production.

Pre-pl. nitratin @ 1.5 kg/ha reduced broadleaf and grassy weeds by 95% during active growth period of crop and raised the yield of dry pods by 5 q/ha over no weeding (6.3 q/ha). This treatment was followed by alachlor and dichloromate @ 3 and 5 kg a.i./ha respectively. All treatment combinations appeared suitable for the crop. In the commencing year, oat crop of the rotation following herbicide treatments, grew without any hazard from soil residues. Post-em. MCPA @ 0.75 kg a.i./ha appeared effective in oat crop raising yield from 45.6 (control) to 48.4 q/ha (d.m.).

WE-7.11 : Soybean-linseed

Pre-pl. nitratin and EPTC @ 1 and 4 kg a.i./ha respectively and pre-em. nitrofen, alachlor, chlorbromuron and dichloromate at 3, 2.5,

1.0 and 4.0 kg a.i./ha respectively with weedy check were repeated with 50 and 100 kg P_2O_5 /ha in the second year on sandy loam soil. All the treatments reduced weed intensity and increased fodder yield. Pre-em. alachlor controlled 92.4% of weed population at early crop stage and increased dry matter yield significantly from 12.1 (weedy check) to 68.0 q/ha. These two promising treatments were followed by chlorbromuron @ 1 kg/ha. Phosphate levels did not influence weed intensity or herbicide efficiency. Promising herbicides gave better yield at 100 kg than 50 kg P_2O_5 /ha. These treatments had no phytotoxic effects on the subsequent linseed crop.

WE-7.12 : Guar-linseed

On sandy loam soil, the treatments consisted of pre-em. alachlor @ 1.5 and 2.5 kg a.i./ha, nitralin pre-pl. @ 0.75 and 1.5 kg a.i./ha and no weeding control (in sub plots) and four combinations of 2 seed rates (40 and 60 kg/ha) and two sowing methods, broadcast and line sowing (in main plots). Pre-pl. nitralin @ 1.5 kg/ha eliminated 99% of the weeds at 3-week-crop stage and increased dry matter yield by 41.6 q/ha over severely infested control. Interfering with the growth rate of crop plants at seedling stage, alachlor @ 2.5 kg/ha was not as good as above treatments. Variable seed rates or sowing methods did not affect weed intensity and crop yield. Maximum fodder yield of 60 q/ha was obtained with nitralin at 1.5 kg/ha under broadcast sowing @ 40 kg seed rate. Subsequent linseed crop appeared to be safe to these herbicide treatments.

WE-7.14 : Moong-oat

Pre-pl. nitralin and trifluralin and pre-em. alachlor each @ 1 and 2 kg a.i./ha with hand weeding and weedy check were tried at 20 and 40 kg N/ha for the second year on sandy loam soil. Pre-pl. nitralin and trifluralin each @ 2 kg/ha caused above 80% control of weeds and gave 12.6 and 12.0 q/ha additional fodder yield (d.m.) on weedy check (10.2 q/ha) respectively. 40 kg N/ha showed 25.5 percent more yield than 20 kg N/ha. Residual effects are being assessed on oat crop.

WE-7.15 : Bajra-peas

Pre-em. atrazine, chlorbromuron, linuron mechanical and no weeding treatments were tried on sandy loam soil. Pre-em. atrazine @ 0.5

kg a.i./ha proved better for bajra. This treatment controlled 76.6% of weeds in early phase of crop growth and raised fodder yield appreciably over unweeded control i. e. from 57.7 (control) to 91.9 q/ha. Chlorbromuron and linuron each at 1 kg/ha and atrazine at 0.75 kg/ha reduced the crop stand considerably.

WE-8 : PHYSIOLOGICAL STUDIES WITH HERBICIDES ON FODDER CROPS

(C. N. Rao, O. P. S. Verma and T. R. Dutta)

(a) Effect of herbicides on transpiration in fodder crops.

During *rabi* 1974, a laboratory study was undertaken to study the effect of diuron and atrazine on the transpiration of fodder oats. The herbicide was mixed with Tween-20 surfactant, sprayed as foliar drench at 10^{-3} , 10^{-5} , 10^{-7} M with an untreated control. Transpiration was measured by differential weight method. The results indicated a significant reduction in transpiration even upto 43% on fresh weight basis (diuron) at 10^{-3} M. This reduction in transpiration was due to the induced closure of stomata (10%) caused by herbicide treatment.

(b) Effect of triazine herbicides on N content in sorghum

In a field study with sorghum, the triazine herbicides were applied as foliar spray at peak tillering stage @ 0.05 and 0.10 kg/ha. Three levels of N were included viz. 0, 25 and 50 kg/ha, Samples were drawn at 50% flowering for analyses of Nitrogen content. The results gave an indication that herbicide tended to promote nitrogen content of the shoots (fodder) at higher level of N (50 kg) while at lower levels the differences were not much. In all the treatments under N_{50} the protein content was more than 13 percent while in control N_{50} the protein content was 11.50.

PLANT ANIMAL RELATIONSHIP DIVISION

Salient features

Two cuts of 15 varieties of oat were chemically evaluated. In the 1st cut harvested after 70 days of sowing, the yields of drymatter (30.8 q/ha) and crude protein (4.91 q/ha) were found maximum in V-8 and V-7 respectively. A maximum crude protein percent of 23.1% and 11.7% were obtained in V-4 and V-11 in the 1st and 2nd cuts respectively. While in the 2nd cut harvested 45 days after the first cut, the dry matter yield (43.0 q/ha) and crude protein yield (357 kg/ha) were maximum in V-12.

In a study on the "gross" nutrient content and yield and the quantitative presence of oxalates in 16 varieties of hybrid napier, it was observed that in general there was decrease in C. P. and increase in oxalate percent with the increase in the height of the plant. N. D. F. as well as oxalate yields have increased due to advancing maturity.

In vitro true dry matter digestibility values in 3 promising varieties of fodder oat at different stages of growth could be predicted well from the corresponding crude protein estimates. In another study on 10 varieties of lucerne, IV TDMD content could be predicted from the corresponding estimates of crude protein and/or neutral detergent fibre.

Greater crude protein content associated with increased dry matter intake, digestibility and body weight gain/head/day in barbari goat was obtained with berseem hay made by fence method of Jhansi as compared to the ground and chaff methods. Conservation of turnips with M. P. chari kadbi (3 : 1) gave a satisfactory product (haylage) which could be a good substitute for green fodder during summer.

Fortification of M. P. chari kadbi with urea (1%), supermindif mineral mixture (1.5%) with the addition of 20 kg of water to 100 kg mixture – all put in a silo pit for 30 days, gave a palatable fodder giving on an average, a little over 2 kg dry matter intake/100 kg body weight in Haryana and Murrah buffalo calves. DCP in the untreated fodder (0-0.5%) raised to 4.0% on fortification indicating its adequacy as a maintenance ration in growing animals.

There has been no difference in milk production when Haryana cows in milk were grazed on Sehima and Cenchrus pasture. Pregnant female goats under 3 planes of nutrition viz., (1) grazing on Cenchrus pasture alone (2) grazing on Cenchrus pasture+100 g concentrate/head/day, and (3) grazing on Cenchrus pasture+200 g concentrate/head/day were kept to study the birth weight of kids and no difference on kid weight was observed.

Experimental findings revealed that anorexia syndrome in sheep and goat followed the same pattern as in cattle and buffaloes. Several cases of bloat were treated with procaine penicillin and oxytetracycline hydrochloride. The response to single dose therapy was 75% and 94.5% respectively.

There has been increase in body weight of rabbits when these have been fed with *Borreria stricta* only as the sole diet. A number of crystalline constituents such as, B - sitosterol, B - D - glucoside of B - sitosterol, myricyl alcohol, a flavonol and three anthroquinone derivatives have been isolated and identified from *Rumex dentatus*.

RESEARCH WORK DONE

PAR-1 EVALUATION OF FORAGE CROPS IN RELATION TO LIVESTOCK PRODUCTION.

1.1 : Chemical evaluation of forage crops for nutrient yield and possible phyto-toxic substances (L. K. Karnani & S. C. Gupta)

Expt. No. 1 : Final evaluation trial on promising varieties of fodder oat (Multi-cut)

Samples of two cuts of 15 oat varieties replicated thrice were received from the Plant Improvement Division of this Institute. The harvesting of the 1st cut was done 70 days after sowing and of the second cut, 45 days after the 1st cut. These samples were analysed for dry matter, crude protein, crude fat and neutral detergent fibre.

For the first cut, the average percentages of dry matter ranged from 14.3 to 18.3; the percent C. P. from 14.2 to 23.1; the crude fat from 1.82 to 4.29 percent; and the NDF from 37.5 to 45.8 percent. The corresponding ranges of yields were 13.1 to 30.8 q/ha; 257 to 491 kg/ha; 44.5 to 89.6 kg/ha; and 530 to 1208 kg/ha respectively.

In the second cut, the D. M., C. P., crude fat and NDF percentages ranged from 14.6 to 28.1; 6.8 to 11.7; 4.05 to 5.07 and 50.8 to 66.2 respectively with their corresponding yields varying from 22 to 43 q/ha; 205 to 357 kg/ha; 98.9 to 216.0 kg/ha and 1203 to 2767 kg/ha respectively.

Dry matter digestibility determinations using *in vitro* technique are in progress. However, from the chemical analysis data the variety I. G. 2672 appears to be promising since it gave the maximum dry matter and crude protein yields and also the NDF yield was not very high.

Expt No. 2 : Nutritional status in terms of "gross" nutrients content and yield and oxalic acid concentration in different varieties of napier as affected by stages of growth

16 varieties of napier harvested in July, 1974 at 75 cm, 100 cm and 125 cm heights were analysed for DM, CP, NDF and total and water soluble oxalates. Results indicated that in the first cut, the DM ranged from 9.34% to 18.34% whereas the CP ranged from 6.37% to 12.04%. The total and water soluble oxalates were maximum (4.72% and 2.09% respectively) in Gajraj at 125 cm height. The NDF content ranged from 54.8% to 69.2%. In the 2nd cut, harvested in September, 1974, the DM ranged from 15.35% to 23.75% the CP ranged from 4.40% to 10.72%, whereas the NDF ranged from 61.29% to 74.30%.

In the first cut, the D. M. and C. P. percentages were nearly same in all the varieties from 75 cm to 125 cm height except NB-31, NB-35 and Napier-2 which showed an increasing trend as the height increased for D. M.; except Napier-1 which showed a decreasing order and NB-9 and NB-31 which showed the reverse order for C. P. For NDF percentage also, there was nearly no change with the increasing height, However, ordinary napier showed a decreasing order and NB-17, NB-31 and NB-38 showed an increasing trend.

In the 2nd cut, varieties NB-21, NB-35, NB-38, P. G. Napier and Napier-1 showed an increasing trend from 75 cm to 125 cm height for dry matter while the reverse trend was observed in NB-3, NB-9, NB-31, Gajraj and Napier-2. However, in varieties NB-17, NB-25, NB-37, Dharwar, Coimbatore and ordinary napier the dry matter remained the same with increasing height. For C. P., a decreasing trend was observed

from 75 cm to 125 cm height in most of the cases, except NB-9, which showed an increasing trend and NB-31, Dharwar and Coimbatore in which this content was nearly constant. For NDF, an increasing trend was observed from 75 cm height to 125 cm height except NB-17 which showed a decreasing trend and NB-9, NB-21, NB-31, NB-38, Gajraj, Coimbatore and Napier-2 which showed nearly constant NDF.

It may be concluded that in the first cut variety NB-37 gave best results as it gave maximum green fodder, dry fodder and crude protein yields, and in the second cut, NB-9 gave best results as it was having maximum green fodder, dry fodder and C. P. yields. Considering both the cuts, NB-9 proved better as it was having higher green fodder, dry fodder and crude protein results.

1.2 : *In vitro* studies on the digestibility of important fodders and forage crops

(S. C. Gupta and A. Rekib)

(a) Studies on the successful establishment of two-stage *in vitro* digestion technique.

Five samples of Australian grasses were obtained from the Cunningham Laboratory, St. Lucia. Their *in vitro* dry matter digestibility values (determined in Australia) were compared with the corresponding estimates obtained at our laboratory with two-stage *in vitro* technique. The results, though higher, compared well as shown below :—

Species	<i>In viiro</i> D. M. digestibility (as obtained from Australia)	<i>In vitro</i> D. M. digestibility (as determined under our laboratory conditions)
1. <i>Panicum coloratum</i> (Kabulabula)		
(a) 4 weeks regrowth (cut No. 539)	66.2	68.7
(b) 6 weeks regrowth (cut No. 586)	58.8	58.2
(c) 13 weeks regrowth (cut No. 566)	43.7	43.8
2. <i>Panicum maximum</i> North Queensland Guinea)		
(a) 4 weeks regrowth (cut No. 543)	60.5	62.8
(d) 9 weeks regrowth (cut No. 555)	53.9	55.1

(d) Herbage quality in natural *Sehima* grasslands v/s *Cenchrus* pasture.

36 grass samples from a sheep-grazing experiment of the Grassland Management Division were analysed for their IVTDMD and NDF contents. These samples pertained to four treatments, viz., *Sehima* grasslands (control), *Sehima* grasslands + 60 kg N/ha, *Sehima* grasslands + Siratro legume (seed rate : 8 kg/ha with an application of 18 kg P/ha and 60 kg N/ha) and *Cenchrus ciliaris* + *C. setigerus* with 60 kg N/ha. They represented the herbage available at the start of each grazing period in each treatment.

The experiment was carried out from 8.8.73 to 12.12.73. Each treatment had three sub-plots. Three samples from each sub-plot were taken at about six week's interval for the above study. The results showed that, in general, % NDF was lower (66.5-81.2% and IVTDMD values higher (55.8-73.0%) in the months of November and December (on the basis of 12 observations) as compared to those (NDF : 72.4-82.0%, IVTDMD : 47.8-74.3%) pertaining to August, September and October months (on the basis of 24 observations).

(c) Preduction of IVTDMD values from CP content in promising varieties of fodder oat :

(i) Quality ranking of fodder samples has largely been conducted on the basis of crude protein (CP%). It is now being either replaced or accompanied by *in vitro* dry matter digestibility determinations. In this connection, it was interesting to find that IVTDMD values in three promising varieties of fodder oat viz., Australian Kent, Algerian and Weston-11, harvested at different stages of growth in the first cut could be predicted well from the corresponding CP estimates. The regression equation on the basis of 26 observations was :—

$$\text{IVTDMD}\% = 2.4307 \text{ CP}\% + 54.9660, \text{ and}$$

the percentage of variation explained by this equation was 82.6%. The ranges of IVTDMD and CP values employed during the above study were 62.9-95.0% and 4.5 - 18.8%, respectively.

(ii) Another regression equation of IVTDMD on CP (on

the basis of 24 observations pertaining to pooled data from various cuts) was developed as follows :—

$$\text{IVTDMD}\% = 3.5059 \text{ CP}\% + 47.6960, \text{ and}$$

this equation accounted for 77.71% of variation. The range of IVTDMD and CP values used for the above study were 62.9–92.2% and 4.5–13.6% respectively).

(d) Prediction of IVTDMD values from NDF and CP estimates in lucerne :

Ten varieties of lucerne were analysed for their IVTDMD content which ranged from 78.45 to 83.48%. These samples were also evaluated for their percent crude protein (CP%) and neutral detergent fibre (NDF%), whose range was from 15.10 to 17.28 and 31.57 to 37.66% respectively. Studies on the predictability of above IVTDMD values with the help of percent NDF alone and percent NDF and CP together enabled computation of the following regression equations :—

$$\text{IVTDMD}\% = -0.7232 (\text{NDF}\%) + 105.9286,$$

which explained 79.88% of variation, and

$$\text{IVTDMD}\% = -0.8766 (\text{NDF}\%) - 0.7754 (\text{CP}\%) + 123.8491,$$

which accounted for 89.36% of variation.

1.3.3 : In vivo evaluation of forage and fodder crops on cattle, buffalo and goats.

(A. Rekib, I. Kumar, A. P. Singh and V. S. Upadhyay)

1 : Nutritive value of teosinte

A digestion cum metabolic trial was conducted on 6 Haryana male calves to determine the nutritive value of teosinte at flowering stage. Chemical composition data indicated that the crop is very poor in CP (4.68%). The digestibility coefficient of C. P. was also quite low (12.4%). Dry matter intake was 64.6 gm per kg W^{0.75} Negative balance for N and positive balance for Ca and P was observed.

Nutritive value of *Penisetum pedicellatum* :

A digestion cum metabolism trial was conducted on 5 barbari bucks to know the nutritive value of *Penisetum pedicellatum* grass at flowering stage. Chemical composition data revealed that the crop is low

in C. P. (5.0%) and high in crude fibre (42.7%) content. Digestibility coefficient of crude fibre is very high (71.1). Dry matter intake was 29.7 gm per kg $W^{0.75}$ body weight which is quite low. Balances for N and P were negative and for Ca it was positive. From these results it can be concluded that *Penisetum pedicellatum* grass at flowering stage is not sufficiently palatable to barbari bucks and so it did not meet the nutritional requirement of goat.

PAR-2 : STUDIES ON THE ECONOMIC USE OF FODDER FOR INCREASED LIVESTOCK PRODUCTION.

2.1 : Studies on the production potential of different forages in terms of quantity and quality of goat meat.
(Charan Singh and A. Rekib)

Effect of feeding berseem hay prepared by three different methods on the growth rate of barbari kids

An experiment was undertaken to evaluate the quality of berseem hay prepared by three different methods namely fence method (IGFRI, Jhansi), chaff method (H.A.U., Hissar) and ground method (Indigenous practice). Second cut of berseem was taken on 2.2.74 for this purpose.

A metabolism trial was also conducted with 12 barbari kids (about 9 to 12 months of age) divided into 3 groups of 4 animals each to evaluate the relative feeding values of the hays prepared by the three methods. The dry matter intake, digestibility coefficient of various nutrients and the growth rates obtained by the three methods are given in the following table :—

Method of hay making	Dry matter intake kg/100 kg b. w.	Digestibility Co-efficient				Growth rate TDN in gmy/head per day	
		Dry matter	Org. matter	Crude pro-tein	Ether Extract		
1	2	3	4	5	6	7	8
1. Fence method	3.55	65.72	66.09	58.36	38.68	59.55	45
2. Chaff method	3.25	61.98	62.75	53.91	28.46	56.15	35
3. Ground method	3.04	59.16	60.39	54.60	40.05	51.77	36

It is thus indicated that values for the intake of D. M., digestible organic matter, digestible crude protein, total digestible nutrients and growth rate were higher in the hay prepared by fence method.

2.2 : To study the effect of feeding fodder and forage based rations on the efficiency of milk production in dairy animals

(V. S. Upadhyay, K. A. Shankarnarayan, P. Rai and A. Rekib)

Comparative feeding value of *Cenchrus ciliaris* pasture vis-a-vis natural *Sehima* grasslands on milk production in Haryana cows

A study was undertaken on 24th August, 1974 to compare the feeding value of *Cenchrus* pasture and natural *Sehima* grasslands for milk production using 12 Haryana cows giving about 4-5 kg of milk per animal per day. Each animal was given 500 gm concentrate at the time of each milking (twice in a day) for release of milk irrespective of their milk yield.

Results showed that there was practically no difference in milk yield between the two groups of animals. Animal on *Cenchrus* produced on an average 4.29 kg milk daily while animals on *Sehima* grassland produced 4.22 kg/head/day. However, when the animals grazing the *Cenchrus* pasture were switched over to *Sehima* grasslands, the reduction in milk yield was slightly greater (0.345 kg/head/day) as compared to the switch over in the reverse direction (0.201 kg/animal/day). Similar trend was also observed in the body weight gains. The results indicated that there was no apparent difference in feeding values of primary growth of *Cenchrus* pasture vis-a-vis *Sehima* grasslands for milk production during the months of September-October.

Effect of three planes of nutrition on the birth weight of barbari kids

An experiment was undertaken to study the effect of three planes of nutrition on the birth weight of barbari kids. Twenty-four female goats (who had conceived during the months June-July, 1974) were given the following treatments.

Treatments :

1. Grazing of *Cenchrus* pasture alone (control);
2. 100 gms concentrate/head/day and grazing on *Cenchrus* pasture;
3. 200 gms concentrate/head/day and grazing on *Cenchrus* pasture;

Four paddock rotational grazing was practised.

The experiment was started on 13.8.74 and completed on 12.12.74. The body weight of the animals were recorded at fortnightly intervals. During the experimental period one animal each in treatment I and II died. Five goats in each group who kidded between the period from 1.12.74 to 12.12.74 were included in the study.

Results indicated that practically there was no difference in birth weight of kids as affected by three different planes of nutrition of their dams. It showed that if good quality *Cenchrus* pasture is provided to goats, additional feeding of concentrate is not necessary.

PAR-3.1 : CONSERVATION OF FODDER CROPS

(A. P. Singh and A. Rekib)

Quality of silage made from turnips, when ensiled with M. P. chari kadbi

Chaffed M. P. Chari kadbi was mixed with freshly harvested chaffed turnip (1 : 3). The fresh mixture was fed to Hariana heifers for a period of 10 days to know dry matter intake. A portion of it was also ensiled in *pukka* pits. This material was opened after about 120 days of ensiling and was fed to the same calves for a period of 18 days, for dry matter intake. Silage was analysed for quality aspect. Dry matter intakes of the fresh mixture and of the silage were 2.47 ± 0.85 kg and 2.37 ± 0.9 kg/100 kg body weight respectively. Analytical values also gave an indication of good silage stability test (Co₂ production after opening the silage). It can be concluded that M. P. Chari kadbi can be very well utilized by ensiling with turnips. The silage thus produced could be a good substitute for green fodder during summer.

PAR-3.2 : FORTIFICATION OF LOW GRADE ROUGHAGES

(A. Rekib, A. P. Singh, V. S. Upadhyay and B. K. Bhadoria)

Fortification of M. P. chari kadbi with urea-mineral mixture

97.5 kg of chaffed M. P. chari kadbi was mixed with 1 kg urea, 1.5 kg supermindif and 20 kg water and kept in a silo pit just like silage. After 30 days of storage, it was fed to 9 Haryana heifers, 4 Haryana calves and 8 Murrah buffalo calves for 60 days. A digestion-cum-metabolism trial was conducted on the Haryana calves after 40 days of feeding.

Intake study on the 21 growing animals revealed that fortified stover was quite palatable (2.14 kg, 2.12 kg and 1.98 kg dry matter intake per 100 kg body weight for Haryana heifers, Haryana male calves and Murrah buffalo calves, respectively). The animals maintained their body weight.

D. C. P. and T. D. N. contents were 4.0% and 52.1% as compared to 0-0.5% and 50% respectively in untreated fodder, Digestibility co-efficients of all the nutrients were about 50% except of crude fibre which was 63.6%. A positive balance for N and P was observed while the balance for Ca was negative.

PAR-5.1 : STUDIES ON ANOREXIA SYNDROME IN SHEEP AND GOAT

(S. V. Joshi and J. Prasad)

Studies on incidence and physico chemical properties of rumen liquor in various indigestions in sheep & goat

56 cases of primary anorexia syndrome (29 in sheep and 27 in goats) were observed. The incidence of simple, acid and alkaline indigestions, tympany and ruminal impaction was recorded as 62.5%, 16.1%, 1.8%, 17.8% and 1.8% respectively. pH of the rumen liquor varied between 4.6 to 5.8 in acid indigestion, was 8.2 in alkaline indigestion, and 6.7 to 7.0 in simple indigestion and rumen impactions. In rumen acidosis and alkalosis, rumen movements were almost imperceptible indicating that pH changes have marked inhibitory effect on the motility of reticulo-ruminal musculature. The rumen was also found atonic or hypomotile in other cases of anorexia syndrome indicating

that besides pH changes other factors also play an important role in controlling the rumen motility. Activity of rumen infusoria was markedly affected in acid and alkaline indigestions. However, in simple indigestion there was little changes in the motility of the rumen infusoria.

Odour of the rumen liquor varied from vinegar like in acid indigestion to bitter almond like in cases of tympany due to bitter ingestion of *A. leucophloea*. Colour variation in rumen liquor could not be ascribed to any specific reason. In cases of bloat, the rumen liquor was comparatively viscous. Amongst the secondary anorexia syndrome, indigestion was found mainly associated with pneumonia.

It seems that the anorexia syndrome followed the same pattern in sheep and goat as reported in cattle and buffaloes by earlier workers, except that the rumen impaction and alkaline indigestions were practically a rare clinical disorder probably due to peculiar grazing habits and management factors.

PAR-5.2 : Clinical studies on the intraruminal use of antibiotics in the management of bloat

(J. Prasad)

Thirty four cases of primary bloat (20 in cows and calves; 5 in buffalo; 5 in sheep and 4 in goats) were subjected to intraruminal antibiotic therapy. Procaine penicillin in 4-20 lac doses and oxytetracycline hydrochloride 100-500 mg doses were used intraruminally in 16 and 18 cases respectively. The doses of the antibiotics varied according to the species and size of the animal and severity of the disease. 75% and 94.5% cases treated with procaine penicillin and oxytetracycline hydrochloride respectively responded to single dose therapy.

Disease investigation work :

(1) Nine cases of poisoning in sheep and goat grazing in the pasture area infested with *A. leucophloea* (Reunja) bushes were studied in detail. Chemical examination of the rumen contents and the ingested plant material revealed presence of higher levels of hydrocyanic acid. Pods, new leaves, and old leaves were found to contain 600, 400 and 1094 ppm. of HCN respectively. Clinical observations were confirmed by experimental production of the toxicity in goat by feeding pods and

leaves of *Acacia leucophloea*. Treatment with 25% sodium thiosulphate with or without sodium nitrite or terramycin was tried with variable results.

(2) Vitamin A deficiency syndrome was clinically detected in a herd of 21 growing calves fed on fortified M. P. chari kadbi ration without supplementation with greens. All the affected calves showed excessive lacrimation, hyperkeratinization and starring coat in the beginning. In later stages some calves developed non-specific diarrhoea, weakness odomatous swelling of face, vulva and brisket region. One calf also exhibited muscular incoordination and staggering gait. On post mortem both optic nerves were found constricted and epithelium of rumen and reticulum denuded in a buffalo calf. All the rest of cases responded well to the oral administration of shark liver oil.

(3) In order to find out the incidence of subclinical mastitis in the herd, milk samples were subjected to white side plate taste, modified california mastitis test, pH examination, Pfizer mastitis reagent, rapid field test for milk chloride, mastaid solution and cell count. On the basis of whiteside test 48.6% morbidity amongst animals and a quarter incidence of 19.3% was detected. Incidence amongst hind and fore teats was found as 57.7% and 42.3%. Right side was found more vulnerable as compared to left. pH of the milk samples was more towards alkaline side in asymptomatic mastitis glands. Amongst indirect tests like CMT, whiteside test, Pfizer mastitis reagent and mastaid solution, whiteside plate test was found superior and simple.

Clinical work :

(a) Treatment done					
	Medical	Surgical	Gynaecological	Operation	
No. of cases	2326	891	163	30	
(b) Prophylactic vaccination					
	FMD	HS	BQ	Anthrax	Enterotoxaemia
No. of cases	37	247	267	267	100
(c) Deworming — 477					
(d) Clinicopathological examinations :—					
	(i) Haematological			105	

(ii) Biochemical	15
(iii) Rumen liquor	100
(iv) Urine	30
(v) Milk Samples	776
(e) Autopsy —	20

PAR-6.1 : Chemical evaluation of physiologically active constituents of forage plants

(R. K. Gupta, B. K. Bhadoria and V. S. Upadhyay)

Studies were undertaken on *Borreria stricta* (an annual herd) to evaluate its bio-stimulating properties. A preliminary feeding trial conducted on rabbits, showed a significant increase in body weight in the animals maintained purely on *Borreria* diet over those of control. Four kg of powdered plant material was exhaustively extracted with alcohol (95%). The alcohol extractive was fractionated with different organic solvents. Further work on the isolation, purification and identification of the chemical constituents to evaluate their biostimulating properties is in progress.

6.3 : Forage poisoning in livestock investigation on the toxicity of *Acacia leucophloea* and *Rumex dentatus*

(R. K. Gupta, B. K. Bhadoria, S. V. Joshi and J. Prasad)

Investigations on *Rumex dentatus* and *Acacia leucophloea* known to be highly poisonous to farm animals have been taken up to isolate and characterize the toxic constituents present in them with a view to find out a suitable antidote for plant poisoning in animals. Extraction with organic solvents, chromatography on silica gel column and physico-chemical examination of various extractives yielded a number of crystalline constituents from *Rumex dentatus*. Some of the constituents identified were B - sitosterol, B-D glucoside of B - sitosterol, myricyl alcohol, a flavonol and anthraquinone compounds. Further work on the identification of other plant principles and their evaluation is being continued. Seasonal variation in the hydrocyanic acid contents of *Acacia leucophloea* pods and leaves is being carried out. Exeperiments on the isolation of cyanogenetic glycoside, the nature of its aglycone and other phyto-toxic constituents will be undertaken.

Research contemplated :

1. Continuation of studies on the chemical evaluation of forage crops for nutrient yield, possible phyto-toxic and other physiologically active constituents.
2. *In vitro* evaluation of herbage at different period of growth, different combination of legumes and non legumes, conserved forages, etc.
3. *In vivo* evaluation of green guar.
4. Nutritional requirements of Barbari goats.
5. Standardization of nylon bag technique for using it as a tool for evaluation of forages.
6. Growth study in Haryana and buffalo heifers will be undertaken on *Sehima* and *Cenchrus* pasture.
7. Milk production study will be undertaken with cows/buffaloes by feeding oat hay and silage.
8. Studies on growth rate of barbari kids based on forage ration.
9. Studies on conservation of forage into quality hay and silages.
10. *Borreria stricta* plant will be chemically analysed for both organic and inorganic constituents with a view to isolate, identify and evaluate its biostimulatory properties. Feeding studies will be conducted on rabbits and kids to confirm the earlier findings.
11. Seasonal variation in the hydrocyanic acid content in various parts of *Acacia leucophloea* will be studied. Investigations are contemplated on the isolation and characterization of the toxic constituents of the plant and to explore the possibility of utilizing this leguminous shrub, which is relished by goats and kids as a stock animal feed after eliminating its toxic chemicals.

EXTENSION AND ECONOMICS DIVISION

RESEARCH WORK DONE

AES-1 : STUDY ON COST OF CULTIVATION OF CROPS AT CENTRAL RESEARCH FARM, JHANSI

(Ram Prakash, H. H. Datta, I. P. S. Yadav, Ravi Kumar
and C. L. Yadav)

Cost of cultivation of kharif grasses, namely, *Cenchrus ciliaris* (Var. 3108), *Cenchrus ciliaris* (Var. Molopo), *Cenchrus ciliaris* (Var. buffel) and *Cenchrus setigerus* along with relative contributions of different inputs involved in their cultivation for the year 1973-74 had been worked out.

Analysis of data revealed that cost of cultivation of *Cenchrus ciliaris* (Var. 3108), *Cenchrus ciliaris* (Var. Molopo), *Cenchrus ciliaris* (Var. buffel) and *Cenchrus setigerus* for seed production was Rs. 829.21 per ha., Rs. 947.93 per ha., Rs. 942.13 per ha. and Rs. 917.96 per ha. respectively with estimated corresponding seed yields at 77.37 kg/ha, 63.79 kg/ha, 53.77 kg/ha and 51.26 kg/ha resulting in net cost of seed production at Rs. 667/q, Rs. 833/q, Rs. 890.79/q and Rs. 924.76/q.

It was further observed that hired manual and bullock labour together farming the pool of non-mechanisation accounted for the largest portion of total cost and was 43% of the total gross cost in *Cenchrus ciliaris* (Var. 3108), 47%, in *Cenchrus ciliaris* (Var. Molopo), 48% in *Cenchrus ciliaris* (Var. Buffel) and 37% in *Cenchrus setigerus*. Mechanisation of farm operations in the form of tractor operation involved cost to an extent of 6% in *Cenchrus setigerus*, 7% in *Cenchrus ciliaris* (Var. 3108) and 8% each in remaining two grasses. Among the other inputs seed cost accounted for 8% in *Cenchrus ciliaris* (Var. 3108), 15% in *Cenchrus setigerus* and 9% each in *Cenchrus ciliaris* (Var. Molopo) and *Cenchrus ciliaris* (Var. buffel), while the corresponding fertilizer cost involved 16%, 20% and 14% respectively in that order. Overhead charges including depreciation, interest on working capital repairs to dead stock and rental value accounted for 26% in *Cenchrus ciliaris*, (Var. 3108), 22% each in *Cenchrus ciliaris* (Var. Molopo) and *Cenchrus setigerus*

and 21% in *Cenchrus ciliaris* (Var. buffel).

The results of input-output ratio for these grasses revealed that the cultivation of *Cenchrus ciliaris* (Var. 3108) provided the most profitable having ratio of 1 : 2.25, followed by *Cenchrus ciliaris* (Var. Molopo), *Cenchrus ciliaris* (Var. buffel) and *Cenchrus setigerus* with their respective ratios of 1 : 1.80, 1 : 1.68 and 1 : 1.62 during the year 1973-74.

AES-2 : SOCIO-ECONOMIC SURVEY IN AMBABAI VILLAGE (H. H. Dutta, P. R. Sreenath and Ram Prakash)

Preliminary survey of all the 335 household in this village was completed during the period. Of these households 299 were found to be landowners, and the rest 36 landless labourers. Amongst the landowners, 288 were cultivators and 11 non-cultivators, the latter having pastures and grazing lands only. Size of operational holding ranged from 1 to 90 acres. The average size of holdings of the two categories were 5.96 acres and 4.82 acres respectively. The operational holdings had been classified into three groups : (i) Below 6 acres - small group; (ii) 6 to 12 acres - Medium group; (iii) 12 acres and above - Large group. For the purpose of detailed study, a random sample of 60 operational holdings 20 each from the small group of 161 holdings, the medium group of 108 holdings and the large group of 30 holdings - had been selected. As the numbers of non-operational holdings was too small for sampling, all the households (11) in this category were selected. Thus in all 71 holdings were taken up for the detailed study. As per comprehensive schedule, data for the year 1973-74 were collected for 7 holdings in the low group, 6 holdings in the medium group and 12 holdings in the large group of the operational category. Data collection for the remaining holdings of both the categories was under way.

AES-3 : STUDIES IN ECONOMICS OF LIVESTOCK PRODUCTS (H. H. Datta, P. R. Sreenath and Ram Prakash)

As far as livestock product i. e. milk production of cattle and buffaloes was concerned, data for the year 1973-74 as per comprehensive schedule were collected simultaneously from the same holdings as were enumerated for the Project AES-2. Data for the remaining holdings of both operational and non-operational categories randomly selected under the project AES-2 was under way.

AES-4 : ALLIED STUDIES IN THE CENTRAL RESEARCH FARM

- A. BULLOCK MAINTENANCE COST :
- B. COST OF TRACTOR OPERATION :
- C. COST OF PUMPING SET OPERATION :

(Ram Prakash, H. H. Dutta, I. P. S. Yadav, S. N. Sankhwar, R. B. Varshney and V. S. Upadhyay)

A. BULLOCK MAINTENANCE COST :

Annual cost of bullock maintenance per pair alongwith its allocation among the different components per working day/per hour had been worked out from the data of the year 1972-73. Net maintenance cost per working day was estimated at Rs. 7.05 registering a rise of 40% over the corresponding estimate of 1971-72. This rise in cost was ascribed to relative rise in the total cost of fodders and concentrates fed to the animals caused by rise in the price of animal feeds.

B. COST OF TRACTOR OPERATION :

Overall, as well as, break-up cost of operation of Russian Bylarus No. 1, Russian Bylarus No. 2, Massey Ferguson (135) Massey Ferguson (165) and one old Massey Ferguson (1035) was worked out from the data of the year 1972-73. The analysis revealed that per hour cost of operation was Rs. 16.04 for R. B. No. 1, Rs. 12.54 for R. B. No. 2, Rs. 5.66 for M. F. (135), Rs. 7.00 for M. F. (165) and Rs. 7.20 for old M.F. (1035). Per hour cost last year was Rs. 11.51 for R.B. No. 1, Rs. 12.87 for R. B. No. 2, and Rs. 7.13 for the old M. F. Nearly 40% rise in the overall cost of R. B. No. 1 during this year over that of last year was on account of occasional breakdown resulting in higher repair and replacement cost incurred during the current year. The cost of operation of old M.F. remained almost even in both the years. The slight comparative fall in cost of operation of R. B. No. 2 was due to better care and maintenance and more annual use.

C. COST OF PUMPING SET OPERATION :

Per hour cost of operation of three pumping sets (Kirloskar Diesel Engine) No. 1, 2 and 3 had been worked out from the data of

the year 1972-73. Analysis revealed that per hour cost of operation was Rs. 15.06 for pumping set No. 1, Rs. 3.96 for pumping set No. 2 and Rs. 3.35 for pumping set No. 3 during this year, as against the corresponding estimates at Rs. 13.95, Rs. 3.08 and Rs. 3.68 respectively during last year. All the three pumping sets registered a marked rise in the unit cost of their operation during this year over that of the previous year on account of their less utilization compiled with higher cost of the operational inputs.

AGRICULTURAL ENGINEERING DIVISION

Salient features

Developed a bullock drawn grass seed collector for collecting the ripened grass seeds of various species.

Developed a low cost farm implement for efficient water management.

An inter-row weeder-cum-mulcher was developed for inter-cultural operations and mulching.

Field trials on mechanical harvesters revealed that use of forage harvester increased the yield of M. P. Chari in the first as well as in second cuttings as compared to the manual methods.

Stem crushing reduced the drying rate of berseem and oats hay to the extent of 60%.

RESEARCH WORK DONE

AE-1 DESIGN, DEVELOPMENT AND EVALUATION OF FORAGE HARVESTING, SEED COLLECTING AND PROCESSING MACHINERY

(Jai Singh)

(a) Combined forage harvester

The combined forage harvester developed after incorporating modifications in the exotic flail type forage harvester was put under rigorous field trials for harvesting of the cultivated fodder crops and range grasses for evaluating the working efficiency of the machine under different soil-crop climatic conditions. During these trials further modification on the synchronisation of the upward and downward movements of the machine was felt necessary in order to completely avoid the digging of soil from the top of the ridges. This could be possible providing 4-wheels on the side of main frame instead of 3-wheels provided presently. The working of the machine was found to be satisfactory on the plain areas.

During the above field trials the machine was also found working satisfactorily for (i) automatic pickup of the hay windrows and loading in the trailer and (ii) for hay conditioning which help in quick drying of the stalks for quality hay making.

(b) Grass seed collector

The bullock drawn grass seed collector designed for collecting the ripened grass seeds from the standing grasslands was further developed for structural strength, static and dynamic stability and ease of operation.

A simple tractor drawn grass seed collector was also designed, developed, fabricated and tested in the field. The machine gave promising results in *Cenchrus ciliaris* grasslands. The machine however could not be considered useful for undulating and rolling topography because it requires a very high ground speed of the tractor ranging about 18-20 km/hr.

(c) Irrigation channel-cum-bund former

The bullock and tractor drawn channel-cum-bund former developed for making the different sizes of field channels and/or bunds for efficient water management in the irrigated areas was also found useful in the rainfed areas for making close spaced field bunds/levels for water harvesting and conservations.

The tractor and bullock drawn channel-cum-bund formers were evaluated under different conditions in and around the Jhansi area with good results.

(d) Berseem seed cleaning and grading machine

Development of the chicory seed separator from berseem seed continued during the year. The prototype manufacturing drawings were prepared and supplied to the National Seeds Corporation, New Delhi and Animal Husbandry Deptt., Govt. of Punjab for fabrication at their end.

**AE-3 DESIGN DEVELOPMENT AND EVALUTION OF HAY
CONDITIONER AND RAKE FOR QUALITY HAY
MAKING**

(Jai Singh)

(a) Development of rake

Functional prototype of a tractor mounted rotary star type wind-

rower was designed, developed and fabricated. The implement is used for placing the swath in loose and fluffy windrows overturning of the windrows and raking up of the material. The machine will help making quality hay by faster curing thus reducing the loss of nutrients. Further development and testing of the machine will be done in the next year.

During field trials on windrowing it was found that the combine forage harvester can also be made to place the harvested fodder into a windrow. This can be achieved by attaching a fodder chute on the blower head of the harvester.

(b) Development of hay conditioner

The combine forage harvester was evaluated for conditioning of oats, M. P. Chari and grass hay. The results revealed that by simply harvesting the crop using forage harvester the drying period can be reduced by 50%.

Crushing effect on berseem hay was also studied in the laboratory scale and found that crushing reduced the total drying period to the extent of 70%.

AE-4 INFLUENCE OF ENGINEERING PRACTICES ON MOISTURE CONSERVATION AND FORAGE PRODUCTION IN RANGE GRASS OF *SEHIMA DICHANTHIUM* COVER

(R. B. Varshney, Jai Singh and B. K. Trivedi)

The experiment to study the effect of pitting, contour bunding and contour furrowing on the production of fodder and improvement of the botanical composition of the existing flora was laid out. The observations are being collected.

Development of hand tools

A simple manually operated star wheel inter-row weeder-cum-mulcher was developed which in simultaneous operations chops the weeds, tills the soil and gently rolls the earth to create mulching effect. With the use of this equipment the weeds need not be removed from the field as after decomposition they add organic matter in the soil. The

equipment is adjustable for different row spacings in the multiples of 15 cm. It can cover an area of about 0.2 ha per day and can be got fabricated at an approximate cost of Rs. 100 to 120/-.

Effect of mechanical harvesters on regeneration and production of multi-cut fodder crops

The studies were conducted on M. P. Chari (*Sorghum bicolor*). Three methods of harvesting namely (i) by hand i. e., control (ii) by tractor-drawn forage harvester and (iii) tractor drawn mower were tried. The crop was harvested twice, first cut at 55 days after sowing and second cut at 45 days after the first cut. The plot sizes were kept as 30m × 8m. The trial was repeated for 3 years with four replications.

The green fodder yield in different cuttings with different methods of harvesting are given below :

Year	No. of cut	Green fodder yield in q/ha		
		Forage harvester	Harvester Mower	Hand Sickle
1971	Ist	444.0	442.0	415.0
	IInd	317.0	316.0	300.0
1972	Ist	201.0	180.0	176.0
	IInd	129.0	120.0	119.0
1973	Ist	223.0	215.0	208.0
	IInd	145.0	134.0	131.0

From these observations it is seen that the total green fodder yield increased by tractor-drawn forage harvester and tractor-drawn mower over the manual methods in the first as well as in the second cuttings.

Miscellaneous work

Petty works :

Design, estimation and construction of 2000 rm under ground water conveyance channel with appropriate outlets was dug up and made pucca at the Central Research Farm of the Institute campus. Three pump houses with over-head tanks were also constructed. Repairs and maintenance of the farm structures were carried out regularly.

Repair, maintenance & operation of farm Machinery

All the pre and post farm operations including the irrigation, repairs, maintenance of all the tractors, transport vehicles, farm machinery and implements, laboratory equipments and other allied hand tools were carried out by the Division.

Farm Development

The staff of the Division was actively associated in the development and face lifting of the farm and the Institute campus through reclamation, bush cleaning, land levelling and grading providing the irrigation and drainage facilities, farm electrification and establishment of the lawns and gardens etc.

I. G. F. R. I., SUB STATION, MANASBAL (J & K)

RESEARCH WORK DONE

EFFECT OF DIFFERENT LEVELS OF NITROGEN ON THE GROWTH AND FORAGE PRODUCTION OF DIFFERENT RANGE GRASSES

The experiment was initiated during April 1974 to study the effect of different levels of Nitrogen (0, 30, 60, 90 and 120 kg/ha) on the growth and production of 4 range grasses viz., *Dactylis glomerata*, *Lolium perenne*, *Festuca arundinacea* and *Bothriochloa pertusa*. The results obtained indicated linear response to the application of Nitrogen upto 90 kg/ha in natural *Bothriochloa grasslands* and also in cultivated *Dactylis glomerata* with the highest green fodder production of 135 and 230 q/ha respectively.

The highest green fodder production (188 q/ha) in *Lolium perenne* was obtained with the application of 120 kg N/ha as compared to 92 q/ha, obtained without the application of Nitrogen. In case of *Festuca arundinacea* the response to the application of Nitrogen was obtained with 60 kg N/ha. Here the maximum green fodder recorded was 242 q/ha.

In all these range grasses the height of the plant and number of tillers per plant showed remarkable increase as the level of Nitrogen increased.

(B) EFFECT OF THE APPLICATION OF VARYING DOSES OF PHOSPHATE ON GROWTH AND FORAGE PRODUCTION OF *TRIFOLIUM SUBTERRANEUM*

The experiment was initiated during April, 1974 with a view to study the effect of different levels of Phosphorus (0, 30, 60, 90 and 120 kg P₂O₅/ha) on the growth and forage production of *subterraneum* clover.

Results showed that in *Trifolium subterraneum* responded to the application of Phosphorus only upto 60 kg P₂O₅/ha. The highest green

fodder production of 490 q/ha was obtained with this level of application as compared to 222 q/ha, obtained without application of Phosphorus.

Highest of the plant, number of branches per plant and lateral spreading of the plant were recorded and was found maximum under 60 kg P₂O₅/ha fertilization.

(C) **PRODUCTIVITY STUDIES OF THE NATIVE GRASSLAND SPECIES AT MANASBAL**

In natural grasslands, productivity of *Bothriochloa pertusa*, *Trifolium pratense*, *T. repense*, *Medicago sativa* and *M. minima* were estimated fortnightly from start of growth in nature with the onset of spring in April until its cessation of growth in the month of November. Fresh weight of the biomass (standing) was estimated.

Fresh weight of the standing biomass in *Bothriochloa* showed maximum values (2.096 kg/m²) during the second fortnight of July. Thereafter there was, no freshgrowth until March. For *Trifolium pratense* and *T. repense*, maximum fresh weight of herbage was recorded in the first fortnight of July being, 8.528 and 2.656 kg/m² respectively. In *Medicago sativa* the maximum fresh weight (3.296 kg m²) of the standing biomass was obtained during the second fortnight of June. The highest standing biomass for *Medicago minima* in terms of fresh weight was 1.562 kg/m², recorded during the first fortnight of June.

(D) **COMPARATIVE PERFORMANCE OF DIFFERENT COLLECTIONS OF *TRIFOLIUM REPENSE***

Ten collections of *Trifolium repense* were sown as pure stand for evaluating their performance. Fodder attributes such as height of plant, lateral spreading and green fodder yield were recorded.

Among the 10 collections maximum height was recorded in var. Luisiana (39 cm) and minimum in E C 65860 (18 cm). Lateral spreading was also found to be maximum in var. Luisiana. The green fodder yield was highest in var. Luisiana (being 7.2 kg/m²) followed by E C 21578 (6.1 kg/m²) and was lowest in E C 65870 (2.1 kg/m²).

PUBLICATIONS

During the year 1974, the following research papers and articles of general interest pertaining to various aspects of forage production and its utilization were sent for publication to various scientific journals and/or presentation at various All India Seminars/Conferences :

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3. Ahmad, S. T., Magoon, M. L. and Mehra, K. L. : Evaluation of certain forage plants introductions for resistance for plant diseases; XII International Grassland Congress, Moscow.
4. Amar Singh and Ahmad, S. T. : Grow healthier cowpea; Gosamvardhana.
5. Amar Singh, *et. al.* : Two African grasses for year-round green fodder supply; Gosamvardhana.
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21. Gupta, R. K. and Dutta, T. R. : Estimation of linuron residues in some fodder crops and soils; Indian Chemical Society.
 22. Gupta, S. C., Rekib, A, Sreenath, P. R., Singh, A. P. and Verma, N. C. : Prediction of nutritive value of freshly harvested and conserved fodder oat using laboratory analysis data; Journal of British Grassland Society.
 23. Handa, D. P. and Rekib, A. : Fodder-impact on the economics of milk production; Indian Farming.
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A

In local and multiple
components in 12
phenotypic and
sub-species or
crosses were
studied :

SUMMARY OF RESEARCH WORK

As a pre-requisite for breeding programme, the germplasm bank of forage crops was further enriched with exotic and indigenous collections of legumes and grasses thus bringing the total to 4562 in legumes, 4158 in grasses and 15 in other forage crops during 1974. Evaluation of these collections was carried out.

In *Cenchrus ciliaris*, based on the cumulative green fodder yields in two separate trials in sixth and fourth year of evaluation, varieties 3813, 3108, 3801 and 59-1 were found superior to Pusa Gaint Anjan (control). Correlation studies in 28 varieties of *C. ciliaris* revealed that selection of tall plants bearing broad leaves and long spakes having many involucels could lead to high fodder and seed yielding type of *C. ciliaris*.

In guar several high yielding lines were isolated following evaluation of 100 collections in replicated trial.

Yield differences among 25 collections of moth were found to be significant and four promising selections were isolated.

Genetic variability was studied in berseem, soybean, *Pennisetum pedicellatum* and *Cenchrus ciliaris*.

Varietal evaluation trials were conducted in *Clitoria ternatea* and *Atylosia scarabaeoides*.

In cowpeas, 832 collections were screened for vigour, growth habit and flowering; 100 promising segregants of five intervarietal crosses were selected for economic characters; 11 F₁ hybrids between sub-species of *Vigna sinensis* were screened; and nature and extent of 28 phenotypic and environmental correlation coefficients for fodder yielding components in 154 cultivars from five regions of the world were studied. In local and multilocation yield trials besides IGFRI-S-978, -985 and

-457, three other selections, IGFRI-S-998, -143 and -515 were found superior in green fodder yield.

In lucerne, 250 cultures were screened for drought hardness, growth habit, general vigour, leafiness and seed setting ability. In the lucerne varietal evaluation trial, Syn-4 and Syn-5 gave higher green fodder yield in two cuts than Sirsa-9.

In velvet bean, 40 cultivars were screened for different growth characters. High fodder yielding types were isolated based on evaluation of eight cultures in replicated trials.

Germplasm collections of horsegram and field bean were screened for fodder characters. In field bean maximum green fodder yields were secured in IGFRI-S-228-I (280 q/ha) and IGFRI-S-2230-III (220 q/ha) cut at flowering stage.

In fodder sorghum, 23.33% increase in green fodder yields over M. P. chari (control) were recorded in advanced generations hybrid derivatives of two crosses and two selections. Promising selections were isolated based on evaluation of germplasm.

In oats intrapopulation selection could be successfully practiced for fodder and seed yields; selections viz., IGFRI-S-2672, -2636 and -2660 were found to be promising with comparable cumulative green fodder yield (two cut) as S-3021 recommended for pre-release multiplication; the physico-morphic characteristics underlying fodder yield superiority in 'drooping' plant types among the three plant types studies were identified.

Breeders seed were multiplied in lucerne (IGFRI-S-244) and Oats (IGFRI-S-2688 and -3021).

The peak period of incidence of insect parts in lucerne was between second week of February to fourth week of March and in Cowpea fourth week of September. Early sowings of lucerne and cowpea favoured low incidence of pests and higher fodder yields. In lucerne a dose of 1.5 kg/ha of dipterox, endosulfan and malathion was efficacious in checking incidence of leaf hopper, lucerne weevil and aphid. On the other hand, in cowpea, soil application of carbofuran (even @ 1.0 kg/ha) was quite effective in checking the incidence of leaf hopper and flea beetle as com-

pared to 1.0, 1.5 and 2.0 kg/ha applications of endosulfan and malathion. However, foliar formulations of all the three chemicals were effective in checking insect pests of cowpea.

Application of growth regulators (GA, Phosfan-D, Ascorbic acid, B-nine and CCC) increased fodder and seed yields in cowpea, berseem and lucerne.

Vitavax and Dithane M-45 were found to be superior in controlling rust of lucerne. Rust resistant F₂ generation plants were isolated in Oats.

Several useful findings emerged from experiments conducted on the cultural, manurial and irrigation aspects of forage cultivation both for fodder and seed purposes.

For maximisation of fodder yields in fodder oats cv. Kent, basal application of 120 kg N/ha proved superior to split applications leading to a turn-over of 544 q/ha of green fodder (86.9 q/ha D. M.). Efficacy of Mussoorie, Laccadive and Udaipur rockphosphates in terms of fodder yields of lucerne to the extent of 78, 62 and 54 percent, respectively, over superphosphate was recorded in pot culture studies with a soil pH of 6.8.

Interesting informations were gleaned regarding micronutrients in forage crop cultivation. In jowar (M. P. chari) raised under rainfed conditions, Zinc and Manganese applications to soil favoured fodder yields even though significant treatment differences were not recorded. Deficiency of sulphur occurred in 65% of forage growing areas of Bundelkhand and in light textured soils which were under grassland for several years. Further Nitrogen-Sulphur ratio in herbages was not balanced and as against the desired 10 : 1 ratio, ratios of 15 : 1, 22 : 1 and 38:1 were observed in lucerne, benkulthi and oats, respectively.

Seed production aspects of fodder crops were taken up. Guar crop grown exclusively for seed gave over twice as much seed yield as a crop where a cut is taken around 70 days (seed yields being 8.88 q/ha and 3.69 q/ha respectively). In the seed production of berseem, economy in water use could be practiced without detriment to seed yields. Thus, two irrigations on 15 and 30 days after third cut was adequate for

securing comparable seed yields as would be realized with one or two additional fortnightly irrigations.

The closure of forests to grazing under Bundelkhand conditions proved beneficial in restoring fertility.

Fertilizer application to grassland favoured productivity. Different sources of nitrogenous fertilizers were evaluated. In the *Sehima-Heteropogon* grasslands, application of Ammonium sulphate @ 60 kg N/ha increased the dry forage yield to 79.2 q/ha as against 75.4 q/ha in case of Calcium ammonium nitrate, 72.6 q/ha in Urea-treated plots and 60.6 q/ha following FYM application. While neem cake coated urea did not show any effect on forage production but its timely application (around mid-July) favoured a good harvest in the first cut. Both *Sehima nervosum* and *Heteropogon contortus* recorded excellent root proliferation as judged by root number and total weight in treatment combination of $N_{60} + P_{40}$.

Considering the lack of pasture-legume component in our natural grasslands the work on introduction of legumes into grasslands was given due priority in the programme. *Stylosanthes humilis* and *Glycine javanica* could be broadcast in pre-monsoon or sown in lines during monsoon with 20 kg P_2O_5 application for best germination and establishment. Comparative performance of grass-legume mixture and their pure swards was studied with three varieties of *Cenchrus ciliaris* and three tropical legumes, namely, *Stylosanthes humilis*, *Macroptelium Atropurpureus* and *Clitoria ternatea*. Mortality percentage of transplants of the three *C. ciliaris* varieties differed in the three situations. Variety Moloce sustained high mortality in *S. humilis* while 3108 in *M. atropurpureus* and Pusa Giant Anjan in *C. ternatea* swards.

The performance of Mandya sheep clearly showed the superiority of mixed pasture in respect of weight gain of animals. The highest gain of 37.5 kg was obtained in *Cenchrus-Siratro* pasture as compared to 21.9 kg in *Sehima* control. *Sehima-Stylosanthes* mixed pasture caused weight gain of 24.7 kg. The *Cenchrus-Siratro* pasture additionally provided highest grazing days of 1818 against 1776 in *Sehima-Stylosanthes* pasture, 1662 in *Sehima* with 60 kg N/ha and 989 in *Sehima* control.

Experiments on the merit of continuous versus deferred-rotational

grazing system in *Sehima* grasslands in its 5th year showed the superiority of the latter. The two treatments provided, respectively, 1602 and 2136 grazing days to Haryana heifers. However, the continuous system was found to be conducive for body weight gain of 412 g/heifer/day under continuous system and 362 g/heifer/day under deferred grazing.

The effect of burning with or without grazing on changes in botanical composition of *Sehima* grasslands showed very interesting relationships. In ungrazed but annually burned plots, *Sehima* showed very low (6.5%) population while *Heteropogon contortus* increased to 38.5%. In grazed plots with biennial burning *Heteropogon contortus* showed vigorous growth.

Conditions favourable for seed health and germinability of the range grass, *Heteropogon contortus* was assessed in an experiment. The heaviest seed with longer viability were found to be associated with vigorous plant types secured from 20 kg P plots.

Silvipasture studies were intensified. A comparative evaluation of *Acacia tortilis* and *Leucaena leucocephala* in combination with the pasture grass *C. ciliaris* revealed superiority of the former in terms of forage production. The establishment of *Leucaena leucocephala* in between lines of various forage grasses was evaluated in terms of survival percentage. Among the grass stands tried, namely, *Setaria sphacelata*, *Chrysopogon fulvus*, *Cenchrus ciliaris* and *Heteropogon contortus*, both *C. fulvus* and *S. sphacelata* seem to be conducive for the establishment of legume.

Comprehensive studies on extent of crop yield losses due to weed infestation and effectiveness of herbicides were undertaken in this year. Yield losses in fodder crops during *rabi* were assessed under weed infestation and weed free conditions. In lucerne such losses were estimated as 11.7% and in oat 8.3%. Appropriate weedicides have been determined along with the doses for the various fodder and other crops. The suitable weed control measures which were found to be promising in increasing the fodder yields for crops include : pre-pl. trifluralin @ 1 to 2 kg for fodder turnip, pre-emergence linuron @ 0.5 kg to fodder oat, pre-pl. nitratin @ 1.5 kg for guar, pre-emergence atrazine @ 0.5 kg for pearl millet and pre-emergence alachlor @ 2.5 kg for Soybean. Evaluation trials with new components were also undertaken to isolate selective weedicides for both cereal and legume fodders. Bentazone @ 1 to 3 kg/ha and benefin @ 0.5 to

1.5 kg/ha were found to be promising for this purpose. Dicamba @ 0.5 to 1.0 kg/ha was found to be selective for graminaceous crop in *rabi* screening trial. Excellent weed control for as long as 3 months with good selectivity could be obtained with Methabenzehiazuron @ 2 to 4 kg/ha in case of wheat, barley, oats and lentil.

Synthesis of herbicide analogues was pursued with success and as many as 12 herbicides analogues using *B* - amino-benzo-trifluoride and carboxylic acids was synthesised for large scale testing.

The other beneficial effects of herbicide application were also unravelled through critical laboratory studies. In oats herbicide induced stomatal closure and curtailed transpiration losses upto 40 percent at seedling stage when sprayed with diuron or atrazine at 10^{-3} M. Foliar spray of S-triazines @ 0.05 to 0.1 kg/ha improved protein content of fodder sorghum at higher soil-applied N-levels.

Autecological studies of *Sachharum spontaneum* indicated greater sprouting of buds lying at upper zone soil profile. Alternating high and low temperatures of 40°C and 10°C (7 hrs each) or applications of either 100 ppm GA₃ or 3.5 percent ascorbic acid, broke bud dormancy while moisture stress induced early flowering.

Detailed studies on the nutritive value of forages, as green, conserved and fortified were conducted both for cultivated fodders and pasture species. The proximate analysis was followed up with *in vitro* true dry matter digestibility (IVTDM) and animal feeding tests. In addition, non-conventional plant species were also evaluated for the possible feeding value and as sources of biological active components.

Chemical evaluation of 15 oat varieties harvested after 70 and 115 days of sowing enabled to identify varieties superior with respect to dry matter (DM) yield, crude protein (CP) and neutral detergent fibre (NDF) judged on the overall performance in the two cuts, the variety IG 2672 appears promising on account of its maximum DM and CP yields and relatively lower NDF yield. Among the 16 hybrid napier varieties studied on the gross nutrient content, yield and presence of oxalate revealed a decreasing trend in CP. While an increase in oxalate percentage showed the increase in the height of the plant. Both NDF and oxalate yields

increased with maturity.

In vitro true digestibility values were obtained for three promising oat varieties at different stages of growth. The CP estimates showed a very good correspondence with the IVTDMD values. A similar relationship was also observed in case of lucerne where ten varieties were subject to detailed evaluation. Both CP and NDF could be used to predict IVTDMD values.

To tide over the lean period in fodder availability, conservation methods for production of hay and haylage were paid due attention. In berseem hay making by fence method of Jhansi was compared with traditional ground and shaft methods of conservation. The superiority of the fence method was evident in the increased DM intake, digestibility and body weight gain/head/day in barbari goat. The greater CP content of the hay made by fence method was closely associated with all the three parameters. A satisfactory product (haylage) was obtained when turnip with M. P. chari kadbi (3 : 1) was conserved. The conserved herbage could be a good substitute for green fodder during summer.

Fortification studies of crop residues was taken up with M. P. chari kadbi. 1 percent urea, 1.5% supermindif mineral mixture with the addition of 20 kg water to 100 kg mixture of M. P. chari kadbi conserved in silo pits for 30 days gave a palatable fodder. The fodder had 4 percent DCP against 0-0.5% in untreated fodder, portending adequacy of fortified fodder as a maintenance ration in growing animals. The fortified fodder gave on an average a little over 2 kg DM intake/100 kg body weight in Haryana and Murrah buffalo calves.

The potentiality of *Sehima-Cenchrus* pastures were compared for the milk production with Haryana cows. There was no significant difference in milk yields when Haryana cows grazed on these two pastures. Birth weight of kids from pregnant female goat maintained exclusively on *Cenchrus* pasture as well as with supplement (100 or 200 g concentrate/head/day) showed no difference indicating the adequacy of *Cenchrus* pasture for maintenance of goats.

Experimental findings revealed that anorexia syndrome in sheep and goat followed the same pattern as in cattle and buffaloes. Several cases of bloat were treated with procaine penicillin and oxytetracycline

hydrochloride. The response to single dose therapy was 75% and 94.5% respectively.

There has been increase in body weight of rabbits when these have been fed with *Borreria stricta* only as the sole diet. A number of crystalline constituents such as, B - sitosterol, B - D - glucoside of B - sitosterol, myricyl alcohol, a flavonol and three anthroquinone derivatives have been isolated and identified from *Rumex dentatus*.