Annual Report
2004-2005

RAU Bihar

Rajendra Agricultural University, Bihar
Pusa (Samastipur) 848125, India

Dr. H. P. Singh
Vice-Chancellor
Rajendra Agricultural University
Pusa (Samastipur) 848125

FORE WORD

The State of Bihar, stretched between 24^0-27^0 latitude and 83^0–88^0 longitude, with total geographical area of 19104 sq km shares 2.86% national area and supports more than 8% of population. With a favourable agro- climatic conditions and adequate amount of water, agriculture continue to be the main stay for the livelihood security of more than 73 million people. However, despite the favourable natural resources, production and productivity of large number of agricultural crops continue to be low. Low productivity is associated with poor infrastructure, technological gap and in adequate human resources.

Rajendra Agricultural University, established in 1971, at Pusa, has provided human resources in agriculture and also the technologies for improving production during the last 3 decades, but this is not adequate in changing scenario of agriculture, to address emerging needs. The University has strength in honeybee production, rice improvement, maize programmes of vegetable, tuber crops, litchi and more exclusively, varieties of sugarcane. The cultivars of sugarcane has developed wide adoption in the country. Graduates and post graduates of the University are also certifying to agriculture development loading different position. The present Annual Report is an attempt to compile all the information together for it critical examination to have re-orientation of programme, if needed. The Annual Report contains information on academic, research and extension under different heads, based on the activities done during the last year.

It is surprising to note that number of seats available in agriculture is not tuned to the needs of 83 million population, resulting in shortage of human resources and also out flow of the students for getting their education outside the State. Through the research new cultivars & new technology have been developed but there is no institutional mechanism to provide efficient delivery system. Establishment of KVK may now prove a vehicle for dissemination of technology.

It is the time to introspect now and adjust the existing resources, and man power to address emerging needs. In the last three weeks an extensive exercises have been done to make the agriculture led development in the State, a reality. I am sure, this Annual Report will provide an insight for louder thinking in our endeavour of knowledge based, technology driven farmer centric approach in agriculture. I compliment Dr. B. N. Verma, Registrar and his colleagues for their untiring efforts in bringing out the draft of this Annual Report in the period of one week.

The concerted efforts with targeted goal in mission mode with cooperation of all the concerned, will bear the fruits for achieving the vision of our Hon'ble Chief Minister. Finally, I wish a prosperous and fruitful new year to all, with hope of brightest future.

H. P. Singh

December, 2005
RAU, Pusa

(H. P. Singh)
Vice-Chancellor

PREFACE

It gives me pleasure in getting this Annual Report of RAU, ready for circulation. It presents the status of teaching, research and extension in agriculture and allied sector initiated and completed successfully by RAU during a period 2004-2006.

The sequence of the sections under which report from various units have been arranged are, the teaching activities, research achievements under the heads: crop improvement, genetic resources research management and environment, crop protection, basic and strategic research, soil science and technology transfer, budget estimates etc. Trends in some of the teaching aspects determined on the occasion of golden jubilee celebration of the 50th Academic Council on the basis of the related data complied since inception of this university has also been presented here. Besides, wherever possible some data have been illustrated with the help of suitable diagrams. Appropriate photographs have also been used to make the presentation more impressive in the report. I must extend my sincere thanks to Dr. S. K. Jain, Associate Professor, College of Agricultural Engineering for his expertise in computer techniques with which he has made the task easier and more impressive. Others who worked night and day on computer are Sri Ravi Shankar Sahay, Sri Devendra Kumar Sinha and Sri Ravindra Kumar and they deserve appreciation.

Thanks are due to direct and indirect contribution of all in different Faculties and Directorates of the University without which such a comprehensive attempt of completing this report in such a shorter period would not have been possible.

Last but not least, I much express my gratitude to the force of leadership of our new Vice-Chancellor Dr. H. P. Singh, the man behind the mission who always inspired we all to undertake such effort and to complete the same with a continued zeal and confidence.

December, 2005
RAU, Pusa

(B. N. Verma)
Registrar

CONTENTS

1. Academic Report

With the establishment of Rajendtra Agril University on 3rd of December 1970 by an act in the length and breath of undivided Bihar, the University had the following colleges, which imparts education both for Undergraduate and Postgraduate (M.Sc./Ph.D.) Programmes transferred from Govt. of Bihar with its assets and liabilities.

1. Bihar Agril. College Sabour (Bhagalpur)
2. Ranchi Agril. College , Kanke, Ranchi
3. Tirhut College of Agriculture, Dholi (Muzaffarpur)
4. Bihar Veterinary College, Patna and
5. Ranchi Veterinary College, Kanke, Ranchi.

The Birsa Agricultural University, Kanke Ranchi, came into existence in the year 1981, thereafter Rajendra Agril University left with the following colleges.

	Colleges		Date of Establishment
1.	Bihar Agril. College Sabour (Bhagalpur)	:	17th Aug., 1908
2.	Bihar Veterinary College, Patna	:	2nd Apr., 1927
3.	Tirhut College of Agriculture, Dholi (Muzaffarpur)	:	18th Aug., 1960
4.	Sanjay Gandhi Institute of Dairy Technology, Patna	:	14th Dec., 1980
5.	College of Home Science, Pusa (Samastipur)	:	1982
6.	College of Agricultural Engineering, Pusa (Samastipur)	:	07th Dec., 1983
7.	College of Fisheries, Dholi (Muzaffarpur)	:	13th Jan., 1987

These institutions impart education leading to undergraduate and postgraduate (M.Sc./Ph.D.) degree. The P.G. departments of Agriculture Faculty, Faculty of Agricultural Engineering, Basic Sciences & Humanities and Home Science faculty are located at its main campus at Pusa except Horticulture (Pomology/Olericulture) at Bihar Agriculture College, Sabour (Bhagalpur). All the P.G. departments of Veterinary & Animal Science faculty are located at Bihar Veterinary College, Patna.

The University is having six faculties as under:

1. Post Graduate Faculty
2. Agriculture Faculty
3. Veterinary and animal Science Faculty
4. Agriculture engineering Faculty
5. Faculty of Basic Science & Humanities.
6. Home Science Faculty

The intake capacity in each U.G. and P.G. programme is as follow.

Under Graduate Programme

S. No.	Programme	Intake Capacity
1.	B.Sc. Ag.	100
2.	B.V.Sc. & A.H.	60
3.	B.Tech. (D.T.)	25
4.	B.F. Sc.	10
5.	B.Tech. (A.E.)	25
6.	B.Sc. (Home Sc.)	25

Post Graduate Programme

A. Faculty of Agriculture

Department	Intake Capacity			
	RAU	ICAR	Inservice	Total
Agronomy	10	04	04	18
Agril. Econ.	06	02	02	10
Agril. Stat.	02	-	01	03
Entomology	06	02	02	10
Extn. Edn.	04+01	02	02	09
Hort. (Oler.)	03	01	01	05
Hort. (Pomo)	03	01	01	05
Nematology	01	-	01	02
Plant Breeding	06	02	02	10
Plant Pathology	05	02	02	10
Soil Science	06	02	02	10
B. Faculty of Agricultural Engineering				
P.H.T.	02	-	-	02
S.W.E.	03	-	-	03
Farm Power & Machinery	02	-	-	02
C. Basic Science & Humanities				
Botany & Plant Physiology	03	01	01	05
Genetics	03	01	02	06
D. Home Science				
Extn. Edn.	02	-	-	02
Foods & Nutrition	02	-	-	02
F.R.M.	02	-	-	02
E. Vet & Animal Science				
A.B. & Genetics	02	02	01	05
A. Nutrition	02	01	01	04
L.P. Management	02	-	-	02
L.P. Technology	02	-	-	02
V.O. Gynocology	02	01	01	04
V.P. Technology	01	01	-	02
Vety. Medicine	01	-	01	02
Vety. Parasitology	02	-	-	02
Vety. Physiology	01	01	-	02
V.P. Husbandries	01	-	-	02
V.S. Radiology	01	01	-	02
Vety. Extn. Edn.	01	-	-	01

Ph.D. Programme

Department	Intake Capacity		
	General	Inservice	Total
Agronomy	02+01	02	04+01
Plant Breeding	03	02	05
Soil Science	03	02	05
Plant pathology	02	02	04
Entomology	01+01	01	02+01
Agril. Economics	01	01	02

Department	Intake Capacity		
	General	Inservice	Total
Extn. Education	01	01	02
Hort. (Pomology)	01	01	02
Hort. (Olericulture)	01	01	02
Plant Physiology	01	01	02
Genetics	01	01	02
Vety. Anatomy	01	01	02
Vety. Microbiology	02	01	03
Vety. Parasitology	01	01	02
A.B. Genetics	01	01	02
Vety. Pharmacology	01	01	02
Vety. Medicine	01	01	02

Number of students passed out is given below.

Degree Programme	U.G.	P.G.	Ph.D.
Agriculture Science	36	47	18
Veterinary Science & A. H.	37	33	-
Fisheries Science	03	-	-
Dairy Technology	04	-	-
Home Science	01	-	-
Agricultural Engineering	07	04	-
Total	88	84	18

Awards

Dr. M.K. Sinha award was conferred to Mr. Dheeraj Kumar Shudhanshu Ex-student M.Sc. (Ag.), Deptt. of Soil Science, R.A.U., Pusa

4th Convocation

It's a pleasure to inform that the IVth Convocation was held on 14th of February, 2004, in which H.E. the President of India Dr. A.P.J. Abdul Kalam was the Chief Guest and the H.E. Chancellor and Governor of Bihar, Justice (Retd.) M. Rama Joice presided over. The University has conferred degrees to the pass out students as under :

1	B.Sc.Ag.	121
2	B. Tech (D.T.)	44
3	M.Sc. (Ag.)	97
4	B. Tech (A.E.)	31
5	M.V.Sc.	42
6	B.F.Sc.	13
7	B.Sc. (H. Sc)	08
8	M. Tech	11
9	B.V.Sc.& A.H	36
10	M.Sc. (H. Science	08
11	Ph.D.	26

Besides 12 students were awarded Gold Medals by the H.E Chancellor and Governor of Bihar.

1	Dr. Sanjay Sahay	Ph.D. Hort (Pomo)
2	Sri Sanjay Kr. Gupta	M.Sc. (Ag.) PP
3	Sri S.K. Choudhary	M.Sc. (Ag.) PP
4	Sri Nilanjay	M.Sc. (Ag.) P.B.

5	Miss Nilanjali	M.Sc. (Ag.) Ag.Econ
6	Sri S.M.R.A. Faridi	M.Sc. (Ag.) Hort (Pomo)
7	Miss Manorma	M.Sc. (Ag.)Hort (Pomo)
8	Miss Sarita Srivastava	M.Sc.F.N. (H.S.)
9	Veenita Kumari	M.Sc. EE (H.Sc.)
10	Sri Sunil Kumar	M. Tech. (F.M.)
11	Sri Ankesh Kumar	M.V.Sc. (VOG)
12	Sri Abhay Kumar	B.Sc. (Ag.)

Among the recipients of the degee holder, one student was finally selected for Indian Administrative Service; it's a great achievement of an alumni of RAU.

Number of students on-roll in the current Monsoon Semester,05 started from 18.07.05 is as under :

College	IInd	IVth	Vth	Short	VIIIth	IXth	Xth	Total
BAC, Sabour	26	32	27	14	16	-	-	115
T.C.A., Dholi	31	29	27	08	11	-	01	107
C.A.E., Pusa	16	15	09	-	09	03	-	52
B.V.C., Patna	35	26	29	-	29	35	-	154
S.G.I.D.T., Patna	15	17	12	-	11	-	02	57
College of Fisheries	07	05	06	-	05	-	-	23
College of Home Science	02	01	04	-	01	-	01	09
M.Sc.(Ag.)								127
M. Tech								04
M.V.Sc.								97
Ph.D.								64
U.G.- 517		**P.G.- 228**			**Ph.D.- 64**			

Faculty Development Committee/Professional Development Programme

In order to encourage both the Faculty members and the Technical staff, there is a provision to enhance their academic attainments and are being selected and permitted to go for higher studies leading to Masters and Ph.D. programme based on the regulation framed for the purpose. This year following number of candidates selected/admitted for Master's & Ph.D. programme in different department.

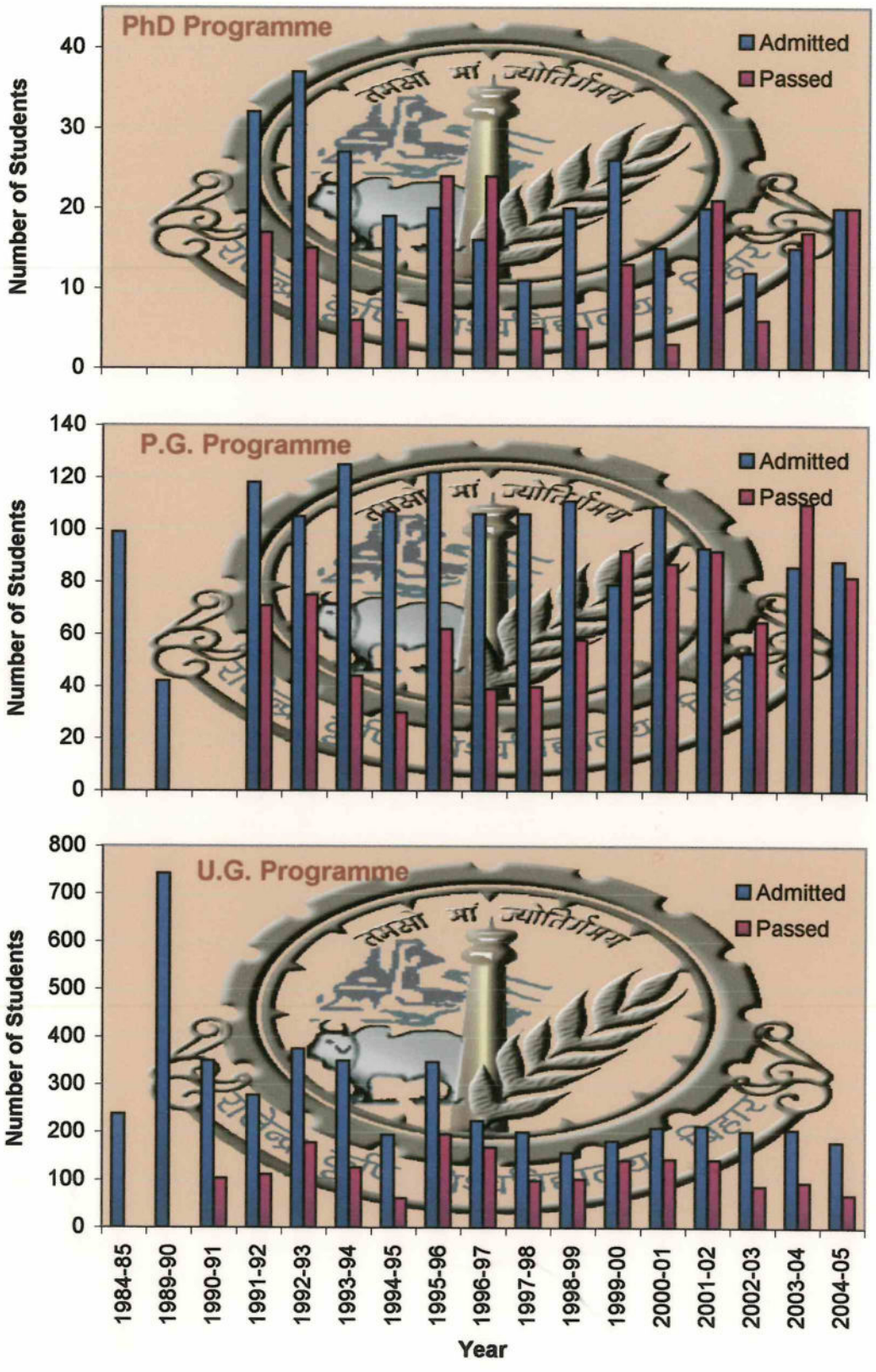
	Ph.D.		**Ph.D.**	**M.Sc.(Ag.)**
FDC	02	PDP	07	02

Competitive Test Examination for admission to Master's & Ph.D. Programme

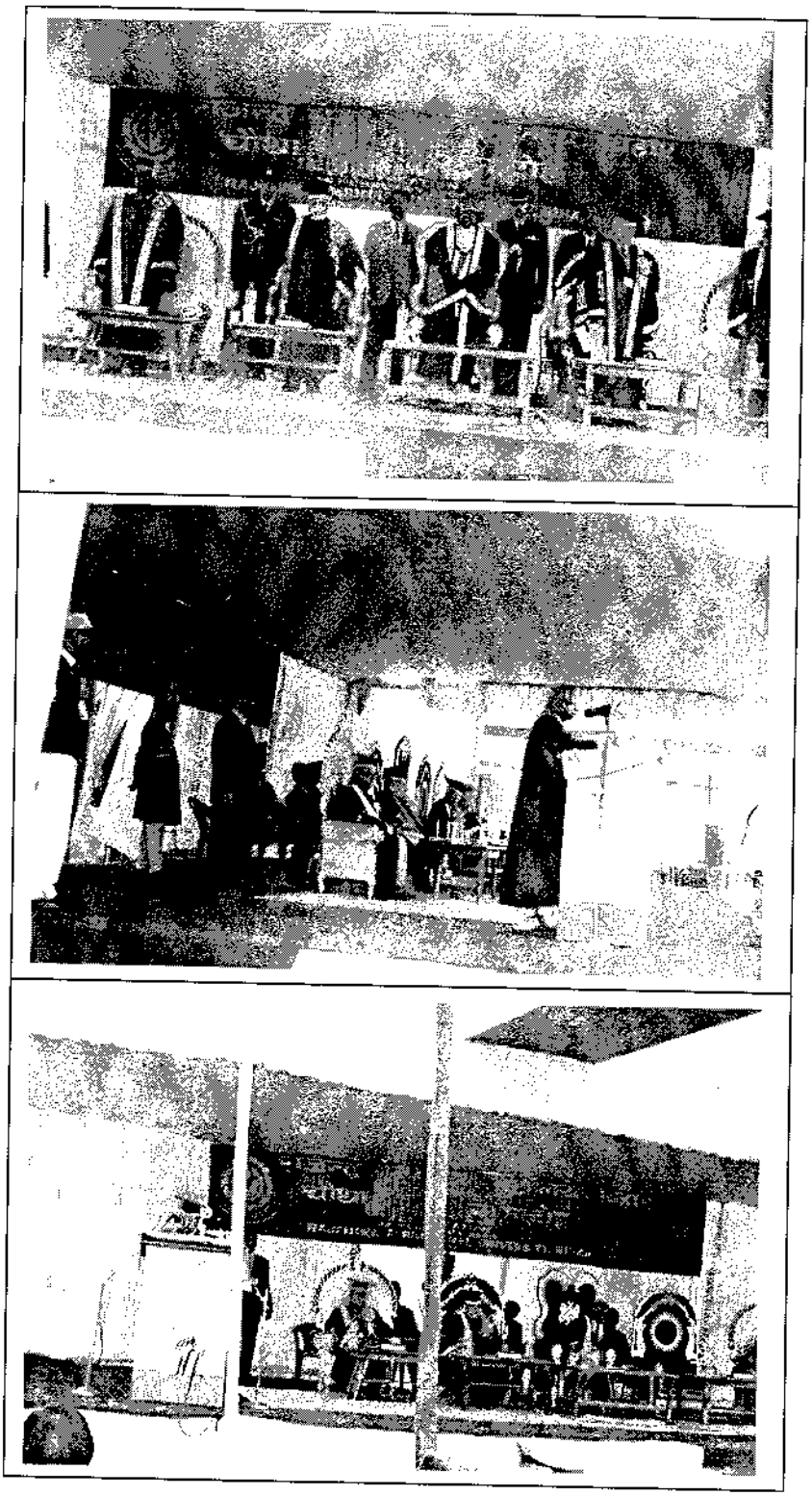
The University is conducting the Competitive Test Examinations for admission to Masters and Ph.D. programme. This year the Competitive Test examination was conducted on 5th June, 05 and students thus selected and admitted on 29-30th of July, 05 in the different departments of the University be details are as follows:

No. of Candidates	Masters Degree	Ph.D. Degree
Appeared	180	68
Selected/admitted	73	15

Number of students admitted and declared passed in various degree programmes is shown in Fig. 1.



Trend in admission of students under different academic programmes.



H. E. President of India A. P. J. Abdul Kalam delivering Convocation Address during his visit on the eve of 4th Convocation in R.A.U., Pusa

2. RESEARCH

2.1 General

The research activities of the University are carried out in the areas of Agriculture, Veterinary & Animal Sciences, Agricultural Engineering, Basic Sciences, Home Sciences, Dairy Technology as well as Fisheries at different locations under the jurisdiction of the University.

Presently there are altogether 38 All India Co-ordinated Research Projects on various aspects of crops and resources are under operation in this University. Besides, researches in many fields are being carried out under *Adhoc* Research Projects as well as centrally sponsored projects. Till date, 15 new projects are submitted to the different Sponsoring/Funding agencies for sanction.

The progress of the research projects are reviewed in Research Council Meetings (*kharif* & *rabi*) which are held twice in a year. The new research proposals are also discussed in these meetings and suggestions, refinement and improvement, if any, are advised to the scientists. New crop varieties and agri-techniques developed by the scientists of the University are discussed and if found suitable released for adoption. The University has developed many crop varieties and also recommended new technologies for the farmers.

In brief the salient achievements of the research work done at RAU are as follows:

- Research undertaken in the University covers all economically important crops grown in the state with focus on rice, wheat, maize, vegetables, fruits (mango banana, litchi, papaya, acid line, guava etc.), spices (turmeric, ginger, coriander, chilli, garlic, etc), medicinal and aromatic plants, agro-forestry, animals (cattle, goats, pigs and poultry); fisheries, farm machines and implements, crop and animal management, farming systems and post harvest technology of different crops. In that process, the University developed several improved varieties, farm practices and technologies which resulted in increased income even in areas where severe biotic and abiotic constraints impeded production of the crops.
- The university is pioneer in recommending the cultivation of maize and pigeonpea in *rabi* season in the country. The technology has been adopted on large scale by the farmers of other states.
- Various nutritionally superior QPM based preparations viz. infant food, health food etc. have been prepared. QPM based animal feed have also been prepared where pulse as one of the ingredients has been totally replaced by QPM leading to cheaper cost.
- A pioneer in the field of sugarcane research, the University has evolved a large number of commercial varieties of sugarcane. Some of them such as BO-91, BO-102 & BO-128 have been considered as wonder varieties. BO-102, BO-128, BO-99 have been found very high in sucrose contents, BO-120 & BO-128 have been found to be suitable for waterlogged areas and making good quality *gur*. Similarly, variety BO136 & BO137 has been found better for main season. BO128 and CoP9702 varieties have been identified as salt tolerant. CoP9206, CoP9301, CoP9302, Bo130 are rich in sucrose content and high yielding. Recently, BO138 (early group) and CoP 9702 (mid-early group) varieties have been released for high yield and better sucrose content.

- The state of Bihar has monopoly in litchi production. About 70% of the country's production comes from this state. As the shelf life of the litchi fruit is very short at ambient conditions, significant achievement has been made in extending its post-harvest storage life upto 32 days at low temperature. A protocol has also been developed for handling fresh litchis for export.
- Honey yield with the Italian honey bee species is highest in Bihar as compared to any other state of India with a production of 40 and 60 kg honey/hive/year under stationary and migratory bee keeping, respectively.
- The scientists of BVC, Patna have prepared nugget from goat meat. A goat farm with several improved breeds has been established at APRI Pusa. The objective is to produce cross-bred kids having good body weight and meat quality by crossing she-Bengal goat with Beetal/ Jamunapari/ Sanana/ Barabari bucks.
- Causes and suitable treatment of summer infertility in buffaloes, a major problems confronting the livestock owners causing them a great economic loss in terms of calf and milk production, were found out through a series of investigation at BVC, Patna.
- Research in agricultural engineering has led to the development of farm machinery and power, improved agricultural implements, optimizing energy input in agriculture, post-harvest technology and application of plastic in agriculture. The use of zero tillage machine has been successfully demonstrated for sowing of what. The cultivators have started using the machine for sowing wheat after paddy.
- The faculty of Basic Science and Humanities had made a head way towards the development of a hybrid rice variety. Bio-chemical markers for screening pigeonpea varieties have been developed which would enable development of some virus resistant pigeonpea cultivars. Pure culture techniques have also been standardized for brinjal, some tuber crops and maize.

2.2 Research Projects at a Glance

The University is implementing its research mandate through a number of coordinated and *adhoc* research projects sponsored by various Government and non-government organizations. An account of the research projects is presented in the following sections.

Table. 2.1 List of *Ad-hoc* Projects under operation

S. No.	Title of the Project	Principal Investigator
1.	Popularization of extra short duration Mungbean cultivars for poverty Alleviation and Improved Nutrition in Bihar and Rajasthan, India Bases on Panjab Mode AVRDC-The World Vegetable Centre.	Dr. Ravi Nandan
2.	National Network on Integrated Development of Jetropha and Karanja financed by NOVOD	Dr. M. S. Ali
3.	Survey of Street Food, Indigenous & Imported Food Products and Consumers - under World Bank assisted capacity building project.	Dr. Meera Singh
4.	Networking project on wilt crops under pigeonpea	Dr. J.P.Upadhyay
5.	Network Project for Management of Alternaria blight in Brassica Juncea and Vegetable crops	Dr. M. M. Jha

S. No.	Title of the Project	Principal Investigator
6.	Effect of Distillery Effluent on Soil, Crop and Ground Water	Dr. M. Alam

Table 2.2 List of Coordinated Projects in operation

S. No.	Title of Project	Principal Investigator
	Faculty of Agriculture, Pusa	
1.	AICRP on Honey Bee Research and Training	Dr. R. Singh
2.	AICRP on Pesticide Residue	Dr. S. P. Singh
3.	All India Networking Project on Betelvine	Dr. B. P. Yadav
4.	AICRP on Soil Test Correlation Response	Dr. J. Prasad
5.	AICRP on Micronutrients in Soils and Plants	Dr. A.P. Singh
6.	AICRP on Rice	Dr. N.K. Singh,
7.	AICRP on Agro forestry	Dr. D.K. Das
8.	AICRP on Agro meteorology	Dr. I. B. Pandey
9.	AICRP on Water Management	Dr. A. K. P. Singh
10.	AICRP on Experiments on Cultivators Field	Dr. N. K. Choudhary
11.	AICRP on Tropical Fruits	Dr. P.K. Rai
	College of Agricultural Engineering, Pusa	
12.	AICRP on Post Harvest Technology (P.H.T.)	Dr. M. Shrivastava
13.	AICRP on Farm Implements & Machinery (FIM)	Dr. A. P. Mishra
14.	AICRP on Ground Water Utilization	Dr. S. K. Jain
	Sugarcane Research Institute, Pusa	
15.	AICRP on Sugarcane	Dr. K. D. N. Singh
	Directorate of Research, Pusa	
16.	AICRP on Weed Control	Dr. S. J. Singh
	Tirhut College of Agriculture, Dholi	
17.	AICRP on Seed Technology	Dr. S. K. Varshney
18.	AICRP on Maize	Dr. M. M. Jha
19.	AICRP on MULLaRP	Dr. R. P. Yadav
20.	AICRP on Pigeon pea	Dr. R. P. Yadav
21.	AICRP on Chickpea	Dr. R. P. Yadav
22.	AICRP on Small Millet	Dr. R. S. Rai
23.	AICRP on Tuber Crop	Dr. C. P. Singh
24.	AICRP on Potato	Dr. L. M. Yadav

S. No.	Title of Project	Principal Investigator
25.	AICRP on Spices	Dr. R. A. Choudhary
26.	AICRP on Rapeseed & Mustard	Dr. R. K. Akhauri
27.	AICRP on Sunflower	Dr. R. K. Akhauri
	Directorate of Seeds & Farms, Dholi	
28.	AICRP on Breeder Seed Production	Dr. S.K. Varshney
	Bihar Agriculture College, Dholi	
29.	AICRP on Wheat	Dr. R. N. Sharma
30.	AICRP on Rice	Dr. R. N. Sharma
31.	AICRP on Cropping System Research	Dr. R. P. Sharma
32.	AICRP on Sub-Tropical Fruits	Dr. Jayant Singh
33.	AICRP on Vegetable	Dr. D. N. Choudhary
	Agricultural Research Institute, Patna	
34.	AICRP on Rice	Dr. V. N. Sahay
35.	AICRP on Chickpea, PRC, Mokama	Dr. Pawan Kumar
36.	AICRP on Castor, Mokama	Dr. Pawan Kumar
	Bihar Veterinary College, Patna	
37.	AICRP on FMD	Dr. C. Jay Chandran
38.	AICRP on Improvement of Feed Resources and Nutrient Utilization in Raising Animal Production.	Dr. C. Singh
	Regional Research Station, Agwanpur	
39.	All India Networking Project on Jute & Allied Fibers	Dr. M. Rahman

Table 2.3 List of Centrally Sponsored Projects

S. No.	Title of The Project	Principal Investigator
1.	Agromet. Advisory Service	Dr. I. B. Pandey
2.	Precision Farming Development Centre	Dr. R. Suresh
3.	Development of Medicinal and Aromatic Plants	Dr. J. K. Handoo
4.	Development of Spices	Dr. S. P. Singh

Table 2.4 List of State/International level projects

S. No.	Title of The Project	Principal Investigator
1.	United States Agency for International Development (USAID) Project on Accelerating the tillage revolution in Indus-Ganges Basin by CYMMIT	Dr. Umesh Singh

S. No.	Title of The Project	Principal Investigator
2.	International Fund for Agriculture Development (Funded by IRRI-IFAD)	Dr. A. K. Singh
3.	NOVOD Board Sponsored Project on "National Network on Integrated Development of Jatropha & Karanja"	Dr. M.S. Ali

2.3 Varieties Released

Rice

First time the Rice groups of B.A.C. Sabour developed a Basmati cultivar under agro ecological condition of Bihar. Rice Variety, namely, **"Rajendra Basmati-1"** was released for cultivation in all parts of Bihar. This variety has long slender grains with bent terminal end and high aroma. This is resistant to stem borer and BPH. It is also resistant to brown leaf spot, blast and BLB, and resistant to lodging & shattering. It possesses aroma with good cooking quality and hence suitable for export.

The Rice group of A.R.I. Patna developed a rice variety to replace the leading variety **MTU 7029 (Nati Mahsuri)** which has become susceptible to BPH. The Research Council released the variety as Rajendra Mahsuri-1 . It is recommended for medium to favourable shallow low land (upto 30 cm water depth.) eco-system. It is semi dwarf with medium slender grain. It mature in 140 to 145 days (seed to seed), moderately resistant to BPH and has medium slender grain with good milling and cooking quality. Average yield under normal condition is 55 q/ha.

The variety **"Rajendra Sweta"** was developed by rice group of Agricultural Research Institute, Patna. The variety is semi –dwarf with medium slender (fine) Basmati type grains, the hull is straw colour and kernel is white. The grain is awn less with straw colour apiculus. The variety is photoperiod in sensitive. It is medium duration variety maturing in 135-140 days. It is moderately resistant to bacterial leaf blight, sheath blight, Sheath rot, brown spot and blast under field condition. It is also moderately resistant to plant hopper, leaf folder and stem borer. Resistant to lodging, stiff straw, responsive to fertilizer (up to 80 kg N/ha) and suitable for normal planting conditions. Cooking quality is good and yield potential of this variety is 40-45 quintals per hectare.

The Variety **"Rajendra Kasturi"** has been developed by rice group of Bihar Agricultural College, Sabour (Bhagalpur). It is recommended for irrigated, medium and medium upland soils of Zone-III. It is semi –dwarf with short slender grain, Hull straw colour and the kernel greenish white, maturity is 115-120 days. It is resistant to lodging and shattering, fertilizer responsive, suitable for semi late planting condition. The variety moderately resistant, bacterial leaf blight, brown leaf spot and blast diseases under field condition .The variety moderately resistant, bacterial leaf blight, brown leaf spot and blast diseases under field condition. It is also moderately tolerant to stem borer and BPH. It has short slender grain, highly aromatic with very good cooking quality. Yield potential is 40-45 quintals per hectare.

Sweet Potato

An early bulking sweet potato variety named **"Rajendra Sakarkand-92"** was released for commercial cultivation. The average yield in multi-location trials was found to be 24 t /ha after 120 days of planting. This variety is suitable for flood prone and *Diara* areas of North & South Bihar where food and green fodder for human and livestock are much needed in shorter time after the flood water recedes. The farmers

can get grass after three months of planting. The variety is also tolerant to major diseases and pests.

Potato

A new potato variety named "**Rajendra Alloo-3"** a clonal selection resembling to **"Kufri Kuber"** was released for commercial cultivation. It is of medium maturity requiring 75-85 days. It produces large, light yellow and smooth skinned tuber with fleet eyes. The flesh is yellowish, easy to cook and waxy in texture with average tuber yield of 225 -250 q/ha. It is moderately resistant to late blight and leaf spot diseases. This variety is superior than **"Rajendra Aloo- 1 & 2** released earlier in terms of cooking quality and tuber yield.

Oil Seeds

As long awaited requirement of farming community of Bihar, improved mustard line **RAURD-9403** developed by oilseeds group, TCA, Dholi was released in the name of "**Rajendra Rai Pichheti**". This variety offers opportunity for horizontal expansion of mustard in late to very late maturing Rice-Fallows with limited irrigation potential and vertical yield boost in late sown agro-ecology, for which there is no variety as yet.

The variety **"Rajendra Anukul"** was recommended for rice-fallow areas after harvest of late paddy under late sown mustard (mid November- mid December) condition of Bihar. It is moderately susceptible to mustard aphid found having similar reaction to check varieties Varuna, Kranti, Pusa Bold and Vardan. The seeds are brown, medium bold with 40% oil content. It matures in 107-115 days having yield potential of 12.75 q/ha.

Quality Protein Maize Hybrids

Two Yellow grained, very high yielding full season, single cross, quality protein maize hybrids, namely, "Shaktiman-3" and "Shaktiman-4" and for general cultivation in Bihar Plains. Both hybrids are of full season maturity, suitable for timely as well as late sown condition in both *kharif* and *rabi* seasons. **"Shaktiman –3"** has an average yield potential of 8.5 – 9.5 t/ha. It has 9.63 % protein in grains, 0.73 tryptophan and 2.96 % lysine in grain protein "**Shaktiman –4**" has an average yield potential of 9-10 t/ha, 9.88 % protein in grain and 0.93 % tryptophan and 3.78 % lysine in grain protein. These two hybrids full potentiality of providing feed and nutritional security to maize growers and consumers of Bihar.

Sugarcane

Two new improved sugarcane varieties; namely, **"B.O.-138" & "CoP-9702"** are early sown and mid early group, respectively. The average yield of **"B.O.-138"** is 78.30 t/ha and in plant crop with 17.10% sucrose in the juice. The ratoon crop gives and average yield of 69.40 t/ha with 17.18% sucrose in the juice. The stalk of this variety is straight, light green with purple colour, cylindrical, medium to long internode with slightly constricted root zone . This early variety is ready for harvest from mid November.

The average yield of plant crop of mid early sugarcane variety "**CoP-9702"** is 85.53 t/ha with 17.34 % sucrose in the juice . The ratoon crop gives on average yield of 70.75 t/ha with 17.39 % sucrose in the juice. The stalk of this variety is straight, ivory green with purple colour, cylindrical, medium thick, inter node with wax coating, green medium leaves with semi spreading carriages. This variety will mature from mid December for harvesting. This variety performs well in salt affected soil also. The quality of *gur* prepared from CoP 9702 is much better than most of the varieties.

Two new sugarcane varieties i.e. "B.O. 136" and "B.O. 137" of mid late maturity group with average yield of 72 t/ha and 85 t/ha, respectively and sucrose percentage of 16.4 and 16.5, respectively were released. The ratoon crop gives an average yield of 68 t/h and 73t/ha with 16.6% and 16.8% sucrose in the juice in case of B.O. 136 and B.O. 137, respectively. There is a yield advantage of 10 t/ha and 15 t/ha in comparison to previous popular varieties of mid-late maturity group. The sugarcane growers will get an additional gross income of more than Rs. 8000/- per hectare by growing these two newly released varieties. These varieties are also tolerant to major diseases and pests.

2.4 Technologies Released

Amelioration of Zinc deficiency in soils

Most of the soil types in Bihar have become deficient in Zinc availability for the growing crops. Basal soil application of 25 kg Zinc sulphate per hectare every year for short duration crops under such situation has been recommended. For rice-wheat cropping system or for long durations crop like sugarcane, however, basal soil application of 50 kg Zinc sulphate per hectare alternate year is recommended. Half of the zinc-sulphate fertilizer can be saved if it is applied in the soil along with 50 q/ha FYM or compost. In case, Zinc deficiency system appear on the standing crop, 2 to 3 foliar sprays of 0.5% Zinc sulphate + 0.25% slaked lime at 10 days interval is recommended. This technology improves crop yield by 50%. Besides it also improves the quality of the produce and health of the soil for sustainable crop production.
Farmers are now aware regarding getting their soils tested for available Zinc content.

Amelioration of sulphur deficiency in soils

Ten to more than 50% soils of Bihar have been found to be deficient in available sulphur. Intensive cropping cultivation of high yielding crop varieties and application of sulphur free high analysis fertilizers has further aggravated the problem. Soil application of sulphur in the form of phosphogypsum or single super phosphate (SSP) @ 40 kg/ha for short duration crops (Pulses, Oilseeds, etc.), 60 kg per hectare for long duration crops (sugarcane) every year will take care of sulphur deficiency in soils. This technology not only enhances the crop yield from 10 to 40 per cent but also improves the quality of produce and maintains the soil health as well. Farmers are now aware regarding getting their soils tested for available sulphur content.

Soil Test Based Fertilizer recommendation for specific yield target of crops

For obtaining the real benefit of fertilizer application based on targeted yield approach, soil testing should be done frequently as possible fertilizer prescription equations have been developed and tested for achieving targeted yields of different crops in different kinds of the soils of the state of Bihar. Crops like, paddy, wheat, maize , sugarcane, pea, arhar, moong, rapeseed, linseed, sunflower, mustard etc and Vegetables like lady's finger, cauliflower, cabbage and brinjal and spices like coriander, turmeric have been developed equations for obtaining targeted yield for calcareous soils of Bihar. The use of this approach not only achieves the target of crops but also increases maximum profit for farmers as well as maintained soil fertility for sustainable.

Irrigation in Potato

Under upland sandy loam soil condition a light irrigation, ten days after planting of Potato helps in quick and uniform emergence of the plants. By adopting this practice, an additional yield of 30 q/ha may be obtained. This leads to an additional benefit of Rs. 6000 to 9000 per ha depending upon the market price of Rs. 200 to 300 per quintal of Potato.

RAUSTAT Window Version 1.0

A statistical data analysis software RAUSTAT for Window Version 1.0 is a group of several program files written in Computer language. These program files are written as per the requirement of statistical data analysis needed by the researchers. It is capable of analyzing the experimental observation arising from CRD, RBD, SPD upto 3 factors factorial structure, transformation of data, analysis of co-variance, t, F, Z, Chi-square tests of homogeneity of variances, stability analysis , computation of Mahalanobis D- Square for large number of varieties and pooling of results arising form SPD are the advanced features of this software.

2.5 Crop Improvement

2.5.1 Cereals

Wheat

Altogether 8 (7 at Sabour and 1 at Pusa) coordinated trials, seven different nurseries and 2 state trials (at Patna) were conducted during Rabi 2004 – 2005. The salient findings of these trials are given here.

75 germplasm lines from National and International sources were desirability to different yield components and grain characteristics. The desirables lines were selected and would be utilized in future Breeding Programme.

23 fresh crosses were made during the season under report at Sabour involving promising parents with desirable agronomic traits and resistance to various diseases.

In NIVT-5A(TS – RF), 36 entries including four checks,viz;C-306, PBW-175, HW 2004 and NI – 5439,were evaluated in simple lattice with two replications at Sabour. The varietal differences were found to be highly significant. The entry WH-1024 was the best performer yielding 30.43 q/ha . It was followed by HD-2944(28.96q/ha),HI-1547(27.12q/ha) and K-443(26.08 q/ha).These entries were significantly superior to the best check NI-5439 which yielded 23.81 q/ha.

In AVT(TS-RF), 15 entries including 3 checks,namely C-306,HUW-533 and MACS-4115 were tested in RBD with four replications. Highly significant differences among the various treatments were found.The entries,UP-2643 and PBW 561 were the top yielders each giving 25.87 q/ha.These closely followed by HD 2888 and UP 2644 each yielding 25.44 q/ha.These entries were significantly superior to the best check HUW 533 which yielded 19.96 q/ha.In NIVT-1A (TS-IR), 49 entries including 5 checks namely,PBW-343,HD-2687,K-9107,HD-2733 and HUW-468 were evaluated in simple lattice with two replications.The entries showed highly significant differences among themselves. The entries Raj-4093 and PBW-567 were the top yielders each contributing 44.57 q/ha and outyielded the rest including the checks significantly.

In NIVT –1B, 49 entries including 5 checks viz; HD-2733. K-9107, PBW-343, HD-2687 and HUW – 468 were tested sample lattice with two replications. The varietal differences among the entries were significant. The entry, RW 3655, an entry from Sabour, was the best performer yielding 52.17 q/ha. It was significantly superior to the rest including the best check HD 2733 which yielded 35.87 q/ha.

In AVT (TS-IR) , 10 entries including 5 checks,namely,K-9107,HUW-468,PBW-343, HD-2733 and HD-2824 were evaluated in RBD with four replications. Highly significantly differences were observed among the treatments under study. The entry PBW-532 was the best performer yielding 43.26 q/ha and was closely followed by K-3076 with 42.30 q/ha. These two entries were statistically superior to rest including the best check K-9107 with 36.31 q/ha.

In NIVT-3(LS-IR), 49 entries including 5 checks viz; HUW-234, UP-2425, NIAW-34, GW-173 and PBW-373 were considered in simple lattice with two replications. Significant differences were observed among the treatments under consideration. The entry, Raj 4101 was found to be the top yielder contributing 45.65 q/ha. It was significantly superior to rest including the best check HUW –234 with 44.18 q/ha.

In AVT (LS-IR), 10 entries including 5 checks, namely, HUW-234, DBW-14, NW-1014, NW-2036 and PBW – 524 were evaluated in RBD with four replications. Significant differences were found among the treatments. The entry PBW-559 was the best performer yielding 33.33 q/ha. It was significantly superior to rest including the best check HUW-234 which yielded 28.61 q/ha.

In AVT (TS-IR) 10 entries including 5 checks, namely, K9107, HUW468,PBW 343, HD 2733 and HD 2824 were testes in RBD with 4 replications at Pusa centre. Highly significant differences were noticed among the various entries. The entry PBW 533 was the top yielder giving 52.8 q/ha which was at par with the best check HD 2733 with 52.4 q/ha.

Two trial were conducted at Patna center the first trial was the maintenance of 32 commercially recommended wheat varieties for future use in breeding work and the second trial was on mutation Breeding in which 8 desirable plants were selected from the Gamma rays treated HUW-234 (7 dozes) in M3 generation along with 3 desirable bulk harvested materials. These will be further advanced and desirable plants will be selected.

Rice

Germplasm

A total no. 1080 cultures were grown and evaluated at Patna, Pusa and Sabour/Tilaundha. Fifteen new cultures were collected from farmers' field. Promising germplasm lines were incorporated in hybridization programme. At Pusa, germplasm remain submerged for 20 days i.e. 16th July to 50th August 2004. The cultures survived with 95% survival were, Dusari-1, Silhat-2, Dudhraj and Meghand-2.

Breeding material

Altogether 252 breeding lines of different segregating generation (F3-F6) were grown at Patna and Sabour. 226 breeding lines were selected for further evaluation.

Mutation breeding

At Patna, 10 traditional basmati rice varieties namely, Sugandh Kamini, Katarni, Kala namak, Br-9, Br-10, Kari bak, Dehradun basmati, intermediate basmati Lal basmati were treated with Gamma Rays. Two desirable mutants were identified. A semi dwarf mutant line has been selected from tall Kala namak variety. The other trend of mutant was similar to the parent Kala namak.

Another desirable mutant line with awn less grain has been selected from awed basmati-1 variety. The mutant was alike to its parent in respect of other agronomical traints.

Varietal evaluation

In the variety evaluation programme 6 State, 14 DRR (ICAR), 3 Shape Breeding (ICAR-IRRI) and 2 IRRI trials were conducted at Patna, Pusa, Sabour and Bikramganj.

A. **Upland ecosystem:** In uplands, drought is the foremost yield-limiting factor. Drop can occur at seedling, tillering and at flowering stages causing yield losses.

In this situation duration cultures (up to 110 days maturity) were evaluated. Promising culture IR56383 (36a/ha) and RAU 1415 (35q/ha) were identified.

B. **Irrigated (Medium lands) ecosystem:** The irrigated ecosystem which occupies around 35% of the rice area in Bihar achieved maximum production and productivity gains in post green revolution era. However, genetic improvement with tolerance to pests and diseases are required. Varieties cultivated in irrigated areas are mostly mid-early (115-125 days maturity) and medium duration (130-140 days maturity) with high yield potential. RAU 735-17-2 (42 a/ha) in UVT-2, TNRH 52 (H) (51.9q/ha) in AVT-1 IME, RAU 631-90-10 (62 q/ha) in GUT-3, MRP 5402 (57 q/ha) in AVT-2 IM and MTU 1072 (52 q/ha) in AVT-1 IM were identified as promising.

C. **Lowland ecosystem:** The lowland ecosystem consists favourable shallow lowlands and rainfed lowlands. Favourable shallow lowlands need intermediate height/semi dwarf where as rainfed lowlands require tall plant type to intermediate tall plant type with other characters like submergence tolerance, drought tolerance and suitability under late planting conditions. Efforts are continued to identify suitable genotypes through different trails. The promising entries RAU 678-82-4 (59 q/ha) in UVT-4, OR 18835 (46.5 a/ha) in AVT –22 and RAU 1422-16-1 (42 q/ha) in UVT-5 were identified.

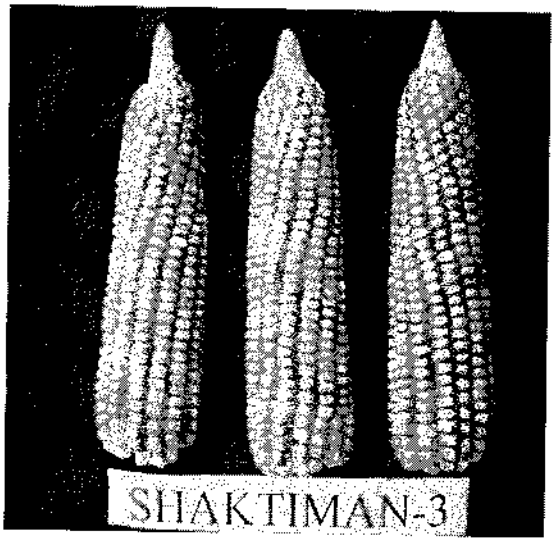
D. **Deep-water ecosystem:** Most of the area of deep-water situation falls under north Bihar. Generally photoperiod sensitive, tall variety with low productivity is being grown in deep water areas. The promising entries IR 53945 – CN-35-8 (60 q/ha) in IVT-SDW and CN 1230-27-5-1 (50 q/ha) in NSDWSN were identified.

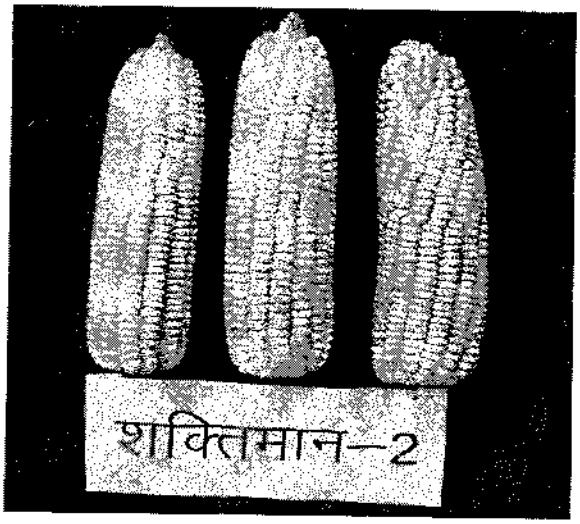
E. **Slender grain quality rice:** Developing high yielding with long slender, medium slender and short slender grains possessing high milling and desirable cooking quality traits as assumed great importance. Slender grain quality rice get higher price at domestic as well as foreign market and consumers prefer such types. Eight lines identified based on yield and quality attributes are out line RAU 724-48-33 (52 q/ha) in SGVT, P 1121-92-8-1-33 (37 q/ha) in AVT-2 BT and WGL 32100 (43 q/ha) in AVT-2SG were identified.

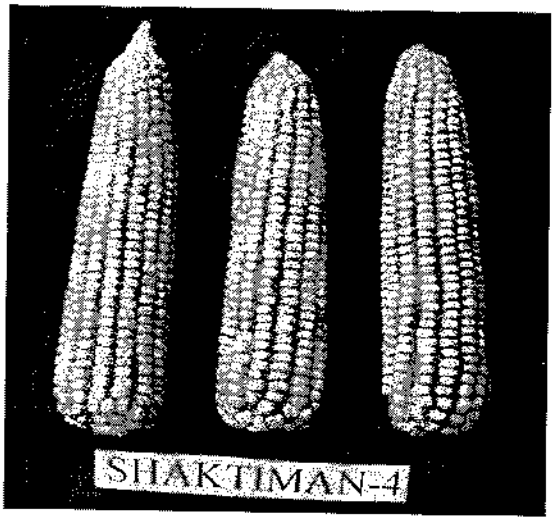
Breeder Seed Production:

Breeder seed of the following 8 varieties were produced.

S. No.	Variety	Target (Qtl.)	Breeder seed produced (q)
PATNA			
1.	Rejendra Sweta	5.0	4.80
2.	Sita	4.0	4.41
3.	Rajendra Mahsuri-1	5.0	5.33
4.	Sugandha	1.0	4.14
5.	Pusa Basmati-1	1.5	1.84
6.	Saket-4	1.0	1.50
7.	Kanak	1.0	1.50
8.	Shakuntla	0.5	0.75
SABOUR			
1.	Rajendra Basmati-1	-	3.0
2.	Rajendra Kasturi	-	3.0
3.	MTUI 7029	-	6.0







Quality Protein Maize (QPM) Hybrids

Boro Rice

During Boro 2004-05 two set of experiments, one UVT-Boro and other Station trial Boro were conducted at RAU, Pusa and R.R.S.S, Birual center respectively. In UVT-Boro, twenty four genotypes were tested in RBD with two replications. The genotypes, RAU 1397-18-3-7-9-4-2 (Boro Basmati late) and RAU 1397-18-3-7-9-4-1 (Boro Basmati early) recorded more that 60 q/ha grain yield. Other genotypes, RAU 1428-3-5-7-4-2-8 yielded 52 q/ha. All these three genotypes have good degree of cold tolerance at seedling stage. Theses genotypes have been multiplied during Kharif'05 and will be nominated in national trial in 2006.

Station trial Boro was tested at R.R.S.S., Birual and among the genotypes, RAU 1428-43-2-7-26-8-10 and RAU 1428-43-2-7-28-8-16 recorded more than 50 q/ha grain yield followed by RAU 1415-35-7-6-9-5-9 which yielded 49 q/ha. Among the checks Gautam yielded 63 q/ha followed by Saroj 54 q/ha.

Maize

Breeding trials

The experimental hybrids and composites were tested in 14 coordinated trials, 2 QPM and three special corn trials alongwith three CIMMYT trials during kharif, 2004. In AET (2^{nd} Year) medium maturity group two entries namely PM-2-131 and NECH-120 significantly out yielded best check Navjot by superiority of 25.81 per cent and 21.61 per cent, respectively; Among early maturing hybrids the experimental hybrid MCH-6 produced significantly higher yield than (7.86%) the best check X-3342, whereas in extra early maturing group FH-3210 out yielded by15.56% superiority over the check HIM-129 (34.85q/ha). In AET 1^{st} year medium maturing hybrids, B10-22069 (58.72q/ha) significantly out yielded the best check KH-510 (51.61q/ha) and in early maturing group, three experimental entries were found superior over the check Kiran (33.77/ha) by a margin of 39.06 q/ha to 46.16 q/ha. In initial evaluation trial of full season maturity group NECH-129 gave the highest yield 76.71 q/ha over the best check SEEDTEC-2324 (65.09 q/ha); among medium maturing group, 4 experimental hybrids viz. MH03-2, X-85, SMH-3103 and JKMH-702 were found significantly superior to the check Navjot (37.88q/ha) and their yield superiority ranged 30.73% to 40.46%, respectively and in early maturing group, the hybrid X-1363B gave the highest yield 57.17 q/ha followed by MCH-27 51.81 q/ha with respect to best check X-3342, 46.78q/ha. In extra early maturing group the entries FH-3248 (45.93q/ha), FH-3245 (44.33q/ha), CH-212 (43.17q/ha) and FH-3248 (42.94q/ha) out yielded by 32.651%, 27.98%, 24.62% and 23.95% respectively over the best check HIM-129 (34.64q/ha). In QPM trial-4, experimental QPM hybrids significantly out yielded the check Shaktiman-1 whereas in QPM trial-2, 5 QPM hybrids produced significantly higher yield over the Shaktiman (47.67q/ha) by a superiority range of 53.56q/ha to 58.82q/ha.

Altogether 8 coordinated trials, 1 QPM trial and 6 CIMMYT trials were tested during Rabi 2004-05. In AET (2^{nd} year) Full season maturity group the experimental entries seedtec and Biscobumper were found significantly superior over best check 3342(Y) by a superiority of 18.03 per cent and 28.13 per cent, respectively. In AET (1^{st} year) medium maturity group BI022027 (87.36q/ha) gave the highest yield followed by B1022027 (84.15q/ha) to best check KH-510 (73.17q/ha) and for early maturity group the entry JKMH1701 produced significantly superior (22%) over the best check Kiran whereas in full season the experimental hybrid PM101 out yielded 7.71 per cent superior over the best check seedtec 2324. In IET medium maturity group 5 entries namely X-2059, JKMH702, SEEDTEC 2054, SEEDTEC 2064 and BI0 31001 significantly yielded and their superiority ranges were 24.15 to 36.99 per cent. Among full season maturity group PM106 was found significantly superior to the best check

SEEDTEC 2324(65.31q/ha) by a margin of 69.16q/ha. In QPM trial-1, BHQPM-102 (55.8q/ha) was found at par with the check Shaktiman-1 (47.12q/ha).

Experimental hybrids development programme

All together 29 experimental single cross hybrids were evaluated (during kharif) under station trials no 1 & 2. On the basis of superiority of hybrids over the best check, 5 promising experimental hybrids were identified during kharif 2004 and their crosses had been made during Rabi 2004-05 for testing in National co-ordinated trials, 4 QPM hybrids(2 white + 2 yellow grained) were also identified and their seed had been produced for inclusion in initial evaluation trials. Moreover in IET medium maturity group MH03-2 single cross developed by Dholi centre was identified for AVT 1st year and their seeds had been produced during kharif 2004 for testing in advance varietal trial stage-1 during kharif 2005.

Altogether 63 experimental hybrids were evaluated (during rabi) under station trials of 1, 2 and 3. On the basis of superiority of hybrids over the best check 6 promising experimental hybrids were identified and their crosses had been made during *kharif* 2005 for testing in National Co-ordinated trials.

Evaluation and maintenance of germplasms/inbreed lines

Kharif

- 150 germplasm of different maturity groups were evaluated, 15 inferior & poor germplasm of early maturing group were discarded and rest were maintained for further evaluation.
- All together 276 inbred lines were evaluated through top cross, Only 24 promising inbred lines were selfed at S_4 stage and their progenies would be further evaluated and advanced by selfing during kharif 2004.
- 840 new inbreds were evaluated, only 50 promising inbred lines were selfed at S_3 stage for further selfing and testing and rest were discarded.

Rabi

- 136 germplasm of different maturity groups were evaluated and maintained for further evaluation.
- 10 promising QPM inbred lines selected on the basis of top cross progenies were selfed at S_6 and their progenies would be further evaluated and advanced by control selfing during *kharif* 2005.
- 88 introduced advance inbred lines were evaluated; 68 inferior and poor germplasms were discarded and rest were maintained through artificial selfing for use in breeding programme.
- New inbred lines were evaluated through top cross progenies, only 15 promising progenies were selfed for further evaluation during kharif 2005.

Breeder and parental seed production of hybrids

- Breeder seeds of Dewaki, Laxmi, Suwan and QPM parental lines were produced by controlled pollination.
- 3 Kg nucleus seeds of 26 genotypes consisting inbred lines; populations were produced by hand pollination.

- Breeder seeds of Dewaki, Laxmi, Suwan, Madhuri and QPM parental lines Viz. CML-142 x CML-150, CML-186, CML-176, CML-142, CML-150, CML-161, CML-163 and CML-169 were produced by control pollination.
- 3-5 Kg nucleus seeds of 24 genotypes consisting of inbred lines, populations were produced by hand pollination.

Synthesis and Improvement of Pool/populations

- Synthesis and Improvement of National Pool- 4 and Dholi pool – 65 : maintained by mating of mass selected plants.
- Synthesis and Improvement of Dholi pop corn i.e. MCP03; maintained by mating of mass selected plants.
- Synthesis and Improvement of local pool-2 maintained by mating of mass selected plants.

Promoted experimental hybrids

- QPM maize –MHQPM 05 from station to IET trial
- Common maize –MH03-2 from IET ti AVT 1st year

2.5.2 Millets

Prosomillets

In advanced varietals trial, 13 entries were tested among them genotype TNAU-123 showed maximum grain yield(11.2q/ha) followed by DC 6 (10.56q/ha) with maturity period of 72 and 61 days in comparison to national check K1 (8.52q/ha).

Finger millet (*Eleusine coracana*) - Breeding trials

In initial evaluation trial genotype VL 328 recorded highest grain yield 21.91 q/ha followed by OEB 27(21.87q/ha) with maturity period of 116 and 112 days respectively where as national check HR 374 gave19.88 q/ha grain yield with maturity period of 118 days. In the advanced varietals trial early and medium maturity entries are tested none of the entries was found better than national check PS 400, but in All India test level entries DM 2 was superior performance in AP, Karnatka, Orissa and Tamilnadu with yield potential of 25.12q/ha with maturity period of 109 days in 24 location tested. In the station trial, genotype Dholi Marua 9 exhibited 21.91q/ha grain yield. This genotype was found superior than national check HR 374 and RAU 8. The maturity period of this genotype is 100 days only. Nucleus and breeder seed of varieties RAU 8 and other was produced.

Foxtail millet (*Setaria italica*) - Breeding trials

In AVT, none of the entries were found superior than national check SIA 326, with grain yield 23.25 q/ha, whereas TNAU 204 gave 20.81 q/ha grain yield with maturity period of 83 days only. The earliest variety RAU 12 recorded 1778 q/ha grain yield with per day production of 24.3 kg/ha/day. In the station trial of Setaria 30 genotype were tested among them 9 genotypes were found superior found superior than national check Arjuna among them RAU-10 recorded highest grain yield 21.36 q/ha with maturity period of 72 days.

Barnyard millet (*Echenochlon frumentasea*) - Breeding trials

In AVT, genotype ER 72 recorded grain yield 29.60 q/ha grain followed by VL 199 (26.98 q/ha) with maturity period of 92 and 87 days respectively. In the station trial,

genotype RAU-12 gave highest grain yield 42.74q/ha. Most of the genotype was good record of grain yield with maturity period of 70 and 73 days only.

Besides these in F_2 generation 122 single plants, were selected from 11 crosses from Bangalore.

Small Millet

Evaluation and maintenance of germplasm

The summer season of 2005 was not favourable for production of prosomillet. An exploratory expendition was organized with the collaboration of Biodiversity Project to number of germplasm were collected of different small millet crops, like prosomillet, Barnyard millet, Foxtail millet paspalum and Finger millet during the crop period. Besides these 289 germplasms of prosomillet were planted in augmented block design with two checks. Days to 50% flowering varied from 36 days to 53 days. Similarly grain yield varied from 18 gm to 55 gm. 25 germplasm were resistant to shoot fly and *Helmintho sporium*. Many promising materials have been identified in preliminary and station trials.

Breeding trials

In the coordinated advanced varietal trial the maximum grain yield was obtained by DC6(19.01q/ha) grain yield/ha followed by TNAU 143(17.96q/ha). 5 entries were found significantly superior than national check K 1. In the station trial DC-8 gave highest grain yield 23.70q/ha followed by DC2 (22.59q/ha) with maturity period of 67 days only. 3 entries contributed for co-ordinanated advanced trial. In hybridization programme single plant have been selected from further programme.

Breeder/Nucleus seeds were also produced for the varieties/entries which are under testing in coordinated trial and where performance have been found satisfactory.

2.5.3 Pulse crops

Pigeonpea

Breeding trials

- Out of five experiments conducted during kharif 2003-04, one trial viz., IVT(Late) filled due to water logging condition.
- In IVT (Late), one out of 17 entries viz., MAL-18 recorded significantly higher yield(16.63q/ha) than the best check i.e. MAL-6(12.96q/ha) and the local check i.e. Bahar(12.62q/ha).
- Out of nine entries in IVT(Pre-rabi), Pusa(B)- 0338 gave significantly higher yield (16.63q/ha) than the local checks viz., Pusa-9 (12.66 q/ha) and DA-11(14.82q/ha).
- In AVT-1(Pre-rabi), among ten test entries, NDA-99-8 registered significantly better yield(17.14 q/ha) than local checks viz., Pusa-9 (12.66q/ha) and DA0-11(14.82q/ha).

Evaluation of germplasm

Altogether, 36 genetic stocks were maintained and evaluated but none of the lines was found promising for further use.

MULLaRP

Crop Improvement (Breeding) trials

- Altogether 20, 09 06 mung bean entries in IVT (Spring) AVT1 & 2 (Spring) and AVT1 & 2(Summer), respectively were tested for yield potential and yield contributing traits, but none of these entries qualified for promotion in view of their poorer yield performance as compared to the respective check or yield being below the state average.
- Among 17 and 05 Urd bean entries tested under IVT and AVT1 + 2 in spring season, none was considered worth prmoting because of their lower yield than the state average of 689 kg/ha.

Nucleus and Breeder Seed Production

Crop	Variety	Quantity(Kg)		
		A	B	C
Pigeonpea	Bahar	25.0	300.0	325.0
	Sharad	07.0	50.0	57.0
Mung bean	Sona	2.8	18.0	20.8
Urd bean	T_9	1.6	10.0	11.6
	Naveen	12.0	115.0	127.0

A: Nucleus; B: Breeder Seed; C: A+B

Chickpea

Breeding trials

- In station trial-1 on advanced lines of chickpea deshi type under late sown conditions (14th December) at Dholi, out of 23 entries only two viz; BG256/GNG 469 (1158 Kg/ha) and IPC 2003-7 (1120kg/ha) significantly out yielded the check i.e. Pusa 256 (850 kg/ha).
- In station trial-2 on wilt resistant lines of chickpea deshi type under late sown condition (14th Dec.) at Dholi, out of 15 entries, three viz; ICP 1997-72(3500kg/ha), ICPK 1999-18 (3401 kg/ha) and ICP200-52 (3174 Kg/ha recorded significantly higher yield potential than the best check i.e. Pusa 256(1804 kg/ha).
- In IVT trial on chickpea deshi type under normal sown condition (1st Dec.) at Dholi, among 28 entries tested, none was found significantly superior to the check i.e. Pusa 256 (1768 kg/ha).
- Among 26 entries of chickpea (Bold type) in IVT, under normal sown condition at Dholi, only one viz CSJ-416 (2407Kg/ha) performed significantly better than the best check i.e. GCP 105(1777 kg/ha) or Pusa 256(1712 kg/ha) while three entries viz. IPC2002-54 (1796 kg/ha), GL-22044 (1722 kg/ha) and GNG 1602 (1712 kg/ha) IPC 2002-54 (1796 kg/ha). were at par with the check.
- In IVT trial on deshi chickpea under late sown condition (14th Dec.) at Dholi, Out of 21 entries, only three viz; NDG-4-39(1433kg/ha) followed by CSJ-253(1303 kg/ha) and BGM 552 (1257 kg/ha) were found significantly superior to the best check i.e. BG 372 (950 kg/ha).
- None of the entries in AVT-1 trial on chickpea deshi type (05) under normal sown condition (2nd Dec.) at Dholi was found superior to the check Pusa 256 (1516 kg/ha).

- In International Chickpea Screening Nursery (ICSN), out of 19 entries (deshi) from ICRISAT, three viz; ICCV 04108 (23.10q/ha), ICCC 37 or Kranti (22.38q/ha), ICCV 04101(21.01q/ha) recorded significantly higher yield as compared to others including the check i.e. Pusa 256 (16.67 q/ha). Under normal sowing (2nd Dec.) in rainfed situation at Dholi.
- None of the chickpea entries in ICSN-Kabuli type of ICRISAT proved significantly superior to the local check (9.05q/ha).Only one entry viz; ICCV 04305(9.19q/ha) was found as good as the local at Dholi.
- In IVT trial on chickpea (Kabuli type) under normal sown condition at Dholi, among 24 entries tested, only one viz; CSJK-18(1104kg/ha) was found significantly superior to the best check i.e. BG 1053 (875 kg/ha).
- All the three coordinated trials on chickpea at PRC, Mokammah failed due to grazing of plants by rabbits.

MULLaRP (Lentil, Lathyrus, Rajmah & Peas)

Breeding trials

- At Dholi, out of 20 lentil entries including 03 checks in IVT (small seeded), IPL-211 recorded higher yield (23.40 q/ha) but was at par with the check i.e. PL-639 (23.33q/ha).
- Out of four small seeded lentil entries including two checks tested at Dholi under AVT2, L 4598 recorded significantly highest yield (25.01q/ha) followed by the best check i.e. PL-406 (22.45q/ha).
- None of the four small seeded lentil entries including two checks in AVT2 at Dholi performed significantly better than the best check i.e. PL-406(26.86q/ha) which was closely followed by the entries like L-4595(25.65q/ha) and WBL-77(25.02 q/ha).
- At Mokammah, out of 19 lentil entries including 03 checks in IVT (Bold & Extra bold), VL-510(9.68q/ha) followed by L,906-1(9.50q/ha) and L 4674(9.18q/ha) gave significantly higher yield than the remaining entries including the best check i.e. L 4076 (5.85q/ha).
- Of the eighteen field pea entries of all type under IVT at Dholi, IPF 04-26 gave highest yield (14.13q/ha) followed by HFP 01-10(13.81q/ha) and VL-45(13.18q/ha) which were at par with the best check Rachna(12.10q/ha).
- None of the entries of field pea (tall type) in AVT_2 at Dholi was found superior to the check i.e. Rachna (11.45q/ha).
- Among 19 field pea entries (dwarf type) IVT at Dholi, Pant P-31 gave the highest yield (21.62q/ha) followed byNDDP-4-20(20.90q/ha) and HUDP-27(18.31q/ha). All these entries were significantly superior to the checks i.e. HUDP-15(13.81q/ha) and HFP-4(13.50q/ha).
- Of the four high yielding field pea genotypes (dwarf) at Dholi, HFP (14.26q/ha) followed by HUDP-15(13.95q/ha) gave the best yield performance.
- Among six entries of Rajmah in AVT_2 at Dholi, the two checks i.e. PDR-14 and Amber recorded the highest yield (15.77q/ha)followed by the test entries like HUR-40 (15.48q/ha), with non significant difference among themselves.
- In AVT_1 coordinated trial on *Lathyrus* at Dholi, none of the test entries out yielded the check i.e. P-24 (13.0q/ha).One entry viz.; WBK 13-1 (12.44q/ha) stood closer to Pusa-24.

- At Mokammah, out of six Lathyrus entries of AVT_1 three viz; WBK-2 (7.82q/ha) followed by WBK-13-1(7.03q/ha) yielded higher than the checks i.e. BIOL-212 (6.02q/ha) and Pusa 24 (5.86q/ha).

Nucleus and Breeder Seed Production

Crop	Variety	Quantity (Kg)		
		A	B	C
Chickpea	Pusa256	8.00	25.0	33.0
	Pusa 372	3.50	-	3.5
Lentil	PL 406	3.00	230.0	260.0
	Arun	20.0	140.0	160.0
	PL 639	13.0	-	13.0
	L9-12	02.0	-	02.0
Peas	Rachna	15.0	30.0	45.0
Rajmash	PDR-14	13.0	50.0	63.0

A= Nucleus seed; B= Breeder seed; C= A+B

2.5.3 Oilseed crops

Sunflower

Breeding trials

Altogether 6 (six) experiments on sunflower were conducted during kharif 2004-05 at T.C.A., Dholi. The weather conditions during this year were not favourable for sunflower

- Collection and maintenance of germplasm for utilization in breeding programme. Total 68 germplasm were raised in augmented design germplasm were categorized according to maturity, plant height, seed yield, head diameter and other trials.
- Development of open pollinated populations-10 open pollinated populations were developed during period under report.
- IAVT (Initial advance varietal trial), 14 entries were evaluated in RBD with four replications. Varietal differences in kernel yield were highly significant. Variety GAUSUF 12 gave the maximum kernel yield of 1581 kg/ha, 41.1 per cent oil content and matured in 86 days which was closely followed by DRSF-108 giving kernel yield of 1573 kg/ha, oil content 43 per cent and matured in 86 days.
- IHT (Initial hybrid trial-I): In this trial, 22 hybrids were evaluated in RBD with four replications.
- Varietal differences in kernel yield were highly significant. Hybrid PAC-1091 gave the highest kernel yield of 1740kg/ha, oil content 44% and matured in 89 days which was closely associated with hybrid Surya 444 yielding 1669/ha, oil content 43.7 per cent and matured in 82 days.
- IHT-II (Initial hybrid trial set-II): In this trial, 19 hybrids were evaluated in RBD with four replication. Varietal differences in kernel yield were highly significant. Hybrid 65 A 41 recorded the maximum kernel yields of 1271 kg/ha, oil content 42.4 per cent and matured in 85 days which was closely associated with hybrid PAC 1091 giving 1136 kg/ha kernel yield, oil content 38.6 per cent and matured in 82 days.

- AHT (Advanced hybrid trial): In this trial, 14 hybrids were evaluated in RBD with 4 replications. Varietal differences in kernel yield were highly significant. Hybrid 64A 43 has recorded the maximum kernel yield of 1213 kg/ha, oil content 44.7 per cent and matured in 82 days which was closely followed by hybrid KBSH-1 giving the kernel yields of 1090 kg/ha, oil content 43.3 per cent and matured sin 82 days.

Seed Production

Crop	Variety	Nucleus (kg)	Breeder Seed (kg)
Sunflower	Morden	1.0 Kg	30 Kg
	Perodovic	1.0 Kg.	50 Kg.
Toria	RAUTS-17		08.0
Yellow Sarson	YS66-197-3		12.0
	Rajendra Sarson-1		09.0
Mustard	Varuna		35.0
	Kranti		14.0
	Pusa Bold		26.0
	Rajendra Rye Pichheti		13.0

2.5.5 Tuber crops

Potato (Rabi)

Crop Improvement trials

Altogether, 12 experiments were conducted. Among them 9 experiments were on crop improvement and 3 experiments on crop production. The details are as under.

Trial with early maturing hybrids in the plains (60 and 75 days harvest)

In this experiment 3 new germplasms viz., J/92,-13, J/93-58 and J/94-90 were tested against check Kufri Ashok and Kufri Jawaha. It was observed that all the new germplasms were statistically at par with check varieties.

Trial with early maturing hybrids in the plains (60 and 75 days harvest)

In this experiment 7 new germplasms viz. J/92-167, J/93-4, J/93-97, J/93-81, J/93-86, J/93-87 and J/93-139 were tested against the check varieties Kufri Ashok, Kufri Jawahar and Rajendra Alu -3. It was observed that all the new germplasms were found statistically at par with local check varieties.

Trial with early maturing hybrids in the plains (60 and 75 days harvest)

In this experiment 2 new germplasms J/92-159 and J/92-164 were tested against check varieties Kufri Ashok, Kufri Jawahar and Kufri Pukhraj.It was observed that at 75 days harvest only J/92-164 showed significant superiority over checks.

Trial with medium maturing hybrids (75 and 90 days harvest)

In this experiment 3 new germplasms viz. MS/95-117, MS/95-1309 and 13-420 (2) were tested against the check Kufri Sutlej and Kufri Pukhraj. It was observed that new germplam MS/95-117 and MS/95-1309 showed significant superiority over checks.

Trial with medium maturing hybrids (65 and 90 days harvest)

In this experiment only one new germplasms MS/94-1118 was tested against check RA-3, K. jawahar, K.Puskar, K. Ashok, K. Sutlej and K. Pukhraj. It was observed that germplasm was found statistically inferior of the best check(RA-3).

Trial with red skin medium maturing hybrids in the plain (75 and 90 days harvest)

In this experiment 2 new germplasms 94-P-31 and 94-P-31 and 94-P-59 against the checks MS/92-2105, Kufri Lalima and 97-2-DR. It was observed that all the new germplasms were found statistically *at par* with check varieties except 97-2-DR at 75 days harvest with respect to yield.

On farm trial (90 days harvest)

In this experiment 2 new germplasms JX-576 and MS/92-1090 were tested with 5 local check varieties JW-160, Kufri Anand, Kufri Sutlej, Kufri Bahar and RAjendra Alu-3, It was observed that both the new germplasms were statistically *at par* with check varieties except Kufri Sutlej and K. Bahar.

Storage behaviour trial at room temperature at 120 days after storage

In this experiment both the new germplasms JX-576 and MS/92-1090 were tested against check varieties JW-160, Kufri Ananad, Kufri Sutlej, Kufri Bahar and Rajendra Alu-3. It was observed that both the new germplasms were statistically *at par* with check verities with respect to tuber rotting.

Maintenance of germplasm

Altogether 1462 accessions of different tuber crops are being maintained at Dholi centre. As compared to ten other centers of AICRP on tuber crops, Dholi centre maintained highest number of germplasm in sweet potato (1140), Yam bean (175), *Colocasia* (75), Elephant foot yam (18), *Dioscorea esculenta* (10), Fur (12), Cassava (22), Winged bean (20), Kanda (24), Coleus (01), White yam (02) and Katchu (01).

Uniform Regional Trial (URT) on sweet potato

Ten clones received from different coordinating centre were planted during September 2004 and harvested at 120 days after planting. The clone RS 47 recorded highest yield (20.0 t/ha) which was statistically at per with D.O.P. 93 -19 (18.4 t/ha).

Varietal trial on sweet potato

Thirteen clones generated at Dholi centre were planted in September 2004 and harvested at 120 days of planting. The maximum yield (20.0 t/ha) was recorded in RS.-92 and D.O.P. 93-19 each which were statistically at par with standard check i.e. RS. 47 (20.8 t/ha)

Varietal trial on sweet potato for early maturity

In another set of varietal trial, twelve clones generated at Dholi centre were planted in September, 2004 and harvested at 90 days of planting. Out of 12 germplasm two germplasms vig; D.O.P. 92-93 and C_1 recorded highest (20.8 t/ha) and lowest (15.5 t/ha) tuber yield, respectively as against standard check i.e. Rs. 92 (18.6 t/ha)

Uniform Regional Trial (URT) on Elephant Yam

Five genotypes received from different co-ordinating centre were evaluated for their corm yield. The genotype Gajendra recorded highest yield (60.6 t/ha) followed by NDA-4 (52.2 t/ha).

Uniform Regional Trial (URT) on Cassava

Amongst thirteen genotypes, I.G.T.-1 recorded significantly highest yield (37.7 t/ha) followed by C_1-850 (27.3 t/ha).

Varietal trial on Yam bean

Eleven genotypes collected from different sources sown in August 2004 and harvested in January were evaluated for their marketable tuber yield. The genotypes

D.P.H.-5 recorded highest marketable tuber yield (32.5 t/ha) which was statistically at par with white flower (30.3 t/ha), D.P.H. 88 (30.3 t/ha), D.P.H.-9(30.3 t/ha) and standard check i.e. R.M.-1. (30.0 t/ha).

2.5.6 Vegetables

Breeding and Varietal :- Germplasms in the following Crops were maintained:

S. No.	Crops	No. of collections maintained	No. of promising lines	Remarks.
1.	Early cauliflower	35	11	Out of 35, 11 collections were found promising in respect of curd size.
2.	Garlic	17	07	Out of 17, 7 collection were found promising in respect of weight of bulb.
3.	Pointed gourd	15	08	Out of 15 collections, only eight were found promising in respect of yield and quality.
4.	Tomato	75	08	Out of 75, only 8 collections were found promising in respect of Yield.

Varietal Experiments

Cow pea

S.No.	Varieties	Sources	Yield (Q/ha)	Result
1.	CHCP –1	HAFRP,Ranchi	74.13	Out of 6 entries, the variety CHCP-1 produced the highest yield of 74.13 Q/ha. Followed by CHCP-2 (62.33 Q/ha)
2.	CHCP –2	HAFRP,Ranchi	62.33	
3.	Ajeet –11	Ajeet Seeds	56.60	
4.	Sel- 16	IIHR	50.00	

Vegetable Peas (Mid season)

S. No.	Varieties	Sources	Yield (Q/ha)	Result
1.	NDVP-8	Faizabad	80.99	Out of 11 entries NDVP-8 produced the maximum yield of 80.99 Q/ha. Which was at par with VL-8, VL-3, VRP-7 and VRP-8.
2.	VL-8	VPKAS	77.16	
3.	VL-3	VPKAS	75.31	
4.	VRP-7	IIVR	74.20	
5.	VRP-8	IIVR	72.84	
6.	VP-5	Almora	62.10	

Tomato (Determinate type)

S. No.	Varieties	Sources	Yield (Q/ha)	Result
1.	DVRT-2	IIVR	413.42	Out of 8 entries, The variety DVRT-2 recorded the highest yield of 413.42 Q/ha. Which was alike with NDTS-2001-3 and NDTS-2001-4.
2.	NDTS-2001-3	Faizabad	380.55	
3.	NDTS-2001-4	Faizabad	375.69	
4.	Mani Leima	Barapani	336.11	

Tomato Indeterminate type

Sl.No.	Varieties	Sources	Yield (Q/ha)	Result
1.	Arka Vikas	IIHR	452.08	

2.	NDTS-2001-2	Faizabad	413.54	Out of 5 entries, The variety Arka vikas recorded the maximum yield of 452.08 Q/ha. Which was similar to NDTS-2001-2 (413.54 Q/ha)
3.	BT-107	Bhubneshwar	403.64	
4.	JTL-2	Junagarh	390.77	

Hybrid Experiments

Bottle gourd

Sl.No.	Hybrids	Sources	Yield (Q/ha)	Result
1.	NDBGH-4	Faizabad	256.16	Out of 12 entries, The highest NDBGH-4 produced highest yield of 256.16 Q/ha. Which was at par with Rajendra Chamatkar.
2.	VRBGH-1	IIVR	237.88	
3.	VRBGH-2	IIVR	232.82	
4.	Rajendra Chamatkar	Sabour	252.07	
5.	VBGH-101	Vijoy Seeds	176.97	

Cucumber

Sl.No.	Hybrids	Sources	Yield (Q/ha)	Result
1.	Pusa Sanyog	IARI	154.36	The hybrid Pusa Sanyog out yielded 154.36 Q/ha. Which was at par with hybrid KTCH-11 (151.08 Q/ha).
2.	KTCH-11	Katarni	151.08	
3.	Hybrid No-1	Century	137.94	
4.	Ragini	Ankur	118.80	

Tomato (Determinate type)

Sl.No.	Hybrids	Sources	Yield (Q/ha)	Result
1.	ARTH-3	Ankur	465.76	Out of 14 entries hybrid ARTH-3 produced the highest yield of 465.76 Q/ha followed by hyb. BSS-422 (430.56 Q/ha)
2.	BSS-422	Bejo.	430.56	
3.	TH-1	PAU	428.70	
4.	BSS-419	Bejo	421.30	
5.	SMTH-203	Sreema Seeds	380.56	

Tomato (Indeterminate type)

Sl.No.	Hybrids	Sources	Yield (Q/ha)	Result
1.	BSS-20	Bejo	484.93	The hybrid BSS-20 produced the highest yield of 484.93 Q/ha. Which was statistically at par with hybrid ARTH-4. (442.71 Q/ha).
2.	ARTH-4	Ankur	442.71	
3.	TH-806	Syngenta	421.35	
4.	TH-977	Syngenta	414.08	
5.	KDTH-61	Krishidhan seed	407.46	

2.5.6 Vegetables

Varietal trials

In long group brinjal trials, check variety KS-331 produced significantly the highest yield significantly the highest yield of 289.85 Q/ha which was statistically at par with variety JBGL-03-04 (260.92 Q/ha) in IET where as in AVT-I check variety KS-331 recorded the maximum yield of 284.33 Q/ha which was significantly alike with variety 71.19 (169.37 Q/ha).

In round group of brinjal trials AVT-I & AVT-II, indicated that the highest yield of 312.11 Q/ha was recorded in DBR-8 which was statistically at par with variety KS-224 (274.03Q/ha) in AVT-I. In AVT-II trial the same variety DBR-8 produced the highest yield

of 309.91 Q/ha which was at par with varieties KS-224 yielding 277.19 Q/ha and IVER-2 (272.03 Q/ha).

Spongegourd

The variety KSG-14 produced the highest yield of 109.64 Q/ha which was statistically at par with varieties Pusa Chikni (106.25 Q/ha) and NSG-1-11 (103.77 Q/ha) in AVT-I where as in AVT-II trial, variety CHSG-1 recorded the highest yield of 110.77 q/ha which was statistically alike with the varieties CSBG-2 (104.41 Q/ha) and check variety Pusa Chikni (102.87 Q/ha).

Hybrid trials

In long group of hybrid brinjal trials, Pusa Hybrid-5 significantly produced the maximum yield of 360.29 Q/ha and 352.88 Q/ha in IET & AVT trials, respectively.

In round groups of hybrid trials Pusa Hybrid-6 significantly recorded the highest yield of 351.22 Q/ha and 380.22 Q/ha in IET & AVT experiments, respectively.

Ridgegourd

In IET hybrid trials, The hybrid BSS-405 produced the highest yield of 95.40 Q/ha which was statistically at par with hybrids BSS-580 (83,15 Q/ha), IRGH-023 (82,89 Q/ha) and sanchita (82.11 Q/ha) where as in case of AVT trial, the hybrid Arati recorded the highest yield of *86.70 Q/ha) which was statistically similar to Mahima (82.98 Q/ha) and NRGH-211 (76.55 Q/ha).

2.5.7 Fruits

Mango

Varietal trial

Mallika cultivar performed best yield (78.94 kg) per plant, cumulative yield of 10 years 2132.50 kg per plant, TSS (21.33° Brix) and acidity 0.317. Mallika has performed best among the other except cumulative yield (1093.07 kg) per plant.

Veneer grafted plants performing better. Root stocks Latra giving the maximum dwarfing effect, highest fruit yield (40.00 kg) per plant in Kalapaddy. Double Hedgerow system of planting produced the highest yield.

Use of Paclobutrazol (CULTAR – PP_{333}) @ Soil application 10 g active ingredient per square metre of Plant Canopy produced highest yield (103.74kg/plant) Cumulative yield was highest (4527.30 kg/plant) with application of CULTAR @ 0.5 g a.i. in Soil application. Under this project 147 germplasm under Horticulture Garden. Maximum fruit, high pulp content in Puttu (89.00%), TSS (26.00°Brix) in Ananas, Bharotbhog, Husneara, and Kalapaddy, highest yield in Lucknow Safeda (181.4 kg) per plant. Cumulative yield in Kaitki (1115.60 kg) per plant after 9 years.

Guava : Double Hedgerow system has given higher yield (74.00 kg) as compare to others.

Litchi

Altogether 17 litchi accessions were maintained in the field gene bank at the centre. In variety evaluation studies, eight varieties were compared and the highest fruit yield was recorded from China trees. All cultivars except Late Bedana were *at par* with China, the highest yielder.Late Bedana yielded about 50% of the established cultivars like China and Shahi.

Banana

A total of 86 banana clones belonging to different genomic groups were maintained and studied for their economic characters. The maximum accessions were of genomic group AAB (36), followed by ABB (24) and AAA (16). There are 6 diploids (AA, AB and BB) and 4 tetraploids (AAAB, AABB and AAAA).

In a variety evaluation trial with four FHIA Hybrids and same ABB clones, FHIA 1, FHIA 3 and FHIA –23 produced consistently better yields in 3 crop cycles. Their average yield over 3 crop cycles ranged from 60 to 70 t/ha.

2.5.8 Sugarcane

Altogether, 52 clones were evaluated in third clonal (C_3) generation; 31 promising clones of different maturity groups (Early: 9 and Mid-late: 22) were selected on the basis of cane yield, juice quality characters and field resistance to major diseases and insect pest.

In advanced varietal trial II plant on mid-late varieties, the testing variety CoSe 95436 was found best both in respect of cane (63.95t/ha) and sugar yield (7.83 t/ha) at harvest. Other entries in order were CoSe 98231 (49.50 t/ha, 5.92 t/ha), Co 98020 (43.98 & 4.92 t/ha) and CoSe 97232 (42.0 t/ha & 4.95 t/ha) and were found statistically at par with the best check CoSe 95422 (47.50 t/ha & 5.78 t/ha). Maximum sucrose % which was statistically found at par with most of varieties except Co 98020 (16.35%) and CoSe 99233 (16.76%).

In initial varietal trial on early varieties, maximum cane yield was found in variety CoBln 94063 (63.25 t/ha) which was found statistically at par with the variety B.O. 144 (62.30 t/ha) but superior than the best check variety CoSe 95422 (54.48 t/ha). In respect of sucrose % in juice, variety B.O. 144 recorded maximum sucrose (18.34%) in juice followed by CoSe 01421 (18.31%) CoSe 95422 (17.78%) and CoSe 00235 (17.59%) which were at par. The variety B.O. 144 also recorded maximum sugar yield (7.80 t/ha) at harvest followed by CoBln 94063 (7.61 t/ha) which were at par to each other but statistically superior to others.

In initial varietal trial on mid-late varieties, the two testing entries namely, CoBln 90006 (66.33 t/ha) and CoP 01182 (63.83 t/ha) recorded higher cane yield than others including the best check B.O. 128 (56.75 t/ha). Maximum sucrose % in juice at harvest was recorded by the variety CoBln 90006 (18.45%) followed by B.O. 142 (18.33%), CoP 01181 (18.21%) and CoP 01182 (18.18%) which were at par themselves including the best check B.O. 91 (18.13%). In respect of sugar yield at harvest again the entries CoBln 90006 (8.15 t/ha) and CoP 01182 (7.82 t/ha) performed superior than others.

In advanced varietal trial I plant on mid-late varieties, the testing variety B.O. 136 was found best both in respect of cane yield (68.84 t/ha) and CCS (8.39 t/ha) at harvest. The variety B.O. 137 which ranked 2nd recorded statistically higher cane yield (64.09 t/ha) than the best check B.O. 120 (59.96 t/ha) but had similar sugar yield (7.72 t/ha) to the best check B.O. 128 (7.49 t/ha). However, varietal performance in respect of sucrose % in juice at harvest was found non-significant.

Sugarcane Breeder's Seed Production

During the year, 1869 quintals of Breeder's seeds were supplied to sugar factories and Cane Development department.

2.5.9 Spices

Ginger

Studies on organic input in ginger yield

All the organic input except T_2 (Ponagamic oil cake + Neem oil cake + Sterameal + Rock phosphate + wood Ash) gave better result in comparison to inorganic forming (NPK)regarding yield per plot and per hectare. Among all the treatment T_1 (F.Y.M.+Pongamia oil cake + Neem oil cake + sterameal + Rock phosphate +wood Ash) gave maximum yield (7.10 kg/plot and 23.67 t/ha) followed by treatment T_7 "F.Y.M. + Pongamia oil cake +Neem oil + sterameal +Rock phosphate" (6.30 kg per plot and 23.53 t/ha)

Effect of micro-nutrients (complex) on ginger

Application of micro –nutrients i.e. Zinc sulphate, Borax and Ferrous sulphate showed positive effect on the growth and yield of ginger crop with recommended dose of N, P and K nutrients over Zero level of micro-nutrients. Basal application of zinc sulphate @ 25.0 kg/ha, Borex @ 10.0 kg/ha and foliar spray of ferrous sulphate @ 1.0 percent at 60 and 90 days after sowing, yielded maximum fresh rhizome of ginger crop followed by foliar application of zinc sulphate @ 0.5 percent, Borex @ 0.2 percent (60 & 90 DAS) and basal application of ferrous sulphate @ 10.0 kg/ha. While interaction was found non significant. For basic status of NPK micro-nutrient we had taken the help of scientist working in the AICRP on micro-nutrients, Deptt. of soil Science, R.A.U., Pusa

Turmeric

Initial evaluation trial

Nine genotypes including check (Rajendra Sonia) were tested under initial evaluation trial. The genotype RH-80, RH-50 and RH 9/90 produced maximum yield over check (Rajendra Sonia). However, RH-80 was out yielded (46.17 kg/plot and 64.12 t/ha) followed by RH-50 (45.83 kg/per plot and 63.66 t/ha).

Yield comparison between raised and flat bed method

The pilot trial was conducted in the area of 150 square meter raised bed and flate bed. The raise bed method produced 325 kg in the area of 150 square meter while 290 kg yield was recorded in flate bed method in the same area. However raised bed method produced 35 kg and 12.07 percent more yield as compared to flate bed method.

Corainder

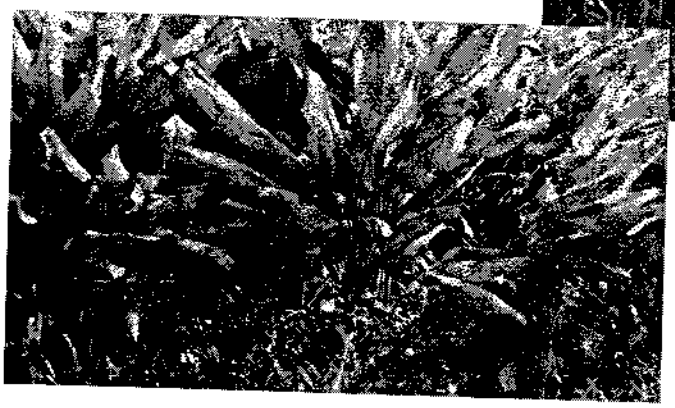
Varietal trial

The experiments were conducted three consecutive year from 2002-03 to 2004-05. All the genotypes were not significantly superior over check variety Pant Haritima regarding yield. However, maximum grain yield1.69 t/ha was recorded with genotype RD-120 which produced 9.03 % higher grain yield over check variety Pant Haritima. So far, cost : benefit ratio is concerned, this genotypes RD-120 gave more return (1:1.11) over other genotype.

Initial evaluation trial

The Experiments were conducted three consecutive year from 2002-03 to 2004-05. The genotype RD-366, RD-373, RD-154 and RD-121 were found significantly superior over check variety Rajendra Swati regarding yield. However, genotype RD-366 gave the maximum yield 1.75 t/ha followed by RD-373 (1.51 t/ha). So for the genotype RD-366 proved superior over other entries with cost benefit ratio (1:1.19)

Zinger crop exhibiting iron deficiency.



Experimental plot of fennel

Turmeric crop on raised bed

Experiments on Spice Crops

Fenugreek

Germplasm collection, characterization, Evaluation and Conservation.

Forty germplasms of ginger were tested for selection of promising line in report of yield and quality of rhizomes yield of germplasm varied from 0.10 kg(RG-45) to 14.0 kg (RG-30) in the area of 6.0 m^2.

Eight four germplasm of turmeric were tested for promising line in respect of yield and quality. Yield of germplasm were varied from 11.00 kg (Dehradoon) to 43.50 kg (RH-2) in the area of 7.2 m^2.

Eighty five Germplasm of coriander were tested for selecting selection promising line in respect of yield and quality. The seed yield of germplams verified from 2.5 g/plan with UD-37 to 12.8 g/plant with UD-241. Following genotypes namely UD-241, UD-686, UD687 and M-1 were found high yielding.

Ninety Seven germplasms of fenugreek were evaluated to select promising line for getting higher yield with quality produce. The seed yield of germplams varied from 2.8 g (M-22) to 8.8 g/plant (RM-15). Following genotypes namely RM-18, RM-33, RM-15, UM-109, UM-125, RM-28 and RM-44 were found high yielding.

Comparative yield trial

The experiments were conducted three consecutive years from 2002-03 to 2004-05.Genotype HM-444 produced significantly maximum number of branches per plant (7.79), number of pods per plant 59.24 and grain yield 1.61 t/ha as compare to check variety Rajendra Kanti however, rest entries were not significantly superior over check variety. The genotypes H.M.-65, H.M.-376, RM-28 and H.M.-444 were significantly delayed maturity as compare to check variety Rajendra Kanti and so far cost : benefit ratio is concerned this genotype (H.M.-444) gave more return (1:0.85) over other.

Initial evaluation trial

The experiments were conducted three consecutive years from 2002-03 to 2004-05. Genotypes RM-70 was found significantly superior over check variety Rajendra Kanti regarding number of pods per plant and grain yield which was produced the maximum number of pods 40.43 and 1.66 t/ha. Genotype RM-70 proved better to all genotypes and produced 22.06 percent higher grain yield over check variety Rajendra Kanti as well as cost:benefit ratio is concerned this genotypes gave more return (1:0.91) over other.

Screening of genotypes for un-irrigated areas

The Experiments were conducted three consecutive from year 2002-03 to 2004-05. there was found significant differences among the genotypes. Genotype RM-5/90 produced the maximum number of grains per pod 16.10 and grin yield 0.92 t/ha followed by 15.83 and 0.88 t/ha respectively with genotype RM—15. So far the genotype RM-5/90 proved superior over with cost : benefit ratio (1:0.32).

Coriander

Germplasm, Collection , Characterization, Evaluation And Conservation

Eighty five Germplasm of coriander were tested for selecting selection promising line in respect of yield and quality. The seed yield of germplams verified from 2.5 g/plan with UD-37 to 12.8 g/plant with UD-241. Following genotypes namely UD-241, UD-686, UD687 and M-1 were found high yielding.

Effect Of Bio-regulators

Foliar application of Triacontanol @ 0.5 ml/liter water produced maximum grain yield 1.66 t/ha at three spray 40, 60 and 80 days after sowing followed by Triacontanol @ 0.5 ml/liter water (1.41 t/ha) of two spays 40 and 60 days after sowing. However interaction was found non significant.

Fennel

Germplasm Collection, Characterization, Evaluation and Conservation

Altogether thirty one germplasms of fennel were collected from different sources and tested for obtaining promising lines for higher yield. Out of thirty one genotypes, only three genotypes namely RF-18, Rf-31 and J.F.-303 produced higher yield which varied from 0.1 Kg to 0.13 Kg/plant.

Varietals trial

All the genotypes were observed non-significant over check variety Rajendra Sourabh. However, genotypes RF-31 & RF-21 gave the maximum grain yield 1.21 Kg/plot & 1.35 t/ha while genotypes NDF-5 was recorded lowest grain yielder 0.80Kg/plot and 0.89 t/ha. Genotypes RF-31 & RF-21 produced 13.45 more grain yield over check variety Rajendra Sourabh.

2.6 Agronomy

2.6.1 Cereals

Maize

Crop management trials

All together 3 experiments were conducted during kharif, 2004. All trials were on N x germplasm (one each on extra early, early and medium maturing pre-release germplasm).

In N x G medium maturing germplasm, NECH-120 significantly out yielded (42.6q/ha) rest of germplasms followed by PMZ-36(35.7q/ha). Levels of N could not affect the yield level of any germplasm significantly.

In N x G extra early maturity group neither of the N and not any germplasm responded significantly. In N x G early maturity JH 3851(32.83 q/ha) significantly surpassed rest of the germplasm followed by Prakash 27.11 q/ha and X 2184 (22 q/ha) and rest were alike where none of N dose could affect the yield of germplasm significantly.

All the tested entries of full maturity group (rabi) showed positive response with increasing level of nitrogen. However, PRO-311 exhibited the best response (72 q/ha).

In case of early maturity group (rabi) also increasing trends of yield response were recorded with increasing level of nitrogen. In this case, response of N_2 (160 Kg/ha) and N_3 (240 Kg/ha) proved significantly at par response. Among tested entries SEEDTEC BUMPER resulted the best yield of 55Q/ha.

2.6.2 Pulse crops

Pigeonpea

Crop management trials

Field evaluation of four promising genotypes of late pigeonpea under different dates of sowing and at different plant population level revealed that sowing of NDA-1 on July 26 at wider spacing of 75x20 cm recorded highest yield (23.2 q/ha). Under late

sown condition (16th August) too but at closer spacing (60 x 20 cm), this genotypes gave the best yield performance.

In the field trial on varietal cum sowing date in pigeonpea based intercropping system, the variety Bahar sown on 5th August and intercropped with Yam bean recorded highest arhar equivalent yield (22.5q/ha) in comparison to that sown on 5th September and intercropped either with yam bean or Urd bean. The Urd bean intercropped with pigeonpea cv. Bahar or MAL-13 on 5th September completely failed to flower under late sown condition (5th September), inter-cropping of pigeonpea cv., MAL-13 with Yam bean proved more productive with arhar equivalent yield of 15.58 q/ha followed by Bahar + Yambean (14.19q/ha).

Cropping system

In pigeonpea + rice intercropping trial, one row of rice cv. Prabhat transplanted between two rows of pigeonpea cv. Bahar spaced at 75 cm recorded maximum arhar equivalent yield(18.73q/ha). Different planting pattern and fertility levels, i.e. 50, 75 and 100% RDF to rice, however, did not bring about a significant variation in grain yield. However, application of 75% RDF to rice proved more productive with arhar equivalent yield of 18.71 q/ha.

Effect of micronutrient

In micronutrient fertilization studies, application of chelated iron at 2.0 kg/ha as foliar spray resulted in higher grain yield of pre-rabi arhar cv. Sharad (13.12q/ha) but it did not differ significantly from seed treatment with $ZnSO_4$ at 4g/kg seed (12.34q/ha) or $FeSO_4$ at 4g/kg seed (12.04q/ha). Seed treatment with sodium molybdate at either g or 4 g/kg seed did not show significant role in yield enhancement whereas, application of borax either as foliar spray (5.0 or 10.0 kg/ha) or as seed treatment (4g/kg seed) over and above the RDF proved deleterious to crop yield.

MULLaRP

Crop management trials

Agronomic evaluation of mung bean genotypes revealed that the variety Sona significantly out yielded (410 kg/ha) the other test entries like Pusa 95-31, HUM-12, PDM-11, HUM-1 and Pusa Vishal. Among plant populations, medium population of 4.0 lakh/ha and recommended population of 3.3 lakhs were found at par with each other but proved superior to higher plant population of 5.0 lakhs/ha from yield performance point of view.

Cropping system

Urd bean intercropped with ragi in 2:2 ratio produced significantly higher urd equivalent yield (667 kg/ha) and it was at par with Urd+ragi at 4:4 row ration (636kg/ha), Urd bean + ragi at 3:3 row ratio(625 kg/ha) and sole ragi (606kg/ha).

Chickpea

Crop management trials

In crop management trial, three years data (2002-03 to 2003-04) revealed that seed priming i.e. pre-sowing seed soaking in water for 8 hr accelerated seedling emergence but did not influence the yield of chickpea cv. BG 372 probably due to adequate soil moisture under normal sown condition (2nd fortnight of Nov.) Normal row spacing of 30 cm gave significantly higher yield (15.54 q/ha) than wider row spacing of 45 cm (13.44 q/ha).

Under rainfed condition the foliar spray of urea (2.0%) and KCl(3.0%) at 10 days interval, starting from flower initiation stage significantly increased the grain yield by 23.4 and 10.1 per cent, respectively over unsprayed control(13.03q/ha). Maximum yield (16.17 q/ha) was obtained in case of row spacing at 30 cm combined with urea (2.0%)spray.

In chickpea mustard intercropping at different nutrient level, the first year trial revealed that chickpea sole crop produced higher equivalent yield (17.25q/ha) than its intercropping with mustard. No significant difference was found in chickpea + mustard intercropping at 6:1 and 6:2 row ratio. Poor yield of mustard alone or its intercropping with chickpea was due to its late sowing (16th Nov.). Application of 100% RDF produced higher chickpea equivalent yield (13.62q/ha) which was however, at par with that at 75 % RDF (13.18q/ha). No significant difference was found between 75 % and 50% RDF in respect of chickpea equivalent yield.

Cropping system

In rice based cropping system trial, rice-chickpea cropping sequence produced maximum chickpea equivalent yield (17.24q/ha) than all othe cropping sequences viz; rice cv. Prabhat followed by wheat cv. 1731 (13.86q/ha) mustard cv. Varuna(4.50 q/ha), field peas cv. HFP-4 (9.13q/ha), lentil cv. PL 406 (8.00q/ha) and maize cv. Deoki (10.31q/ha) sown on 26th Nov. Rice chickpea cropping system yielded 24.4% more yield than widely prevalent rice-wheat system in the state. Likewise, rice-chickpea cropping system proved most profitable and increased additional income by Rs. 5,746.00over rice-wheat system.

MULLaRP(Lentil, Lathyrus, Rajmah & Peas)

Crop management trials

- The result of 3rd year trial on plant population and fertility requirements of bold seeded lentil at Dholi maintained consistency with that of previous year. Bold seeded lentil cv. DPL-15 responded to FYM application and at 5t. FYM/ha, it recorded significantly higher grain yield (12.80q/ha) than that in plot without manuring with FYM (10.56q/ha). Phosphorus application @ 20 Kg P_2O_5 gave higher seed yield (11.56q/ha) than no phosphorus (10.50q/ha). Higher level of P_2O_5 i.e. 40 Kg/ha further increased the yield to the tune of 12.97q/ha but it was at par with that at 20 kg P_2O_5.
- A seed rate of 62.5kg/ha was found optimum for achieving higher yield (12.76 q/ha) as compared to the seed rate of 50.0Kg/ha (10.50q/ha) or 75.0 kg/ha(11.77 q/ha).
- In the 3rd year of trial, foliar spray of urea and KCl at 2.0 per cent each, when applied twice, increased the seed yield of lentil cv. PL 406 over absolute control or water spray but not to the level of significance. Basal application of 20:40:16:20 kg/ha of NPKS gave significantly higher yield as compared to no basal application of fertilizer (7.54q/ha).
- The results of 3rd year trial on sowing time and seed rate requirements for increasing yield of extra early field pea maintained consistency with that of the previous crop season at Dholi. The extra early dwarf field pea cv. DDR-23 planted on 20th November recorded highest yield (12.50q/ha) and deviation in sowing time on either side i.e. earlier on delayed sowing resulted in drastic decline in its yield.

- The row spacing (15 x 10 cm) yielded maximum (8.75q/ha) but it was at par with that of 22.5 x 10 cm spacing (7.50q/ha). There was a significant decline in yield (5.77q/ha) at wider row spacing 30 cm.
- Results of the 3rd year trial revealed that grain yield of extra early field pea cv. DDR-23 increased with increasing levels of nitrogen and phosphorus upto 40 kg/ha each, with 13.07q/ha and 13.31 q/ha, respectively. However, there were no significant differences in yields at 20 or 40 kg/ha of either nitrogen or phosphorus.

2.6.3 Oilseed crops

Sunflower

Crop management

An Experiment was conducted during kharif 2004-05 to know the response of sunflower to bio-fertilizer (Azospirillum and Azotobactor) and found the treatment T_3 (100%N application) recorded higher seed yield (1606kg/ha) followed by T_9 (50%N+Azospirillum + Azotobactor seed treatment) seed yield(1587kg/ha) but difference was not significant. Lowest seed yield(737 kg/ha) was recorded in control (T_1). Therefore, application of 50 per cent N with Azospirillum + Azotobactor seed treatment can save 40-50 per cent nitrogen.

2.6.4 Sugarcane

Varietal trial on sugarcane

On the basis of 3 years experimentation in the main season group, genotype CoX of 97110 recorded cane yield of 98.23 t/ha and significantly out yielded all the varieties. CoX 97010 (89.63 t/ha) and X 97285 (84.89 t/ha) were similar and both of them were significantly superior to Standard. B.O. 110 (66.90 t/ha) However, varietal differences in sucrose % juice were non-significant.

In the zonal varietal trials (combined analysis), in the main season group, genotypes CoX 96915 (69.1 t/ha) and CoX 961001 (69.02 t/ha) both recorded significantly higher cane yield than Std. B.O 110 (64.68 t/ha). There was no marked differences in their juice quality.

In varieties x N-levels trial, among varieties B.O. 147 (83.8 t/ha) and B.O. 141 (79.2 t/ha) recorded significantly higher cane yield than B.O. 138 (72.9 t/ha) and CoP 9301 (67.1 t/ha) under irrigated condition. Nitrogen responded significantly up to 180 kg N/ha (81.01 t/ha). The increase in cane yield by 240, 180 and 120 kg N/ha over60 kg N/ha was to the extent of 26.3, 24.4 and 9.7 percent respectively. However, varietal differences in respect to sucrose % juice were non-significant.

Weed control in sugarcane

In weed control trial, all the method of weed control practices, significantly decreased number of weed and recorded significantly higher cane yield than unweeded control. Among them, application of metribuzin @ 1 kg/ai as pre-emergence +2,4 D-a kg ai/ha at 60 DAP + hoeing at 90 DAP recorded maximum cane yield (70.25 t/ha) followed by valper (Hexazinone 46.8% + diuron 13.2 % mixture @ 1.20 kg ai/ha as pre-emergence + hoeing at 90 DAP (65.46 t/ha), Metribuzin 1 kg ai/ha as pre-ecergence +2,4-D 1 kg ai/ha at 60 DAP (64.84 t/ha) and Atrazine 2 kg ai/ha as pre-emergence +2,4-D 1 kg ai/ha at 60 DAP (64.02 t/ha). Sucrose % juice did not exhibit significant differences due to different weed control practices.

2.6.5 Fruits

Litchi

- In plant density trial, five densities ranging from 100 to 222 plants/ha were compared with different planting geometry. Results indicated progressive increase in yield with increase in plant density per unit area. Double hedge row planting with 222 plants/ha produced 44% higher yield than the control in 17th year of planting.
- In tree training experiment on litchi cv. China, the impact of training was noticed only when central leader trees were compared with modified leader trees. When compared with the control, all treatments were found statistically at par.
- Pruning 50 cm or 75 cm twigs with fruit bunches at harvesting adversely affected next year's fruiting. There was significant reduction in yield as compared to the control where < 30 cm branch was pruned with the fruit bunch. Removal of new vegetative flushes in Nov- Dec. did not help in improving yield in any treatment.
- Irrigation and sprinkling of water had significant impact on reducing fruit cracking in Shahi litchi in comparison to the unirrigated control. Keeping orchard soil near field capacity and maintaining atmospheric humidity between 46 and 50% reduced the cracking up to 8% as against 22 % in the control.
- Application of bio-fertilizers had significant effect on tree height and canopy spread. The effect on fruit yield was not statistically significant. However, application of biofertilizers along with 50 kg FYM compensated for 50 % reduction in quantity of N, P and K applied through inorganic fertilizers.

Banana

- A study setout to evaluate the different forms of nitrogenous fertilizers revealed that, banana did not respond differently to different Nitrogenous fertilizers, used alone or in combination. Ammonium Sulphate was found little more effective than urea alone or different combination like Urea + Ammonium Sulphate or Urea + Ammonium Sulphate + CAN. Statistically, the effect of different treatments was not significant.
- In a plant density trial plant densities ranging from 4629 to 7500 plant /ha were tried. Results indicated that planting three suckers per pit at 1.8 x 3.6 m distance was the better as composed to other densities e.g. 5001 and 7500 plant/ha.
- A trial laid out with different levels of Nitrogen and six bio-regulators revealed that application of 200 g Nitrogen per plant produced better results and was statistically at par with 200 g N + 2% Urea spray. The additional application of N through urea did not produce any positive effect. The impact of bio regulators and the interaction between Nitrogen and bio- regulators were found statistically non- significant.

Papaya

In papaya some bio-fertilizers viz., *Azospirillum, Tricoderma harzianum,* VAM and PSB were used with 100 per cent recommended dose of NPK and 25 and 50 per cent reduction in the recommended of fertilizers (RDF). The results indicated that bio-fertilizers had positive influence on fruiting and yield of papaya plants. 25 per cent reduction in the recommended NPK dose produced at par results with full dose of NPK when the four bio-fertilizers were used with RDF.

2.7 Crop Protection

2.7.1 Nematology

Nematode Problems identification

Ear-cockle nematode *Anguina tritici* continued to be sporadic problem in Rabi Wheat in the state. Root-knot nematode *Meloidogyne incognita* was major nematode of Pulse crops such as chickpea, fieldpea, Lentil, Lathyrus and Rajmash. Root-knot nematodes (*M. incognita* and *M. javanica*) and Reniform nematode (*Rotylonchulus reniformis*) were major nematodes of Kharif vegetables. Among ectoparasitic nematodes, stunt (*Tylnchorhynahus nudus* and *T. mashhodi*), Lance (*Hoplolaimus indicus*) were found in predominant population in wheat and Rice. Ufra disease of rice and white tip disease of rice were not found in any of the samples surveyed.

2.7.1.1 Cereals

Wheat

Post harvest survey for the Ear-Cockle disease of wheat was conducted during April-June' 05. 30 samples were collected from the threshing floor and the market at different places of Samastipur and Muzaffarpur. In the places surveyed the percentage of ear-cockle gells ranged from 0-2.

Nematological survey of wheat based on 120 soil samples collected from 12 locations of the 4 districts namely Samastipur, Muzaffarpur, Vaishali & Purnia revealed the presence of Tylenchorhynchus nudus T.mashoodi, which was predominant over others, comprised 43.64 density of total nematode population. This was followed by Hoploaimus indicus.,Meloidogyne sp,Helicotylenchus indicus, H.dihystera,and Tylenchus sp.

Under rice-wheat cropping system there was increase in number of total plant parasitic nematodes both after paddy as well as after wheat. The percent increase over initial nematode population after rice was 235 where as it was 45 after wheat. However, the rice crop has favoured more population build up of Hirachmanniella oryzee and Meloidogync Juveniles which decreased after wheat.

2.7.1.2 Pulse crops

Chickpea

Out of 67 chickpea genotypes tested for their resistance to root knot nematode (*Meloidogyne incognita*), only three genotypes viz; Phule G 00110, Phule G 96006 and Vihar (PG95311, Kabuli type) showed resistance reaction. Thirteen genotypes viz; Phule G 94259, Phule G00109, WCG 2000-04, PDG 84-16, HOO-126, H99-265, HO1-20, HO1-12, GNG-1488 and RSJ 865 had shown moderately resistant reaction while, the remaining genotypes were susceptible or highly susceptible.

MULLaRP(Lentil, Lathyrus, Rajmah & Peas)

- Of the 33 accessions of lentil screened in pot experiment to locate resistance source against M. incognita, only L 4076 was found resistant. Eleven entries viz; NDL3-11, L45-97, L4670, L4671, L4674, L4595, L4666, L4677, KLB 97-7, KLS 225 and K 75 showed moderately resistant reaction while remaining test entries were found either susceptible or highly susceptible to M. *incognita*.
- Among six genotypes of *Lathyrus* evaluated, only one, i.e. WBK05 was found resistant while all other showed susceptible reaction to M. *incognitata*.

- None of the 44 entries of field peas, which were screened against M. *incognita*, was found resistant. Five entries viz.; IPF04-9, DMR-48, DDR-69, HFP0118 and HFP 8909 showed moderately resistant reaction while all others were found either susceptible or highly susceptible to M. *incognita*.
- Out of seven genotypes of Rajmash screened against M. *incognita*, two entries viz; HUR137 and IPR 98-3-1 showed moderately resistant reaction and all other were found susceptible.

2.7.1.3 Sugarcane

Survey of the fungal predators & parasites of nematodes associated with sugarcane during cropping season 2004-05 at Pusa revealed that 17.8 to 29.3% of nematodes were found infected with nematode destroying fungi, Maximum percentage were recorded in August and September while minimum were found in January during crop season.

Varieties of sugarcane - B.O. 138, B.O. 141 and CoP 9702 were found tolerant against spiral nematode (*Helicotylechus*) while CoP 9301 and CoP 9702 were tolerant against lesion nematode (*Pratylenchus*)

Total population of plant parasitic nematode enhanced by 133% in un-treated plots, if compared with in solarised + treated plots, the most effective treatment was carborfuran and FYM followed by bagasse and poultry manure. It also reflects on the growth characters including cane yield.

2.7.1.4 Vegetables

On the basis of host differentials Cotton (Daltapine), Tobacco (9C-95) and Okra (Parbani Kranti), *Meloidogyne incognita* population present in the Pusa was identified as Race-2.

2.7.1.5 Medicinal and Aromatic Plants

Ashwagandha, Chandrsur, Lemongrass, Miut, and Palmarosa were surveyed for the presence of plant parasitic nematodes. The results of survey revealed predominant population of stunt, and lesion nematodes. Other nematodes observed were spiral, root-knot, reni form and lance nematodes.

Bio-control

It has been found during studies of fungal predators and parasites of nematodes in amended soil and conventional soil, that out of 40 soil samples analysed, maximum percentage of fungal predators and parasites were recorded in organic amended soil. Most frequent predator of nematode was *Monacrosporium psichophila* while *Catenaria anguillulae* was most frequent amongst parasites.

2.7.2 Entomology

2.7.2.1 Cereals

Maize

Biology and management of Maize stem borer, *Chillo partellus* Swinhoe

Among the screening trial, five maize genotype viz., BHOPM-50, BHOPM-47, JHWX-29, XP-0130 and KH-510 were found tolerant to *Chilo partellus* as compared to the genotypes like BHOPM-40 and JHOPM-144 besides the local check i.e. Ganga Safed-2, on the basis of stem tunneling (%) and intensity of pest infestation. Among the neem based formulation, 'Neem rakshak' and neem oil, each at 0.2 per cent proved effective against stem borer (*C. partellus*) on maize. The folier spray of Decis (0.002%)

thrice at fortnightly intervals starting from 10 days old seedlings proved most effective in controlling *C. partellus* and also it exhibited phytotonic effect on plant growth, number of cobs/plant and maximized the yield.

2.7.2.2 Pulse crops

Gram

Study on the role of HNPV

There were altogether 10 treatments including control (water spray). The lowest population of pod borer was recorded in the treatment HNPV 500 LE + Endosulfan 0.07% which was at par with HNPV 250LE + Endosulfan 0.07% whereas water spraying recorded the highest pest population, in terms of pod borer damage.

Integrated insect-pests management of gram in Tal & diara

Altogether there were 11 treatments including control (water spray). Data shows that the treatment, seed treatment with chlorpyriphos + foliar application of endosulfan proved to be the best treatment in maintaining low seedling damage due to termite and cricket in diara area, followed by seeds treated with cow dung + cow urine incubated with molasses for a weak in earthen pot.

With regard to pod borer management seed treatment with chlorpyriphos + foliar application of endosulfan proved to be the best treatment. However, the mixed cropping with coriander (100:1) gave the lowest pod borer damage (20.86 %). The highest pod damage (30.65%) was in control.

Pigeonpea

Screening of germplasm for insect & pest

- Of the six advance stage pigeonpea materials of late maturity group, two entries, viz. MA-6 (21.7% pod damage)followed by MAT-18 (29.0% pod damage) proved least susceptible to *Heliothis* whereas, NDA-1(check) and MA-3 with 48.5 and 40.2 per cent pod damage, respectively proved most susceptible to this pest. Two entries viz., MA-3 and MAL-19 with 13.9 and 15.2 per cent pod damage, respectively were found least susceptible to pod fly. Two entries viz., NDA-1 (28.6% pod damage) followed by MA-6(26.7% pod damage) proved most susceptible to this pest.
- Out of eight genotypes of medium late maturity group in AVT, two entries, viz., IPA3-3, KAWR-92-02 (33.3-34.0% pod damage) proved least susceptible to *Heliothis* whereas, MAL-20 with 56.8 per cent pod damage was found most susceptible to this pest. Against pod fly, the entries like MAL-21, MAL-20, IPA-3-2, IPA-3-3 and IPA-3-1 with mean pod damage of 16.8-17.3 per cent proved less susceptible as compared to the check entry i.e. NDA-1(26.8% pod damage).
- Among the newer insecticides field evaluation against pod borer complex on pigeonpea cv. Bahar, spinosad 45 SC (75 g a.i/ha) was found to be most effective by recording lowest pod damage (15.2%) due to *Heliothis* as compared to the same being highest (44.3%) in untreated control. Spraying of spinosad 45 SC at lower dose (56g a.i./ha) with 18.7 per cent pod borer damage proved as good as its higher dose (75 g a.i./ha). Novaluron 10 EC (75 g a.i./ha) and endosulfan 35 EC (2L/ha) being at par with each other did not differ significantly from spinosad 45 SC (56 g a.i./ha) in reducing pod borer damage. None of the newer insecticides proved superior to either endosulfan 35 EC(2L/ha) closely followed by monocrotophos 40 EC (1L/ha) and spinosad 45EC(75 g a.i. /ha) with

mean grain yield of 1676.30 Kg and 1655.50Kg/ha, respectively as against the same being lowest (995.70kg/ha) in untreated control.

MULLaRP

Screening of germplasm

Kahrif

- Out of six Urd bean entries belonging to AVT-1 and AVT-2, two entries viz., VBG-73 and NDU-3-2 with 3.2-4.5 per cent pod damage proved least susceptible to the incidence of blue butter fly whereas, the entries like COBG-643(13.1% pod damage) closely followed by IPU-3-1(19.54% pod damage) and JKU-99-19(9.8% pod damage) were found highly susceptible to this pest. From yield point of view, none of these entries could be considered to be promising one (109.60-296.20kg/ha).
- Among the 13 mung bean entries, belonging to AVT-1, pod damage due to blue butter fly varied widely from 4.2 to 17.2 per cent. Six entries viz. LM 2000-58 closely followed by ML-1108, MMIK-25, ML-1165, SML-668 and COGG-917 proved least susceptible to the pod borer (4.2-5.7 pod damage) whereas, three entries viz., ML-1108 followed by Pusa-0371 and IPM-02-2 were most susceptible to the pest (15.8-17.2% pod damage).
- Out of seven mung bean entries belonging to AVT2, ML-818 and HUM-1 (2.6-4.6%) pod damage) proved least susceptible to blue butterfly infestation whereas, ML-131 was found most susceptible to this pest (16.5% pod damage).

Rabi

- Among 24 field entries belonging to IVT and evaluated under field condition, five viz; HUP-31, KPMR-707, IPF04-9, HFP-0110 and HUP-30 recorded fairly low stem fly damage(<1.0%) as against the same being highest (9.4%) in P_{42}, whereas the check entry i.e. HFP-4 recorded 2.6 percent plant mortality due to this pest four entries viz; HUP-30, HUP-31, IPF-04-9 and Pant P-40 exhibited low pod borer damage (3.0-4.7%) and were at par with the check i.e. HFP-4(4.1%).Two entries HUP-30 and HUP-31 showed dual resistance to stem fly as well as pod borer. From productivity point of view, HFP01-28 excelled all others with highest grain yield (1414 kg/ha) whereas, entries like HUP-30, IPF04-9, HFP01-10 and HUP-31 with yield ranging from 1234.50 to 1333.20 kg/ha were at par with the highest yielder entry i.e. HFP01-28.
- Out of 18 field pea entries alongwith the check under $AVT_{1=2}$, seven entries viz; DMR-7, KPMR-698, KPMR-682, KPMR-698, HFP-2005 and IPFD-2-6 recorded less than 1.0 percent plant mortality due to stem fly, Pant P_{25} registered highest stemfly damage (7.2%) followed by DDR-690(6.3%). Pod borer infestation varied significantly from 3.2 to 17.1 per cent, the lowest and highest being in HFP-4 and IPFD-1-10 respectively. The entry like HFP-8909 with 3.6 per cent pod damage proved as good as HFP-4 and showed relatively high level of resistance to stem fly and pod borer as well. Considering the productivity, the check entry HFP-4 recorded the highest yield (1037 kg/ha) followed by HFP-8909(1006.0kg/ha) and KPMR-682(1000.0 kg/ha).
- Field evaluation of insecticidal treatments revealed that all the insecticides were superior to untreated control with non significant difference among themselves, in reducing stem fly as well as pod borer incidence on field pea cv. HFP-4 (Aparna) and preventing yield loss. Minimum stemfly damage (1.6%) was obtained in seed treatment with dimethoate 30 EC (8 ml/kg seed) as against the

same being maximum (11.4%) in untreated control. It was closely followed by spraying of thiomethoxam 70 WS (25.0 g a.i./ha or 100 g product/ha) at one week after germination or profenophos 50EC(1.5 L/ha) spray at 15 DAS which recorded 2.3 per cent fly damage. Pod damage was in the range of 2.1 to 3.8 per cent in the treated plots as against the same being as high as 16.6 per cent in untreated control. Highest grain yield (1394.30 kg/ha) was obtained in seed treatment with thiomethoxam followed by the same in seed treatment with dimethoate (1393.40 kg/ha).

- Among four *Lathyrus* entries including the check, mean pod damage varied from 2.3 to 17.3%, lowest and highest being in RLS 3001 and Pusa 24 (check), respectively. RLS 3002 was found at par with the least susceptible entry i.e. RLS 3001 whereas; the entry like BIOL-212 with 11.7 per cent pod damage was closer to Pusa 24. From yield point of view, the entry RLS 3001 proved superior to all the test entries with 833.30 kg/ha followed by RLS 3002 (720.0 kg/ha) and Pusa 24 recorded lowest yield (583.30 kg/ha).

Field evaluation trials

Field evaluation of newer insecticides against major insect pest on bean cv. T_9 revealed that all the treatments as foliar sprays proved significantly effective in reducing pod borer damage whereas, seed treatment with either dimethoate (5.0ml/kg seed) or thiomethixam (2g/kgseed) did not prove significantly better than untreated control. Among foliar treatments, lamda cyahalothrin (0.04%) recorded the lowest pod borer damage (3.9%), highest grain yield (574.okg/ha) and found most effective in preventing yield loss(47.64%). Seed treatment with thiomethixam (2 g/ka seed)+ foliar spray of hostahion (0.04%) at flower initiation stage, closely followed spray of hostathion (0.04%) alone proved as effective as lamda cyahalothrin)0.04%) in reducing pod damage, preventing yield loss and enhancing grain yield over untreated control.

Chickpea

Field survey

A field survey of farmers' field around Patna and Dholi at podding stage of chickpea crop revealed that mean larval population of pod borer (*Helicoverpa armigera Hubb.*) varied from 6.2 to 15.4/m row length with mean pod damage from 14.2 to 42.8 per cent.

Among the chickpea entries of deshi type in AVT-1, HOO-78 with minimum pod damage (18.4%) was found least susceptible to pod borer whereas, the entry BG2019 was found most susceptible to the pest with 35.2 per cent pod damage. The check entry i.e. C-235 recorded 21.4 per cent pod damage.

All the three entries of chickpea viz; BG1053, RSG-902 and BG372, which were identified as least susceptible in the previous year (2003-04), recorded 19.2, 21.2 and 21.6 per cent pod damage, respectively as compared to the check i.e. P-256 (31.2%)

Field trial on PAT

In a field trial on determination of pesticide application technology (PAT), high volumes spray of NSKE (5.0%) or low volume spray of NSKE (10.0% or 5.0%) with pod damage ranging from 9.4 to 11.7 per cent proved at par with endosulfan 35 EC(350 ga.i./ha) which recorded lowest pod damage(8.6%) as compared to the same being significantly highest (26.7%) in untreated control. Highest grain yield (1265.40kg/ha) was obtained with endosulfan 35 EC (350 g a.i./ha) followed by low volume spray of NSKE (10.0%) and high volume spray of NSKE (5.0%) yield around 1111.0 and 1076.0 kg/ha as compared to the lowest yield (816.0Kg/ha) in untreated control.

All the insecticides besides the recommended one i.e. endosulfan 35 EC recorded significantly lower pod damage and higher grain yield as compared to untreated control. Among the newer insecticides, Novaluron 10 EC (100 g a.i./ha) proved the best treatment with lowest pod damage (5.1%) followed by spinosad 45 EC (60 g a.i./ha) with mean pod damage of 5.3 per cent. Insecticidal treatments prevented yield loss by 52.9 to 80.7 per cent over untreated control, the highest and lowest being due to spin sad 45 EC(60g a.i./ha) and endosulfan 35 EC(350 g a.i./ha)

2.7.2.3 Oilseed crops

Screening of linseed varieties for resistance against aphids and gall midge. No infestation of any insect pests was observed. Screening of germplasm of groundnut against Bihar hairy Caterpillar:

None of the 95 germplasm was found free from infestation by Bihar hairy caterpillar. The per cent leaf damage ranged from 4.25 to 22.25 %. The germplasm AH-5-3-2, NRCG-1472 and JH-60 were found least susceptible as they recorded the 4.25%, 4.55% and 4.75% damage respectively while 63-B and Polachi were found most susceptible as they recorded the maximum damage 22.25 % and 21.34%, respectively.

2.7.2.4 Tuber crops

Survey of insect-pests of tuber crops:

During the course of survey the mean per cent sweet potato tuber and yam bean pod infestation by sweet potato weevil and pod borer were recorded maximum i.e. 12.3 and 27.0 per cent on cv. Cross-4 and RM-1, respectively.

Screening of late maturity sweet potato germplasms against sweet potato weevil

Among 13 germplasms evaluated under open field conditions against sweet potato weevil, three germplasms viz; RS-92, D.O.P. 93-19 and RS-47 recorded maximum healthy tuber yield ranged between 20.0-20.8 t/ha while two germplasms viz; D.O.P. 92-138 and R.S.92 recorded lowest (1.8%) and highest (6.7%) tuber infestation, respectively.

Screening of early maturity sweet potato germplasms against sweet potato weevil

Among 12 sweet potato germplasms under early maturity group, four germplasms viz; D.O.P.-93-36, D.O.P. 92-163, Sreebhadra and X –24 recorded maximum tuber infestation ranged between 5.9-6.3 per cent as against standard check RS-92 (4.9%). Remaining germplasms occupied lower pest infestation.

Varietal screening of sweet potato against sweet potato weevil under uniform regional trial (URT)

Among ten germplasms, the mean healthy tuber yield varied from 13.9 to 20.0 t/ha with minimum and maximum being in D.O.P. 92 –151 and RS-47, respectively. Two germplasms viz; D.O.P.92-151 and BCSP-7 suffered most (11.2%) and lest (6.4%) due to weevil infestation, respectively.

Effect of insecticides and plant products on the incidence of spotted pod borer on yam bean

Among the different treatments, monocrotophos (0.04%) showed its superiority in reducing pest infestation (6.0%) and gave highest seed yield (10.1 q/ha) as against 28.3 per cent and 6.2 q/ha, respectively in untreated control. Remaining treatments occupied intermediate position.

Management of Melon fruit fly (*Bactrocera cucurbitae* (cog.) in bitter gourd

Among bitter gourd varieties, the incidence of fruit fly was recorded to be relatively low on two varieties, viz., F_1 'Hybrid vivek' and 'Hybrid Kiran' which gave higher Marketable yield of 974.19 g and 920.94g/plant respectively. Early sowing of bitter gourd variety 'Arkat Harit' on 7th February followed by 15th February resulted in minimum fruit fly infestation and maximum marketable yield. Basal application of phosphoric and potassic fertilizers in the soil helped in lowering the fruit fly incidence and maximizing marketable yield in bitter gourd.

2.7.2.5 Sugarcane

The incidence of shoot borer (*Chilo infuscatellus Snella*) and root borer (*Emmalocera depressell* Swinh) was observed upto 11.5%, while top borer (*Scirpophaga excerptalis Wlk*) was recorded from 5 to 16.8 percent and stalk borer (*Chilo auricillius Ddgn*) found to be 2.5 to 12.5% in Pusa Farm. The incidence of Termite, white grub, mealy bug and black bug was also observed in traces during the course of pest survey. The survey was conducted at Pusa farm as well as different sugar factories, the heavy attack of grasshooper reported from Gopalganj sugar factories reserved area. In this, rainy season, heavy attack of pyrilla was reported from Gopalganj, Sidhwalia and Majhaulia sugar factories.

Synthetic chemicals, namely Carbofuran, Chlorpyriphos, monocrotophos, acephate, phorate and endosulfan were tested against shoot borer (*Chilo infuscatellus)* at Pusa. Among the insecticidal treatments, chlorpyriphos 20 EC @ 1.0 kg a.i./ha treated plot had recorded high cane yield (75.6 t/ha) when applied at the time of planting with 2.5, 4.5 and 7.5% incidence of the pest at 60th, 90th and 120th days, respectively after planting was recorded.

Among insecticides tested against stalk borer Monocrotophos 36. S.L. @ 0.75 kg a.i./ha applied during last week of September and 2nd week of October was observed to be significantly superior in controlling stalk borer (13.6%) at harvest. The maximum yield (76.2 t/ha) was recorded in acephate treated plot which was at par with Monocrotophos with (74.2 t/ha) yield having pest incidence (15.2%).

The insecticidal treatment proved significantly superior over control in respect of top berer incidence as well as crop yield. Among the treatments, phorate 10 G@ 1.50 kg a.i./ha recorded maximum yield (75.2 t/ha) with minimum incidence of 3rd brood of top borer (8.2%) and 4th brood (10.2%) of top borer.

The first appearance of *Stenobracon deseae* and *Cotesia flavipes* were observed in the month of May, 04 in the surrounding areas of Sugarcane Research Institute, Pusa, Bihar. The maximum parasitization of 16.1% was recorded in the month of September by *S. deseae* and in the case of *C. flavipes* 15.3% parasitization was observed in the month of October against different borers of sugarcane.

Foraging activity of honey bees on summer cucurbits

Apis mellifera predominated on all cucurbits, followed by *A. florea* on bitter gourd. *A. cerana indica* on sponge gourd and *A.dorsala* on cucumber. The period between 06.00 to 09.00 hrs was found most congenial for foraging. Sponge gourd attracted more number of insect visitors followed by bitter gourd.

Inter specific variation in epigeic earth worms for their efficiency of bio-converting animal and agro-industrial wastes into vermi compost

None of the three earth worm species viz., *Eisenia foetida, Eudrillus eugeniae* and *Perionyx excavatus* could survive and establish in press mud of sugar factory when it was used alone. On mixing of press mud with cow dung (4:1), only *E. foetida* could establish and produce vermicompost throughout the year. Increased proportion of cow

dung (3:2) ratio in press mud based feed was found suitable for survival and establishment of *E. eugeniae* and *E. foetida* as well to produce vermicompost. *P. excaratus* did not establish it self in press mud alone or in combination with cow dung either at 4 :1 or 3 : 2 ratio. Of the three epigic earthworm species, *E. foetida* and *E. eugeniae* maintained their activity in all the four seasons i.e. summar, autumn, winter and spring. Whereas, *P. excavatus* remained active during summer and autumn seasons only. Shortest duration of vermicomposting (41 days) was due to *E. engeniae* from buffalo dung in summer season whereas, *E. foetida* took shortest duration of 44 days on cow dung in spring season. *E. foetida* and *e. engeuiae* took lowest duration of complete bioconversion of pressmud + cow dung (4:1) in autumn season and press mud + cow dung (3:2) in winter season, respectively Reproductivity of the three test worm species was greatly influenced by type of Organic substrate as well as seasonal changes. In case of *E. foetida*, it was maximum in spring season. whereas, *E. eugeniae* and *P. excavatus* as well recorded better reproductivity in summer seasons. Among the organic substrate tested as worm feeds, mixture of cow dung + buffalo dung (50:50) proved most favourable for all the three worm species under test. The earthworm species viz., *E. foetida* and *E. eugeniae* were found compatible with each other when these were allowed to share common organic substrate for their survival and multiplication in summer seasons. On addition of jaggery (2.0% w/w) or whey (1.0% w/v) to cow dung or buffalo dung multiplication of *E. foetida* and *E. eugeniae* increased, composting process has tened up and organic matter turn over considerably enhanced between two additives, Jaggery (2.0%) and Whey (1.0%) were found to accelerate the speed of vermicomposting of buffalo dung by *E. foetida* in autumn and summer seasons and that of cow dung or buffalo dung by *E. eugeniae* in summer and winter seasons, respectively.

2.7.2.6 Vegetables

Management of brinjal pests

Altogether there were 8 treatments, The treatment included both seedling root dip and foliar spray of the insecticides. All the insecticidal treatments were found to be effective against brinjal pests. However, Cypermethrin was found to be the most effective showing minimum shoots and fruits damage (4.97 & 6.28) respectively with a highest yield of 275.95 q/ha.

IPM module for the management of brinjal pests:

The treatments included both plants products and synthetic insecticides used at different stages of crop growth. Among the treatments, the combination of NSKE with profenphos and cypermethrin was found to be the most effective recording lowest fruit damage of 4.37% with a yield of 258.31 q/ha.

Seasonal incidence and population dynamics of brinjal shoot and fruit borer

The moth was initially low which varied between 2 to 12 during 1st week of July to 2nd week of October. The catches were comparatively high between 3rd week of October to 2nd week of January (15 to 33). The highest population of 33 and 22 male moths were recorded on 4th week of December in 1st & 2nd trap, respectively.

Synthetic pheromone was used to study the incidence of shoot and fruit borer infestation. The highest catch of the adult month (male) was recorded in first week of June (9 & 10) in 1st. and 2nd. Trap, respectively. In respect of fruit damage, it was recorded quite low in trap plot with a minimum of 1.77% in 2nd week of June. Maximum damage was found in 2nd week of July, 7.22% and the damage persisted. On the basis of study it was revealed that borer damage the use of the pheromone drop is effective against the borer incidence.

The male adult catches were found to be the highest between 2nd week of October to 3rd week of January (12 to 33). The correlation study indicated negative correlation with maximum temperature. It was also revealed that there was positive correlation between the traps.

All the treatments were found effective in reducing incidence of disease and increasing the crop yield as compared to control. However, Among the treatment Green manuring + Neem cake + Trichoderma viride were most effective recording minimum wilt incidence of 2.1 per cent and maximum yield of 268.4 q/ha.

Observational weeks	No of months		% fruits damage by borer	
	1st. trap	2nd. Trap	Trap plot	Control plot
1st. Week May	8	3	5.52	9.32
2nd. Week May	10	8	6.22	5.77
3rd. Week May	5	3	2.89	8.32
4th Week May	7	4	3.10	5.67
1st. Week June	9	10	1.77	7.52
2nd. Week June	6	7	3.22	8.95
3rd. Week June	7	6	4.27	10.50
4th. Week June	5	4	5.27	12.50
1st. Week July	8	3	6.20	9.32
2nd. Week July	6	9	7.22	10.25
3rd. Week July	7	6	3.89	7.89

In long group brinjal trials, check variety KS-331 produced significantly the highest yield significantly the highest yield of 289.85 Q/ha which was statistically at par with variety JBGL-03-04 (260.92 Q/ha) in IET where as in AVT-I check variety KS-331 recorded the maximum yield of 284.33 Q/ha which was significantly alike with variety 71.19 (169.37 Q/ha).

In round group of brinjal trials AVT-I & AVT-II, indicated that the highest yield of 312.11 Q/ha was recorded in DBR-8 which was statistically at par with variety KS-224 (274.03Q/ha) in AVT-I. In AVT-II trial the same variety DBR-8 produced the highest yield of 309.91 Q/ha which was at par with varieties KS-224 yielding 277.19 Q/ha and IVER-2 (272.03 Q/ha).

Bhindi

Seasonal incidence of insect pests

Jassid population varied from 2.10 to 21.30/ 3 leaves between 4th week of June to 2nd week of August. Later, the population started to decline gradually but the jassids activity was remained there on crop.

The damage by borer to shoots was 3.15% in the 2nd week of July and maximum was found in the 3rd week of August 11.35 % while the maximum fruit damage (12.85%) was recorded in the 4th week of July and the damage persisted upto the end of the crop.

The population of red spider mite was found 2.70 per 2.5 cm^2 in 1st week of August and maximum (9. 77/ 2.5 cm^2) at the end of the crop.

Jassid population varied from 2.27 to 36.95/3 leaves between 3rd week of March to 2nd week of May and population were remained there upto the end of the crop.

The damage by borer to shoots was 1.27% in 3rd week of April and maximum was found in 4th week of May 11.45 while the maximum fruit damage 12.32% in 1st week of June and the damage persisted upto the end of the crop.

The mite population was initially low and reached to maximum of 7.28 per 2.5 cm^2 leaves in the 3rd week of May. The population of mite was remained there upto the end of the crop.

Management of pests

Amongst the treatments, lambda-cyhalothrin and profenophos recorded minimum, Jassids population of 4.12 and it was at par with individual sprays of profenophos, 4.16 per three leaves. In respect of borer as shoots and fruits damage this treatment also gave minimum of 4.35 and 3.73% respectively. The treatment with profenophos was at par with alternate sprays of lamba-cyhalothrin and profenophos. The yield was highest to the tune of 83.65 q/ha in lambda-cyhalothrin and profenophos as alternate sprays. It was at par with individual use of profenophos (78.09 q/ha). The economics calculated also showed the highest net return of Rs.11350=00 with cost benefit ratio of 1:4.93.

The trial was conducted consecutively for three years (2003-04) on the basis of pooled data alternate spray If Lambda – Cyhalothrin (15 g a.i./ha) and profenophos (800 g a.i./ha) showed to be effective against jassids and borer pests. This treatment also recorded the highest net return of Rs. 11,350.00 with a cost benefit ratio of 1:4. 93. Thus, the alternate use of this chemical initiating at 35 DAS & the rest three at 50, 65 and 80 DAS is hereby suggested to manage the insect-pest of Bhindi.

Pointed gourd

Integrated management of disease complex

Effect of different treatments for the control of disease.

Treatments		Pooled Mean data years i.e. 01-02, 02-03 & 03-04.			
		% Disease intensity		Yield (Q/ha)	C/B ratio
		Vinerot	Fruit rot		
T_1	Soil application of neem cake + 3 Soil drenching of T.Viride.	9.63	10.33	149.80	1: 1.8
T_2	Soil application of Carbofuran 3 spraying of copper fungicide.	14.20	14.83	139.54	1: 2.0
T_3	Soil Solarization +4 Spraying of copper fungicide.	8.66	11.90	153.54	1: 3.0
T_4	Raised cultivation + 4 Spraying of Copper fungicide.	4.96	5.03	172.88	1: 3.7
T_5	Control	21.23	22.10	123.71	-

Amongst the five treatments, raised cultivation alongwith 4 sprayings of Copper fungicides (T_4) showed most effective in reducing disease intensity of Vine rot 4.96% and fruit rot 5.03 as compared to control (Vice rot 21.233 % and fruit rot 22.1%) producing highest fruit yield of 172.88 Q/ha. The second best treatment was soil solarization with 4 sprayings of Copper fungicides yielding 153.54 Q/ha. In T_4, cost of additional yield and C/B ratio were maximum i.e. Rs. 29,502/- per hectare and 1: 3.7, respectively.

Keeping in view, the total net return and maximum C/B ratio, raised cultivation with 4 sprayings of Copper fungicide (1st. Spraying in 2nd. Week of May followed by 3 sprayings at 15 days intervals) were found most effective in controlling disease intensity in Pointed gourd.

Cabbage

Management of pests

Management of Cabbage pests using pulverized neem seed powder, neem soap and pongamia soap. Among the treatments, Neem seed powder @ 6% showed to be effective by recording lowest damage by pests with highest yield of 238.86 q/ha.

Muskmelon

Management of red pumpkin beetle and leaf miner

Amongst the treatments, soil application of carbofuran followed by drenching with chlorpyriphos @ 1.0 ml/lit of water was found to be superior recording lowest damage by pumpkin beetle with highest yield of 186.53 q/ha

Cucumber

Seasonal incidence of insect-pests

Red pumpkin beetle damage the crop with minimum 6.62 % and maximum 23.42%. The fruit fly damaged the crop with 5.82% in the 4th week of April and maximum 16.08% in the 3rd week of May. Both pests remained there till the end of the crop.

Seasonal Incidence of insect-pests: Two insect-pests namely red pumpkin beetle and fruit fly were found to infest the crop to a varying extent in the growth period of cucumber. The damage by fruit fly was found to be severely to the extent of 16.87 % in the 3rd. week of August.

Spongegourd

The variety KSG-14 produced the highest yield of 109.64 Q/ha which was statistically at par with varieties Pusa Chikni (106.25 Q/ha) and NSG-1-11 (103.77 Q/ha) in AVT-I where as in AVT-II trial, variety CHSG-1 recorded the highest yield of 110.77 q/ha which was statistically alike with the varieties CSBG-2 (104.41 Q/ha) and check variety Pusa Chikni (102.87 Q/ha).

2.7.2.6 Fruits

Mango

Management of Mango Anthracnose (*Colletotrichum gloeosporiodes*)

Spraying of 0.1 per cent carbendazim was found most effective for control of the disease as it registered minimum intensity of 5.63 per cent in comparison to control in which maximum intensity of 32.41 per cent was recorded.

Studies on mango malformation (*Fusarium moniliforme)*

None of the germplasm screened against malformation was free from the disease. However, varieties Karpuria, Hathijhula, Dudhia Maldah, Police Maldah (Surajgarha), Maldah (Dholi Kothi) showed minimum incidence of only 1 per cent in comparison to maximum incidence of 22.0% in Amrapali.

Screening of Germplasm against Powdery mildew (*Oiodium mangiferae indicae*)

None of the germplasm/ CVs included in the trial was free from infection. Varieties Gulabkhas, Zardalu, Anupam, Sensation, Hansraj, Calcuttia maldah, Maldah (Surajgarha) Malda (Dholi Khoti), Alphanso and Keshar showed below 10 per cent infection and maximum incidence of 31.50 per cent was recorded in variety Amrapali.

Surveillance of mango pests and their natural enemies

Mango hopper and mango mealy bug were considered as a major pests as they damage the crop upto 20% while shoot gall psylla and fruit fly were medium and rest of the insect pests were minor.

Hopper population was found to be negatively correlated with average maximum relative humidity (RH) while other weather parameter had no significant influence in the fluctuation of hopper population. However, hopper population was maximum in the month of April when the relative humidity was lowest (34%).

Crop loss assessment and bio-ecology of mango hopper

Altogether there were four treatments including control. Data pertaining to this showed the significant difference among the treatment, however, three sprays of monocrotophos proved to be the most effective treatment as it recorded the minimum survival (42.19) of mango hopper as well as the maximum yield of mango fruit (149.70 kg/plant).

Integrated pest management of mango hopper

Altogether there were five treatments including control. The statistical analysis of the data showed significant difference among the treatments. A perusal of the data revealed that neem based product alongwith fungal bio-agents proved to be most effective treatment as it recorded the minimum survival of mango hopper (46.98) after 72 hrs of treatment as well as the maximum yield (237.50 kg) per tree.

Management of Shoot gall psylla

Altogether there were five treatment including control. Among the treatments monocrotophos @ 0.072% and quinalphos (0.05%) proved to be the most effective insecticides in reducing the infestation of shoot gall.

Litchi

- Litchi leaf roller (*Platypeplus aprobola* Meyr.), fruit borer (*Conopomorpha cramerella/Conopomorpha sinensis*) and Erinose mite (*Aceria litchii*) were identified as major litchi pests in Samastipur, Vaishali and Muzaffarpur districts.
- Pruning of infested litchi leaves and shoots and destruction by burning in June and August, Castor Cake (4Kg) + Neem Cake (1Kg) application at root zone and spraying of kelthane @ 0.05% at the time of new flush (Sept.-Oct.) gave the best management of litchi mite, *A. litchii* Keiffer.
- Insecticide carbaryl 0.1% (two spray at 10 days interval starting from 1st May) produced the best results and minimized infestation of fruits up to 17.0% fruits.

2.7.3 Plant Pathology

2.7.3.1 Cereals

Wheat

Monitoring of wheat diseases through trap plot nursery

Black rust and yellow, rust did not appear. Out of 20 varieties grown in this experiment the varieties HW 2021 (Lr 24/Sr 26) HW 2008 (Lr 24/Sr 24), Kharchis Mutant, HP1633, DL 784-3 and Lr 24 were free from the brown rust. The minimum severity of SS were recorded in varieties HD 2160, HD 2204, C 306, K 8804 and HP 1102 and in rest of varieties the severity varies between 105 to 255. Out of 20 varieties none of the variety was free from leaf blight. However, minimum severity of 01 was recorded in variety Lr 24 and in rest of varieties, the severity varied between 23 to 35 in DD scale. Out of 20 varieties, 4 varieties namely Agra Local, C 306, WH 147 and K-8804 were infected by Loose smut and incidence was in traces.

Rice

Screening of germplasm in boro rice

It has been running under the department from 2002 to December, 2004. Eleven districts of Bihar namely Samastipur, Muzaffarpur, Darbhanga, Madhubani, Patna, Munger, Motihari, Bettiah, Purnea, Saharsa and Katihar were surveyed and Brown spot was identified as major disease in seedling stage. *Khaira* disease was of minor importance. Bacterial blight, sheath rot and blast were not found in seedling stage. In vegetative and reproductive phase also Brown spot was identified as major disease. Blast and false smut were not observed. Out of 63 germplasm/ varieties only four germplasm namely CR 749-20-2, IET 17519, IET 16933 and IET 172 were resistant. In 2003-04 boro season, out of 171 germplasm/ varieties screened, a single germplasm RAU 1419-2 was found free from Brown spot disease. In case of grain, only six germplasm namely RAU 1428-3-5-9-22, IET 17711, CR 749-20-2, RAU 1416-1, IET 17455 and IET 17906 were free from brown spot disease. Three germplasm namely RAU 1428-3-5-9-4-22, IET 17711 and CR 749-20-2 were also free from Bacterial blight. Dhan laxmi and Boro Basmati were rated as high yielder. Boro Basmati is under release proposal. Resistant lines against sheath rot had also been identified. Besides diseases stem borer and leaf folder have been identified as major pest. Several germplasm/varieties have been identified with excellent ratiooning ability in boro season. Germplasm identified have been passed on to breeder for their use in breeding programme. Two research papers have been accepted for publication out of the project. One popular article on *boro dhan* had been published in *Adhunik Kisan* and one radio talk has also been delivered on diseases of rice.

Maize

Germplasm screening

Altogether 14 trials were conducted. Out of which 12 relate to the screening trials and one each was as the Trap Nursery and Integrated Pest Management Trail.

Among the screening trials a total of 212 entries/varieties of different maturity groups were screened against *Helminthosporium maydis* under artificially inoculated conditions, Out of which only 19 entries viz., MS Pool C_7, PHS-25(Y), X-2406, NECH-129, PRO-311, KH-510, AH-31403, EC-3121, BH-2359, X-11820, JH-3851, Shaktiman-1, BQPMH-11, 33, 43, 46, HQPM-1, 4, and 5 proved resistant against the test organism.

Altogether 178 entries, belonging to different maturity group, were screened (during rabi) against Turcicum leaf blight and Common rust diseases under artificially inoculated conditions out of which only 39 entries, namely BH3165, HKH-1200, JH-7934, 8005, 8016, JC-1492, PHS-45(Y), GSC-733, X-5042, 1353 X, SEEDTEC-1054, BISCO-1074, 1084, JANAK, ZMH-1921, MON-24, X-24059, BISCO-2074, KH-510, AH41406, BISCO-3084, GSC-711, SEEDTEC CODE-102, JH-7233, PM-01, JKMH-462, 810, SEEDTEC-810, 2204, 6005, 6008, 6010, 6011, 6018, 6019, 6031, 6037, 6038 and 6041 indicated resistant reactions against both of the tested pathogen.

Trap nursery, survey & surveillance & IPM trials

The Trap Nursery trial indicated that only Maydis leaf blight disease is the major problem of kharif maize cultivation at and near Dholi area.

In the Integrated Pest Management Trial, Sowing of Thiram treated Shaktiman-1 variety of maize on 5th June in the soil approved with 5 qtls Oil Cake alongwith recommended dose of nitrogen, phosphorus, potash and zinc followed by pre-emergence spraying of Atrazin @ 0.15% and one spraying of 0.1% Endosulphan after 30 days of sowing proved as the best management to save the crop from weeds, insects and disease.

The trap nursery and survey and surveillance reports showed that only Turcicum leaf blight and common rust diseases are problems for the Rabi maize cultivation.

In the integrated pest management trial, sowing of treated seed of Shaktiman-1 in the first week of November in the soil amended with neem cake @ 5 Q/ha alongwith recommended dose of N:P:K & Zinc at the spacing of 75 x 20 cm followed by pre-emergence spraying of Atrazin @ 0.15per cent and irrigation at 25 days interval exhibited the best response, resulting least problem of weed, insect and diseases and thereby the grain yield of 65 Q/ha.

2.7.3.2 Pulse crops

Pigeonpea

Screening of germplasm against *Fusarium* wilt

- In National nursery for evaluation of pigeonpea entries in IVT and AVT against *Fusarium* wilt in sick plot, 18 out of 47 entries, viz., BDN708, ICPL 96053, JJ65, Phule T 25-6, TT301, TT 302, NDA 2001-3 and IPA 3-2 showed resistant reaction(0-10%) against the disease.
- Out of 10 pigeonpea wilt differentials, six viz., ICP8863, C-11, BDN-2, ICP-9174, ICP 8858 and ICP 8859 exhibited resistant reaction against wilt in sick plot. Two wilt differentials viz., ICP 8863 and ICP 9174 have been recording resistant reaction against wilt consistently for the last five years.
- In National Nursery for evaluation of pigeonpea entries IVT and AVT against sterility mosaic (SMD) only four out of 48 entries viz., NDA-99-7 IPA 16F, NDA-99-8 and NDA 03-7 showed resistant reaction against the disease.

Screening of germplasm for SMD

- In National Nursery of disease resistant genetic stock, five out of ten test entries viz., LRG3, MAL3, MAL6, MAL20 and MAL24 showed resistance against wilt disease but none was found resistant moderately resistant to sterility mosaic.
- Epidemiological studies on sterility mosaic of pigeonpea indicated that final disease incidence recorded on 1st December, 2004 varied from 96.6 to 100.0 per cent in 15th July, 20th July and 14th August sown crop. Maximum spread of the disease was noted between 8th September to 6th October, 2004 which might be considered as peak period of disease spread. Mean temperature and relative humidity during this peak period prevailed between 20.4-34.4^{0}C and 69.0 to 96.7 per cent, respectively.

Field survey

In a periodical survey on farmer's field around Dholi, the incidence of wilt and sterility mosaic went up to 20 and 15 per cent, respectively in different plots. *Alternaria* leaf spot was observed on September sown crop only and in one of the plots in Bakhari village its intensity was around 80.0 per cent.

MULLaRP

Screening of germplasm

Kharif

- In National Nursery for evaluation of mung bean entries in AVT1 and AVT2 against yellow mosaic and powdery mildew, four out of eight entries viz., HUM-1, ML131, and ML818 showed resistance against yellow mosaic. Later two entries

i.e. ML1108 showed moderately resistant reaction to powdery mildew also. In AVT1 trial, YMV disease pressure was moderate.

- In National Nursery for evaluation of urd bean entries in AVT1, and AVT2, five out of eight entries viz. KU321, IPU3-1, VBG-73, NDU3-2 and JKU99-19 showed resistance against YMV disease while three entries viz., VBG-73, COBG-648 and LBG-623 exhibited resistant reaction to powdery mildew. Lone entry i.e. VBG-73 showed resistant reaction to both the diseases.
- Studies on variability of mung bean yellow mosaic virus (MYMV) infecting mung bean and urd bean revealed that three mung bean differentials viz., 006, PDM-11 and Pusa Bold whereas, five urd bean differential viz., Msh1-1, Pant U30, Pant Pant U35, DPU-88-31 and IPU94-1 recorded resistant reaction against MYMV.

Rabi

- Out of 35 entries of lentil in AVT and IVT screened against rust at Dholi, seven viz; PL 202 L 4076, DPL 92, L 1887 and L 4677 showed resistant reaction against rust.
- In tracking of field pea rust pathogen (*Uromyces fabae*) through trap nursery trial, first symptom of rust appeared on 21st Feb. 2005 on variety HFP 4. It increased gradually to the extent of 15.0. 35.0 and 70.0 per cent on 28th Feb; 7th March and 14th March, 2005 resepctively. Withering and drying of whole plant was recorded on 21st March 2005.
- Out of eight entries of Rajmash evaluate against white mold caused by *Slelerotinia sclerotiorum* in sick plot, only one i.e. Gujrat Rajmash-1, recorded moderately resistant reaction against the disease and none was found resistant.

Summer

In National Nursery of mung bean AVT entries, six out of 25 entries evaluated against yellow mosaic viz., ML337, SML668, Pusa 0331, ML408, HUM17 and HUM 18 showed resistance against yellow mosaic under high disease pressure in field.

In National Nursery for Urd bean AVT entries, 11 out of 13 entries viz., NDU-96-3-2, KU99-9, Mash 218, Shekhar 342, NDU 96-4-1, KU 96-8, KU-96-7, KU-1078, KU99-32, UG91 and Shekhar 327 showed resistance against yellow mosaic disease in the field.

Field survey

Local surveys of villages around TCA, Dholi were conducted from 12th to 18th June, 2004 to record the incidence of yellow mosaic disease in mung bean plots of farmers field. A total of 20 plots in 8 villages were examined. The Disease incidence ranged from 10-73 per cent.

Chickpea

Screening of germplasm

In evaluation of advanced varietal and initial varietal trials, out of 97 chickpea entries evaluated in sick plot, only seven viz; H00-78, NDG3-31, JG 2004-110, Vijay, H-01-12, HK 98-155 and H 01-74 recorded resistant reaction (<10% wilt) against wilt disease.

In National Nursery, among 43 entries screened against wilt, only nine viz; GL 91061, GNG1477, GNG 1515, IPC97-29, IPC 2K3-19, IPC 2K3-20, BCP-15, BCP-91 and CSJ 364 exhibited resistant reaction against the disease in sick plot.

Field survey

In field survey of farmers field at and around Dholi, and also some areas of Patna, the incidence of chickpea wilt in different plots ranged from 3.0 to 10.0 per cent.

2.7.3.3 Oilseed crops

Sunflower

Screening of Sunflower germplasm

69 entries of 4 different AICRP trials viz. IAVT-14, IHT(I)-22, IHT(II)-19 and AHT-14 were screened to obtain resistant lines against Alternaria leaf spot/blight using one row of composite sunflower var. Morden as factor after every 5 test rows.

IAVT : None of the IAVT entries showed resistant reactions (< 5% severity) of alternaria blight. However, seven entries shoed moderately resistant (MR) reaction, diseases severity ranging from 8.5% to 25% of Alternaria blight. The minimum being 8.5% in RSFV-901, and the maximum 55% in DRSF-116 which showed highly susceptible (HS) reactions.

IHT(I) : The minimum disease severity (10.5%) was recorded in PAC-1091 closely followed by (15%) in IHT-627 and ASH 100 grouping both under MR. NDSH-608 and KBSH-53 recorded the maximum severity 55% and 60%, respectively showing HS to Alternaria blight.

IHT(II) : Only one entry i.e. 65A 41 gave the resistant (R) reaction recording 5% diseased severity of Alternaria blight in both the replications. Six entries recorded MR reactions giving <25% severity and others showed susceptible reactions (30% to 45% severity) of Alternaria blight (AB).

AHT : Out of 14 AHT entries under test only one i.e. MLSFH-93 gave R reactions recording 5% severity of AB, while other 7 entries remained under MR recording12.5% to 25% disease severity and the others showed susceptible reactions recording 27.5% to 35% disease severities.

Castor

Screening of castor germplasm

Altogether 35 coordinated entries under 3 AICRP trials namely IAVT-(12), IHT-(16) and AHT-(07) were screened against Alternaria blight (AB) during kharif 2004.

IAVT: Out of 12 entries under rest, only one i.e. IAVT-28 recorded minimum disease severity (10%) where as 6 entries six IAVT-21, 22, 23, 27, 29 30 recorded 12.5% to 25% severities. Rest remained under 27.5% to 45% and grouped under 3, 5 and 7 grades on 0-9 scale, respectively.

IHT : Out of 16 entries only one i.e. IHT-11 gave minimum disease severity (10%) recording grade 3 whereas viz., IHT-5, 6, 9, 10, 12, 13 and 14 recorded 12.5 % and 25% disease severity grouping them under grade 5 and other having 30% to 37.5% were grouped under grade 7 on 0-9 scale.

AHT: Among 7 AHT test lines none was found resistant. Minimum disease severity 12.5% was recorded in AHT 65 & 66 closely follow by AHT 63 (15%) and AHT 62(22.5%). Other 3 gave 27.5% to 35% disease severities grouping them under grade 7 on 0-9 scale.

2.7.3.4 Tuber crops

Survey of diseases on tuber crops

Colocasia crop was found to be affected by leaf blight (10-30 %) in farmers field.

Evaluation of promising cultivars of Colocasia against leaf blight

Among nine cultivars minimum per cent leaf area infection (6.66%), disease incidence (12.33%) and maximum yield (13.40 t/ha) was recorded in Muktakeshi.

Integrated disease management for leaf blight of Colocasia

Minimum disease intensity (6.00%) with high yield (14.20 t/ha) was recorded under IDM practice in Muktakeshi as against white gauria (12.40% and 12.80 t/ha, respectively).

2.7.3.5 Sugarcane

In course of survey, red rot, wilt smut, top rot and ring leaf spot diseases were observed affecting these 13 sugarcane varieties viz. Red rot (7) B.O. 120, Co 1148, CoS 687, CoS 8436, Co 87263, Co 87268 and CoS 8118; Wilt (9) B.O. 120, Co 1148, CoS 687, CoS 8436,Co 87263, Co 87268, CoS 767, BO 128 and Co 8230; Ring leaf spot (1) B.O. 91; Smut (2) Co 1158 and B.O. 128; Top rot (1) Colk 8102.

In varietal resistance trial, 76 promising sugarcane genotypes of different clonal generations and maturity groups were evaluated artificially against red rot, wilt and smut diseases to find out the level of their resistance. Out of 76 genotypes, 8 were graded as highly resistance 28 were resistant, whereas 30 were found moderately resistant.

On the basis of pathological behaviour on 11 differential varieties, 8 isolates of red rot pathogen were catagorised into 3 pathotypes.

The incidence of sett rot disease caused by *Ceratocystis paradoxa* was greatly reduced from 7.8 to 2.6 per cent when setts were treated with Emisan-6 with 0.5% concentration were planted. Similarly, incidence of ring leaf spot disease caused by *Leptosphaeria sacchari* was also reduced from 35.6 to 5.8% after spraying the crop twice with Blitox-50 with 0.25% concentration.

2.7.3.6 Vegetables

Integrated management of pointed gourd disease complex

On the basis of three years pooled data experiment was concluded and cost benefit ratio was compiled. On the basis of conclusion and C/B ratio it was recommended that raised bed cultivation with four spraying of copper fungicides (0.35 %) started first spraying in second week of May followed by rest spraying at 15 days intervals were suggested for the control of disease in this agro-climatic condition.

Survey and Surveillance of disease of *Tomato & Cauliflower* on the farmers' field

Diseases like damping off, early and late blight, wilt, mosaic and leaf curl in varying intensity were observed on tomato. However, early blight was most serious recording 25.6 % intensity followed by late blight. In Cauliflower besides other diseases Alternaria leaf blight spot was serious recorded 22.6% intensity.

Effect of seed dressing chemicals, bioagent on seed germination of tomato

Seed treatment with Carbendazim (1 g/kg seed) + Captan (2 g/kg seed) was found most effective followed by seed treatment with *I. viride* (6g/kg seed) + Thiram (1g/kg seed).

Integrated management of Soil borne diseases of brinjal

Application of green manuring + neem cake (10 q/ha) + *Trichoderma viride* 5 kg/ha) was found superior for the control of soil borne disease (wilt).

Studies of Associated seed Mycoflora of Tomato, Brinjal and Chilli

Aspergillus flavus, Curvularia lunata, Fusarium semitectum, Phomopsis vexans and *Alternaria alternata* were associated with brinjal seed whereas *Aspergillus flavus, Aspergillus niger, Cercospora* sp. *Fusarium equsettii* and *Colletotrichum capsici* with chilli seed and seed showed the presence of *Aspergillus niger, Rhizopus nigricans* and *Verticillium albo-atrum* sp. with tomato seed. Among the fungicides seed treatment with captan 0.25 % was found most effective for all the three crops.

Bhindi

Resistance varietal trial against Yellow Vein Mosaic

Varieties AOL 03-1, NOH 303, PB 266, BO-13 and NOD 10 were rated as resistant having less than 10% disease intensity. Epidemiology of Most Important Diseases of Commercially Important Vegetable crops of the locality: The disease intensity of early blight (*Alternaria solani*) of Tomato increased with age of crops. Maximum disease intensity 45.8 % was recorded during the week ending 17th Feb.2005. Infection rate increased in the last week of January having low temperature and more number of rainy days.

In resistant varietal trial against YVMV, the varieties AOL-03-1 and PB-225 were rated as resistant having less than 10 per cent disease intensity at 90 DAS and yielding 78.4, 85.6 and 82.9 Q/ha, respectively in IET trial and AVT-II trial, the varieties BO-12 and NDO-10 were rated as resistant having less than 10 per cent disease intensity yielding 72.5 Q/ha and 74.4 Q/ha, respectively.

2.7.3.7 Fruits

Banana

- In Vaishali belt of Bihar mainly tall banana are grown which suffered from Panama wilt, bunchy top, leaf spot and anthracnose. Heart rot of banana is emerging as a serious problem which caused total loss in some localities. In Koshi belt bunchy top a leaf spot were major problems because there Dwarf Cavendish bananas are grown. In Samastipur, rhizome rot disease was observed in newly establish orchards in the last week of July.
- *Fusarium* isolates causing Panama wilt of banana were characterized *in vivo* and *in vitro*. The wilt symptoms were observed on leaves' pseudostem and rhizome. The wilt symptoms were grouped in two categories. On the basis of results two races of *Fusarium oxysprum* f. sp. *cubense* i.e. race I and race II were reported in this locality.
- Incidence of Banana bunchy top virus (BBTV) was correlated with five major parameters and vector population. The correlation matrix showed that BBTV was positively correlated with maximum temperature and minimum temperature at 1% level of significance while numbers of colony and population of aphid/ colony were positively correlated with minimum temperature at 5%. level of significance. Total number of aphids were positively correlated with minimum temperature, minimum RH and total rainfall at 5% level of significance.

- In Bihar incidence of scarring beetle, Basilepta *subcostatum* was observed to be maximum during second fortnight of September and minimum during first fortnight of December
- Insecticide spraying with quinalphos @0.05% carbaryl 0.1% (two sprays at 10 days interval starting from Ist May) produced the best results and minimised infestation of fruits up to 7.6% fruits.

Citrus

- In Bihar citrus canker and twig blight were observed in citrus orchards of all age groups, while gummosis was encountered mostly in old orchard. In few orchards fruit cracking due to severe canker was also observed. Sudden drying type of symptom due to *Colletotrichum gloeosporioides* was also observed in poorly managed orchards.
- In fixed plot survey maximum intensity of twig blight/ die-back disease was recorded in July and August. Canker intensity was more in August. September and October.
- Correlation matrix showed that twig blight/ die-back of citrus was positively correlated with min tem. (r = 0.7866) min. R.H (r = 0.7763) and total rainfall (r = 0.8848) at 1% level of significance. However, is case of citrus canker all the weather parameters were found positively correlated except total rainfall but the correlation was not significant statistically.
- *In Vivo* efficacy of plant extract and bio- agents were evaluated against *Xanthomas axonopodis citri* incitant of citrus canker. The results reveated that the minimum number of lesions were observed in *Aspergillus* niger and *Pseudomonas flurosence* sprayed plants followed by *Tagetis* leaf extract

Papaya

- Among papaya diseases papaya ring spot virus disease is becoming a limiting factor throughout the state. Its incidence varied from 60-100 per cent. Leaf curl disease was considered as second important disease. Damping off, collar rot, fruit rot were also encountered frequently throughout the state.

2.7.3.8 Betelvine

All together 20 germplasm/cultivars were artificially screened against two major diseases of betelvine i.e. Anthracnose and Phytophthora rot by inoculating healthy plants with pure culture of the causal pathogens. Only four germplasm/cultivars i.e. Calcuttia Bangla with long internode, Ghana ghatte, Kapoori Bihar and Hara Patta showed moderately resistant reaction to both the pathogens whereas remaining 16 had moderately susceptible to susceptible reactions.

Epidemiological studies of Phytophthora leaf rot caused by *Phytophthora sp.* and anthracnose disease incited by several species of *Colletotrichum* such as *capsici, gloeosporioides* and *piperis* with Bangla variety of betelvine were done. Important contributing environmental components for Phytophthora leaf rot disease incidence and index were maximum relative humidity above 90 per cent and minimum temperature 25.2 to 28.1°C which prevailed during the period of observation seems to have accounted for maximum share in the total variation of disease.

The important contributing environmental elements for anthracnose disease incidence and disease index were maximum relative humidity above 90 per cent, maximum and minimum temperature ranging between 34.5 – 25.2°C during the period of observation which accounted for lion's share in the total variation of disease.

Sanitation integrated with one soil drench of Bordeaux mixture (1%) followed by one soil application of bioagent (*Trichoderma viride*) inoculated in 500 kg oil cake ha^{-1} after 30 days of first drenching of Bordeaux mixture (1%) after 60 days of first drenching of Bordeaux mixture (1%) was found significantly superior to other treatments in respect of reducing per cent disease incidence of leaf rot, foot rot and thereby increasing the yield of marketable leaves ha^{-1}. This treatment was found the most production and produced Rs. 2.05 on investment of rupee one.

Fifty g unit inoculum per 10 kg of oil cake had maximum number of spores of *Trichoderma viride* and such inoculated cake may be used for 60 days of inoculation when packed in polythene bag at temperature range of 21 - 35°C.

Biofertilizers alone or in combination with inorganic fertilizers had significant effect on elongation of vine, number of consumable leaves per hectare, fresh weight of 100 leaves and leaf area of betelvine in addition to nutrient content in plants, nutrient uptake by the plants and finally soil nutrient status. However, vermicompost @ 12 t ha^{-1} significantly increased the bio mass of the leaves.

Integrated crop management of betelvine wherein IPM and INM were taken into consideration, it was found that 4 applications of *Trichoderma* accompanied with sanitation and protecting the crop with recommended dose of insecticide was found at par with 3 drenches of Bordeaux mixture (1%) followed by 6 sprays of Bordeaux mixture (0.5%) in terms of vine growth, number of consumable leaves ha^{-1}, fresh weight of 100 leaves, shelf life, per cent disease index and bio mass of leaf including dry matter yield.

Application of Bio-dynamics or EM (Effective micro-organism) alone or in combination with each other supplemented with nitrogen @ 100 kg/ha in the form of FYM was found at par with 200 kg N 100 kg P_2O_5 and 100 kg K_2O/ha. BD + EM with 100 kg N/ha in the from of FYM was found significantly superior to other treatments pertaining to productivity of betel leaves i.e. no. of leaves/ha, biomass of leaves and leaf area. It had also profound effect on nutrient content of plant, nutrient uptake by plants and finally nutrient status of the soil.

2.8 Agricultural Resource Management

2.8.1 Cereals

A coordinated trial was conducted at BAC, Sabour in wheat Agronomy to evaluate the performance of various genotypes at different dates of sowing. Significant differences were observed due to different dates of sowing and varieties. The crop sown on 25th November registered significantly superior grain yield (35.83 q/ha) over the crop sown on 15th December (31.27 q/ha). Among the various wheat genotypes the check HD-2824 recorded the highest grain yield of 37.86 q/ha was statistically superior to all the tested genotypes. The lowest yield of 27.66 q/ha was recorded by the test variety PBW-533.

2.8.2 Tuber crops

Organic farming for Potato Production

In this experiment Kufri Sutlej was tested at 5 levels of fertility viz., T_1-FYM@20 t ha^{-1} + bio-fertilizer T_2 – FYM @ 20 t ha^{-1} + crop residue, T_3 - FYM @20 t ha^{-1} + bio dyanamic T_4 -100 per cent RDF for potato N_{150} P_{90} K_{100}/ha T_5-control (No fertilizer + No

FYM). It was observed that significantly higher yield was obtained with T_4 followed by T_3, T_1 and T_2 in comparison to control.

Integrated nutrient management in potato

In this experiment variety Kufri Anand was tested with 3 levels of organic manure viz., O_1- control, O_2-FYM@ 20 t ha^{-1}, O_3 crop residue !@ 10 t ha^{-1+} + biofertilizer alongwith two levels of fertility viz., F_1-75 per cent RDF and F_2per cent RDF of N_{150} P_{90} K_{100}. It was observed that significantly higher yield was obtained with treatment of O_2F_2 followed by O_2F_1 in comparison to rest of the treatments.

Effect of cultural practices on maize + potato intercropping system

In this experiment potato variety Kufri Jawahar was tested with composite maize variety Laxmi with five levels of cultural practices viz. P_1-No weeding, P_2-One hand weeding at 30 days after planting of potato P_3-Two hand weeding at 30 days interval, P_4-One spray with Atrazine @ 1.0 Kg a.i. ha^{-1} on the 3rd day of planting of potato and 2nd day of maize sowing P_5-One spray of Atrazine @ 1.0 kg a.i. ha^{-1}+ one hand weeding at 30 days after sowing of potato alongwith three cropping systems viz., C_1-Sole potato, C_2-Sole maize and C_3-maize + potato. Each crop was dressed with 100 per cent recommended dose either in sole crop or in intercrop. It was observed that significantly higher yield of maize equivalent recorded 203.80 q ha^{-1} under intercropping system, which was found significantly higher in comparision to the maize equivalent yield obtained by the sole crop of potato (157.60 qha $^{-1}$) and maize (65.36 q ha^{-1}). The net return obtained by intercropping system (Rs. 55.88th ha^{-1}) was found significantly higher in comparison to the net return obtained by the sole crop of potato(Rs. 42.74th ha^{-1}) and maize (Rs. 14.75 ha^{-1}).The yield obtained by the sole crop of potato(157.6 q ha^{-1}) and maize 65.36 q ha^{-1}) were found significantly higher in comparison to the yield obtained by potato (143.41 qha^{-1}) and maize (60.41 q ha^{-1}) under intercropping system. Among the cultural practices treatments Atrazine @ 1.0 kg a.i. ha^{-1} day at planting of potato and 2nd day of sowing of maize + one hand weeding at 30 days after planting of potato showed significant superiority over rest of the treatments. Significantly higher yield of potao (202.8 q ha^{-1}), maize (80.71 q ha^{-1}), maize equivalent yield (188.91q ha^{-1}) and net return (59.43th q ha^{-1}) were obtained under this treatment in comparison to the rest of the four cultural practices treatment. The interaction effects were found significant. Significantly higher yield of potato (196.6 q ha^{-1}), maize (77.32 q ha^{-1}), maize equivalent yield (274.0 q ha^{-1})and net return (Rs. 89.16 thousand ha^{-1}) were recorded under the treatment combination maize + potato intercropping system with Atrazine spray followed by one hand weeding at 30 days after planting of potato in comparison to the rest of the treatment combinations.

Effect of bio-fertilizer for increasing N use efficiency in sweet potato

Application of 2/3 dose of Nitrogen (40 Kg N) alongwith 2 Kg *Azospirillum*/ha as vine dipping and 10 Kg *Azospirillum* as soil application recorded maximum tuber yield (28.0 t/ha)

2.8.3 Sugarcane

Fertilizer trials

Nitrogen fertilization significantly influenced seed cane yield, 200 kg N/ha recorded maximum seed cane yield (80.90 t/ha) and it was significantly superior to 150 kg N/ha (71.98 t/ha) and 100 kg N/ha (52.71 t/ha) and all of them differed significantly among themselves. Application of 100 kg K_2O/ha produced significantly higher seed cane yield (70.51 t/ha) than 60 kg K_2O/ha (66.54 t/ha). Increasing levels of nitrogen and potassium increased the glucose content in cane juice significantly

Nitrogen and potassium application half as basal +¼ N and half K_2O 90 DAP + ¼ N 6 weeks before harvest significantly influenced glucose content in cane juice and germination percent of seed cane.

Application of sugarcane trash and SPMC @ 10 t/ha each to sugarcane plant crop only along with recommended dose of NPK to each crop recorded significantly higher yield of sugarcane plant, ratoon first and ratoon second over 100% NPK i.e., recommended dose to each crop and was most efficient in sustaining soil productivity in sugarcane based cropping system ie. Rice - S/C plant- Ratoon I-Ratoon II – moong. Yield of crops (Rice- s/c plant Ratoon-I Ratoon- II moong) viz. s/c plant as well as both ratoons, obtained by application of s/c trash and SPMC each @ 10 t/ha to s/c plant crop only along with 50% N and full P and K to each crop was at par with yield of these crops due to application of 100% NPK only to each crop which confirmed saving of 50% N in each crop of the crop rotation.

In the experiment to study the effect of the levels of trash mulch and phosphorus on yield and quality of s/c var. B.O. 137 it was observed that trash mulching @ 10 t/ha significantly improved the thickness, height, average cane weight, sucrose content in juice, cane and sugar yield in comparison to control i.e. No mulch. Whereas increasing levels of phosphorus significantly improved the average cane weight, number of millable canes, cane and sugar yield upto 80 kg P_2O_5.

Sustaining soil health for production

Sustaining sugarcane production and soil health through integration of nutrient sources in sugarcane based cropping system (Plant) showed significant improvement due to application of 25% of N through FYM or CSPM either with or without Biofertilizers (*Azotobacter* and PSB) along with 75% NPK through inorganics in comparison to application of 100% NPK through inorganics However, the highest cane yield was obtained due to application of 25% N through FYM +Biofertilizers in addition to 100% NPK through inorganics. Cane yield due to application of 25%N, through organics alongwith biofertilizers (*Azotobacter* + PSB) and 50% NPK through inorganics improved over application of 100% NPK through inorganics. Sugar yield and uptake of N,P,K by plant crop followed the cane yield trend. Application of organic manure either with or without biofertilizers alongwith different levels of NPK through inorganics recorded significant increment in the organic carbon content as well as available P_2O_5 and marginal improvement in available N & K_2O with respect to application of 100% NPK through inorganics, in post harvest soils.

Staling behaviour of varieties

In staling behaviour of sugarcane varieties the deterioration of sucrose content in juice was higher in CoP 9301 (1.63) and CoP 9302 (1.59 unit) as compared to B.O. 136 (1.42), CoP 9702 (1.30) and B.O. 137 (1.34) respectively of different maturity group.

Screening of varieties against soil salinity

In screening of sugarcane cultivars against soil salinity, the germination of cane decreased by 70 to 7.5 % as well as delayed by one month with increasing levels of salinity from 0 to 12 dS/m. The yield of cane also decreased by 21.5 to 70.4 per cent with increasing levels of salinity in order of CoP 9301 > B.O. 137 > CoP 9302 > B.O. 136 > CoP 9702. Therefore CoP 9702 and B.O. 136 are comparatively more tolerant to salinity.

***Gur* quality**

In the experiment to study the effect of levels of phosphorus on gur quality, it was observed that increasing levels of phosphate upto 80 kg/ha increased the cane

yield in both the varieties CoP 9206 and B.O. 110. The colour of gur, the most desirable parameter, in both the varieties improved significantly upto 120 kg P_2O_5/ha.

2.8.4 Fruits

Integrated weed management in Elephant foot yam

Seasam leaves mulching recorded significantly highest yield (42.6 t/ha) over unwedded control (27.0 t/ha). Among other treatment mulching with black polythene, application of pendimethaline @ 1 Kg a.i./ha + hand weeding, application of oxyfluorfen @ 1 Kg a.i./ha + hand weeding and pendamethaline @ 1 Kg a.i./ha performed more or less similar in recording higher yield (35.4 to 33.0 t/ha) and statistically at par with seasam leaves mulch.

Intercropping tuber crops in litchi orchard

Growing of tuber crops in litchi orchard have been proved practically possible and economically viable. Elephant foot yam when grown as intercrop in litchi orchard with full recommended dose of fertilizers (80:60:80 Kg/ha) gave highest yield (31.5 t/ha) with net return of Rs. 124000/ha. Colocasia occupied second position in term of yield and profitability.

Effect of size and source of planting material on Colocasia yield

Whole mother tuber when used as planting material recorded maximum cormel yield (17.5 t/ha) which was statistically at par with planting of whole side tuber (16.5 t/ha).

Mango

Dudhiya Maldah produced highest yield (109.90 kg) per plant, Cumulative yield of last 10 (ten) years in Bangalora remained highest (1214.04 kg) per plant. The maximum fruit weight (485) in cultivar Bangalora.

2.8.5 Vagetables

Integrated nutrient management in Cucumber

Treatments		Yield (Q/ha)
T_1	F.Y.M. @ 20 t./ha	85.33
T_2	Vermicompost @ 4 t./ha	86.30
T_3	F.Y.M. @ 10 t./ha + Vermicompost @ 2 t./ha.	88.44
T_4	Legume green leaf manure @ 5 t./ha + Biofertilizers (Azotobactor)	87.85
T_5	F.Y.M. @10 t./ha + Biofertilizer (Agotobactor)	101.55
T_6	Half rec. NPK+FYM @ 10 t./ha+ Biofertilizer (Azotobactor)	110.59
T_7	Half rec. NPK+Legumegreen leaf manure @ 2.5 t./ha+Biofertilizer (Azotobactor)	95.56
T_8	Half rec. NPK+Vermicompost @ 2 t./ha+Biofertilizer (Azotobactor	107.70
T_9	Rec. NPK through fertilizers	90.52

Among the treatment T_6 (Half recommended dose of NPK + F.Y.M. @ 10 t./ha + Biofertilizer Azotobacter produced the maximum yield of 110.59 Q/ha- Which was statistically at par with Treatment T_8 (Half rec. dose of NPK + Vermicompost @ 2 t./ha. + Biofertilizer (Azotobacter) yielding 107.70 Q/ha. The minimum yield of 85.33 Q/ha. Was recorded in treatment T_1 (F.Y.M. @ 20 t./ha.).

2.8.6 Development of organic farming package for high value crops

This experiment aims to develop organic farming package for scented rice-potato-onion cropping system. In this trial, substitution of 100% recommended N through different organic sources were tested with substitution of 50% N through FYM + 50% NPK through fertilizers and application of 100% recommended dose of nutrients through fertilizers for their production potential, quality, economics and soil health.

Application of 100% recommended dose of nutrients through inorganic fertilizers produced the highest rice equivalent yields (226.09 q/ha) of the system and maximum net monetary return (Rs.82,045/ha) which was closely followed by the treatment receiving 50% N through FYM + 50% NPK through fertilizers having corresponding values of 219.79 q/ha and Rs. 75,531/ha. Treatments receiving 100% N through different organic sources produced lesser rice-equivalent yield and net return of the system than those obtained with the application of 100% NPK through fertilizers and integrated use of FYM and NPK.

The variation in quality parameters of rice, potato and onion was very marginal. However, an increasing trend in quality and properties of soil was noted in the plots getting nutrients through organic sources.

Pendimethalin @ 0.75 kg ai/ha was found suitable herbicide for maize + urd bean intercropping system. In a study of late sown wheat, the yield was highest in conventional tillage which was at par with glyfosate + Z.T. but was significantly higher than Z.T.

In a study of irrigation on winter maize based intercropping system, significant increase in maize equivalent yield was observed up to 5 irrigation each of 6 cm scheduled through IW/CPE ratio of 1.2.

While studying planting pattern and fertility management in yam bean + arhar intercropping system, pure yambean yielded maximum yambean equivalent yield though it was at per with 3 rows of YB intercropped with 2 rows of arhar spaced at 60 cm and 5:2 at 90 cm. Highest cost benefit ratio of 2.53 was recorded in 3:1 intercropping system.

2.8.7 Experiments on cultivators' Field (ECF)

Among the rice-based cropping systems for medium land situations Rice-Potato-Sunflower gave higher net return of Rs. 60,323/ha as compared to Rice-Wheat (Rs.17,253/ha) Rice-Wheat-Mung (Rs.24,013/ha), Rice-Rajmash (Rs.32123) and Rice-Maize + Coriander (Rs. 42334/ha): Under upland situation with maize as based crop, most profitable cropping system was found to be Maize-Potato-Mung (Rs.81731/ha) as compared to Maize-Maize + Potato (Rs. 66386/ha) and Maize-wheat (Rs.37240/ha).

2.8.8 Weed Control

A new herbicide mixture i.e. Carfentrazone 75% + Isoproturon 50 WP (Affinity) @ 2.0 kg/ha was found to be broad spectrum herbicide to control weeds in wheat.

Resistance of weeds towards isoproturon, like other States, was not observed in Bihar.

Metribuzine @ 0.15 to 0.20 %, 0.20 to 0.25 % and 0.25 to 0.30 % was found to control *Parthenium* effectively at seedling, juvenile and flowering stage respectively.

Xanthium strumarium was found to restrict the growth of *Parthenium hysterophorus* allelopathically.

Seedling stage

Juvenile stage

A new road-side weed was identified as *Thithonia divaricata.*

Full gloom stage

Flower

Different growth stages of *Thithonia divaricata*

2.8.9 Agromet

A linear relationship was observed between accumulated heat unit and wheat yield in which with every unit increase in heat unit, wheat yield was found to be increased by 4.5 kg.

Significantly higher yield of NW 1014 and HP 1744 variety of wheat per unit heat accumulation suggested their suitability under late sown condition for North Bihar plain zone – I.

Better grain setting was observed in Prabhat variety of rice at low temperature caused by delayed transplanting as compared to Turanta and Richariya.

Feed back from farmers for Agro-advisory service

A survey was conducted to obtain the feed back of the participating farmers. Data were collected through semi-structural-questionnaire and personal contacts were made with farmers for getting the feed back of weather forecast. Out of 30 farmers, 15 farmers replied the questionnaire. The response of the farmers was positive and encouraging. Some of the questionnaire have been appended. About 80 per cent farmers were found to be benefited through Agromet Advisories in terms of their preparedness for timeliness in land preparation. Sowing, irrigation scheduling, fertilizers application, plant protection measures etc.

2.8.10 Water Management

In spring maize significant increase in yield was observed up to IW/CPE ratio of 1.0 with 6 irrigation and 150 kg N/ha.

In fine aromatic rice 6 cm irrigation after 3 days disappearance of ponded water with 100:40:20 kg NPK/ha gave higher yield.

2.8.11 Forecasting Wheat Yield using Biometrical characters

A forecasting model for predicting wheat yield in Bhagalpur and Banka districts of Bihar has been developed. The models comprised of plant characters such as average Plant population /m^2, average no. of tillers /m^2, average length of ear head in cm, Application of N, P and K is Kg/ ha and average plant condition. The average plant conditions as assessed by the farmer were found highly significant is all the models.

2.9 Rice-wheat cropping system

Identification of need based cropping system

In this experiment fourteen rice based cropping systems viz; rice-wheat, rice-wheat-sesbania (G.M.), rice-wheat-moong (Grain + residue incorporation), rice-wheat-maize; rice-maize+ potato (intercropping) rice-potato-onion, rice-potato-onion + maize (relay cropping); rice- potato-sunflower; rice-garlic-maize; rice-cabbage-chilli; rice-merigold- maize + moong (intercropping); rice-fenugreek-maize; rice-sunflower- okra and rice-berseem-maize + cowpea (fodder) were evaluated for their production potential and economics in randomized block design with three replications.

Among the fourteen rice based cropping systems tested, rice- potato- onion + maize gave the highest rice equivalent yield (333.80 q/ha) and productivity (91.45 kg/ha/day) followed by rice-potato-onion having corresponding values of 310.72 q/ha and 85.13 kg/ha/day. Rice-garlic-maize system was third in order producing REY of 280.53 q/ha and productivity 76.80 kg/ha/day. Inclusion of potato and garlic during winter season were instrumental in raising net return (Rs/ha) and profitability of the system. The highest net return of Rs.91,716/ha and profitability (Rs.262.2/ha/day) were realized from rice-garlic- maize system which was at par with rice-potato-onion + maize system. The maximum benefit cost ratio of 1.64 was noted in rice-berseem-maize + cowpea

(fodder) followed by rice-garlic-maize (1.52). Rice-maize + potato intercropping system was found to be most promising energetically producing 59,748 K Cal energy/ha.

Comparative performance of different period bound rotations

In this experiment of rice-wheat system, one of the two cereal crop in the sequence had to be substituted by an oilseed or a pulse crop every second, third or fourth year either during kharif or rabi season alongwith standard one year sequence of Rice-Wheat (control). In this experiment, wheat crop in winter season was replaced by Mustard (Oilseed) and lentil (Pulse) as per treatment.

Data indicated that induction of oilseed (mustard) or a pulse (lentil) crop in place of wheat once in four years have helped in increasing production as well as net return (Rs/ha) of rice and wheat crops in the following years. The highest grain yield of rice (52.37 q/ha) and wheat (43.36 q/ha) as well as net return of Rs. 37947 ha was realized from rice-wheat system after rice-lentil system in the previous years. However, the system involving mustard and lentil in reporting year had the lowest profitability. Substitution of wheat by mustard and lentil showed marginal improvement in organic carbon, available P_2O_5 and K_2O contents of the soil. Lentil in the system established an edge over mustard so far as aforesaid parameters are concerned.

Permanent plot experiment on integrated nutrient supply

The field experiment was initiated at this centre during 1984-85. There were 12 treatments of rice-wheat system, of which 4 treatments had different dose of N P K applied only in inorganic fertilizer forms (50 : 50; 50: 100; 75:75; 100:100%), 6 treatments related to integrated use of fertilizers and organic sources and one each of control and farmers practice of fertilization. The treatments were tested in R.B.D. with four replications.

Substitution of 50% N through F.Y.M., wheat straw and green manuring + 50% NPK through inorganic fertilizers to rice and 100% recommended dose of N P K in wheat (T_6, T_8 and T_{10}), were instrumental in significant increase in grain yield of rice and wheat as compared to the treatment receiving 100% recommended fertilizer dose in both the seasons. F.Y.M. was observed to a better source of organic manure than wheat straw and green manuring. All organic sources showed cumulative residual effect resulting in gradual rise in productivity over the years. Organic carbon status and P-balance in soil was positive in all the treatments except control plot (T_1) and its accumulation was higher when organic matter was incorporated in the soil. A marginal decline in K status of soil was observed in all the treatments except F.Y.M. incorporated plots.

Tillage and planting management

This experiment was conducted to compare the performance of the conventional method of sowing, zero till drilling, strip till drilling and bed planting of wheat under varying sowing / transplanting methods of rice viz. direct dry sowing by zero till drill, direct seeding of sprouted seeds on puddled soil by drum seeder, manual transplanting and mechanical transplanting by self-propelled transplanter. This experiment was laid out in strip plot design with 3 replications.

The manual transplanting (61.491/ha) and transplanting of rice by self propelled transplanter being at par, produced significantly higher grain yield of rice than those recorded under direct wet seeding by drum seeder (57.02 q/ha) and direct dry sowing by zero till drill (54.26 q/ha). The use of self propelled transplanter gave the maximum net income of Rs. 23,857/ha, which was significantly higher than that recorded under other sowing/ transplanting methods of rice. The highest grain yield of wheat (46.91 q/ha) and net return (Rs.23,09 q/ha) were realized when sowing of wheat was done by strip till drill and this method proved significantly superior to other methods of wheat sowing.

Similarly, transplanting of rice by self propelled transplanter and sowing of wheat by strip till drill provided the maximum net profit and benefit: cost ratio from the whole system evaluated.

Site specific nutrient management

This experiment is an attempt to realize maximum possible yield from rice-wheat system through site-specific nutrient management. The experimental site was low in available N, K_2O and S and medium in available P_2O_5. Based over soil analysis report, the treatments comprising combinations of 150 kg N/ha along with 3 levels of each of P_2O_5 (0, 30 & 60 kg/ha), K_2O (0,50 & 100 kg/ha) in both the crops and 4 levels of S (0, 20, 40 & 60 kg/ha) applied only in rice along with one each of recommended dose of fertilizers and farmer's practice. Thus, ten treatment combinations in all were tested in randomized block design with 4 replications.

Application of 150 kg N/ha along with a dose of 30 kg P_2O_5 and 50 kg K_2O/ha both in rice and wheat and 40 kg S/ha only in rice is adequate for achieving higher yields and net profits from rice – wheat cropping system. Further, increment in the doses of P, K and S was not effective in bringing about significant increase in either grain yield, net return or B:C ratio. An application of 40 or 60 kg S/ha in rice has shown pronounced residual effect on wheat yield, whereas, a dose of 20 kg S/ha in rice could not bring about significant residual effect on wheat.

Nematodes in rice-wheat cropping system

Under Rice-Wheat cropping sequence there was increasing number of total plant parasitic nematodes both after paddy as well as after wheat. The increase over initial nematode population after rice was 235% where as it was 45% after wheat. However, the rice crop has favoured more the population buildup of *Hirschmanniella oryzae* and *Meloidogyne juveniles* which decreased after wheat.

2.10 Honeybee

Breeding of *Apis mellifera* Linn. for honey production

Six better performing colonies were selected on their performance during 2004-05 on the basis of bee strength (No. of frames), brood area (cm^2), honey stores (kg) and pollen area (cm^2) in the month of November, 2004 to January, 2005. Two colonies from each location were multiplied and their number was increased to 18. Experiment comprised of 6 treatments with 3 replications. These colonies were studied for their performance in respect to above parameters.

Bee strength: Number of frames completely covered by the bees were recorded and presented in table-1. There were significant variations among the treatments. Maximum no. of frames (16.6) were recorded in the colonies AP_{8b} while lowest (11.0) in SA_{2a}.

Brood rearing: Broods rearing were recorded regularly in respect of total brood area and were expressed in square centimeter at 21 days interval. The data on this aspect was depicted in table-1. Among different treatments AP_{8b} colonies were found significantly superior having maximum brood area (2270 cm^2) while SA_{2a} recorded lowest brood area (1640 cm^2).

Pollen Area: Pollen collected by bees and stored in combs was recorded at an interval of 21 days in term of square centimeter, which ranged between 770 to 1100 cm^2. There were non-significant variations among the treatments.

Honey stores: Periodic observations on honey stored in terms of square centimeter were recorded and then converted into kilogram by multiplying with an appropriate factor (i.e. 1.25 cm^2 honey area yields equal to 1.25 g). The data reveals that honey yield varied from 4.6 to 6.8 kg. There were significant variations among the treatments.

On the basis of observation recorded, it revealed that all the selected colonies were superior in above parameters and had better performance. Thus it may be concluded that selection and multiplication of colonies from superior stock in apiaries will improve the efficiency of honeybees resulting the profession more profitable.

Studies on Colony requirement per hectare for proper pollination in litchi

Studies on colony requirements per hectare for proper pollination of litchi were conducted at different locations. In each orchard five trees were randomly selected and observations on different parameters were recorded. At Simri orchard, there was no *Apis mellifera* colony and it was treated as Control (T_7). The experiment comprised of 7 treatments with 5 replications.

Effect of honeybee pollination on the yield of litchi fruit during the year

Locations	No. of colony ha^{-1}	No. of flower/ panicle	No. of fruits/ panicle	Fruit set (%)	Weight/ fruit (g)
University Apiary (T_1)	35	1480.6	29.4	1.90	15.10
Malinagar (T_2)	30	1660.7	33.5	2.90	16.20
Bhuskaul (T_3)	25	1570.2	35.5	3.25	21.30
Madanpur (T_4)	20	16.5.2	37.6	2.75	16.80
Mahmadpur (T_5)	15	1835.3	31.2	2.50	15.70
Rahua (T_6)	10	1750.0	29.8	2.10	14.70
Simri (T_7)	Control	1675.15	20.2	1.10	12.35

The observations revealed that in the orchard where honeybee colonies were placed produced more in number and heavier fruits of litchi. There was non-significant variation among different locations on mean number of flower per panicle. The maximum number of fruit set (3.25%) and fruit weight (21.30 g) was obtained from the orchard where 25 colonies ha^{-1} were placed over control. Thereafter, the per cent fruit set and fruit weight did not increase. Hence, for proper pollination of litchi orchard, 25 colonies ha^{-1} are recommended.

Production of propolis from *Apis mellifera* colonies:

Studies were conducted to find out the amount of propolis (g) collected by *Apis mellifera* in different method of collection during different month. There were 3 treatments (T_1-screen, T_2- screen + stick & T_3- scrapping) with three replications. The observations were recorded from July, 2004 to February, 2005. Maximum propolis was collected in the month of September (27.90 g) and lowest in the month of February (9.20 g). Propolis collection was the maximum by scrapping (19.36 g) followed by net + sticks (17.16 g) and lowest in net (14.31 g). But in scrapping propolis colour was darker due to mixing of pollen and wax. There were significant variations among the factors and their interaction.

Survey of pests and diseases of honeybees

Survey of pests and diseases of *Apis mellifera* was done in the apiaries of beekeepers during 2004-05. Thirty apiaries having more than 100 colonies were surveyed. Ten *Apis mellifera* colonies were examined for incidence of pest & diseases randomly in each apiary.

Bacterial diseases: Low incidence of bacterial diseases was observed in the apiaries. About 10.35 % apiaries were affected and 12.26% colonies were infested.

Acarine diseases: When Mite infestation is severe it takes disease form. Minor incidence of acarine diseases was observed in the apiaries. About 18.10 % apiaries were affected and 23.60 % colonies were infested.

Wax moth: Wax moth was observed as major pest in stored raised frame.

Mite: - The maximum activity was recorded from August to October. It was major pest of the apiaries. The data showed that about 60.10 % apiaries and 70.30 % Colonies are infested with mite.

Wasps: - Wasps incidence was severe in the month of August-September and causes loss of colony in some apiaries. *Vespa magnifica* was the most harmful. About 75.30 % Apiaries have incidence of wasp and 79.20 % colonies were affected. Beekeepers adopt mechanical control as preventive measures to protect their colonies.

Ant: - Red ants and black ants were regular and serious problem. About 80.25 % apiaries and 90.68 % colonies were attacked by ants

Effect of different artificial diets during dearth period on colony development

To study the effect of different artificial diet during dearth period on the basis of brood area (cm^2), eight different artificial diets with control were tested. Two observations at 15 days interval were recorded in each replication after feeding the colonies at weekly intervals. In the treatments, T_1 to T_3 were nectar substitute, T_4 & T_5 were pollen substitute while T_6 to T_8 were nectar + pollen substitute. T_9 was control, the colonies fed only on natural flora.

The data presented in Table-5 indicate that there were significant variations among different treatments in different months. Maximum brood area (1621.2 cm^2) was observed in the colonies fed with T_8 followed by T_7 (1492.0 cm^2) i.e. diet comprised both nectar and pollen substitute. The lowest brood area (887.5 cm^2) was recorded in T_9 (control). The influence of different diets during different months of dearth period indicated that maximum brood area (1294.2 cm^2) was in the month of July while lowest (1082.22 cm^2) in the month of September. The brood area decreased up to the month of September and then started increasing in October, it may be due to availability of natural flora. The result may be concluded that the colonies should be fed with both nectar and pollen substitute for proper management of colonies during dearth period.

Effect of different artificial diets during dearth period on colony development

Treatments	Mean Brood area (cm^2)*				Mean
	July	August	September	October	
T_1 :Sugar syrup (300 g)	1010	970	830	1100	977.5
T_2 : T_1 + Cobadex (1 cap.)	1190	990	940	1180	1075.0
T_3 : T_1 + Terramycin (1 cap.)	1220	1020	960	1250	1112.5
T_4 : Sattu (200 g)	1240	1180	1040	1190	1162.0
T_5 : Soybean meal (200g)	1350	1240	1100	1380	1267.5
T_6 : T_4 + Soybean meal (100g)	1400	1320	1230	1510	1365.0
T_7 : T_2 + Terramycin (1 cap) + Sattu (200g)	1508	1470	1380	1610	1492.0
T_8 : T_2 + Terramycin (1 cap)+ Soybean meal (200g)	1630	1580	1470	1805	1621.2
T_9 : Control	1100	930	790	730	887.5
Mean	1294.22	1138.88	1082.22	1217.96	-

Studies on infestation of *Tropilaelaps clarae* in colonies during dearth period.

Experiment was conducted to test the different chemicals on infestation of ectoparasitic mite *Tropilaelaps clarae* in *Apis mellifera* hive. The experiment comprised of 7 treatments with 3 replications. Infestation of mite before and after treatment application were recorded by capturing 100 bees per hive as method described by Komeili (1988). The percent reduction was calculated on above data.

The results revealed that there were non-significant variations in mite infestation before application of chemicals. Maximum reduction in mite infestation (41.72 %) was observed in the hives treated with Bromopropylate @ 1 stripe per hive followed by T_4 (36.99 %). The lowest reduction (4.62 %) in mite infestation was observed in T_1. In T_7 (control) the mite infestation was found increased. Thus it may be concluded that fumigating hives with Bromopropylate @ 1 stripe per colony or applying sulphur (5 g) & formic acid (5 ml) alternatively might be useful to managing mite infestation in the hives.

Effect of different chemicals on infestation of *Tropilaelaps clarae* in colonies during dearth period.

Treatment	Infestation before application	Infestation after application	% reduction
T_1: Formic acid (5 ml)	50.67	48.33	4.62
T_2: PDCB (5 g)	48.67	39.00	19.87
T_3: Sulphur (5 g)	49.33	34.67	29.72
T_4: Formic acid (5 ml) & Sulphur (5 g) alternatively	42.33	26.67	36.99
T_5: Bromopropylate (1 stripe)	50.33	29.33	41.72
T_6: Control	48.00	52.67	-9.73

Studies on wax moth infestation on raised comb during storage in dearth period.

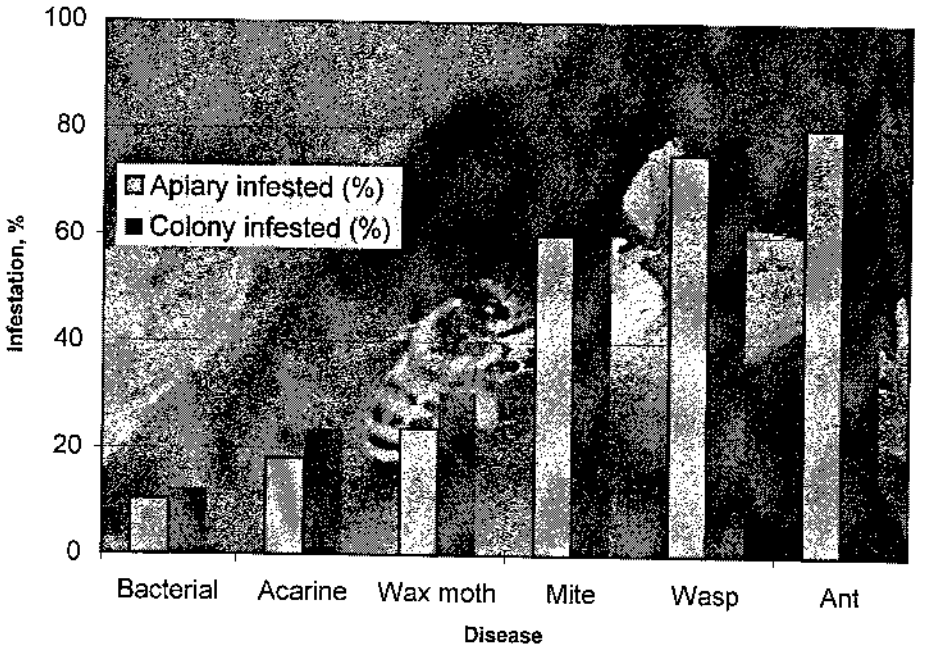
Studies were carried out to find out the suitable chemical for controlling wax moth infestation during storage of raised comb. The data were recorded from July to October, 2005. Five raised frames were stored in a polythene bag and data on infested area (cm^2) was recorded. The treatments were repeated at monthly interval. The observations were recorded and presented in table-7.

The result revealed that all the treatments were superior over control. Lowest infested area was recorded in the bags treated with Aluminum phosphide (220 cm^2) followed by PDCB crystal (305 cm^2). T_6 and T_7 treatments were at par having 900 and 863 cm^2-infested area, respectively. Thus present finding may be concluded that raised frame should be stored in polythene bags treated with Aluminum phosphide (3 g) or PDCB crystal (5 g). This will provide safety to raised combs during storage and could be used when required.

Effect of different treatments on wax moth infestation (area infested cm^2) on raised comb during storage

Treatment	Dose per bag	*Area infested (cm^2)*
T_1- Sulphur	200 g	375.3
T_2- Aluminum phosphide	3 g	220.0
T_3- EDB	3 ml	337.4
T_4- PDCB	5 g	305.2

Production of propolis from *Apis mellifera* colonies



Status of pests & diseases of *Apis mellifera* during dearth period

T_5- Naphthalene ball	3.6 g	598.5
T_6- Dried Neem leaf	50 g	900.7
T_7- Neem seed kernel powder	50 g	863.6
T_8- Control (Untreated)	-	3890.6

Colony performance at university apiary

Altogether 215 colonies of *Apis mellifera* were maintained at the AICRP (Honeybee), Pusa centre and placed at two locations. All the colonies were inspected regularly at weekly intervals and colony performance was recorded. About 16.0 quintals litchi, 7.0 quintal mustard and 3.5 quintal jamun raw honey was extracted during 2004-05. Beside, 194 bee colonies (4 frames) were distributed to the 97 beginners under Macro Mode Management Project on Beekeeping after successful completion of training programme at the AICRP (HB) centre during 2004-05 from the existing strength/stock of the colonies.

2.11 Genetics

Hybrid boro rice

- The backcross substitution program was undertaken to convert elite boro lines into cytosterile lines. Using boro rice lines as the pollen parents, effective restorers have been identified on the basis of extent of fertility restoration in testcrosses involving different cytoplasmic male sterile lines. Twenty promising isocytoplasmic restorer breeding lines have been recently developed from crosses involving non-allelic restorers. A, B, R and elite boro lines were maintained and evaluated in respective nurseries. A lines were maintained by hand pollination. A lines were also maintained using clonal method.
- 140 rice accessions of rice collected from different parts of Bihar under NATP and obtained from IARI, New Delhi were evaluated for various agro-botanical, economical and biochemical traits, to generate information on diversity among the accessions and to identify the promising accessions for their further utilization in genetic enhancement programme. The clusters analysis revealed that there were different qualitative traits arrangements in individual entries of early, medium and late maturity groups and ample possibilities for obtaining combinations of desirable traits in specific materials. Ample morphotype diversity was observed in the entries, but there was low coincidence in the cluster pattern obtained with qualitative and quantitative descriptors. Mean performance in respect of grain yield and component characters in conjunction with clustering pattern of entries based quantitative attributes it appeared that hybridization involving RG67 and RG 102 in early RG 91 and RG64 with RG 126 in medium RG 7 and RG 10 with RG 21 in late maturity groups should generate a wide spectrum of variation among the segregants. Exploitable extent of variation was observed for grain protein content in twelve genetically diverse entries included in the analysis. Genetically diverse entries were identified for developing a core collection of entries in early, medium and late maturity groups.

Pigeon pea

In ongoing research program on rabi pigeonpea Donors have been identified for various traits desirable for rabi cropping system Genotypes IC-274730, VKS/SCC-12/19, RAUP-34, Pusa-9, and Bahar for High rate of biomass accumulation in early growth

period, RAUP-34 and Pusa (B) 35 for Pod borer tolerance and RAUP-32 and RAUP-34, Pusa-(B)-35 resistant to Alternaria blight.

These genotypes can be utilized as working germplasm for pigeon pea improvement program in future. Promising lines selected from germplasm, NATP collection and advance germination segregating bulks, after further evaluation and testing may be identified as variety for rabi cropping system.

Techniques developed/standardized to obtain interspecific hybrids between C.platycarpus and C.cajan will help in undertaking such interspecific hybridization program in future to transfer desirable traits like photoinsensivity and low flower dropping etc. from C.platycarpus into C.cajan and help in improvement of germplasm.

Isozyme pattern of three enzyme systems, namely, esterase, acid phosphates and peroxidase was studied in different accessions of six cajanus species namely, C. cajan, C. albincans, C. cajanifolia, C.platycarpus, C. scarbaeoides and C.sericeus to assess the nature and extent of interspecific and intraspecific variation and the level of genetic diversity. The data on isozyme polymorphism was used to calculated Nei and Li's similarity coefficients as well as Jaccard's similarity coefficients between species. The highest similarity value was observed between C. platycaropus and C. scarbaeoides. Dendorgram obtained following unweighted pair group method using airthmatic means (UPGMA) also indicated a close affinity between C. platycaropus and C. scarbaeoides as compared to other species of thi genus which were evaluated in this study.

Identification of interspecific hybrids using isozyme of peroxidase

The polymorphism observed for esterase, acid phosphatease and peroxidase among Cajanus species was informative and appeared to be useful for its utilizationin formulating wide hybridization programme for improvement of pigeonpea. Isozyme pattern of peroxidase has been identified as marker to identify the interspecific hybrids between Cajanus platycarpus x C. Cajan. Interspecific variation observed in isozyme pattern of different enzyme system can be used as marker in identification of interspecific hybrids.

Characterization and evaluation of Fababean

210 ten accessions of Faba Bean collected from different parts of Bihar under NATP and obtained from NBPGR were evaluated using a descriptors developed for characterization and evaluation of Agri-horticultural crops. Using numerical taxonomic approach, average taxonomic distance as a measure of dissimilarity for quantitative attributes and simple matching coefficient as a measure of similarity for qualitative attributes were computed. The dendrograms were constructed by unweighted pair group method using arithmetic averages.

Evaluation of *vicia faba* collection

The collection exhibited high potential as a genetic base for breeding programes aimed at producing segregants with high yield potential and specific traits. The promising accessions from distantly related clusters maybe utilized for obtaining a wide spectrum of variation among the sergeants.

Tissue culture studies on sugarcane

Tissue culture studies carried out in sugarcane resulted in callus formation and differentiation of multiple shoots as well as roots both directly from the explant and through the formed callus.The callus subculture on the best callusing media with

different levels of red rot culture filtrate resulted in development of the in vitro technique for induction of red rot resistance and screening of genotypes for red rot resistance. The investigation resulted in establishment of a good protocol for sugarcane micropropagation, induction and formation of red rot resistant cells and development of an in vitro method for screening genotypes for red rot resistance.

2.12 Microbiology

Cynobacterial Biofertilizer

- Cyanobacterial biofertilizer package for Bihar paddy soil has been developed. Proper implementation of technology will save 25kg chemical nitrogen per hectare in rice cultivation. The proposed technology has an advancement over existing one in terms of quality, shelf life and establishment.
- The use of neem or bel or tobacco waste as a carrier for cyanobacterial biofertilizer in this technology will result better establishment of cyanobacteria due to control in cyanobacterial grazers (snails and nematodes) population. Indoor production of biofertilizer resulted better quality. Highest inoculum loading of cyanobacteria helped to reduce the recommended dose and it is only 5 kg ha^{-1} than soil based having recommendation of 15 kg ha^{-1}.
- By increasing the amount of carrier other benefits like decrease in chemical nitrogen loss can also be derived. Field trials conducted at Pusa Farm revealed significant increase in grain yield of paddy due to cyanobacterial biofertilizer application. Application of cyanobacterial biofertilizer also resulted an improvement in soil health.
- No residual effect of cyanobacterial biofertilizer was recorded in wheat crop.

Agromicrobes-pesticides interaction

- Endosulfan degrading bacteria was identified and isolated in axenic form. The said microbes had immense Potential in Bihar because endosulfan had highest consumption and their application led to long term decrease in decomposer and diazotrophic microbial population.
- Decomposers especially fungi is worst affected microbes due to pesticide application and situation is alarming in vegetable soils.
- Carbofuran, Bavistin and pyrimethrin had negative effect of shorter duration on Agromicrobes.
- Side effect of carbofuran, chloropyriphos, endosulfan and cypermethrin on microbial population and activities differed widely-such effect was either stimulatory or inhibitory. Thus, every pesticides must be tested against soil micro organisms prior to its recommendation as pest control measures of any crop in future.

Biochemistry

Pleurotus florida was found to be about 69% efficient in generation of the fruit bodies from the substrate. The fresh mushroom with 90.89% moisture contained only 9.11% dry matter. The mature fruit bodies were also analyzed for ash, fibre, total nitrogen, total sugar, reducing sugar, non-reducing sugar as well as ascorbic acid were analyzed on fresh weight basis. The ash & fibre content were 9.10% and 10.93% respectively. The total sugar, reducing & non-reducing sugar were 462.57, 34.17 & 428.39 mg/100g fresh weight respectively while ascorbic acid was found to be 3.72 mg/100g. The wheat straw on which the fungus was grown was analyzed for lignin, hemicellulose, cellulose, ash, total carbon, total nitrogen and C;N ratio at 0,8, 16, & 24 days after the inoculation to assess the degrading efficiency of *Pleurtus florida*.

Studies on lignocellulolytic enzyme profile of *Pleurotus* sp. is being carried out and it has been found that among *Pleurotus* sp. The biological efficiency of *P. ostreatus* is highest followed a local strain *P.sajor-caju. P. ostreatus* is the best lignocellulose degrading mushroom fungus while *P.djamor* has least lignocellulolytic activity.

Study was undertaken on metabolic modification during water logging on the basis of external appearance of various maize cultivars subjected to waterlogging. Desia brown and Suwan were found tobe relatively tolerant to water logging as compared to Laxmi, Ganga safed –2 and Desia yellow. The tolerant cultivars exhibited high ADH, Alanine amino transferase, SOD, peroxidaseand catalase activities since these enzymes provide an edge to the plant for survival under stress.

Mushroom

- It is now possible to cultivate mushroom throughout the year in Bihar.
- *P. djamor* is suitable for the cultivation for the month of September, October and March as evident from Biological efficiency of 75 per cent.
- *P. sajor caju* had maximum biological efficiency i.e. 90.3 per cent.
- *P. sajor caju* and *P. florida* were suitable for the month of October to February.
- *bisporus* with B.E. 15 per cent is suitable from Nov. to Jan.
- *bitorquis* with B.E. 12 per cent is suitable from Oct. to March.
- *V. volvacea* (Paddy straw) with B.E. 12 per cent is suitable from April to Aug.

Pigeonpea

Isolation and evaluation of *Rhizobium* strains

Studies on isolation and evaluation of *Rhizobium* strains for symbiothic effectiveness under field conditions revealed that all the six *Rhizobium* strains on inoculation, increased nodulation and grain yield of pigeonpea. The *Rhizobial* strains like DHA-8 and DHA-19 proved most efficient by recording additional grain yield of 3.5 and 3.4 q/ha respectively over uninoculated control which yielded 9.9 q/ha.

Field evaluation of *Rhizobium* strains

Field performance of *Rhizobium* strains studied under different agroclimatic conditions showed that all the eight *Rhizobial* stains obtained from different co-ordinating centres enhanced root-nodulation and yield in pigeonpea crop. Among these *Rhizobial* starins, A-11 and A-7 from Delhi proved most efficient by recording highest additional grain yield of 2.2 q/ha over uninoculated control which yielded 11.2 q/ha.

Field studies on interaction among three *Rhizobial* strains and three pigeonpea varieties revealed that the strain PH-9022 produced highest grain yield with varieties Bahar and BDN-1(14.9q/ha).

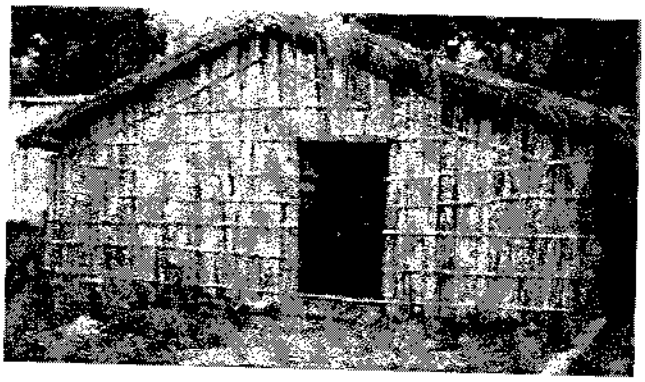
On field evaluation, both liquid and carrier based *Rhizobium* inoculants proved equally effective in enhancing nodulation and grain yield in pigeonpea over uninoculated control, Hence, either of the two can be utilized for seed inoculations.

MULLaRP

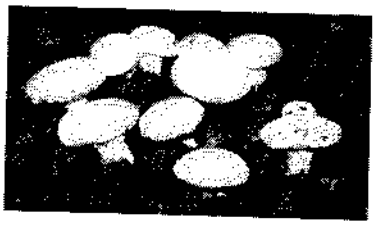
Adoption of *Rhizobium* based bio-fertilizer by pulses growers

From sale record of biofertilizer unit at Dholi, it revealed that pulses growers in Bihar used *Rhizobium* culture based biofertilizer for cultivation of pigeonpea, mung bean and urd bean covering 77.5, 298.0 and 25.5 acre of lands, respectively during 2004-05.

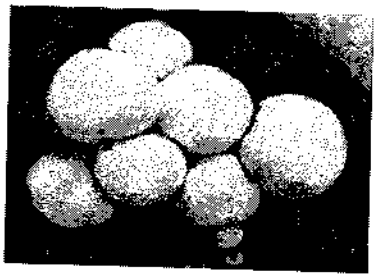
MULLaRP (Lentil, Lathyrus, Rajmah & Peas)



Pleurotus spp.

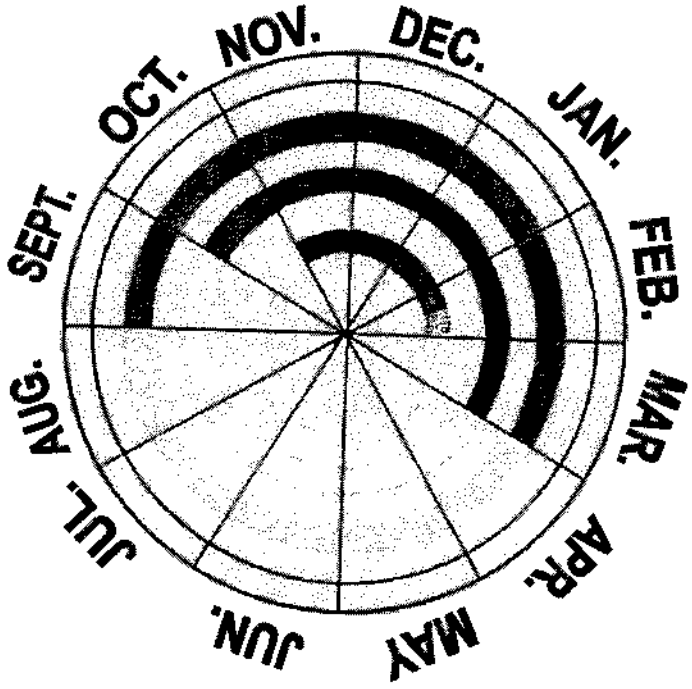


Agaricus bisporus



Agaricus bitarquis

Volvariella spp.



Cropping Cycle of Mushroom

Isolation & evaluation of *Rhizobial* strains

All the six *Rhizobial* strains isolated from Dholi on field evaluation recorded increased nodulation, dry matter and grain yield over uninoculated control in lentil cv. L. 9-12. Grain yield increased to the tune of 1.3 to 28.6% over uninoculated control, the maximum being due to the strain L-2 followed by DL-11(18.6%), DLC1 (11.3%).

Field studies on synergism among *Rhizobium* (LC-5 strain), PSB(*Bacillus polymaxa-9* and PGPR (KB-133) revealed that all the three microbial bio-fertilizers, when applied alone or in different combinations, resulted in increase of grain yield to the tune of 0.7 to 5.5q/ha over uninoculated control. Grain yield was highest in combined inoculation of all the three microbial agents (22.1q/ha) followed by PSB+PGRP (22.0q/ha) and *Rhizobium* + PGPR (21.3q/ha).

Level of adoption of *Rhizobium* based bio-fertilizer by pulses grower

From the sale record of Bio-fertilizer Unit at Dholi in revealed that pulses growers used *Rhizobium* inoculants of chickpea, lentil, peas and *lathyrus* covering around 228.0, 517.0, 20.0 and 2.5 hectare area in the state during 2004-05.

2.13 Micronutrients in soil and Management

Nutrient Indexing for forecasting emerging nutrient deficiency.

The productivity of 20 PBMS was quite different as reflected by yields which are mainly due to variation in fertility status of soil, farmers' economic condition, land situation, cropping sequence and management practices adopted by different farmers. The yield and micronutrient uptake data of different crops grown during 2004-05 season clearly indicated wide variation in these characters. The yield of even same crop grown at different PBMS varied consideration.

After completion of three years soil samples were again tested for pH, EC, org. C., avail. P_2O_5 and K_2O, DTPA extractable – Zn, Cu, Fe and Mn, HWS-B and $CaCl_2$-S following standard procedures. The result shows almost similar variations in these properties. There were negligible changes in soils with respect to extent of micronutrient deficiency.

Reassessment of micronutrients deficiency

The available Zn, Cu, Fe, Mn, B and S in old alluvium 187 soil samples of different blocks of Nawada district ranged from 0.69 to 1.86, 1.78 to 4.36, 13.57 to 37.25, 1.98 to 145.72, 0.23 to 2.26 and 2.08 to 39.79 mg kg^{-1}, respectively. The extent of Zn, Cu, Fe, Mn, B and S deficiencies in different blocks of Nawada district was found to vary from 5 to 75, Tr to 15, Tr to 35, Tr to 12, 5 to 61 and 33 to 82%, respectively. The overall deficiency of Zn, Cu, Fe, Mn, B and S in Nawada district were 46, 7, 16, 5, 21 and 57%, respectively. Out of 187 soil samples, 41.7% samples were deficient in single element, 26.7% in double elements, 10.2 % in triple elements and 4.8% in only four elements. Only one sample was deficient in all the six elements analysed. Based on nutrient index rating of < 1.5 as low, 1.5 to 2.5 as medium and > 2.5 as high, it was noticed that 3 blocks are low in Zn, all blocks are high in Cu and Mn, 5 blocks high in Fe, only one block low in B and 4 blocks are low in avail. S and all other blocks are medium in these nutrients. From the above result it can be inferred that S is the most limiting nutrient followed by Zn and B in Nawada district.

The three land situations of Tal land and Diara land were also evaluated for micronutrients and S status. The extent of Zn, Fe, B and S deficiencies were 50 to 60%, 40%, 30 to 60% and 60 to 70%, respectively in Tal land while the overall deficiency of Zn, Cu, Fe, Mn, B and S in Diara land soils were 81, 22, 47, 16, 41 and 84%,

respectively. The nutrient index of these soils were also computed which fall in mostly medium category.

A long – term experiment was initiated in Kharif, 1985 under Rice-Wheat-Sorghum (R-W-S) and Rice-Mustard-Moong (R-M-M) cropping system at RAU Experimental Farm, Pusa at varying NPK levels (No NPK, 50, 100 and 150% of recommended dose of NPK). Results up to 20 cropping cycles (60 crops) in each rotation showed declining yield trend over time at all fertility levels with more yield decline at higher fertility level. The rate of yield decline was more in R-W-S rotation as compared to R-M-M system. Zinc emerged as most limiting micronutrient hence few replications were superimposed with 10 kg Zn, 10 t FYM and 10 kg Zn + 10 t FYM ha^{-1} at yearly interval after 10^{th} cropping cycle (30 crops). These superimposed treatments arrested the yield declining trend with a consequence increase in yield over time. Zinc-amended FYM proved better than other treatments. The magnitude of yield response and micronutrient uptake in R-W-S was higher than R-M-M system. Available Zn in post-harvest soil was increased from deficiency to adequacy level due to superimposed treatments with higher value in Zn-amended FYM treatment.

The soil available Zn after 20^{th} cropping cycle has gone down the critical level in treatments with no superimposition, however, in all the superimposed treatments the available Zn status was at adequacy level with its maximum values in 10 kg Zn + 10 t FYM ha^{-1} treatment. Available Zn, Cu and Mn decreased with rising fertility levels while available Fe evinced increasing trend with rising fertility levels.

Developing IPNS systems for micro and secondary nutrients

Effect of crop residue recycling under rice-wheat-system up to 11 cropping cycles (22 crops) was evaluated on yield performance, Zn-uptake by crops and available Zn status of post-harvest soil. Four levels of crop residue viz. 0, 25, 50 and 100% of the straw produced are being incorporated after each crop harvest regularly. Zinc was applied @ 0, 2.5, 5.0 and 10.0 kg Zn ha^{-1} once with first crop only. Increasing levels of crop residue progressively enhanced the crop yield and Zn-uptake at varying Zn levels. Application of 5.0 kg Zn ha^{-1} only in first crop and 50% crop residue of every crop were as much effective as 100% crop residue alone with respect to yield and zinc build up in soil. Magnitude of yield increased and Zn-uptake was higher in rice than wheat which indicates that rice is benefited more than wheat from crop residue incorporation. Available Zn status of soil progressively improved with rising levels of crop residue and residual Zn.

Crop residue and zinc management system showed that treatment CR_{100} Zn_5 gave the highest population of microflora like bacteria, actenomycetes, fungi and azotobacter (70 x 10^6, 79 K 10_5, 39 x 10^4 and 39 x 10^4 cfu g^{-1} soil, respectively) in PHS of wheat and (77x10^6, 87x 10^5, 43 x 10^4 and 42 x 10^4 cfu g^{-1} soil, respectively) after harvest of rice. The correlation coefficients of organic carbon with bacteria, actenomycetes, fungi, and azotobacter were 0.956**, 0.612*, 0.860* and 0.886**, respectively after harvest of wheat and 0.950**, 0.625*, 0.876** and 0.884**, respectively after harvest of rice. A definite trend in periodical changes in microbial population was observed under crop residue and Zn management system.

Decomposition of wheat straw increased with increasing levels of crop residue and zinc, carbon mineralization seemed to be the major mechanism of weight loss during decomposition of wheat straw as the pattern of weight loss of straw and carbon mineralization for wheat straw was remarkably similar. As a result of carbon mineralization, the ratio of C/N of remaining wheat straw narrowed down from 85.5:1 to 30.1 : 1, 87.1 : 1 to 30.2: 1, 86.2 : 1 to 30.1 ; 1, 86.6 : 1 to 30.6: 1, 87.6: 1 to 31.1 : 1 and 83.7: I to 29.9: I in the different treatments. The patterns of Zn. Fe, Cu, Mn and nitrogen mineralization from wheat straw are very much similar. Periodical changes in DTPA-

extractable Zn, Fe, Cu and Mn were also studied under crop residue and Zn management system.

Relative performance of green manuring *Dhaincha*, *Sunhemp*, green gram, FYM and zinc application is being evaluated in rice-wheat cropping system since 2000. Maximum yield response in first cropping cycle was obtained at 10 kg Zn ha^{-1} applied to first crop rice followed by green manuring with green gram + 5 t FYM ha^{-1}. However, during sixth cropping cycle, green manuring with green gram in conjoint with 5 t FYM ha^{-1} performed best with respect to yield, micronutrients uptake and their build up in soil. Green manuring with *Sesbania* was superior over other green manuring crops. Available status of micronutrients in soil exhibited increasing tendency due to green manuring, FYM and Zn application.

Environmental Pollution

Use of town waste as source of micronutrient is being explored out in rice-wheat cropping system at TCA, Dholi Farm. Maximum yield response in sixth cropping cycle was recorded at 20 t ha^{-1} sludge applied annually which is at par with annual application of 25 t sludge ha^{-1}. Sludge applied annually was more effective than its alternate year application. Micronutrients concentration and uptake in both the crops progressively increased with increasing dose of sludge.

The build up of available Zn after 6^{th} cycle varied form 0.40 to 1.32 mg kg^{-1}. The variation in available Cu, Fe and Mn after the harvest of 12^{th} crop was 1.28 to 2.09, 8.51 to 9.83 and 5.40 to 7.90 mg kg^{-1}, respectively.

Trials-cum-frontline demonstration

Front-line demonstrations in farmers' field were conducted at three sites in Muzaffarpur and Madhubani district to demonstrate the response of mustard, broadbean and chickpea crops to Zn, B and S application. Although the individual application of Zn, B and S was effective in increasing yield and the seed/grain yield response was to the extent of 3.7 to 25.9 % for mustard, 5.5 to 18.2% for broad bean and 9.0 to 28.3% for chickpea but their combined effect was more effective. The highest seed/grain yield response to 55.6%, 34.5 % and 47.6% for mustard, broadbean and chickpea, respectively were recorded when all the three nutrients were applied together.

The total uptake of Zn, B and S varied from 110.9 to 207.3 g ha^{-1}, 127.4 to 204.8 g ha^{-1} and 18.27 to 36.83 kg ha^{-1}, respectively by mustard, 121.8 to 233.9 g ha^{-1}, 81.8 to 235.5 g ha^{-1} and 12.49 to 17.46 kg ha^{-1}, respectively by broadbean and 59.0 to 141.0 g ha^{-1}, 34.0 to 132.1 g ha^{-1} and 5.96 to 10.42 kg ha^{-1}, respectively by chickpea due to different treatment combinations. The highest uptake of these nutrients by different crops were noted where Zn, B and S were applied conjointly.

Relative efficacy of Granubor – II

The results of all the four experiments indicated that both Borax and Granubor application significantly increased the yield, B content and uptake by crops and available B content in post harvest soil (PHS). For both the oilseed crops i.e. mustard and sunflower, the effect of 125% Granubor and 100% Borax appeared to be similar, however, at equal levels of application, both the sources were statistically at par with respect to B nutrition in oilseeds.

The winter cauliflower was high yielder and removes more B from soil as compared to kharif cauliflower. Similarly, winter cauliflower was also found more responsive to B application. Both the sources of B i.e. Borax and Granubor were found equally effective at equal level of application with respect to yield and B nutrition to cauliflower. (Photo 2 and 3)

From the above results of four experiments it can be concluded that both Granubor and Borax are equally effective and the optimum level of application should be 100% of recommended dose i.e. 7.0 kg ha^{-1} may be substitute of Borax.

Nutrient recycling through crop residue management

In a long term experiment on nutrient recycling through crop residues management under rice – wheat system, the relative performance of organic manure and crop residues on the yield of rice and wheat, uptake of NPK and available nutrient including organic carbon varied in the order : compost + crop residues > compost > crop residues > no compost or crop residues. The results indicated that crop residues could substitute compost @ 10 t/ha. The results also suggest that compost + crop residues could save 50 % recommended dose of NPK *i.e.* 50 kg N, 30 kg P_2O_5 and 20 kg K_2O/ha in each crop i.e. rice and wheat. Balanced use of NPK fertilizer maintained the fertility status of soil whereas organics (compost, crop residues and compost + crop residues) improve it. This indicates that integrated use of crop residues and compost with chemical fertilizers sustained crop productivity and soil fertility under rice-wheat cropping system in calcareous soil.

Development of targeted yield equations

The basic data such as nutrient requirement to produce one quintal of wheat grain, fertilizer use efficiencies, contribution from soil available nutrients and poultry manure nutrients were generated. Based on basic data, targetted yield equations and fertilizer recommendation schedule for wheat were developed. Fertilizer prescription under integrated nutrient supply system for yield targetting of wheat indicated that application of 5 t/ha poultry manure could save the N, P_2O_5 and K_2O by 39, 25, and 28 kg/ha, respectively.

Table: Basic data and targeted yield equation for wheat under IPNS

Basic Data					Targeted Yield Equations
Nutrient	NR (kg/q)	C S (%)	C F (%)	C C (%)	
N	3.31	22.34	56.62	25.82	$FN = 5.85\ T - 0.40\ SN - 0.46\ CN$
P_2O_5	0.59	32.11	15.87	6.96	$FP_2O_5 = 3.72\ T - 2.02\ SP_2O_5 - 0.44\ CP_2O_5$
K_2O	3.23	45.73	81.50	66.67	$FK_2O = 3.96\ T - 0.56\ SK_2O - 0.82\ CK_2O$

Experiments and laboratory analysis were completed to develop basic data, targeted yield equations and fertilizer recommendation schedule for rice and turmeric.

Verification trials for validity of targeted yield equations

Two verification trials on yield targeting of Brinjal were conducted at farmer's fields to test the validity of targeted yield equations. The percent deviation between yield target and actual yield of Brinjal obtained varied from -6.25 to -10.00. Response ratio, benefit cost ratios and net profit with fertilizer application based on equation was found higher than Farmer's Practice (FP) and General recommended dose (GRD). Hence, the fertilizer recommended through STCR basis for obtaining the yield target of Bringal up to 30 t/ha is economical and the developed equation may be used for fertilizer recommendation.

Three verification trials to test the validity of targetted yield equations of Coriander were conducted. The percent deviation between yield target and actual yield obtained varied from -0.42 to -15.00. Variation in yield (-10.50 to -15.00 %) at 20 q/ha yield target indicated that the equation is valid up to 16 q/ha yield target of coriander. Response ratios, benefit / cost ratios and net profit with fertilizer application based on equation was higher than FP and GRD at 16 – 20 q/ha yield targets. Hence, the fertilizer

Effect of B on Sunflower head

Response of Cauliflower to Boron application

recommended through STCR basis for obtaining the yield target of Coriander up to 16 q/ha is economical and the developed equation may be used for fertilizer recommendation.

A verification trial was conducted in farmer's field to test the validity of targeted yield equations developed for cabbage. The percent deviation between yield target and actual yield obtained varied from + 3.45 to + 4.30 which is under reasonable limit. Response ratio, benefit / cost ratios and net profit with fertilizer application based on equation were higher than FP and GRD. Hence, the fertilizer recommendation through STCR basis is economical and the developed equation may be used for fertilizer recommendation.

Follow up trials for acceptance of targeted yield equations.

The results of two follow-up trials conducted at farmers' field on wheat under IPNS revealed that per cent deviation between actual yield obtained and yield target of wheat ranged from ± 3.00 which is under reasonable limit. Economic analysis revealed that fertilizer application with or without IPNS based on STCR recommendations is more economical than any other fertilizer recommendation.

Three follow-up trials, two under IPNS and one without IPNS were conducted on yield targeting of winter maize. Per cent deviation in yield target and actual yield were – 2.25 to + 12.09 and response ratios varied from 12.99 to 20.02 kg grain / kg nutrient. The net profit were found higher when fertilizer was used based on soil test values for obtaining yield target 70-80 q/ha with or without IPNS than GRD and FP. Economic analysis revealed that fertilizer application based on STCR recommendations under IPNS concept is more profitable than any other practices.

In four follow-up trials, the per cent deviation in yield target and actual yield obtained of rapeseed varied from -10.60 to + 0.67 and response ratios were 7.03 to 23.84 at yield target 15 to 25 q/ha which were higher than GRD (6.07 to 8.71). Economic analysis revealed that fertilizer recommendations based on STCR is more profitable than GRD and F P and economical than GRD.

The results of three follow-up trials indicated that the response yard stick of linseed in STCR calibrated fertilizer were always higher (6.76 to 7.63) than that of GRD (3.85 to 5.33) and FP (5.50 to 6.50) fertilizer application. Similarly, the benefit / cost ratios were also higher in STCR recommendation (9.11 to 10.67) than GRD (5.07 to 7.03) and FP (6.60 to 7.80). Therefore, the linseed production is economical when STCR based fertilizer is applied for 8q/ha yield target as compared to other fertilizer recommendations.

The percent deviation between yield target and actual yield obtained in three follow-up trials on yield targeting of cauliflower varied from +6.15 to +13.07. Response ratios varied from 48.37 to 62.57 at 15 - 25 t/ha yield target which were higher than GRD (40.84 to 56.54) & FP (43.27 to 49.73). Benefit / cost ratios and net profit was higher than FP and GRD. Hence, the fertilizer recommendation through STCR basis for obtaining the yield target up to 25 t/ha is economical and profitable.

The grain and straw yields of wheat increased with increasing fertility levels. Available N, P_2O_5 and K_2O increased considerably with increasing levels of fertilizers. Low available P increased to medium and high levels indicating that fertility gradient in relation to P had been created more pronounced than N and K.

Soil Testing Programme

445 soil samples and 19 water samples were received in which 256 soil samples were received from farmers of Bihar comprising Samastipur, Motihari (East Champaran), Begusarai, Vaishali, Madhepura, Muzaffarpur, Madhubani, Darbhanga,

West Champaran, Sheohar, Katihar, Kishanganj, Saharsa, Saran, Bhagalpur and Patna districts. Soil samples were analyzed for pH, EC, organic carbon, available P_2O_5 and K_2O content. Fertilizer recommendation was given based on targetted yield concept. In addition to the farmer's samples, 177 soil samples of Soil Survey Scheme, 12 samples of AICRP on "Tuber Crops" and 19 water samples of CAE, Pusa were also analyzed.

2.14 Soil Survey and Landuse Planning

Until recently, soil survey activities were basically confined to inventorying the natural land resources. However, attempts have been systematically initiated to work out on actual landuse planning during the assessment period (2004-05). For this purpose, four blocks of Bhagalpur district (Kahalgaon, Sanhaula, Pirpainti and nathnagar) wereundertaken for detailed soil survey at the first phase of the project sponsored by the Government of Bihar, Ministry of Agriculture.

In addition, other activities including on-going ad-hoc ICAR research project, 25 years perspective plan on landuse planning of different agro-climatic zones (I, II and III) of Bihar, teaching, advisory services etc were the main priorities under this Scheme. The brief details are as under:

Detailed soil survey

- Starting from planning and execution of the detailed soil survey in four blocks of Bhagalpur district, the activities covered the field traversing, profile description, surface soil sample collection and processing in order to inventorying the existing land resource for interpretation, laboratory analysis, map reparation and computation of capability as well as productivity rating as the took for land use planning.
- Representative surface soil samples were collected for laboratory analysis in order to evaluate soil fertility and relevant map to be used for the purpose of landuse planning.
- Collected soil samples were also proposed to be analysed for selected micronutrients in order to prepare micronutrient map of the surveyed area.
- Land capability, suitability and productivity classifications including preparation of thematic maps are underway.

Fertility Map preparation

Preparation of village level fertility map of Sabour and Goradih blocks, Bhagalpur is on-going

Characterization of watershed vs landuse planning

Land use planning map of Chandan and Badua watershed in progress

Soil Series Correlation

Correlation of soil series of Bihar : Patna division in progress

Agro-modelling approach

Agro-modelling of soil-crop-water system of Bhagalpur district in progress

New Research Project

Ad-hoc Research project on possibility of using flyash as a source of nutrient for sustainable agriculture (submitted to NTPC, Kahalgaon): Approved by now (Rs. 12,00000)

2.15 Agricultural Economics

The period under reference of the "ANNUAL REPORT" has been a very dynamic and important period of this department. During this period for the department of Agricultural Economics. During this period, department had an opportunity to host an all India Economic Society Commonly called as AERA (12th Annual Conference of the Agricultural Economics Research Association) New Delhi, November 2-3, 2004.

In this conference Dr. S.S. Archarya, the president of the society, Dr. Mrutyunjaya, the Secretary the then Director, NCAP, New Delhi and members from all parts of the country visited RAU Campus and particularly the Department of Agril. Economics. The theme of the conference was Impact of Agricultural Technology on Growth, Equity and Sustainability of Natural Resources".

On the occasion what made the contribution of the department memorable was the compilation and publication of a volume. "The three decades of research in Agril. Economics". Besides this, during successful completion of M.Sc. and Ph.D. level academic programmes during the period under reference, the following student level research were conducted.

I. A study on land utilization in Bihar.

II. Agro-tech and Socio-economic dimension of rice cultivation in Motihari district – A village level analysis.

III. A study on maize production and marketing in Samastipur district.

IV. Economics of pesticide use in vegetable crops in Bihar.

V. Techno-economic analysis of wheat and maize production in North Bihar.

VI. A study on production and marketing of rice in Bihar.

VII. Direction of export of agricultural commodities in India.

VIII. Social and human development aspect of poverty in Bihar.

During the period under reference, the following research projects have been conducted.

I. A study on male labour out migration and its impact on rice economy and gender role in Bihar.

II. Social science information repository in Bihar.

III. Pulse production in Bihar – A techno-economic perspective.

IV. Land use planning for the management of agricultural resources.

Under Comprehensive Cost of Cultivation Scheme, the data collection and submission to the Directorate of Economics and Statistics, Ministry of Agriculture have been successfully completed for the reference years 2003-2004 and 2004-2005.

2.16 Agroforestry

Improvement and development of Jatropha and Karanja based Agroforestry systems in wastelands

Under national network on integrated development of Jatropha and Karanja, the zonal trial at R.A.U., Pusa Centre, Bihar has also very high value to select the most promising accessions for the optimization of the quality and oil content of Jatropha and Karanja under agro-climatic conditions of Bihar.

- The best performance with maximum germination percentage and poor performance with minimum germination percentage was recorded 45.0% in T_6 (RJ-H7 Ganjam Rahuri, Maharastra) and 1.67 in T_7 (PKVJ-DHWI Jalana, Maharastra), respectively.
- The maximum and minimum height (cm), diameter (cm) and number of leaves in Jatropha accessions was recorded 28.63, 2.10, 24.67 and 18.93, 1.26, 11.00 and 0.33 respectively.
- The best performance with maximum germination percentage and poor performance with minimum germination percentage was recorded 71.67 in T_1 (RAK-22) and 1.67 in T_3 (Bijapur) respectively.
- The maximum minimum height (cm), diameter (cm), number of leaves in Karanj accessions was recorded 15.84, 0.038 and 12.33 and 12.47, 0.029 and 11.01 respectively.
- The maximum and minimum height (m), dbh (cm), number of branch and sub-branch, number of fruiting branch, number of floweing branch and number of fruits of the Jatropha plus trees varied from 4.55-6.14, 23.0-34.0, 2-4, 21.30, 5-8, 2-12, 7-38 respectively.
- The number of seeds per 100 gram of dry fruits ranged from 60-66.
- Among the biotic stresses, sap feeders and leaf infester as pests and mosoic diseases causing pathogens recorded during different sampling periods.

Transfer of Technology of Agri-horti-cropping system for the utilization of uncultivated shed area of orchards in Bihar.

- The area under demonstration was covered only 2.0 ha.
- New area was identified for next demonstration.
- Intercropping of ginger, ol, turmeric, colocasia, kanda, cowpea and oat was done in the interspaces of heavy shaded Litchi orchard established in the Campus of R.A.U., Pusa.
- Yields of the ginger, ol, turmeric, colocasia, kanda, cowpea and oat were 50, 135, 140, 42, 75, 117 and 132 q ha^{-1}, respectively. These yields varied from 25 to 40% as compared to open field.

2.17 Agricultural Engineering

2.17.1 Microirrigation and green house cultivation

Fertigation/ mulching in Onion

Under fertigation studies with and without plastic mulch and intercropped with Kharif onion, the better in treatment of 100% fertigation without mulch resulting into 140cm as average plant height;12 cm as average plant girth and 4.52 sq m as the canopy area of litchi plants. On the other hand, in case of 100% fertigation with mulch the average plant height, plant girth and canopy area were found to the tune of 160 cm, 14 cm and 5.24 sq m, respectively. In case of inter crop (onion), the maximum yield was noticed in treatment F1, i.e.8.8 t/ha while in control treatment (100% application of fertilizers through traditional method) it was 6.90 t/ha.

Micro irrigation for Litchi

The effect of micro-sprinklers irrigation on fruit cracking and yield of litchi fruits was studied through demonstration at farmers' field. The effect of micro sprinkler irrigation on litchi fruit cracking was found to be very significant, i.e. only 2.15 % fruit

cracking was observed while it was about 7.90% in case of untreated litchi tree. The fruit yield was about 24.42 greater in case of micro-sprinkler treated litchi trees might be due to lesser fruit drop and fruit cracking.

Polyhouse cultivation of Tomato

In case of year round cultivation of tomato with fertigation inside polyhouse,the average number of fruits, fruit weight per plant and yield were found to be highest in treatment F_1 (application of 100% recommended dose of fertilizers through drip), i.e.39.2, 2.87 kg and 7.97 kg /sq m area, respectively. There was about 26.51% increase in quality yield of tomato crop inside poly house and 25% saving of fertilizers (N) over control treatment on 100 % fertigation through drip, whereas on fertigation of 80% of recommended dose of fertilizer, the yield was increased to the tune of 23.50% over control treatment (application of 100% of fertilizer through traditional method). The treatment F_2 was at par with F_1 with saving of 20% fertilizers, whereas treatment F_3 was inferior to F_4 (control).

Micro irrigation for Banana

Composite effect of drip irrigation and plastic mulches on banana crop was evaluated under three main treatments, i.e. T_1 (100% of V vol. through drip): T_2 (80% of V vol. through drip) and T_3 (60% of V vol. through drip); and four sub main treatments on different colours plastic mulch (black, red, blue and white). Amongst different colours plastic mulches the black colour along with 80% application of water through drip was found to the best to cause maximum plant height (176.15 cm); maximum plant girth (60.23 cm) ,maximum number of functional leaves (17.6), maximum water saving (15%), smallest flowering time (292.1DAT), bunch emergence time(318.4DAT) and harvesting time(391.53DAT) of banana crop. The highest B/C ratio of banana cultivation was estimated in treatment T_2 (80% of v-volume of water through drip) i.e. 3.76, while lowest in treatment T_3 (60% of v-volume of water through drip) i.e. 3.36.The B/C ratio 3.51 was found in treatment T_1 (100% of V-volume of water through drip

Seedling (vegetables) raising in Polyhouse

On early seedling raising of different commercial vegetable crops inside poly house, the harvested data revealed that, inside poly house the number of days taken for germination was found less (i.e. at earlier) ; and the germination percentage as well as number of healthy seedlings were also found to be greater as compared to outside of poly house. In case of **tomato** (Adity-2, variety), the seeds were found to germinate in 6 days. Similarly, the germination percentage, days taken to attend the transplanting height and percent of healthy seedlings were found to the tune of 90.2, 23 days and 92.8, respectively. In **cauliflower**, the germination percentage, days taken to attend the transplanting height and percent of health seedlings were found to be 78.3, 31 days and 87.96 respectively. In **capsicum**, the germination percentage, days taken to attend the transplanting height and percent of health seedlings were found to be 56.8, 24 days and 92.7, respectively.

2.17.2 Farm power

An Energy Park has been developed in the premises of College of Agricultural Engineering under the sponsorship of Ministry of Non-conventional Energy Sources, New Delhi. The units installed in the park are as follows:

(a) Solar steel light
(b) Solar water heater
(c) Solar lantern
(d) Solar cooker
(e) Solar still

(f) Cut model of Biogas plant.

Solar cabinet dryer for vegetables

A solar cabinet dryer of 30 kg capacity was developed to dry vegetables successfully. It was tested for cauliflower, pointed gourd, and ladies finger (Okra). The performance of dryer was tested under loaded and unloaded conditions. Vegetables could be dried only in 3-4 days as compared to 8-10 days in open sun drying. The quality characteristics was also tested and found acceptable. The dried vegetables could be stored for 3-4 months with loss in quality. The cost of this dryer is only Rs.2000.00

2.17.3 Post Harvest Technology

Testing of power maize sheller

A power maize sheller was tested and demonstrated successfully for four varieties of maize viz. Laxmi, Deoki, Suwan and Shaktiman-I. Best recommended m.c. of lab was 14.2% with maximum machine capacity of 485 kg/h. Thus when combined with 1385 kg/h feed rate resulted in 99.8% shelling efficiency and about 8.25% grain damage.

Screen cleaner cum grader and specific gravity separator

The optimum sieve size and type of grading screen for maize seed was also evaluated. Extensive experiments were conducted on two screen cleaner-cum-grader and specific gravity separator. Using all four varieties of maize viz. Laxmi, Deoki, Suwan and Shaktiman-I. Various machine and grain parameters were tested. The overall maximum machine capacity was 88 kg/h with maximum specific energy consumption of 6.82×10^{-3} kWh/kg. The maximum seed recovery was found as 97.50% for Laxmi, 96% for Suwan and 85.9% for Deoki and 88% for Shaktiman-I variety of maize seed.

Testing of mechanical oil expeller for Mustard

A mechanical oil expeller was also tested for Toria and Sarso (Mustard) successfully. The processing cost of both the oilseeds was found as Rs.110.9/quintal. The benefit cost ratio was also calculated as 4.7 and 6.17 respectively for Tori and Sarso. The optimization of processing parameters for maximum oil recovery were done, which were

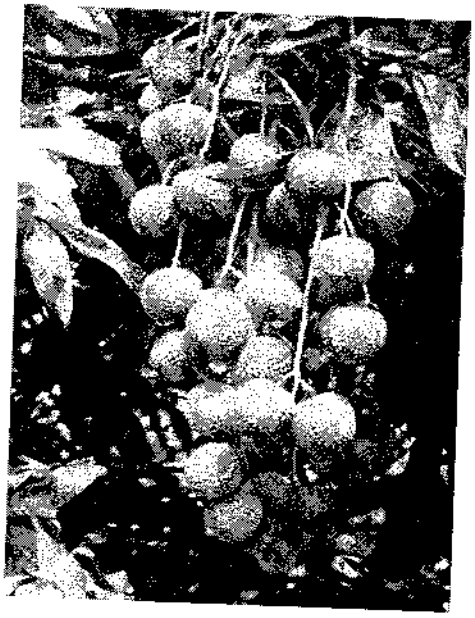
	m.c.	Clearance	Ceed rate
For Mustard	11.9% d.b.	7.3 mm	63.5 kg/h
For Tori	12.5% d.b.	7.2 mm	61.47 kg/h

A agro-processing center has been established at Dept. of Post Harvest Technology, College of Agril. Engineering, Pusa also developed to process pulses, oilseeds, maize and paddy. This also comprises hand papad press and its set of other machine. The machines are installed and their testing is also done, soon it will be inoquoted for training and processing various crops.

2.17.4 Farm Machinery

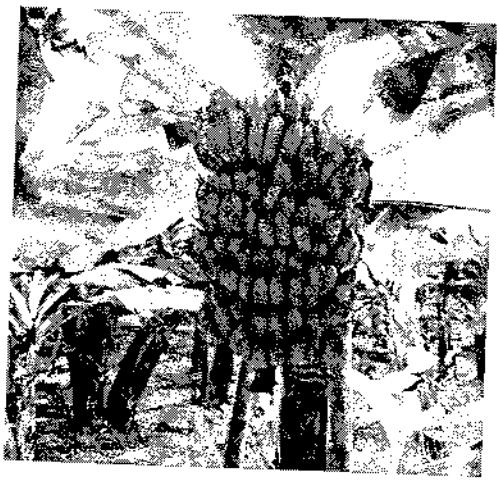
Testing and popularization of zero till drill machine

Zero till drill machine was tested in the farmers fields in Samastipur, Muzaffarpur, Vaishali, Patna, Nalanda, West Champaran, Munger, Bhagalpur, Banka and Saharsa districts. The field capacity was 0.65 ha/h. Cost of sowing was Rs 310/ha. There was a saving of Rs 1900/ha. There was significant reduction in the populations of phalaris



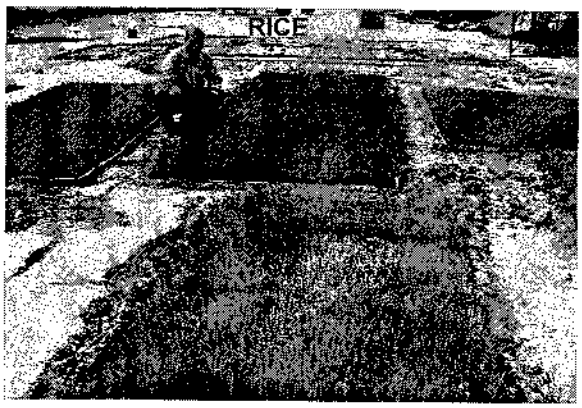
Water Sprinkling with micro sprinklers for Cracking problem

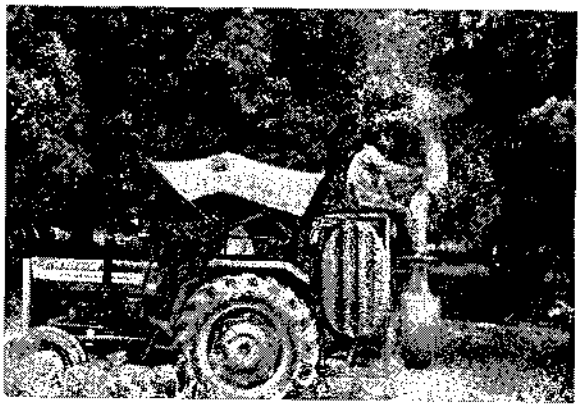
Tomato cultivation in Polyhouse



Drip irrigated banana

Microirrigation in fruit and vegetable crops





Demonstration of Mechanized Farming

minor and Chinopodium album in comparison to traditional method. On our initiative some farmers of Muzafferpur, Begusarai and Patna districtspurchased zero till drill machines. They are using them on custom hiring charging Rs 1700.00/ha for sowing of wheat.

Testing of rice transplanter/seeder

Testing of self propelled rice transplanter was done in the fields of farmers. The field capacity was 0.12 ha/h. The cost of use was Rs 2100/ha. There was a saving of Rs. 1900/ha. Testing of manual rice transplanter was done in the fields of farmers. The field capacity was 0.04 ha/h. Cost of use was Rs. 1000/ha with a saving of Rs 3000/ha. Testing of manual rice seeder was done in the fields of farmers. The field capacity was 0.23 ha/h and cost of use Rs. 200/ha.

Testing of rotavator

Tractor operated rotavator was tested in the farmers fields. The field capacity was 0.43 ha/h. The soil inversion was 70 %. The cost of use was Rs 330/ha.

Testing of Post-hole digger

Power operated post hole digger was tested for digging holes for banana plantation. Maximum depth and diameter were 60 cm and 20 cm respectively. Time required to dig one hole was 15 seconds.

Testing of aeroblast sprayer

Tractor mounted aeroblast sprayer was tested for spraying in litchi orchard. Time required to spray one tree was 82 seconds. 48 trees were sprayed in one hour.

Testing of combine harvestor

Combine harvestor was tested for harvesting wheat and paddy crops. The field capacity for harvesting wheat was 1.08 ha/h. The cost of use was Rs 800/ha. Cost in traditional method was Rs 2720 /ha. The field capacity for harvesting paddy was .91ha/h. The cost of use was Rs 950 /ha. Cost in traditional method was Rs 2550/ha.

2.15 Dairy Technology

Bihar ranks among the first 10 states of India in milk Production. Dairying had attained a status of growing industry in the early 80's thanks to the impetus rendered by the Operation Floods I and II and was in a great need of technical personnel to procure process and market the increased quantity of milk available to it. Therefore, Sanjay Gandhi Institute of Dairy Technology (SGIDT) was established in 1982 under the auspices of Rajendra Agricultural University, Bihar, Pusa (Samastipur) with following objectives:

- To train personnel in Dairy Technology and Dairy Husbandry in order to handle dairy development programme in the state of Bihar.
- To provide short term training to dairy farmers. Dairy entrepreneurs and dairy technicians as and when required.
- To impart training in Dairy Technology and Dairy science to the students of other faculties of Rajendra Agricultural University.
- To conduct post graduate programme in the selected areas of Dairy Science as per requirement of state.
- To carry out research in collaboration with related disciplines on various aspects of Dairy science and Technology.

- To disseminate the scientific knowledge in relation to milk and milk products through extension education programmes.

There is an ample scope of research in different aspects of dairy processing particularly those pertaining to Dairying in Bihar. At present research is being undertaken in the following areas of Dairy Technology :

i. Non-conventional rapid methods for the determination of fat content in milk using detergents.

ii. An engineering approach of selecting the optimum Fat SNF ratio to get maximum heat transfer during recombination of liquid milk.

iii. Microbiological analysis of milk produced under village conditions around Patna City.

iv. Heat transfer, pressure drop and fouling characteristics of tubular heat exchanger.

v. A genetic study on economics of milk production in dairy animals under rural management system.

vi. To study the rheology of Panner made from the milk of Patna shed area.

vii. Technological studies on the manufacture of chum-chum from cow and buffalo milk

viii. Economics of milk production in Gangetic plants of Bihar.

ix. Marketing of milk in Bihar- A study of organized milk markets.

x. Effectiveness of Quality Assurance Management in Dairy Processing.

The two research projects of inter disciplinary nature are under active consideration at ICAR, New Delhi. The projects entitled "Optimizaion of Processing and design parameters in continous manufacture of Chhana and Paneer" and the studies on production of Mozzarella Cheese from mixed milk available at Patna Dairy Project and its Rheological and sensory characteristics for consumers' accepbility in Easter India" would have direct impact on the techno-economic success of these projects in Eastern region.

Additionaly, few research projects are also running under different departments of the Institute namely- Dairy Technology, Dairy Chemistry and Dairy Extension. An extension research project entitled " A study on quality consciousness for milk and milk products" is also in progress in department of Dairy extension.

2.19 Home Science

The faculty of Home Science at Rajendra Agricultural University was instituted in the year 1982 with the objectives to enhance the growth, development and well being of individuals, families and communities by utilizing the developments in technology. The College of Home Science stands for academic excellence whereby young women are equipped to meet successfully the challenges of family life as well as those from the professional world of a changing modern world. Though its curricular which are revised from time to time, the faculty also stands for a socially relevant education and awakens the students sense of social responsibility to reach out and share their knowledge and skills with vulnerable sections of society.

Activities

1. **Enhancing Food & Nutritional Security through Value-Addition and Post Harvest Management.**

Farmer's Day was celebrated in Mutlupur village of Samastipur District. Nutrition awareness camps were also organized in Samastipur, Vaishali, East Champaran, Madhubani and Muzaffarpur district. Besides this five on-campus training programmes were conducted.

2. Development of low cost value added food products

Studies on self life of low cost value added products developed were carried out.

3. Survey of Street Food, Indigenous and Imported Food Products and consumers.

The research is aimed to establish a base line for identified indicators on awareness, attitude and practices related to food safety in big cities to develop a sustainable model for improving food safety through appropriate education and training and to develop effective strategies regarding safe consumption of street foods. The schedule for the survey have been finalized.

4. Studies on Mungbean recipes

At pilot level, 11 recipes from newly developed mungbean have been developed.The protein content per 100 K.cal was the highest (11.53 g) in cutlet followed by mung dal mixture (7.04 g),Chhole (6.51g), Chokha (6.24 g), bread roll (6.0 g), sev (4.64 g), bundi (4.17 g), makuti (3.49g), sabji (93.46g) and halwa (2.29 g). In all the products, the contribution of mung for protein content is above 80% (except cutlet)

5. All India Co-ordinated Research Project on maize-maize nutrition.

To improve the health and nutritious status of our population, the people must be aware to utilize the Quality Protein Maize in form of weaning food, health food, snacks and savoury items, convenience foods and speciality foods. In this connection training programs have been organized. Linkages have been developed with Katyaynee Makka Udyog, Khagaria for commercialization of the products.

- Week long training programme were organized by the Department of Foods & Nutrition, and Deptt. of Clothing & Textiles with a the objective to develop women entrepreneurs to start viable enterprise for economic empowerment of women.
- A six months duration vocational course for the young girls and women of Bihar Family Resource Management was vocational training on "Entrepreneurship development"
- Morsand Panchayat have been adopted for regular extension activities by the College of Home Science.
- During National Nutrition Week-2004 (1st September to 7th September 2005) various on campus and off campus programme were organized by the faculty members of Food & Nutrition. During this programme Diet Counselling of the family members of near by villages were carried out and members were also educated on nutritional aspects. Various skill oriented training were also imparted for taking up viable enterprises out of Fruits and Vegetable Preservation. Health check-up of the vulnerable group of the society were carried out and on spot they were given diet counseling for various disease for which they were suffering.

Training Centre

The Govt. of India, Ministry of Human Resource Development, Dept. of Women and Child Development has approved the College of Home Science, RAU,Pusa as one of the center for running Middle Level Training Centre under ICDS in the State of Bihar.The center was inaugurated on 30.6.05. The college has successfully organized six training programmes.Two programmes were organized as an Orientation programme for ICDS Instructors and four programmes were organized for ICDS Lady Supervisors. Altogether there were 120 trainees in these training programmes.

2.20 Veterinary Science and Animal Husbandry

2.20.1 Animal Breeding & Genetics

Influence of genetic and non-genetic factors on some economic traits in Hariana and its crosses

Effect of genetic and non-genetic factors on average daily milk yield (ADMY) in 291 cows of Hariana (H) and its crosses with Holstein Friesian (HF) and Jersey constituting 6 genetic grades such as Hariana Pure, HF<50%, HF 50%, HF 62.5%, HF 75% and Jersey 50% was studied. The genetic group ½ HF ½ H had the highest (6.05 kg) ADMY. The lowest ADMY was observed in Hariana which significantly (P<0.05) increased with the increase of HF inheritance upto 50% where it had the maximum value, thereafter it significantly (P<0.050) decreased in HF 62.5% and HF 75% genetic groups. The period of calving had significant effect on ADMY, whereas season of calving and parity of lactation did not influence it significantly.

Effect of age and sex on various slaughter traits in Japanese quails

The carcass characteristics of 258 Japanese quails (*Coturnix coturnix japonica*) were investigated at 5th and 6th weeks of age to study the effect of age and sex on it. Both age and sex had highly significant (P<0.01) effect on all the slaughter traits studied. The average dressing %, evisceration%, giblets% and legs weight% were higher at 5th week of age than 6th week, whereas breast weight% and thigh weight% at 6th week of age were more than 5th week in both males and females. In general, females had higher percentage of all the slaughter traits than males at both the ages.

Genetic analysis of variation in some performance and blood biochemical traits in Hariana and its crosses:

The experiment was conducted on 95 cows of four genetic grades namely Hariana Pure, HF < 50%, HF 50% and HF > 50% during 1981-2000. The average lactation yields (kg) in HF > 50%, HF 50%, HF < 50% and Hariana Pure genetic groups were obtained as 1703.83 $\pm$ 89.42 kg, 2233.81 $\pm$ 64.36 kg, 1204.51 $\pm$ 106.92 kg and 837.99 $\pm$ 132.61 kg respectively. Genetic group had highly significant (P<0.01) effect on lactation yield. Period of calving and season of calving influenced lactation yield significantly (P<0.01) whereas parity of lactation and regression of age at first calving had no significant effect on lactation yield.

The average lactation length in HF > 50%, HF 50%, HF < 50% and Hariana Pure obtained as 400.69 $\pm$ 15.32, 423.41 $\pm$ 11.03, 391.88 $\pm$ 18.34 and 328.58 $\pm$ 22.72 days respectively. Genetic group had highly significant (P<0.01) effect on it. However, all other non-genetic factors such as period of calving, season of calving and parity of lactation and also regression of age at first calving were found to have non-significant effect on lactation length.

2.20.2 Animal Reproduction, Gynaecology & Obstetrics

Studies on reproduction performance of ewes and does infected with gastro-intestinal helminth parasites.

Study was conducted to find out the reproductive performance of does and ewes by analysing biochemical profile of serum and its treatment with mineral mixture and albendazole.

The serum levels in helminth infected and control does on 0 day were found to be 9.60 ± 0.14 mg/dl and 11.38 ± 0.14 mg/dl and that of ewes were 9.20 ± 0.16 mg/dl and 10.72 ± 0.16 mg/dl in ewes, respectively .The mean serum phosphorus level on day 0 of infected and normal does were found to be 5.26 ± 0.07 and 6.35 ± 0.06 mg/dl and 5.17 ± 0.13 and 6.41 ± 0.07 mg/dl in ewes, respectively.

The mean serum protein values on 0 day were found to be 5.83 ± 0.10 and 6.87 ± 0.10 in infected and normal does and 5.68 ± 0.14 and 6.41 ± 0.09 in ewes, respectively. Serum glutamic pyruvic transaminase (SGPT) in normal and helminth infected group on 0 day were found to be 19.46 ± 0.68 and 27.30 ± 0.90 IU/L in ewes and 182.60 ± 1.13 and 200.40 ± 2.19 IU/L in ewes, respectively .The serum glutamic oxaloacetate aminase (SGOT) in normal and helminth infected group on 0 day were found to be 180 .27 ± 1.11 and 197.04 ± 1.00 IU/L and in does were 182.60 ± 1.13 and 200.40 ± 2.19 IU/L, respectively.

Serum Calcium, Phosphorus and Total Protein have a definite role in reproduction. Their levels in body system is influenced by helminthic parasites and hence, their levels in the body need to be maintained for effective breeding and improvement in reproductive performance. These performances could be improved by the application of anthelmintics and mineral mixtures in infected does and ewes.

2.20.3 Veterinary Microbiology

Epidemiological studies on Foot and Mouth Disease.

Samples from lesions found at foot and mouth area (epithelial samples) of animals were analyzed for FMD virus serotype. During the period from April 2005 to August 2005, 16 outbreaks were detected in which 270 (Cattle – 155 and Buffalo – 115) animals were found to be affected by the FMD. From these outbreaks 11 samples were analysed for detecting FMD serotype, out of which FMD serotype 'O' was found in 7 of the samples. Rest samples (August & September) are yet to be serotyped.

During various months, highest number of affected animals (73) were found in July, followed by June (52), September (42), May (37), August (34) and the least in the month of April (22), Among the different districts maximum (8) Outbreaks were found in and around Patna followed by Siwan (4), Darbhanga (2) and the least were found in Bhojpur and Chhapra (1 each).

Studies on the occurrence and stability of aflatoxin in milk and milk products in different agroclimatic areas of Bihar

Milk Samples (Unorganized Sector)

A survey of milk samples of cows and buffaloes was conducted for the occurrence of milk toxins (aflatoxin M_1 and M_2) from different areas of unorganized sectors of Bihar. Altogether 798 milk samples were collected, out of which 110 samples (13.78%) were found to be contaminated with aflatoxin M_1 and M_2. Maximum percent occurrence of milk toxins was observed in samples of cow then in buffalo. Maximum percent occurrence was recorded in Vaishali district (25.00%) and minimum in Monghyr and Nalanda district (3.57%). Among 110 positive samples, 63 samples were contaminated with aflatoxin M_1 only, whereas 47 milk samples were found to be contaminated with aflatoxin M_1 and M_2. The concentration of aflatoxin M_1 ranged from trace to 100 ③g/l, whereas range of concentration of aflatoxin M_2 was trace to 80 ③gl.

Milk Samples (Organized Sector):

A survey of milk samples was conducted for the occurrence of milk toxins (aflatoxin M_1 and M_2) from different organized sectors of Bihar viz.Barauni Dairy Project (Begusarai) and Patna Dairy Project (Local Milk Booth of Patna). Altogether 144 milk samples were collected, out of which 15 milk samples (10.41%) showed contamination with milk toxins. Out of 140 milk samples colleted from Patna Dairy Project (Local Milk Booth), fifteen samples (10.71%) were found to be contaminated with aflatoxin M_1. The range of concentration of aflatoxin M_1 was ranged from trace to 40 ③g/l. Samples collected from Barauni Dairy Project (Begusarai) were not found to be contaminated with this toxin.

Milk Product and Samples:

A survey of milk product samples was conducted for the occurrence of milk toxins (aflatoxin M_1 and M_2) from different areas of Bihar. Altogether 327 milk product samples were collected, out of which 57 samples (17.43%) were found to be contaminated with aflatoxin M_1 and M_2. Maximum contamination was observed in Peda samples (35.55%) followed by Kalakand (33.33%), Burphi (27.27%), Khurma (25.00%), Lassi (20.00%), Paneer (15.78%), Rasgulla white (15.38%), Dahi (15.00%), Butter (12.5%), Ghee (6.25%) and minimum in Ice-cream (4.76%) and Rasgulla red (4.34%). The samples of milk powder, condensed milk, baby food and youghurt were not found to be contaminated with milk toxin. Among 57 positive samples, 42 samples were contaminated with aflatoxin M_1 only, whereas 15 milk product samples were found to be contaminated with aflatoxin M_1 and M_2. The concentration of aflatoxin M_1 ranged from trace to 100 ③g/kg or ③g/l and ranged of concentration of aflatoxin M_2 was trace to 40 ③g/kg or ③g/l.

2.20.4 Livestock Products Technology

Quality enhancement of buffalo meat and its unit packaging for export.

The deboned meat chunks from longissimus dorsi and thigh muscles of spent adult female buffalo carcass were packed in LDPE bags and conditioned for about 24 hours at 4 ± 1^0 C. The meat chunks after conditioning were trimmed off separable fat and connective tissue, cut into small cubes and minced in a grinder using 8 mm (coarse) and 3 mm (fine) plate simultaneously to obtain ground buffalo meat. Half of the meat sample was blended with 0.02% BHA, 0.02% tocopherol acetate and 0.5% STPP and the remaining half was used as control without any additives. Aliquots of 200gm each were prepared for each experimental group i.e. control aerobic packaged (CAP), control vacuum packaged (CVP), control modified atmosphere packaged (CMAP) and treated pack sample using polyester/cast laminated plastic bags. The sample were plate frozen in a plate freezer attained -30^0C internal temperature and then maintained at -15 ± 1^0 C for 105 days.

The quality of meat sample were examined at frequent intervals of the storage period for different physico-chemical characteristics and sensory attributes. Standard methods were adopted for evaluation.

The pre blended meat samples (TAP, TVP and TMAP) showed significantly ($P<0.05$) higher pH, WHC% and SEP% as compared to control batches. Vacuum packaging and modified atmosphere packaging did not influence the above parameters. During the storage period pH of meat did not shows any significant change. WHC behaved inconsistently up to 75 days but significantly ($P<0.05$) decreased at 90 days. Salt extractable protein remains unchanged up to 45 days, and thereafter it was found to decrease in significantly. WHC shows positive co-relation with pH and SEP%.

Pre blending of buffalo meat with antioxidant resulted in significantly ($P<0.05$) higher colour score. Though colour score significantly ($P<0.05$) decreased during the storage period as compare to 0 day, it was well acceptable even 90 days of storage. The pre blended sample showed significantly ($P<0.05$) higher total meat pigment% as compared to CAP batch. Vacuum packaging and modified atmosphere packaging did not affect the total meat pigment% in both control and pre blended sample. During the frozen storage period no significant change in content of total meat pigment was observed. The treated aerobic vacuum packaged and modified atmosphere packaged sample showed significantly ($P<0.05$) higher odour score and tyrosine value and lower TBARS number as compared to control batches, but no significant differences were obtained either between TAP, TVP and TAMP or between CAP, CVP and CAMP samples. Vacuum packaging and modified atmosphere packaged produced desirable odour of meat for 15 to 30 days more when compared to aerobic packed sample. Vacuum packaging and modified atmosphere packaging also maintained consistently lower TBARS number meat sample during the storage period. The desirable meat odour significantly ($P<0.05$) decreased as the storage period increased.

2.20.5 Parasitology

Survey of the incidence of G.I. helminthic parasites in different breed of pet dogs in Patna.

To study the incidence of G.I. helminthic infection, faecal sample of 305 dogs of different breeds were screened out. Out of 305 examined samples, 54.09% were found positive for various gastrointestinal helminthic parasites. The crossbred were found to be mostly infected 70.59% followed by Dobermann (64.71). Altatian (56.99%) Spitz (52.73%) and Labrador (33.30%). The predominant infections were *Toxocara canis* (32.13%), *Ancyclostoma caninum* (20.29%), *Trichuris vulpis* (0.98%), *Dipylidium caninum* (4.26%) and *Taenia* sp. The peak prevalence of A. *caninum* was noted between May to Nov., however T.*canis* were prevalent in winter and rainy seasons. The incidence of rest of the parasites noted throughout the year equally. Survey also revealed that most of the owners are totally unaware of zoonotic hazard of these parasites and never follow any deworming schedule. Regular hygiene of pets and their habitat places were least cared even in high status owners. The defecation process in the same places surrounding the owners house invites easy contamination of these parasites. Most of the newly born pups (nearly 85%) carry the infection or ancylostomiasis and ascariasis by their prenatal and postcolostrum transmitting nature and are responsible for cutaneous and visceral larva migrans in children. The parents/dog owners were found completely unaware that habit of nonwashing hands or dirty nails easily made ingestion of these parasitic ova/larva to their infants.

Studies on the Evaluation of the efficiency of Acaricides and Control of Ticks

In vitro trial of Deltamethrin+Piperonyl Butoxide (Butox plus) against semi engorged nymph adults and engorged female *Boophilus microplus* and *Rhipicephalus sanguineus* were carried on. During trial batches of 20 engorged females, 50 engorging nymphs adults were placed in between filter papers impregnated in 5 different freshly prepared solution of Butoxplus at concentration of 0.25 ml/l, 0.5 ml/l, 0.75 ml/lit 1 ml/l, 1.5 ml/l and 2 ml/l and control (water separately). The number of dead ticks counted and percentage of tick mortality were evaluated at 6.12 and 24 hrs on post treatment. At 6 hrs post treatment, more than 95 to 100% mortality of both stages of cattle and dog ticks were observed which reached cent-percent within 12 hrs. at 1.5 and 2.0 ml/l concentrations. The concentration 0.75 and 1 ml/l were possesing nearly 90% mortality within 12 hrs which increased more than 95 to 100% at 24 hrs. at 1 ml. concentration however it was found only 90% and 85 to 90% at 0.75 ml/l at 24 hrs against dog and cattle ticks respectively. The concentration 0.50 ml/l was effective upto 80 to 86% nymph adult

mortality, however it was found only 55 to 65% for adult ticks within 24 hours. There was only 35 to 52% mortality observed against both ticks at 0.25 ml/l concentrations.

2.20.6 Animal Nutrition

Effect of different levels of dietary protein on the performance of Cockerel

Five different experimental groups having thirty chicks in each were utilized in a feeding trial for a period of 6 weeks. The feed ingredients used in the experimental were maize, DORB, fish meal, Deoiled G.N.C. and Deoiled soyabean cake. CP level used in 5 groups were 17%, 19%, 21%, 23% and 25%. All the feeds were isocaloric. Study revealed that 21% CP level with 2800 k cal ME/kg was optimum for cockerels in terms of body weight gain, feed efficiency growth rate, performance index and carcass trait. Optimum caloric: Protein ratio was found to be 134. In terms of profit and economics also 21% CP level showed the best result.

2.20.7 Veterinary Pathology

Pathology of experimental salt toxicity in relation to turmeric feeding in cockerel.

A total of 120, one day old, healthy Cockerel chicks were procured & divided in 6 (six) groups. Sodium chloride simply & with turmeric powder (Curcuma longa) were given in feed. Clinical symptoms, haematology & pathological studies of affected organs were studied.

The clinical signs observed were decreased appetite, increased water intake dullness, muscular weakness & stunted growth but these symptoms were less severe in those chicks given turmeric powder with feed.

Haematological studies showed that haemoglobin, PCV & TLC were increased indicating haemoconcentration. Most of the Sodium chloride fed birds showed distended abdomen with watery fluid in variable amounts. Lungs, brain, heart showed oedema. Other changes were congestion, haemorrhages in lungs & intestine, dilatation of right auricles & pale kidneys.

Histopathological changes found were oedema & degenerating changes in brain, congestion & odema of lungs, dilated sinusoids, degeneration in liver cells, increased number of Kupffer cells in liver parenchyma, fatty changes in liver cells, mild haemorrhages and oedema in myocardium, lymphoid depletion in bursa of fabricius & spleen. Proventriculous showed denuded mucosa with lymphoid infiltration/aggregates in submucosa & cellular debris in glandular lumen. However, the severity of lymphocytic depletion in turmeric feed group was found to be low severe.

To conclude, it is observed that toxicity of Sodium Chloride (Common salts) in Cockerel chicks is dose dependent. More severe changes were observed with concentration of sodium chloride in feed. Turmeric have some preventive effect of salt toxicity. It requires further study.

2.20.8 Veterinary Physiology

Improvement of Feed Resources and Nutrient Utilisation in Raising Animal Production.

During the period under report 5 district namely Katihar, Purnia, Samastipur, Saharsha and Bhagalpur were select villages to collect data on prescribed data sheet. 16 villages of four districts namely Katihar, Purnia, Samastipur & Saharsha were selected to collect data prescribed data sheet & local feeds and fodders samples. Minimum 20 of families from each 16 villages were selected for the study of their socioeconomic conditions. The general health and reproductive health problems of the animals in these villages under rural management system of 320 families were

recorded. Cataloging of the feeds and fodders being fed to the animals of selected villages of 11 districts were also prepared. It was observed that the ratio of reproductive and general health problem in the selected villages was 70:30. Among the reproductive health problem in the selected villages was the major constraints (70%) than the true anestrus contributed 60% while the nulliperous contributed 40% only. Out of total number of repeat breeding animals cattle contributed 80% while buffalo contributed only 20%. Among the true anestrus animals buffalo contributed 65% while cattle contributed only 35%. The types of non infective reasons for this repeat breeding and anestrus condition could not be ascertained due to none estimation of micro-nutrients in the soil were fodders are grown, in the feeds and fodders supply to the animals and in the circulating blood of repeat breeding and anestrus animals. The causes will be ascertained after the estimation of micronutrients when the Atomic Absorption Spectrophotometer in the scheme. The installation and finding of the Atomic Absorption Spectrometer needs one airconditioned dust proof laboratory for which attempts have already been made at university and ICAR level out of saving from contingent grant of the project to improve the existing laboratory of the Department of Veterinary Physiology to make it dust proof and air conditioned.

Response of post partum anestrus cows to progesterone and $PGF_{2\alpha}$ on oestrus cyclicity and blood constituents

By overviewing the response of postpartum anestrus crossbred cows to the administration of prostaglandin and progesterone during summer it revealed that:

- The crossbred cows having normal genitalia and around health can be brought in to fertile estrus during summer months by a combined treatment with 25 mg prostaglandin and 500 mg to 750 mg progesterone.
- The serum total cholesterol concentration is elevated over the basal pretreatment value during follicular phase and at oestrus after treatment which Prostaglandin and Progesterone.
- The serum calcium and inorganic phosphorous concentration is also increased in crossbred cows at oestrus pretreated with Prostaglandin and Progesterone combination.
- The transaminase activities are also increased in crossbred cows at oestrus subjected to the pretreatment with Prostaglandin and Progesterone.
- A little insignificant decrease in daily milk yield in the crossbred cows can occur for a brief period after treatment which resumed to the normal production level within 4 to 26 days after last treatment that may not cause a considerable economic loss to dairy man if the total response to the Prostaglandin and Progesterone is consider.
- A systematic studies needs to be taken upto study the response of these oestrus synchronizing drug on large no. of dairy cows in all the agroclimatic zones in different seasons of the year before drawing any final conclusion.

Response of post partum anestrus buffaloes to progesterone and $PGF_{2\alpha}$ on oestrus cyclicity and blood constituents.

From the over viewing of the observations recorded during present experiment, it reveals that the buffaloes can be brought in oestrus during summer months by intramuscular administration of 500 mg Progesterone either as a single or double injection in the past parturient buffaloes after 6 months of parturition pretreated with broad spectrum anthelminthic and Prostaglandin.

- The serum total cholesterol concentration in buffaloes during follicular phase and at oestrus after the administration of oestrus synchronizing drugs like prostaglandin and Progesterone is increased over the pretreatment values.
- Among the transaminase only the SGOT activity is enhanced at oestrus in buffaloes and it may be considered as a marker for detection of oestrus during summer months in buffaloes.
- The administration of Prostaglandin and Progesterone have no influence on serum calcium and inorganic phosphorous concentration. The values remain maintained at similar level during anoestrus and at synchronized oestrus in buffaloes.
- The daily milk production may decreased by 10 to 30% following $PGF_{2\alpha}$ and Progesterone administration. The milk production resumed fully to the pretreatment level within 15 to 20 days of last duraprogen or prostaglandin injection.
- A more systematic study including a large no. of animals in various agroclimatic regions is needed before final conclusion and recommendation on the response of anoestrus rural buffaloes to the administration of oestrus synchronizing drugs on resumption of oestrous cyclicity, conception rate and economics of milk production.

2.20.9 Veterinary Anatomy

Histomorphological and studies on submandibular and sublingual salivary glands in Rabbit (*Oryctolagus cuniculus*)

Histomorphological and studies on submandibular and sublingual salivary glands of New Zealand white rabbits were conducted. During the study, the tissue samples were collected from six male and six female rabbits.

After proper fixation, microscopical slides were procured and stained for histological and certain histochemical studies. Certain histometrical data were also recorded for statistical analysis.

Submandibular salivary gland

The submandibular gland of rabbit was typed as compound tubuloacinar mixed gland. The glandular endpieces comprised of glandular tubules and glandular acini.

Histochemically the glandular acinar cells were negative for PAS, Glycogen, alkaline phosphatase and lipid. They however, reacted mildly for colloidal iron, toludine blue and mucicarmine stain. The glandular tubular cells however, reacted mildly for PAS and Mucicarmine stain. The cells were negative for glycogen, colloidal iron and toludine blue stain. They were also lacking alkaline phosphatase and lipid droplets.

Sublingual salivary glands:

In rabbits, the sublingual salivary glands were located at two different places. Dorsocaudally, several groups of glandular tissues were located under the mucous membrane which opened into the lateral sublingual papillae with the help of separate excretory ducts. They were grouped together as minor sublingual salivary glands or polystomatic sublingual salivary gland.

Ventrocranially, the major sublingual salivary glands was located whose main excretory duet opened at cruncula sublingualis thus considered to be monostomatic sublingual salivary gland.

Animal Health Camp

Treatment of Metritis in Buffalo at Paharpur, Motihari

Treatment of a female elephant suffering from deep sinus

Histochemically, secretory endpieces reacted moderately for PAS showing intense metachromatics with toludine blue. The cells were lacking in glucogen but were repeated mild to moderately with mucicarmine stain.

2.20.10 Livestock Production and Management

Studies on the effect of supplementation probiotics as growth promoter in commercial diet on the performance of broiler.

Due to paucity of fund and lack of technical staff in the department, the research activities are almost ceased; only teaching works are managed any how. However, some curricular research work have been under taken due to the help of MVSC students.

The studies will be under taken in the existing facilities in the department and with the collaborations of other department like. Department of Animal Nutrition, A.B. and Genetics and Central Poultry farm, Patna under Govt. of Bihar.

Clinical Services Rendered

(i)	Surgical cases	-	82
(ii)	Gynaecological cases	-	702
(iii)	No. of AI done	-	435
(iv)	Physical clinical cases	-	1122
(v)	Pathological examination		
	(a) Faecal samples examined	-	393
	(b) Blood samples examined	-	83
	(c) Urine examination	-	12
	(d) Skin scrapping examined	-	13
	(e) PM conducted	-	16

3. EXTENSION SERVICES

The university comprise with the Department of Education for the purpose of teaching ands research and a Directorate of Extension Education for transfer of technology to the farming community of the state. The Directorate of Extension Education being a statutory unit of the University, provides guidelines, maintains coordination among various centers and sub-centers including the Krishi Vigyan Kendras, involved in extension works and supervise and monitors extension programmes. Its main role is to promote agricultural development through professional extension services and to strengthen/enhance professionalism in extension.

The three principal functional areas of the Directorate of Extension Education (DOEE) are training, information communication and farm advisory services.

Training Programme/ extension activities of various units

Training being an important component of the Human Resources Development is an integral and essential part of the agricultural extension system. Basic responsibilities for providing training to the state extension functionaries lies with the DOEE. However, 19 Krishi Vigyan Kendras working under the administrative control of the University and located in 19 different districts shoulders the responsibilities of providing training support to the practicing farmers, rural youths and to the senior/ middle level extension functionaries including Subject Matter Specialists.

Trainings imparted during the year by DOEE

S. No.	Target Groups	No. of Trainings	Beneficiaries		
			General	SC/ST	Total
1	Practicing Farmers	874	18673	3880	22553
2	Rural Youths	415	7134	1934	9068
3	Extension Functionaries	326	6684	1093	7777
4	Others Sponsored trainings	720	13678	3598	17276
	Total	**2335**	**46169**	**10505**	**56674**

Besides, trainings have also been imparted to the rural youths desirous in obtaining knowledge and skill in the areas of Mushroom Cultivation, Medicinal and Aromatic Plant Cultivation and Honey Production by the departments of Microbiology, Botany and Plant Physiology and Apiary units of the University, respectively. The details of trainings organized and number of beneficiaries are as under.

S. No.	Categories	No. of trainings	Beneficiaries
1	Mushroom cultivation	09	256
2	Medicinal Plants	06	130
3	Honey Production	11	292

In addition to this, the Directorate of Extension Education was also involved in conducting the training programmes sponsored by different agencies, the details of which are as under:

- Under *Swarn Jayanti Gram Swarojgar Yojna* the young farmers belonging to different blocks of Vaishali districts were given training on Animal Husbandry, Fisheries and Goat rearing in three different batches. This training programme was sponsored by Nehru Yuva Kendra

- A training on spices was organized which was sponsored by Ministry of Agriculture, Govt. of India.
- A training, sponsored by the Dy. Director of Extension, Maharajganj, U.P., on production of fruits and vegetables and floriculture was organized at Pusa.
- Sponsored by the District Agriculture Officer, Kushinagar, U.P. a training of three days duration was organized on production of *rabi* Maize.
- 25 farmers of Sidharthnagar, U.P. were trained on production of *rabi* maize which was sponsored by Dy. Director, Extension, Sidhathnagar.
- A three days training programme was organized for the farmers of Gonda (U.P.) in which 25 farmers participated. This training was sponsored by District Agriculture Officer, Gonda (U.P.).
- One training programme on production of Boro rice was organized, which was of three days duration and sponsored by Ministry of Agriculture and Cooperation, Govt. of India.

Information Communication

Besides training, information communication constitutes one of the major functions of DOE. Support to agricultural extension is carried out mainly through organization of State/district level Kisan Melas; publication of Kisan Diary; publication of leaflets / pumplets; Radio/ T.V. talks etc. The progress / achievements made in these areas are as under:

Kisan Mela

The Directorate is organizing Kisan Melas at state and district levels for faster dissemination of latest technologies in the field of agriculture and allied sectors to a larger cliental group. The Directorate also participates in such events being organized at national level to project its achievements.

- State level *Kisan Melas* were organized at Motihari (East Champaran) and Sabour (Bhagalpur). In these two *melas* a large numbers of farmers participated and got benefited through dissemination of latest technologies in agriculture and allied fields.
- Fifteen district level *Kishan Mela* were organized by different KVKs in which a large number of farmers were benefited. The dignitaries such as Union Minister of Rural Development Dr. Raghubansh Prasad Singh and Union Minister of State Md. Taslimmudin also attended the district level Mela at Muzaffarpur and Arariya.
- The University participated in one National and one Regional level fairs at Banana fair, New Delhi and at Orissa University of Agriculture & Technology, Bhubaneshwar.

Radio /T.V. talks

The network of radio and television has been of harnessed to its full potential as mass approach in dissemination of agricultural technologies to the farmers .

- During the period under reference, a total of 73 radio talks were delivered by the Scientists of RAU through Patna, Darbhanga and Bhagalpur Kendras of All India Radio.
- A total of 150 T.V talks were telecasted by 'Doordarshan' from Patna, Muzaffarpur centres and 'ETV Bihar' in which the Scientists of the University participated and delivered talks on various topics of agriculture and allied fields.

Publication of Kisan Diary

The Directorate of Extension Education every year, publishes *Adhunik Kisan* Diary containing detail information on crop and live-stock management including fisheries. During the period under reference, a total of 6000 *Adhunik Kisan* Diary were published and sold amongst the farmers of the state.

Publication of leaflets/publication

During the year 5000 copies of leaflets and 8000 copies of pamphlets containing information related package of practices of various crops and animal science were published and distributed free of cost amongst the farmers of the state.

Publication of Adhunik Kisan Patrika

Publication of *Adhunik Kisan Patrika*, a monthly journal in Hindi for the benefit of the farming community of the state, is a regular feature of the Directorate of Extension Education. During the period under reference the publication of all the volumes of this journal was regular.

Farm Advisory Service

An institutional system of providing direct feed back from farmer to scientists on problems and constraints in agriculture and communicating relevant technological advances to farming community, farmers – scientists interaction assumes a pivotal significance. These interactions are organized through organization of Kisan Gosthi, Field days, Scientists visit to farmers field and Diagnostic services rendered by the scientists.

During the period under reference, the progress made under this operational area of the Directorate is as under.

S. No.	Activities	Number	Beneficiaries
1	Kisan Gosthi	155	10143
2	Field days	63	4272
3	Scientist visit to farmer's field	1226	7474
4	Diagnostic service	197	3242

Several awareness camps were organized in the adopted villages related with the different crop production system, Animal husbandry, allied activities and related with income-generating enterprises.

Demonstration of Technology

A large number of on-farm trials (OFT) and verification trials (VT) under the project were made during the Kharif season as well as during the Rabi season. With the help of these demonstration trails, efforts were made to disseminate the technology transfer and also to convince the farmers related with the profitability and better performance about them at the farmers field.

Field Visit

Frequent field visits were made by the group of concerned scientist, during the crop season in order to identity the problems of farmers and also to get the feed back related with the transfer of technology concerned. On several occasions, authorities of the project such as Hon'ble Vice-Chancellor, Director Research, Dean of Agriculture, Dean of Basic Science and Humanities, Director of Extension Education were also taken trouble to make the field visit of the project areas.

Kisan Diwas

KISAN DIWAS has also been organized under the project area from time to time as per the needs of farmers. Madhu Mela

The farmers of the adopted villages were exposed with the latest technology, marketing and processing avenues of honey production during the several Madhu Festivals /Madhu Mela organized on 7-8 April of every year by the scientist of Honey Bee Research and Development Center , RAU, Pusa

The IRRI-IFAD sponsored project on 'Accelerating Technology Adoption to Improve Rural livelihood in Rain fed Eastern Gangetic Plains" is in progress with the collaboration of the Department. On the basis of Farmer's need and Opportunities Assessment For Matching Identified Prototype Technologies, were identified with the consultation of farming community in the project area. With the help of this exercise, three technological interventions were carried out on farmers' field through their participatory mode. These are:

i. Timely Sowing of Wheat Through Zero-Tillage Machine
ii. Quality Protein Maize (Q.P.M) + potato intercropping system
iii. Mushroom Production as an income Generating Enterprise

Specialised Trainings

Apart from the regular training programmes organized by KVKs under the control of Directorate of Extension Education a number of specialized trainings by the specialists is a regular feature of the university. An account of some of the achievements in this category is given below:

Honeybee

AICRP on Honeybee Research and Training has an ideal Apiary along with separate infrastructure at Pusa campus. Every day about 5 to 6 or more visitors are visiting the centre and take interest in starting this profession. Exhibition of stall of the centre was also displayed at various places in Kisan Mela, Goshti etc organized by KVK, NGO and other agencies. Beekeeping with *Apis mellifera* bees is well established and flourishing in the state and neighbouring states. Presently about 6000 beekeepers are engaged in this entrepreneur. They are also extracting varieties of honey, *viz.,* Jamun, Sunflower, Mustard, Drumstick, Moong & Litchi. Beekeepers are migrating their colonies to Jharkhand for extracting Karanj & Niger honey. Some of the progressive beekeepers are also migrating their colonies to Uttar Pradesh, Chattishgarh, Madhya Pradesh and Rajsthan. Majority of beekeepers are employing 3 to 4 persons in their apiary to maintain their colonies to self.

Every year, AICP on Honeybee Research and Training centre, Pusa organising Madhu Mela on 7th and 8th April at Flex House, Rajendra Agricultural University, Bihar, Pusa (Samastipur). During the period under report Madhu Mela was organized on 7th and 8th April, 2005 under the patron of Hon'ble Vice-chancellor, Dr. S.R. Singh, R.A.U., Bihar. On the occasion Sri Rameshwar Singh, Hon'ble member of Electricity and Finance, Government of Bihar was the chief Guest.

About 1200 beekeepers of the state and neighboring state participated in the function. Honey traders, Bank officials and Officials of Tirhut Milk Union also participated in the function. Chief Guest expressed his views about difficulties in sale of honey and suggested that minimum support price of honey should be fixed like other agricultural commodities at national level so that beekeepers can get reasonable price. Hon'ble Vice-chancellor, Dr. S.R. Singh highlighted the scope of beekeeping in Bihar and production potential of *Apis mellifera* beekeeping being about 50 kg honey/colony/year

which was comparatively higher than the colony of other state. Prizes were distributed to progressive beekeepers for promotion of beekeeping and honey production by the Chief Guest.

Second day Sri B.S. Bhadoria, CGM, NABARD, Patna was the Chief Guest, Sri B. N. Jha, AGM, State Bank of India, Zonal office, Muzaffarpur was the Dy. Chief Guest and other dignitaries from different organizations were on dais. The dignitaries acquainted the beekeepers about financial assistance to beekeepers from their organizations and distributed prizes to progressive beekeepers and other agencies engaged in honey and other equipments trading or promotion of beekeeping.

In the function Dr. R. Singh, Chief Scientist & Organizing Secretary state that AICRP (Honeybee) centre, Pusa is playing vital role in popularizing beekeeping with Apis mellifera for self-employment and increasing the crop productivity through honeybee pollination. The centre is regularly organizing beekeeping training on scientific management of honeybees to rural youth and women and advance training for diversification in beekeeping to beekeepers. Other Scientists delivered their talks on production of quality honey for export and seasonal management particularly in dearth period. Beekeepers interacted with Scientists, Traders and Bank officials on problems in management, marketing and financial assistance.

On this Occasion 25 stalls were displayed on beekeeping equipments, valuable beehive products and other activities related to beekeeping. A Souvenir, Madhu Mela 2005 was also released and distributed to participants. Two books entitled "Amazing World of Honeybee" (English) and "Modern beekeeping technique" (Hindi) were also released in the inaugural session of the function by the chief guest.

Trainings on seasonal management of honeybee were imparted to Unemployed youth, U.G. students, P.G. students, retired persons, rural women & beekeepers. The trainings were regularly organized at the Centre under different schemes. Four Hundred Ninety (490) persons were imparted training during the year 2004-05 and details are presented in table-6.

Plant Pathology

Diseased samples brought by the farmers were examined and suitable recommendations were given to them for management. Suitable recommendations were suggested to the farmers to combat diseases on telephone. Radio talks and Television talks were delivered by the scientists at AIR, Darbhanga, AIR, Patna and Doordarshan, Patna. Talks pertaining to integrated diseases, integrated pests, integrated nutrients and integrated crop management were recorded by Etv Bihar and broadcasted. Scientists of concerned projects participated in the workshop, seminar organized by the project coordinator.

Microbiology

Training programmes were organized on mushroom cultivation. A total of 260 farmers and unemployed youths were trained. One hundred seventy one farmers visited the department and collected literature, advice on mushroom, biofertilizer technology.

Impact

Twenty farmers have started mushroom cultivation unit on medium scale from Samastipur, Begusarai, Muzaffarpur, Patna, East Champaran, West Champaran, Saran Siwan.

Dairy Technology

SGIDT is providing technical know how and consultancy services to both Govt. and Private Dairies as and when being sought by them. At present the Institute is

Awareness camp

Demonstration of crops

Farm advisory service

Field visits

Kisan diwas

Training rural women

Technology Transfer Mechanisms

undertaking extension activities in two adopted villages i.e. Sahalichak near Maner & Persa near Naubatpur (30 K.M. away from this Institute). The students and staff of this Institute are providing technical know how for hygienic/sanitary milk production, animal nutrition and necessary scientific information pertaining to cattle management and improving the milk production. The Department of Dairy Extension has also been organizing meeting for the benefit of dairy farmers. As a result of these extension activities, the milk production in the above mentioned village has increased considerably and the villagers were encouraged to adopt dairying as an occupation.

Veterinary and Animal Science

- 7 days training in the field of Veterinay and Animal Sciences was imported to the 120 unemployed rural youths and ladies in 3 batches funded by Nehru Yuva Kendra, Vaishali, Bihar.
- 15 days training in the field of Veterinay and Animal Sciences was imported to the 50 unemployed rural youths in 2 batches (40+10) for self-employment, funded by Balmiki Byaghra Pariyojna, West Champaran, Bihar.
- Two-days training programme was organised at K.V.K., Birauli in the field of "Goat Rearing" on December 13-14, 2004.
- Advisory Services rendered to the livestock owners
- 860 livestock owners were advised regarding scientific housing, feeding, management, disease control, under NATP funded IVLP Scheme at village Pilkhi and adjacent Village. Besides advisory services were also rendered to the farmers of Pusa and adjoining villages right at their doorstep as well as during their visit to the Cattle Farm and Goat units.

FLD on pulse based cropping systems

Three demonstrations on rice-gram and two demonstrations on rice-lentil cropping systems were conducted on farmers field in Naugachia, Sabour and Pirpainty blocks of Bhagalpur districts.

Both rice-gram and rice-lentil cropping systems produced apparently higher grain yields under improved practice over farmer's practice at all the five locations. Improved package of practices raised the yield level of rice in the range of 38.05 to 42.77 per cent over farmers practices whereas, improved method of gram and lentil cultivation increased the yield level in the range between 26.53 to 31.55 per cent over farmers practice.

In one of the demonstration, hybrid rice variety PHB-71 was compared with high yielding variety (MTU-7029) of the Zone. In this demonstration, hybrid rice increased the yield level by 30.6 per cent over MTU-70.29. This shows that hybrid rice has a scope in the regions.

Altogether 9 training programme for a week on "Italian Honeybee keeping" were organized by the department. About 112 (one hundred twelve) youth and farmers participated in Beekeeping training programme. After training 25 youths and farmers have started beekeeping work on large scale in different villages of Bhagalpur, Banka and Purnia district. About 50 farmers are doing Beekeeping work on domestic scale. The training programme organized at this institution has attracted farmers to a greater extent and they visit the campus regularly to solve their problem.

Agricultural Engineering

Demonstration of improved and appropriate farm machinery for mechanization of farm operations is a regular feature of the departments of Farm Machinery and Post

Harvest Technology at College of Agricultural Engineering, Pusa. Several demonstrations of tillage, harvesting, post harvesting implements/ machineries were organized during the crop seasons.

Training programmes were also organized at various places for the farmers of that region on microirrigation technology for fruit and vegetable crops.

Agromet Advisory Services (BAC, Sabour)

Weather forecasts are being received regularly twice a week. During the year 2002-03, the total number of forecasts received was 76 for 273 days. A total of 76 Agromet Advisory Bulletins were prepared and distributed among 30 selected farmers of different villages in Sabour Block of this region. Weather forecasts and agro-advisories were also communicated telephonically to some of the farmers of Bhagalpur, Banka and Munger districts of this region. For immediate benefit of local farmers, All India Radio, Bhagalpur has started broadcast of Agromet Advisories at 18.30 and 19.00 hours every Tuesday and Friday. Weather forecasts and Agro-advisories are also faxed to Annadata, Bihar (Hyderabad) for telecast among the farmers of this region. Among the officials, Agromet Advisory Bulletins were forwarded to Joint Director Agriculture and District Agriculture Officer, Bhagalpur for transmission among the farmers through village extension workers.

4. UNIVERSITY LIBRARY

University Library, Pusa has been the nodal center of agriculture and allied sciences' research in Bihar. The library has been providing up-to-date knowledge resources to its readers.

General Statistics

A. B.

Documents in the Library as on 31.03.2005			53423
Additions during the year			
i.	Books by purchase	350	
ii.	Documents on Gratis	71	
iii.	Bound vols. of Journals	2275	
iv.	Theses	118	

C.

Indian Journals Subscribed in 2004	114

D.

Foreign Journals Subscribed in 2004	43

E.

CD-ROM Databases:	7
i. CAB Abstracts (1984 – Present)	
ii. CROP CD (1973-2003)	
iii. CABPEST CD (1973-2004)	
iv. AGRIS CD (1991-2003)	
v. AGRICOLA (1984-2003)	
vi. CABSAC (1973-1997)	
vii. Food & Human Nutrition CD (1975-2004)	

F.

Circulation of books:	
i. Books issued	3693
ii. Books returned	3772

G.

No. of Readers registered during the year			**351**
i.	Teachers/Scientists	95	
ii.	PG Students	132	
iii.	UG Students	71	
iv.	Staff	53	

H.	**No. of visitors during the year**		**10812**
	i. Teachers/Scientists	1632	
	ii. Students and others	9180	
I.	**No. of Photocopies produced**		**28603**
J.	**Opening hours**		**9.00AM to 5.00PM**

K. Achievements:

i. Data entry of Library catalogue.

ii. Digitization of Ph.D. and M.Sc. (1990 onwards) theses abstracts and made available to readers.

iii. LAN in University Library premises.

iv. Six Computer nodes for surfing INTERNET and CD-ROM Data bases provided.

v. CD-ROM Database Reference service to readers.

L. Projects in progress for automation of University Library:

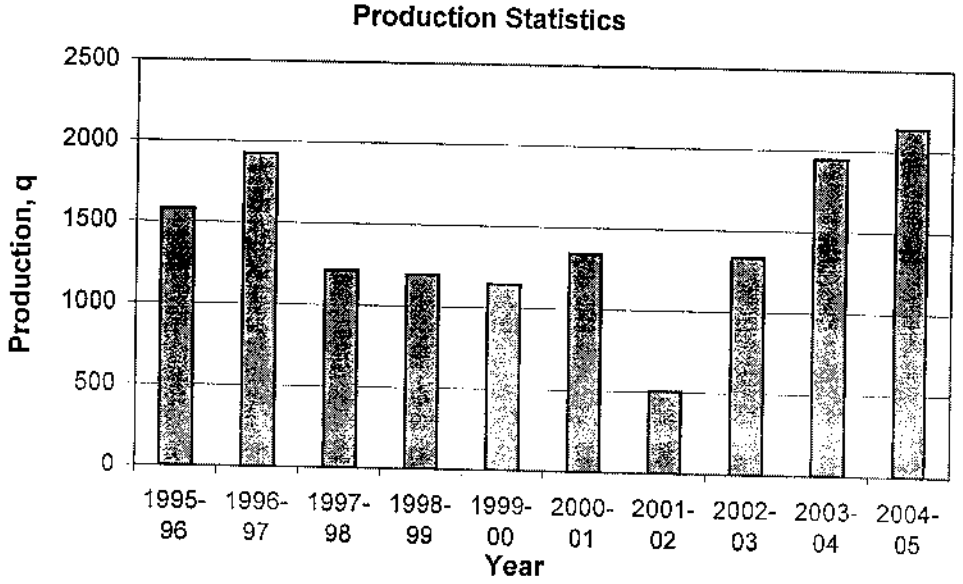
i. Automation of circulation systems.

ii. Bar-coding

5. PUSA FARM

Annual Account of Revolving Fund

Month	Receipt	Expenditure
O.B. on 1.4.04	177146	-
Apr, 04	664200	7117550
May, 04	136800	122236
Jun, 04	20800	127289
Jul, 04	60000	45271
Aug, 04	1114504	773160
Sep, 04	83000	70848
Oct, 04	59850	198247
Nov, 04	594400	619619
Dec, 04	259000	169684
Jan, 05	202000	129691
Feb, 05	-	93287
Mar, 05	989620	968439
C.B. on 31.3.05	-	325994



Achievements

- Full mechanization of wheat cultivation.
- Partial mechanization of rice cultivation.
- About half of the total cultivated area has been manured with Susbania as well as mung bean.
- About 150 acres of land has been leveled with the help of scraper and water level.
- More than Rs. 1.25 lakh has been earned through fish culture in rice-fields.
- Record production of rice has been achieved despite severe draught (which damaged about 70% of crop in nearby area).
- Thousand s of plants like Litchi, Mango, Sagwan have been planted in different farms.

Seed Production

During kharif season rice and arhar were grown for seed production as foundation and certified seeds. Seven varieties of rice were grown in the farm. A total of 396.05-quintal rice seeds were produced as foundation and certified seeds. 30.64 qnt of foundation seed of arhar (Pusa-9) produced besides standing crop fodder auction fetched Rs.85050=00.

Rabi Season

Four wheat varieties UP 262 (F/S) HUW-234(C/S), HP 1761 (C/S), PBW 443 (C/S) were grown from Breeders and foundation seeds and the respective production was 11.80 q, 35.10 q, 21.35 q and 8.06 q was produced.

Besides these truthfully lebelled seeds of Gram (C-235)-15.15 q, Lentil- a) $L_{9\text{-}12}$ 5.16 q (b) Arun- 2.90 q, Linseed (T-397) 1.33 q, Ray (Pusa bold)-0.66 q were produced during the year under report.

Financial expenditures during the year 2004-05

Opening balance on 1.4.04 (Rs.)	Receipt during the year (Rs.)	Total Receipt (Rs.)	Expenditure during the year (Rs)	Closing balance on 31.3.05 (Rs.)
21,648.20	13,20,903.56	13,42,551.76	12,47,864.32	94,687.44

6. ANNUAL ACCOUNT

FINANCIAL YEAR 2002-2003

Receipt		
S. No.	**Particulars**	**Amount**
1	State Non-plan	298499100.00
2	State plan	61706000.00
3	ICAR	84316950.00
4	ICAR Plan	17994344.00
5	University Receipt	7765010.73
6	Misc. Scheme	8691728.94
7	Other Scheme	6960518.64
8	Revolving Fund	15187820.49
9	Students Fund	491018.25
10	Group insurance Scheme	1905225.88
	Total	**503517716.93**
	Add Opening balance	**136194309.54**
	Grand Total	**639712026.47**

Expenditure		
S. No.	**Particulars**	**Amount**
1	State Non-plan	284924109.04
2	**State plan**	47167095.43
3	Special Assistance	26000.00
4	ICAR Scheme	87630985.98
5	ICAR Plan	9225728.06
6	Misc. Scheme	10226230.11
7	Other Scheme	8584898.11
8	Revolving Fund	13741257.89
9	Students Fund	632984.10
10	Group Insurance Scheme	1169883.00
11	Remittance Adjustable in next year	38637111.93
	Total	**501966283.65**
	Closing balance as on	**137745742.82**
	Grand Total	**639712026.47**

FINANCIAL YEAR 2003-2004

Receipt		
S. No.	**Particulars**	**Amount**
1	State Non-plan	326562828.00
2	State plan	73525000.00
3	ICAR	76919822.00
4	KVK	26721100.00
5	Misc. Scheme	9111656.78
6	Other Scheme	6926279.72
7	Revolving Fund	14148754.34
8	Students Fund	3828190.18
9	Group insurance Scheme	3377830.69
10	University Receipt	36499512.66
	Total	**577620974.37**
	Add Opening balance	**137745742.82**
	Grand Total	**715366717.19**

Expenditure		
S. No.	**Particulars**	**Amount**
1	State Non-plan	336379094.43
2	State plan	44822083.59
3	Special Assistance	289030.00
4	**ICAR Scheme**	65186720.26
5	**NATP**	19236816.47
6	ICAR Plan	16666558.70
7	Misc. Scheme	12346297.27
8	KVK	27827016.38
9	Other Scheme	4296075.47
10	Revolving Fund	15826015.44
11	Students Fund	1573800.07
12	Group insurance Scheme	3750063.30
13	Remittance Adjustable in next year	13861686.20
14	University receipt	2714818.64
	Total	**564776076.22**
	Closing balance as on 31/03/03	**150590640.97**
	Grand Total	**715366717.19**

7. SPORTS AND GAMES ACTIVITIES

The games and sports has its own placing in academic institution in order to induce team sprit in tomorrow citizen in India besides inculcating habit of keeping them physically fit and healthy. As a matter of fact sports are essential part of education. Indoor/Outdoor Championship Tournament to promote sports spirit among the students. Keeping in view the glorious tradition of the University its Games & Sports Society organized Annual Sports meet that is.

1.	Table Tennis	-	(a) Single	Boys & Girls
			(b) Doubles	
2.	Volley Ball	-	Boys and Girls	
3.	Badminton	-	(a) Single	Boys & Girls
			(b) Double	
4.	Carrom	-	(a) Single	Boys & Girls
			(b) Doubles	
5.	Foot Ball	-	Boys	
6.	Cricket	-	Boys	

Participation at National Level

University team of selected players in Inter College Tournaments of this University viz. Volley Ball, Badminton and Table Tennis participated in 6th All India Inter Agricultural University (ALLAU) Games & Sports meet, 2005 held at KAU, Kerala from 16-19 March'05.

The Volley Ball Team performed well and reached up to Quarter Final Round.

Debating Society

The University actively participated and performed their best ability in organizing Elocution Competition. In the year 2004-05 students of this University were participated in the East Zone Elocution Competition held at RAU, Pusa in which two students namely Ms. Rashmi, M.Sc. (Home Science) secured 1st position and Mr. Rupesh Ranjan, B.Sc. (Ag.), T.C.A., Dholi 2nd position.

At National Level both students participated in National Level Elocution Gompetition held at Pune, MPKV, Rahuri, M.S. from 16-18 Feb.'2005 in which Miss Rashmi got 3rd position.

BAC

During the year 2004-05 the sports and Games activities of Bihar Agricultural College, Sabour is as follows.

The student of Bihar Agricultural College, Sabour participated in Inter College Cricket tournament of Rajendra Agricultural held at B.V.C., Patna from 25-4-05 to 30-4-05 and successfully played and got winner shield received from R.A.U.

The Football Inter College tournament was scheduled to be held in the month of May'05 from 11-5-05 to 13-5-05 at Bihar Agricultural College, Sabour the foot-ball team of Bihar Agricultural College, Sabour played successfully and also obtained the winner shield from R.A.U.

For conducting inter Class Cricket tournament in the month of Nov.'05 from 20-11-05 to 23-11-05 total 56 (Fifty Six) players played a successfully match among the student of different semester in the tournament and prized were disbursed among the players by Assoc. Dean cum Principal, B.A.C., Sabour.

In the coming semester calendar 2005-06 as per agenda of the proceeding of Annual meeting of Games & Sports, Rajendra Agricultural University held at B.V.C., Patna it is decided to organize sports week in the month of Jan.'05 at Bihar Agricultural College, Sabour the students of the college is practicing the above Sports activities.

8. DIRECTORATE OF ADMINISTRATION

Roster of Teaching and Non-Teaching posts

Roster clearance of the posts of Asstt. Professor-cum-Jr. Scientist has been obtained from the Govt. of Bihar. Whereas, for non-teaching staff roster clearance has been done for the posts of Helper/Cleaner, Lab Attendant, Store Clerk, Cashier, Duplicating Operator, Technical Assistant and Mechanic of S.G.I.D.T., Patna and the clearance of other posts of different units of the University is awaited from the Govt. of Bihar.

Appointments

Large number of posts of Teachers/Scientists in Schemes/Units are lying vacant, out of which the process of recruitment of Junior Scientist/ Asstt. Professor in ICAR schemes has been initiated. The Advertisement were made but interview could no be held due to directives of the Hon'ble High Court.

The advertisement for filling of different posts of teaching & non-teaching staff of KVKs has been made but interview for most of the posts are to be done. The non-teaching posts of S.G.I.D.T., Patna has been advertised but interview is to be made.

Appointment on compassionate ground to the dependents of deceased employees have been given on 06 (Six) Class-III and 05 (Five) Class-IV posts.

Promotion

The promotion of Teachers/Scientists under Career Advancement Scheme (C.A.S.) has been made. Altogether 289 teachers/scientists have been promoted out of which 140 have been promoted in the cadre of University Professor-cum-Senior Scientist / (22) in the cadre of Assistant Professor-cum-Junior Scientist (Selection Grade) (22) / (25) in the cadre of Assistant Professor-cum-Junior Scientist (Senior Scale).

Cadre promotion of non-teaching staff is pending due to roster clearance, but the benefit of A.C.P. to non-teaching staff has been given to eligible candidates which included 87 Technical Staff, 13 Typist and 3 other ministerial staff of University Hq. Similarly in other units also, this A.C.P. scheme has been implemented. Revised Pay Scales for Teachers/Scientist as well as Non-Teaching staff has been implemented.

Contractual Engagement of Teachers and Officers in the University

Due to acute shortage of Faculty Members in different Colleges and Departments many retired teachers have been appointed on contractual basis, so that the teaching of various degree programme may not suffer.

On account of superannuation of some senior Officers of the University appointment of Principal, BVC, Patna, D.R.I.-cum-Dean (PGS), Director, S.R.I., Pusa and Comptroller was made for a period of six months.

Recruitment

1. Reservation Roster for the following posts under Non-Teaching of SGIDT, Patna were cleared by the Dept. of Agriculture, Govt. of Bihar.

    (a) Technical Assistant
    (b) Duplicating Operator
    (c) Cashier
    (d) Store Clerk

(e) Laboratory Attendant
(f) Helper/Cleaner
(g) Mechanic

2. Reservation Roster in respect of Jr. Scientist-cum-Assistant Professor of College of Home Science and Faculty of Basic Sciences & Humanities were cleared by Dept. of Personal and Administrative Reforms, Govt. of Bihar.
3. Altogether 62 posts of Training Associates under KVKs were advertised vide Adv. No. 1/2004 dated 11-08-04.
4. Altogether 135 posts of Junior Scientists-cum-Assistant Professor/Assistant Professor-cum-Junior Scientist under AICRP, Plan and Non-plan were advertised vide Adv. No. 3/2004 dated 20-11-04.
5. Altogether 19 posts of Technical and Non-Technical under SGIDT, Patna were advertised vide Advt. No. 4/2004 dated 24-11-2004.
6. Altogether 147 posts of Non-Teaching under KVKs were advertised vide Advt. No. 2/2004 dated 04-11-2004.
7. One post of Artist-cum-Photographer was filled up on the directive of Hon'ble High Court vide CWJC No. 11598/99.
8. One post of Human Compounder was filled up on the directive of Hon'ble High Court vide CWJC No. 12551/99.
9. Altogether 7447 application forms for Non-Teaching and 2204 for Teaching were sold during the year under report.

Awards

i. Dr. A.P. Singh, Chief Scientist-cum-University Professor, Department of Soil Science was honoured with "S.N. Ranade Memorial Award" with a cash prize or Rs. 1 lakh for his significant contribution in the field of Micro-Nutrients.

ii. Dr. R.K. Sohane, Training Organiser, KVK Khodabandpur was honoured with "Swami Sahajanand Saraswati Extension Scientist /Worker" award by ICAR with a cash prize of Rs. 25000/- and a citation.

iii. Dr. K.R. Maurya, Dean Agriculture was honoured with Rajendra Prasad Award for best Scientific hindi Writing" for his book on "*Latter Wali Sabjiyon kee kheti*" (in Hindi) by ICAR with a Cash prize of Rs. 50000/-.

iv. Dr. Devendra Singh, Officer-in-Charge, Farm for his contribution in the field of Farm production.

v. Dr. (Mrs.) Usha Singh, Associate Professor, College of Home Science for her contribution in the field of Quality Protein Maize and Infant Food.

vi. Dr. S.P. Singh, Associate Professor, Department of Horticulure, T.C.A. Dholi for his contribution in the field of Turmeric Seed Production.

vii. Kumari Rashmi, a student of College of Home Science for her Excellence in the field of Debate.

viii. Miss. Monika Sinha, a student of T.C.A., Dholi for her Excellence in the field of Chess.

In addition to above Dr. B. K. Singh, Retd. Regional Director, A.R.I. Patna; Dr. J.P. Upadhayaya, Senior Scientist-cum-Assoc. Professor, T.C.A., Dholi were also honoured by the University for their valuable contributions in their respective fields.

9. LIST OF PUBLICATIONS

Research Papers

1. Kumar, N. and Singh, R. (2004). Queen production potential under natural conditions in Italian and Indian honeybees. *Shashpa*. 11(2): 165- 170.
2. Kumar, N. and Singh, R. (2005). Relative abundance of Apis spp. on rabi season Sunflower (*Helianthus annus* L.). *J. ent. Res.*, 29(1) : 65-69.
3. Kumar, N. and Singh, R. (2005). Relative abundance of honeybees and nectar sugar concentration Linseed flower (*Linum usitatissimum*). *Enviornment and Ecology*, 23(2): 374-380.
4. Kumar, N. and Singh, R. (2004). Relative abundance of honeybees on *toria* bloom (*Brassica campestris var. toria*). *Shashpa* (In press).
5. Kumar, N. and Singh, R. (2004). Relative abundance of honeybees and nectar sugar concentration safflower (*Carthamus tinctorius*). *PMEZ.* (In press).
6. Kumar, N. and Singh, R. (2004). Relative abundance of honeybees and nectar sugar concentration in Niger (*Guizotia abyssinica* L.), *Annals of Plant & Soil Research* (Accepted).
7. Jha, M.N. 2004. Cyanobacterial diversity in pesticide burdened soil. In : National Symposium on Biology and Biodiversity of Freshwater Algae. CAS in Botany, University of Madras, Chennai, Sept. 8-9.
8. Jha, M.N. 2004. Microbial diversity in pesticides polluted soils. In : National Conference on Biotech. IGIB, New Delhi. Oct. 13-15.
9. R.P. Sharma, R. N. Jha and K. R. Raman (2004). Diversification of rice-wheat cropping system for sustainable production and soil health. Paper presented in National Symposium on Alternate Farming System; Enhanced income and Employment Generation options for small and marginal farmers held at PDCSR Modipuram, Meerut from 16-18, Sept, 04.
10. R. P. Sharma, S. K. Pathak, M. Haque and K. R. Raman (2004). Diversification in traditional rice based cropping system for sustainable production. *Indian Journal of Agronomy*, 49 (4): 218-222.
11. Jha, M.N. 2004. Feasibility of soil based cyanobacterial biofertilizer. *Asian. J. of Microb. Biotech. and Environ. Sci.* 6 (1) : 21-24.
12. Jha, M.N.; Prasad, A.N. and Misra, S.K. 2004. Effect of micronutrients on diazotrophic cyanobacteria and yield of paddy. *Indian Journal of Microbiology*. 40 (3) : 1-4.
13. Sharma, S.G.; Jha, M.N. and Dayaram 2004. Degradation of paddy *Pleurotus* sp. *Oryza*. 40 (1-2) : 34-35.
14. Dayaram and Jha, M.N. (2004). Cultivation of Button mushroom in chicken manure based compost in Bihar. *J. Mycol. Pl. Pathol.* 34 (2) : 185-187.
15. Dayaram, M. Kumar, S. Sharma and O.P. Chaturvedi (2004). Management of Shisham Wilt (*Fusarium solani* f.sp. *dalbergiae*). *Indian J. Agroforestry*, 6 (2) : 67-69.

Popular Article

1. Ramashrit Singh *Evam* Neeraj Kumar. (2003). *Masala wali fasle Madhumakiyon ke bhojan shrote. Bihar mein Masala Faslo ki Aadhunik takniki.* RAU, Bihar: 39-40.
2. Dayaram; Jha, M.N. and Kumar, M. (2004). Impact of training on mushroom cultivation in Bihar. Kheti Duniyan, 24-25.
3. Jha, M.N.; Misra, S.K. and Prasad, A.N. (2004). Cyanobacteria- A wonderful gift of nature, *Science and Culture*. May-June, p. 182-186.
4. n;kjke] ,e- ,u- >k ,oa osnjRu dqekj ¼2004½ xfeZ;ksa esa lkh e'k;e mxk;saA d`"kd lans'k] 71&72A

Technical Bulletin:

1. Agrawal, M. and Singh, R. (200). Amazing world of honeybee, R.A.U., Bihar, Pusa: 45p. (In English).
2. Singh, I.P; Singh, R. and Choudhay, D.K. (2005). Modern beekeeping technique, R.A.U., Bihar, Pusa: 103p. (In Hindi)
3. Souvenir, 2005 on Madhu Mela. (In Hindi)
4. Chand, H. and Singh, R. (2005). *Adunik Madhumakhi Palan*, Kalyani Publishers, Ludhiana: p (In Hindi).

Review/Concept Paper

Jha, M.N. and Mishra, S.K. 2004. Transgenic diazotroph : An Indian Prospective. *Indian J. of Biotechnology*. **3** : 502-510.