Directorate of Research, SKNAU, Jobner

About the Directorate

The Directorate of Research was established in November 2013. There are seven research stations encompassing three agro-climatic zones under the administrative control of Directorate of Research, SKNAU, Jobner. These include Rajasthan Agricultural Research Institute (RARI) at Durgapura, Jaipur, two Agricultural Research Stations located at Navgaon (Alwar) and Fatehpur-Shekhawati (Sikar) and four Agricultural Research Sub-Stations at Tabiji (Ajmer), Kumher (Bharatpur), Gonera - Kotputli (Jaipur) and Diggi (Tonk). Rajasthan Agricultural Research Institute, Durgapura is the main Agriculture research station of the University. There are 17 short and long term AICRP and AINP projects operating in Directorate of Research. The research grant mainly comes from ICAR & matching grant from the state govt. in proportion of 75:25. Out of these 17 projects, twelve are operating at Rajasthan Agricultural Research Institute, four at SKN College of Agriculture, Jobner and one at ARS Fatehpur-Shekhawati. The research is being conducted on most of the crops, fruits, vegetables and other crops suitable for this region. About 879.43 ha land is available in different units of the University to conduct research and for seed production.

Mandates

- Basic, strategic and anticipatory research in field and horticultural crops for enhanced productivity and quality.
- Research in frontier areas to develop resource use efficient integrated crop management technologies for sustainable agricultural production system.
- Breeding and evaluation of new crop varieties and hybrids in wheat, barley, pearlmillet, groundnut, pulses, and seed spices for the zones of SKNAUSA.
- Development of low cost agro-technologies for agricultural and horticultural crops and cropping systems.

Objectives

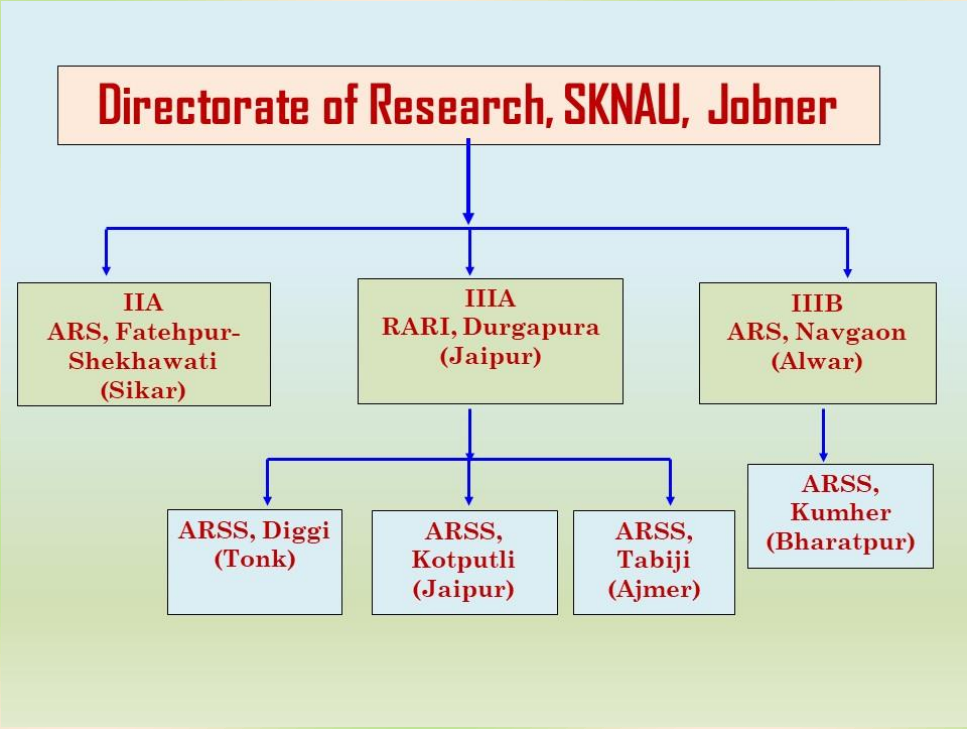
- To plan, coordinate and monitor the Agroclimatic zones need oriented agricultural research
- To develop appropriate production technologies for sustainable production

- To develop linkages with national and international organizations for research and various current aspects
- To extend consultancy services.

Research setup

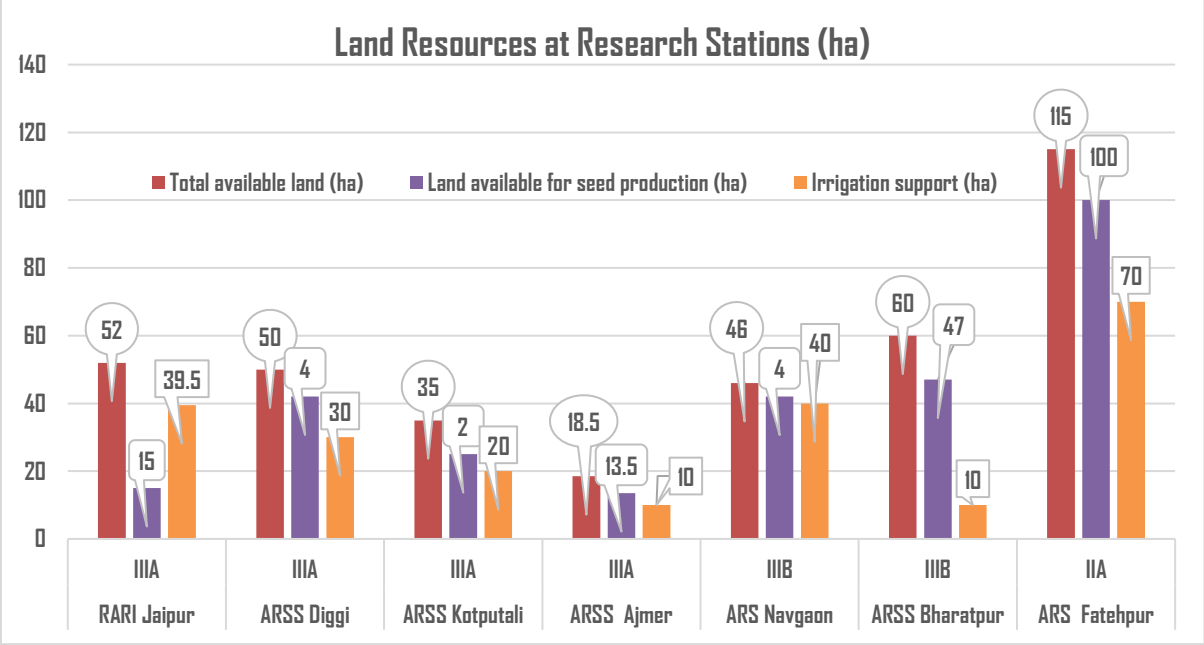
The territorial jurisdiction and responsibility of this University extend to the districts of Jaipur, Sikar, Alwar, Dausa, Tonk, Ajmer, Bhartpur and Dholpur which comprises about 16 percent geographical area of the state. Agricultural research needs time bound solutions of emerging challenges, while re-orient strategy as multidisciplinary approach to develop the technology which is climate resilient, acceleration of technology development with use of modern biotechnological tools, to minimize the post –harvest losses, provide balanced nutrition through accelerated green fodder production to live stocks, use of modern agro-meteorological and remote sensing tools, and integrating conservation/organic farming. University jurisdiction covers three agro-climatic zones of the Rajasthan.

- Plain of inland drainage (IIA)
- Semi-arid eastern plain zone (IIIA)
- Flood prone eastern plains (IIIB)



Land Resources

The land area is available at different research units of SKNAU, Jobner for research experiments and production of quality seed is as follows:



The major crops of the state, viz, Wheat, Barley, Pearl Millet, Chickpea, Mungbean, Moth bean, Cowpea, Groundnut, Cluster bean, Mustard, Taramira, Seed Spices and majority of vegetable crops are grown in the regions under jurisdiction of the university. Thus, the three agro climatic zones under the jurisdiction of the university have potential to address the needs of the state with respect to food crops, vegetables and seed spices.

At present 17 ICAR funded All India Coordinated Research Projects (AICRPs) and the State Government funded long term projects are already in vogue and dedicated to the needs of the three zones along with several ad-hoc projects sponsored by various prestigious funding agencies . Besides the basic mandates, the Directorate is on its way to finalize newer mandates in light of the State Agricultural Policy of the Dept of Agriculture, GOR and new frontier areas of R & D in agriculture covering various aspects of Precision Agriculture, Conservation Agriculture, Secondary Agriculture and Specialty Agriculture etc.

(b) Profile of Director with Picture

Dr. B.L. Kakraliya, Director Research, SKN Agriculture University, Jobner has Born on 5th May 1964 at village Raghunandanpura, District-Jaipur (Raj.). He has awarded his M.Sc. (Botany) in 1986 and Ph.D. in 1990 from University of Rajasthan, Jaipur.

Dr. Kakraliya started his professional career in September, 1988 as Sr. Tech. Asstt. (Plant Physiology) in Seed Technology Research Project at A.R.S. Durgapura, Jaipur. Then he joined as Assistant Professor in May, 1996 at A.R.S. Mandore, Jodhpur in AICRP-Pearl Millet Project. Dr. Kakraliya was transferred to SKN College of Agriculture, Jobner in October, 1996. He was promoted as Associate Professor in 2008 and Professor in 2011. He served as Professor & Head of the Department of Plant Physiology (2013-2019). He was assigned the responsibility of Director, Extension Education (Nov. 2019 - Aug. 2020) before joining on the post of Director, H.R.D, SKNAU Jobner and form 07.06.2023 He is Director Research at SKN Agriculture University, Jobner.

He has been associated in teaching for last 26 years and taught almost all the courses of Plant Physiology at UG, PG and Ph.D. levels. He has specialization in Abiotic Stress Physiology &

Seed Physiology. He guided 24 M.Sc. students as Major Advisor and acted as a member in the Advisory Committee of more than 60 students of M.Sc. and Ph.D. of other department.

He has published 70 research papers in International and National journals of repute, wrote 6 books and recipient of National award on Hindi Divas by Hon'ble Minister of Home Affairs, Govt. of India, several articles, book chapters. He has participates in 47 national seminar/workshop/conference/symposium and 5 international conferences and attended six summer/winter schools. He is life member of five academic societies and Fellow of three academic societies i.e Indian Society for Plant Physiology, Indian Botanical Society and Indian Society of Seed Technology.

He is Presently Vice-President of Indian Society for Plant Physiology and served as a Zonal Secretary for two term of Indian Society for Plant Physiology of central zone and organized one seminar at SKNCOA, Jobner. He also served as convener and members of various committees of university viz. Academic Council, Research Council, Committee of courses, Selection committee etc. He is member of Board of Management of SKRAU, Bikaner and SKNAU, Jobner and member of selection committee for teachers and officers of Agriculture University, Kota, SKRAU & RAJUVAS, Bikaner.

S. No.	Name of the Scientist	Designation	Email ID
1	Dr. B.L. Kakraliya	Prof. & Director Research	blkakralya.pphy@sknau.ac.in
2	Dr. D.K. Jajoria	Assoc. Professor (Agronomy)	dineshjajoria.agro@sknau.ac.in
3.	Dr. Roshan Choudhary	Dy. Director Research	roshan.agro@sknau.ac.in

(c) Details of former Directors

S. No.	Name of Director	From	To
1.	Dr. K. Ram Krishna	13.11.2013	06.01.2015
2.	Dr. N.K. Sharma	07.01.2015	06.10.2015
3.	Dr. (Mrs.) Neelam Yadav	07.10.2016	01.07.2016
4.	Dr. V.K. Yadav	02.07.2016	31.07.2019

5.	Dr. A.K. Gupta	31.07.2019	03.07.2020
6.	Dr. M.L. Jakhar	04.07.2020	07.06.2023

(d) Seed Production

Breeder seed Production (q)

S. No.	Crop	2017-18	2018-19	2019-20	2020-21	2021-22
1.	Wheat	1072.29	1840.00	1499.30	1622.41	1955.33
2.	Barley	718.29	802.22	616.41	417.39	306.20
3.	Gram	326.08	310.17	377.40	252.95	68.04
4.	Field pea	0.50	10.36	8.66	-	2.50
5.	Lentil	2.13	42.71	66.05	7.00	-
6.	Taramira	3.50	0.80	5.91	7.91	4.00
7.	Mustard	0.40	0.60	-	-	-
8.	Coriander	6.00	30.24	25.81	4.40	-
9.	Fenugreek	36.66	-	3.35	8.41	-
10.	Fennel	1.75	-	-	-	-
11.	Mungbean	81.49	55.79	75.68	125.90	75.91
12.	Urdbean	20.00	-	8.50	13.00	14.10
13.	Cowpea	4.65	6.86	11.48	7.95	12.38
14.	Cluster bean	134.25	160.99	101.12	112.50	103.17
15.	Groundnut	96.90	69.60	125.63	118.30	329.08
16.	Pearlmillet	0.40	0.60	11.28	5.05	0.70
	Total	**2505.29**	**3330.29**	**2936.58**	**2703.17**	**2871.41**

TL seed Produced by different units of SKNAU, Jobner (q)

S. No.	Crop	2017-18	2018-19	2019-20	2020-21	2021-22
1.	Wheat	95.38	181.74	438.43	450.61	514.86
2.	Barley	174.61	227.26	744.85	799.03	738.89
3.	Gram	-	107.45	93.40	23.69	471.46
4.	Lentil	-	-	2.30	-	21.81
5.	Taramira	38.38	78.30	69.31	4.46	41.05
6.	Mustard	640.27	1053.83	1055.69	450.76	1330.33
7.	Coriander	-	4.50	0.36	-	2.87
8.	Fenugreek	13.78	73.70	38.12	22.98	65.69
9.	Fennel	-	10.50	21.00	-	25.23
10.	Mungbean	14.03	115.67	46.57	72.64	81.53
11.	Urdbean	64.00	27.00	10.80	-	-
12.	Cowpea	24.95	2.42	4.50	15.53	-

13.	Cluster bean	105.95	113.59	140.70	284.09	153.37
14.	Groundnut	-	5.10	1.34	-	16.30
15.	Pearlmillet	-	-	-	4.75	-
16.	Sorghum	14.00	9.00	-	-	-
17.	Mothbean	0.47	-	-	-	-
18.	Sesame	16.85	4.50	14.50	5.20	0.20
	Total	**1202.67**	**2014.56**	**2681.87**	**2133.74**	**3463.59**

(e) Major Research Projects completed with significant output and achievements

A total of 29 RKVY projects have been sanctioned and completed at various units of SKNAU, Jobner funded by state government under Rashtriya Krishi Vikash Yojana. The salient achievements of these projects are given below:

1. **Establishment/strengthening of seed processing and storage unit in different research stations of SKNAU, Jobner.**

   Eight seed processing units were established at ARS Fatehpur, ARS Navgaon, SKNCOA Jobner, RARI Durgapura (02), COA Lalsot, ARSS Kumher and ARSS Gonera. Five godowns were constructed at SKNCOA Jobner, ARS Navgaon, ARSS Diggi, ARSS Kumher, ARSS Gonera.

   Photographs:

Processing Plant ARS, Fatehpur (Sikar)

Processing Plant ARS, Fatehpur (Sikar)

Seed Godwon and Processing Plant at ASRSS, Gonera-Kotputli

Seed Godown and Processing Plant SKNAU, Jobner

Portable Processing Unit RARI Durgapura

2. **Development of infrastructural facilities and mechanization/ modernization of farms at SKN College of Agriculture, SKNAU, Jobner**

   Under this project water harvesting structures at Kariya Farm & Agronomy Farm, SKNCOA, Jobner and around 4 km gravel road at Agronomy Farm, SKNCOA, Jobner were constructed. Micro irrigation system, drip irrigation system and sprinkler system were established at Agronomy Farm, SKNCOA, Jobner .

Land leveler purchased under project

Drip irrigation system installed at SKNCOA, Jobner

Sprinkler system installed at SKNCOA, Jobner

Water harvesting constructed at farm of SKNCOA, Jobner under this project

3. Establishment of ICT enable Agriculture Technology Knowledge Centre (ATKC)

Through this project ATKC building was constructed at RARI, Dirgapura, Jaipur. The ATKC utilize for providing agricultural information and advice to the farmers, growers, entrepreneurs, researchers and personnels of agricultural industries.

4. Back yard poultry production for raising farm income of small, marginal and landless labours under semi arid conditions of Rajasthan.

Backyard poultry unit at poultry farm, SKNCOA, Jobner with zero input was established under this project. 15 one day training organized in which 489 small, marginal farmers and landless labours participated and about 52538 chicks were distributed to farmers.

	
Brooder house constructed under Backyard Poultry Project	Hatchery building constructed under Backyard Poultry Project

Day old chicks produced at hatchery under Backyard Poultry Project

Rearing of chicks at backyard of small farmer under Backyard Poultry Project

5. **To establish demonstration unit of Sirohi goat for raising farm income of small, marginal and landless labours under semi arid condition of Rajasthan.**

A demonstration unit of sirohi goat was established at Department of LPM, SKNCOA, Jobner. Total of 98 bukcs of amounting Rs. 7.36 lakhs have been distributed to small, marginal farmers and landless labours under semi-arid condition of Rajasthan. 11 one day training progammes on Sirohi goat production organized in which 501 small, marginal farmers and landless labours participated.

Feed Godown and Laboratory constructed under this project

Goat sheds constructed under this project

6. Agriculture Technology and Management Quality Improvement Centre (ATMQIC).

Under this proejct ATMQIC building with educational museum, training hall, ICT hub station, office for managers and trainees were established. Water harvesting structures with the capacity of 10.10 lakhs liter were also constructed. SMART class-room, Kisan Call Centre with ICT enabled Educational kit, E- Kiosk, ICT Lab with video conference facility were also established and maintained. Installation of automatic weather station, micro irrigation, solar water lifting system with generator were procured and installed. Soil & water testing mobile van was also procured.. Total 42 trainings programmes to develop awareness in the farmers, youths and others.

Building of ATMQIC

Construction of water harvesting structure

Micro irrigation, solar water lifting system with generator and inverter

Purchase of soil and water testing mobile van

7. Establishment of Tissue culture set up for capacity building development of regeneration protocol and micro propagation of arid zone crops.

Established tissue culture laboratory and standardize the regeneration protocol of aloe, pomegranate, glyricidia, guggal, seed spices etc. Imparted training of tissue culture techniques to the graduate and post gradute students of the university.

Tissue Culture Laboratatory

Culture Room

Horizontal Autoclave

Water Distilation Unit

Multiple shoots and medium callus induction in coriander shoot apex


Callus and Multiple shoot induction in fennel shoot apex explants


Callus Induction in Fenugreek


Shooting in Fenugreek


Hardening of Aloe vera

8. Evaluation of indigenous seed treating material for managing disease of seed spices.

Under this project seed samples of seed spices were collected from different districts of Rajasthan state. Seven species of five fungal genera were Identified and confirmed from the ITCC, IARI, New Delhi.

- Kota, Baran, Bundi, Jhalawar, Sirohi, Jalore, Nagour, Ajmer, Alwar, Bharatpur, Jaipur and Sikar districts were surveyed to collect seed samples of Coriander, Cumin, Fennel and Fenugreek during the year 2014-15 and 2015-16 and information about indigenous materials used by farmers were also collected.


- Isolation, purification and Identification of pathogens associated with seeds collected from various districts of Rajasthan was done by two methods 1) Blotter method 2) Agar method

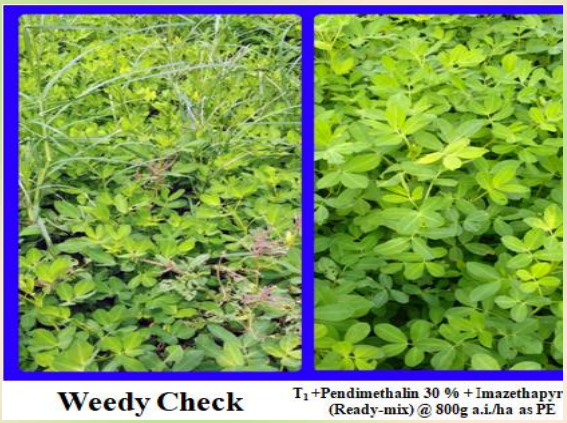

- Seven species of five fungal genera were Identified and confirmed from the ITCC, IARI, New Delhi as under:


9. **Validation and Post Harvest Technology for Dragon Fruit and Fig under semi and conditions of Rajasthan.**

   Orchard of dragon fruit & fig equipped with drip irrigation system were established at Horticulture Farm, SKNCOA, Jobner. One on campus training was organized at Deptt. of Horticulture, SKNCOA, Jobner in which 28 women from rural areas were participated.

10. **Management of Specific Weeds in Resilience with Climate Change in Major Crops of Semi Arid Ecosystem.**

    Under this project a weed museum established at RARI, Durgapura, Jaipur and more than 1000 visitors including farmers, government officials, students, scientists, etc have visited this museum. Seven research trials to manage most problematic specific weed in a particular crop were conducted at the identified hot spots in zone IIIa.



Research trials on Groundnut at farmers field

"Weed Museum" has been established in the Division of Agronomy at Rajasthan Agricultural Research Institute, Durgapura, Jaipur.

11. Micro irrigation management for conserving vulnerable water resource with higher crop water productivity.

Installation of sprinkler irrigation system, fully automated drip irrigation system & weather station were done at Agronomy Farm, SKNCOA, Jobner. More than 400 farmers of nearby villages got training to popularize micro-irrigation systems for realizing more crops per drop.

12. Organic farming for sustainable crop production and better health.

Under this project experimentation on *kharif* and *rabi* crops viz. groundnut, mungbean, sesame, pearlmillet, wheat, gram, mustard etc. on agronomical and plant protection aspects have been conducted to develop different recommendations for organic cultivation of different crops. Organic block of 1.0-hectare area has been registered in Rajasthan State Seed & Organic Production Certification Agency, (RSSOPCA), Pant Krishi Bhawan, Jaipur and organic crops has been cultivated every year on this block. A total of 115 demonstrations were conducted on farmer's fields.

Certified Organic Block

Capacity building programme of scientists and other stakeholders

13. Augmentation of entrepreneurship for rural people through processing.

The major achievements of this project includes development of post harvest technology laboratory at SKNCOA, Jobner. Various trainings of three days were organized in which about 100 farmers were participated.

Introduction of the project and briefly information about training by Dr. Upendra Singh, Principle Investigator.

Inaugural of Booklet and pamphlet during training

Training Activities

Shredded product of Aonla by shredding machine

Extraction of Aonla juice by Hydraulic Press Machine

Developed products by trainees during training session

Trainees preparing Aonla processed fruit products

Practical session during training

Preparing new Aonla processed product by trainees during training session

Aonla Murabba prepared by trainees

Dehydrated Aonla Candy

New product development (Aonla Pachak Goli)

14. Conservation, improvement & production performance of Indigenous Milch Breeds of cows under semi-arid conditions of Rajasthan.

Under this project herd of Gir was established. Large number of small, marginal farmers and landless labours have been demonstrated gir cow dairy to make them aware about Gir cows production. Semi automatic machine for milk packing and storage was installed at dairy farm, SKNCOA, Jobner.

15. Mother Plant Nurseries for High Pedigree Planting Material for Fruit Crops.

The major work done under this project includes production of true to type of fruits and ornamentals plants, production of insect, pest and disease-free fruits (budded plants of ber and lasoda). Approximately 15000 plants were sale and distribution under this project.

Production of insect, pest and disease-free fruits (budded plants of ber and lasoda).

16. Eco-friendly management of pulse beetle, Callosobruchus chinensis on different pulse in Rajasthan.

The salient achievements of this project includes, establishment of experimental and culture lab in the Deppt. of Entomology, SKNCOA, Jobner, development of a laboratory/ culture room for research work in the storage entomology, thus the students will be benefitted in conducting their research work for dissertation. Trainings were imparted

to188 farmers for Anaj Ke Surakshit Bhandaran par ek divasiye krishak avam krishak mahila prashikshan'.

Plate-I Maintenance of stock culture of pulse beetle

Plate-II Evaluation of plant products against pulse beetle

Plate-III Evaluation of IGRs against pulse beetle

Plate-IV View of experimental lab. (Culture lab.)

17. To establish demonstration unit of Sirohi goat for raising income of small, marginal and landless labour under different KVKs of SKNAU, Jobner.

Under this project sirohi goat units have been established at five KVK of SKNAU, Jobner. Training and demonstration on Sirohi goat production has been imparted to small, marginal farmers and landless labours at all KVKs.

Establishment of demonstration unit of Sirohi goat at different KVKs

Raising breeding bucks and supply to farmers for improvement in their herd

Skill oriented programme for experiential learning and self-entrepreneurship

18. To establish demonstration unit of back yard poultry unit for raising farm income of small, marginal and landless labours under different KVKs of SKNAU, Jobner.

Under this project backyard poultry units have been established at Five KVKs of SKNAU, Jobner. Birds of Kuroiler breed have been maintained at Five KVKs under backyard poultry. Training and demonstration on backyard poultry were conducted at all five KVKs.

Establishment of backyard poultry production units at KVKs under SKNAU,Jobner

Study of performance of suitable breed

Skill oriented programme for self- entrepreneurship

19. Creation of training facilities for capacity building of scientists, students and rural youth.

Under this project capacity building of the different stakeholders including faculty, students and rural youth under progress. Six trainings were organized up to till date for human resource development. A seminar entitled “Convergence of Agriculture Research, Education & Entrepreneurship” was organized at Maharana Pratap Auditorium, Rajasthan Agricultural Research Institute, Durgapura, Jaipur.

20. **Genetic Improvement and development of climate resilient Water melon and Musk melon for Rajasthan.**

    In this project some indegenous genotypes are collected and sown in the field to maintain its purity and crossed to develop F1s. High yielding 256 inbred lines of musk melon selected from different region of Rajasthan

21. **Modernization/ Mechanization of Agriculture Research Sub-Station, Diggi (Tonk) through creation of Infrastructural facilities.**

    The major work done in this project includes, construction of 1405 mt stone boundary wall with chain linked fencing, digging of already existed two farm ponds, and installation of micro irrigation system in about 14 ha at ARSS, Diggi.

22. **Farm development of Agriculture Research Sub-Station, Gonera (Kotputli).**

    The achievements of this project includes, construction of 1317 M boundary wall, adding of organic matter and clay in 21 ha. area, 4.5 ha area covered under micro irrigation system & one ha. area under drip irrigation system, construction of small shed net house and construction of pucca pond to harvest roof water at ARSS, Gonera under this project.

Constriction of boundary wall to protect ARSS farm.

23. **Establishment of Water Harvesting System to Maximize Use of Runoff Water for Strengthening of Research and Seed Production Programme at SKNCOA, Jobner.**

    Under this project a pond has been prepared with size of 13154 sqm as top area and 7784 sqm bottom area with a depth of 30 meter. It will store around 11 crores of run off water which will be available for seed production and experimental purpose.

24. **Development of infrastructure facilities for breeder seed production at different ARS & ARSS farms of the SKNAU, Jobner.**

Work done in this project includes fencing wall on the farmland of different units of the university i.e. at ARS Fatehpur (5000 meter), Keriya farm, SKNAU, Jobner (3000 meter), ARSS, Kumher (2400 meter), ARS, Navgaon (1000 meter) and ARSS, Tabiji (450 meter) were constructed.

25. **Studies on Insect Pests and Natural Enemies Diversity in Major Semi-Arid Agro ecosystems of Rajasthan.**

Collected and displayed Insect pests of field crops, established insect biodiversity lab, constructed rain water harvest tank and established insectary for insect rearing and collection at SKNCOA, Jobner.

GENERAL VIEW OF INSECT BIODIVERSITY LAB.

INSECT PRESERVATION IN INSECT BIODIVERSITY LAB.

FARMERS VISITED IN INSECT BIODIVERSITY LAB.

26. Estimation of area and production of existing cropping systems and optimization of water use through Remote Sensing and GIS.

Remote sensing and GIS labs were established. Trainings were conducted for the scientists, researchers and farmers to make them familiar to remote sensing and GIS.

27. Establishment of Herbal Park and Post Harvest Processing in Medicinal and Aromatic Plants.

Work done in this project includes, establishment of herbal park (0.20 ha), maintenance of 50 species of medicinal & aromatic plants, multiplication of quality planting material of important medicinal & aromatic plants to distribute farmer.

28. Quality seed production of important vegetables under semi-arid conditions.

In this project quality seed of different vegetable crop especially suited to the agroclimatic zone IIIa will be produced under this project. Experiments on drip irrigation scheduling in different vegetables have been conducted Seed production of different vegetables have been produced. Different publications on technologies for seed production and commercial production of vegetables are under progress

29. Standardization and characterization of Liquid Organic Formulations.

The major aim of this project is to develop standard protocol for liquid organic formulations. Different types of organic formulations i.e. panchgavya, jeevamrit, vermiwash, matkakhad, etc. have been prepared testing and spray on experimental crops. For standardization of the methods to prepare good quality liquid organic formulations, these products have been prepared by different methods and ratios. After preparation of formulations by different processes biochemical analysis of liquid formulations have been completed. Through the biochemical analysis suitable process and composition has been identified. For the testing of organic formulation four field experiments have been conducted in rabi and kharif season. 90 demonstrations have been demonstrated on farmer's field. Three field days on liquid organic formulations have been organized at nearby villages of Jobner.

30. Modernization and mechanization of college of agriculture Lalsot farm

The RKVY project on modernization and mechanization of college of agriculture Lalsot farm was started at College of Agriculture, Lalsot under RKVY in financial year 2021-2022. Various infrastructural work like construction of godown, vermi compost unit, agriculture implement shed are going to complete by November 2023. The work of purchase of farm implements and installation of poly house will be completed by end of current financial year.

31. Centre of Excellence on Applications of Artificial Intelligence in Agriculture

A laboratory for Centre of Excellence on Applications of Artificial Intelligence in Agriculture has been established in the department of Agricultural Engineering, SKN College of Agriculture, Jobner. To study different applications of drones (UAV's) in agriculture, two drones viz., spraying drone and surveying drone with required cameras were procured and research experiments were conducted to study the bio-efficacy of UAV's in controlling disease in crops, crop health analysis with vegetation indices and effect of UAV's operational parameters on spray deposition and efficiency. Also, one sensor based real time variable rate spraying machine has been developed under this project for efficient and effective spraying in orchard crops. smart sprayer. To promote the use of UAV's in agriculture, one two training on use of drones in agriculture has been oragnised for youth farmers of this region, also drones are being regularly exhibited in the state level exhibitions, Kisan Mela's and the technology has been frequently demonstrated to the students and farmers. In addition to this, with the help of facilities developed under this

project, an DGCA approved Remote Pilot Training Organization (RPTO) has been started in the department of Agricultural Engineering, SKNCOA, Jobner.

32. Developing Agri-entrepreneurship for rural youth self-reliant through mushroom production technology

A demonstration unit has been established for farmers and rural youth. Mushroom spawn production Laboratory has been started. Spawn production work has been started. Produced quality spawn in laboratory has been maintained and kept for sell. Under capacity building programmes on mushrooms production till date four training programs has been

conducted to motivate the rural youth for self-employment through mushroom cultivation. An around 100 participants were trained under the mushroom project.

(e) On-going Major Projects with details (AICRPS/AINPS)

A total of 17 AICRP/AINP projects are running at various research stations of the university.

1. AICRP on Vegetables Research, RARI, Durgapura, Jaipur

The project was started in year 1970 and running at Rajasthan Agricultural Research Institute, Durgapura under SKN Agriculture University, Jobner- Jaipur (Rajasthan). The aim of project is collection, evaluation, conservation and utilization of Germplasm of water melon and musk melon as one of coordinating centers of AICRP on Vegetable Crops. Significant achievements of this project are as given below:

(i) Germplasm maintained: Muskmelon- 149 genotypes, Watermelon- 29 genotypes

(ii) Genotypes registered: Two watermelon genotypes during 2001 get registered first time in country i.e. RW177-3 (INGR1038) and RW 187-2 (INGR1037) at NBPGR, New Delhi.

(iii) Recommendation on production technology: RARI, Durgapura centre has developed about 50 production technologies in the major vegetable crops *viz.* Tomato, Muskmelon, Water melon, Bottle gourd, Bitter gourd, Cauliflower, Cabbage, Broccoli, Onion, Chilli, Radish, French bean, Carrot Sumer Squash and other vegetables.

(iv) Recommendation on Disease management: The centre has also given about 30 technologies/recommendations on disease management and varietal screen in the major vegetable crops like Chilli, Tomato, Brinjal, Peas, Onion, Cluster bean, Cabbage, Water melon, Tinda etc.

(v) Varieties identified/released:

Vegetable	**Varieties identified/released/ notified**
Beet Leaf	Jobner Green
Muskmelon	• Durgapura Madhu- released & recommended in Rajasthan in 1971 and throughout country in 1975 • RM-43 • MHY – 3 released in 1997 and notified in 1999 • MHY-5 and RM-50 notified in 2004
Watermelon	• Durgapura Meetha • Durgapura Kesar • Durgapura Lal (RW-177-3) notified in 2004
Chilli	• RCh -1 released in 2003 and notified in 2004.
Cluster bean (Veg. type)	• Durgabahar • Kanchan Bahar (M-83) notified in 2004
Cow Pea (Veg. type)	• Durga Kranti (RCV-7) notified in 2004
Onion	• RO-1 notified in 2004 • RO-59 notified in 2005
Vegetable Peas	RPV-15 identified

2. AICRP on Wheat and Barley, RARI, Durgapura, Jaipur

Coordinated wheat project started in the year 1971-72 in Rajasthan at ARS, Durgapura, Jaipur. At present the organizational set up includes multidisciplinary research approach in wheat & Barley. Main objectives of the project are (i) the development of high yielding wheat varieties resistant to insect pests, diseases and nematode, development of varieties

tolerance to abiotic stresses (moisture stress, heat, salinity and alkalinity, breeding and evaluation of superior genotypes for better quality traits, development of production and protection technologies (ii) development of dual purpose varieties for feed and fodder, development of high yielding varieties with superior malting qualities, demonstration of technology at farmers' fields through frontline demonstration, development of varieties for restrictive environments i.e. rainfed, saline/sodic soils, brackish water. The significant achievements of the projects are as follows:

(i) Varieties developed (Wheat): The centre has developed 29 wheat varieties for various production conditions

Deshi wheat	
Irrigated timely sown	RS 31-1, Durgapura 65, Mangla, Gangasunhari and Chambal 65
Irrigated, medium fertility	Raj 1114
Bread wheat	
Irrigated timely sown	Lalbahadur, Raj 1482, Raj 1972, Raj 2535, Raj 3077, Raj 4037, Raj MR-1, Raj 4079, Raj 4120 and Raj 4238
Irrigated late sown	Raj 821, Raj 2184, Raj 3077**,** Raj 3765, Raj 3777 and Raj 4083
Rainfed timely sown	Durgapura 134
Saline-alkaline soils	Kharchia 65, Raj 1972, Raj 3077 and Job 666
Very late sown condition	Raj 3765

Raj 4083

Raj 4120

Raj 4238

(ii) Varieties developed (Barley): The centre has developed 26 barley varieties for various production conditions.

Feed Barley Varieties	RDB-1, BL-2, Raj Kiran, RD 103 and RD 915, RS-6, RS 57, RD 221 ,RD 118, RD 2052, RD 2035, RD 2552, RD 2592, RD 2715, RD 2786, RD-2899, RD-2907 and RD-2794
Malt Barley Varieties	RD-2503,RD-2668(Two rowed),RD-2849 (Two rowed)
Dual Purpose Varieties	RD-2715
Rainfed Varieties	RD 31 and RD 137,RD-2508,RD-2624, RD-2660
Salinity/Alkinity)	RD-2794

RD 2715

RD 2849

RD 2899

3. AICRP on Pearl millet, RARI, Durgapura, Jaipur

All India Coordinated Research Project on Pearlmillet at Durgapuracentre started in 1976 with the objective of development of dual purpose hybrids with early to medium maturity, downy mildew resistance and drought tolerance having both higher grain as well as fodder yield, development of dual purpose composites/synthetics varieties with suitable maturity and resistance to downy mildew and tolerance to drought having both higher grain as well as fodder yield and to generate suitable agronomic technology for seed rate, plant population and fertilizer doses for arid, semi-arid and adequate rainfall regions of the State. The significant achievements of the project are as follows;

(i) Hybrids/Varieties Released: The centredevelop total Thirteen varieties till date, out of them two composite and eleven hybrids. Three hybrids released for the state whereas eight hybrid released at national level.

S. No.	Name of Variety/ Hybrid	National/State Release	Notification No. and Date
1.	Variety RCB-2	State	S.O.832(E) Dt.18.11.1985
2.	Variety Raj-171	State	S.O. 814 (E) Dt. 4.11.1992
3.	Hybrid RHB-30	State	S.O. 360 (E) Dt. 1.5.1997
4.	Hybrid RHB-58	National	S.O. 408 (E) Dt. 4.5.1095
5.	Hybrid RHB-90	State	S.O. 821 (E) Dt. 13.9.2000
6.	Hybrid RHB-121	National	S.O. 1134 (E) Dt. 15.11.2001
7	Hybrid RHB-154	National (A_1)	S.O. 2187 (E) Dt. 27.8.2009
8	Hybrid RHB-173	National	S.O. 632 (E) Dt. 20.3.2010
9	Hybrid RHB-177	National (A_1)	S.O. 1134 (E) Dt. 15.11.11
10.	Hybrid RHB-223	National (A_1)	S.O.1379(E)27-03-2018

11.	Hybrid RHB-233	National	S.O. 3220(E)Dt.05-09-2019
12.	Hybrid RHB-234	National	S.O. 3220(E)Dt.05-09-2019
13.	Hybrid RHB-228	State	S.O. 8(E)Dt.24-12-2021

RHB 223

RHB 233

RHB 234

RHB 173

(ii) Production/Protection technology developed:

1. Foliar application of 0.5% FeSO4 at 25-30 DAS increased mean grain & straw yield of pearl millet by about 6.30% and 6.99% respectively which fetch the B:C ratio of 2.46.
2. Under rainfed condition for enhancing productivity of pearl millet, application of crop residue mulch @ 5 t/ha along with the furrow application of hydrogel @ 2.5 Kg/ha after mixing it with dry sand or vermicompost at the time of sowing is recommended.
3. Deep summer ploughing followed by post emergence application of Tembotrione herbicide @100 g a.i/ha at 15-20 DAS is recommended for the control of *Cyperusrotundus* (Motha) weed in pearl millet crop.

4. Application of 100 % RDN through FYM (about 12-15 ton/ha.) + Biomix (2.0 l/ha.) significantly increased pearl millet productivity under rainfed condition with maximum net returns and B:C ratio when applied in soil two weeks before sowing.
5. PE application of Atrazine @ 500 g a.i./ha followed by POE application of Tembotrione 42% SC @ 100g a.i./ha at 3-4 leaf stage of weeds significantly controlled the weed population and increased pearl millet productivity under rainfed condition with maximum net returns and B:C ratio.
6. Furrow application of moisture conservation polymer SPG 1118 @ 5.0 kg/ha at the time of sowing significantly increased pearl millet productivity under rainfed condition with maximum net returns.
7. Minimum tillage (one harrow + one cultivator and planking + two interculturing at 15-20 & 30-35 DAS with the help of wheel hoe) with 100% RDF increased pearl millet productivity under rainfed condition with maximum net returns.
8. Foliar applications of 2ml/litre nano urea at 30-35 and 45-50 DAS alongwith 75% recommended dose of nitrogen significantly increased pearlmillet productivity under rainfed conditions with maximum net returns**.**
9. Effect of mulching and hydrogel on the productivity, water use efficiency and microbial activity of pearl millet exhibited 49.8, 40.2 and 52.2 % improvement in the grain yield by the treatment with Recommended Dose of Fertilizer (RDF) + crop residue mulch @ 5.0 t/ha+ hydrogel @ 7.5 kg/ha over RDF alone in Zone A1, Zone A and Zone B, respectively. The water use efficiency was recorded 70.24, 78.78, & 79.98 kg/ha-cm in the best treatment as compared to 36.60, 52.85 & 52.72 kg/ha-cm in RDF in Zones A1, A & B, respectively.
10. Application of nutrients through organic source of FYM or Vermicompost along with biofertilizer Biomix (*Azospirillum* + PSB) in Zone A1 & A produced equal yield and more protein content to the application of RDF through inorganic fertilizers.
11. In Zone A& B, the best treatment was found T9 (RDF + Pusa hydogel slurry application @ 5.0 kg/ha + crop residue mulch @ 5.0 t/ha after 10-15 DAS) with 33.1 & 43.3 % improvement in the grain yield and having highest net returns, better WUE and microbial counts.

12. In Zone A, CT_1 (Conventional tillage) with 2 intercultural operations followed by MT_1 (Minimum tillage) with 2 intercultural operations recorded best yield, economics, water use efficiency, net energy and energy productivity.
13. Efficacy of different insecticides against shoot fly and stem borer revealed that seed treatment of clothionidin 50 WDG @ 7.5 g/kg seed followed by spray of Fipronil 5 SC @ 0.01 % at 35 days after germination of the crop recorded lowest shoot fly and stem borer incidence, highest grain and fodder yield. This treatment also registered highest ICBR.
14. Seed treatment with clothionidin 50 WDG @7.5 g/kg seed followed by spray of Fipronil 40 %+ Imidacloprid 40 % WG @ 0.04 % (5 g/10 liter water) at 35 days after germination (DAG) gave effective management of shoot fly and stem borer in pearl millet crop.
15. Seed treatment with Imidacloprid 600 FS @ 8.75 ml/kg seed + removal of shoot fly dead heart +fish meal trap @ 10/ha + spray of Dimethoate 30 EC @ 0.03 % (10 ml/10 liter water) 35 days after germination (DAG) gave effective management of pest complex of pearl millet and recorded highest ICBR.
16. In pearl millet standing crop soil pests (White grub and termite) effectively managed by application of Imidacloprid 17.8 SL @ 60 g a.i./ha.
17. In pearl millet 10 % higher seed rate+ treatment with Imidacloprid 600 FS @ 8.75 ml/kg seed + PSB ($1x10^8$ cfu/ml) @ 10ml/kg + neem cake @ 500 kh/hectare furrow application at the time of sowing+removal of shoot fly dead heart +fish meal trap @10/ha + two spray of Azadirachtin 1500 ppm (40 ml/ 10 litre of water) at 30 DAG and at ear head stage recorded lowest shoot fly, stem borer, grass hopper, termite, white grub and *Helicoverpa* incidence with highest grain and fodder yield.
18. Management of Pearl millet blast using fungicides foliar spay of propiconazole 25 % EC @ 0.05 % at the time of initiation of the disease.
19. For blast control, Foliar spay of trifloxistrobin 25 % + tebuconazole 50 % (75 WG) @0.05 % at the time of initiation of the disease. second spray can be repeated at 15-day interval.
20. Seed treatment of Imidacloprid 600FS @ 8.75 ml/kg seed followed by spray of Imidaclorprid 17.8 SL 0.009 % at 35 DAG gave effective control of shoot fly & stem

borer and recorded highest ICBR. Moreover, the residue of the insecticides were below detectable limit at 42 days after spray in pearl millet.

21. Neem leaves powder @ 10 gm/kg seed gave better protection to pearl millet seed upto 6 month against *Rhzoportha dominica* and seed viability was above MSCS level of 75.00%.
22. Seed treatment of clothionidin 50 WDG @7.5 gm/kg seed effective for the management of White grub and termite.
23. Foliar spay of Propiconazole 25 % EC @ 0.05 % at the time of initiation of the disease. Or Foliar spay of trifloxistrobin 25 % + tebuconazole 50 % (75 WG) @ 0.05 % at the time of initiation of the disease. Second spray can be repeated at 15-day interval.
24. Efficacy of foliar spray of growth regulating Substances for enhancing seed yield under rain-fed condition showed that the spray of potassium chloride 1.50 % at the time of tillering and at post-anthesis stages produced maximum grain & fodder yield of pearl millet with the B:C ratio of 2.57.

4. AICRP on Seed Spices, SKN College of Agriculture, Jobner

AICRP on Spices, Jobner centre works on coriander, cumin, fennel and fenugreek with the following objectives:

5. Collection, maintenance and evaluation of indigenous and exotic types of coriander, cumin, fenugreek and fennel.
6. Selection, multiplication and multilocation testing of superior types.
7. Evaluation of germplasm for disease and pest resistances.
8. Standardization of agro-techniques to achieve higher yield and
9. Quality evaluation of these spices.

The AICRP on Seed spices is a lead center for its work on four major seed spices, *viz*. cumin, coriander, fennel and fenugreek. The significant achievements of this project are as under:

(i) Varieties developed: 32 varieties were developed within a span of 48 years (5 of cumin, 9 of coriander, 10 of fennel and 8 of fenugreek).

S. No.	Variety	Year of release/ Identify	Duration (days)	Av. yield (q\ha)	Status	Notification No. & Date
	Coriander					
1.	RCr-20	1996	100-110	15.5	Released for the state	-
2.	RCr-41	1988	140-145	10-12	Released for the state	-

3.	RCr-435	2004	110-130	11.0	Released for the state	S.O. 597 (E) 25.04.2006
4.	RCr-436	2002	90-100	15.0	Released for the state	S.O. 664 (E) 11.05.2005
5.	RCr-446	2001	110-130	12.8	Identified for National release	-
6.	RCr-684	1999	110-130	10.0	Identified for National release	-
7.	RCr-480	2006	110-130	13.25	Identified for state release	-
8.	RCr-728	2010	130-140	13.70	National Released	S.O. 1979 (E) 12.08.2010
9.	RCr-475	2014	130-140	17.40	Identified for State release	-
	Cumin					
10.	RZ-19	1988	120-130	5.7	Released for the state	-
11.	RZ-209	1995	120-130	6.7	Identified for state release	-
12.	RZ-223	2007	120-130	6.0	Released for the state	S.O. 858 (E) 01.06.2007
13.	RZ-341	2006	120-130	4.5	Identified for state release	-
14.	RZ-345	2009	120-130	6.07	Identified for State release	-
	Fennel					
15.	RF-101	2002	150-160	16.0	Released for the state	S.O. 664 (E) 11.05.2005
16.	RF-125	2004	130-140	17.0	Released for the state	S.O. 597 (E) 25.04.2006
17.	RF-143	2007	140-150	18.0	Released for the state	S.O. 858 (E) 01.06.2007
18.	RF-178	2006	130-140	16.0	Identified for state release	-
19.	RF-205	2010	140-150	16.0	National released	S.O. 1979 (E) 12.08.2010
20.	RF-145	2010	140-150	17.0	Identified for National release	-
21.	RF-281	2012	140-150	18.25	Identified for National release	-
22.	RF-157	2015	140-150	21.67	Identified for National release	-
23.	RF-290	2022	140-150	20.65	National released	Notification proposal submitted

24.	RF-289 (Karan Sonf-1)	2021	140-150	17.43	Identified for National release	Awaited
	Fenugreek					
25.	RMt-1	1990	140-150	15.0	Released for the state	S.O. 527 (E) 16.08.1991
26.	RMt-143	1997	140-150	16.5	Identified for state release	-
27.	RMt-303	1999	140-150	19.0	Identified for National release	-
28.	RMt-305	2007	120-125	18.0	Released for the state and is the first determinate type	S.O. 858 (E) 01.06.2007
29.	RMt-351	2006	140-150	18.41	Identified for state release	-
30.	RMt-361	2009	130-140	17.70	Identified for National release	-
31.	RMt-365	2012	125-135	21.08	Identified for National release	-
32.	RMt-354	2022	130-140	15.37	National released	S.O. 3254(E) 20.07.2022

RZ-19

RMt-1

RMt-305

RMt-354

RCr-20

RCr-41

RF-101

RF-290

RF 289(Karan Sonf-1)

(ii) Germplasm collection: The centre has a large collection of germplasm consists of 858 accessions in coriander (756 indigenous and 102 exotic), 376 in cumin (370 indigenous and 6 exotic), 309 in fennel (289 indigenous and 20 exotic) and 485 in fenugreek (473 indigenous and 12 exotic). In addition, Jobner center is maintaining 144 germplasms of Ajwain.

(iii) Package of practices: Different crop management and protection trials are conducted in coriander, cumin, fennel, and fenugreek with a view to evolve appropriate technologies/recommendations for commercial cultivation of the four seed spices crops in the state. The recommendations have been included in the package of practices which have already been formulated and approved by the Department of Agriculture, Government of Rajasthan for general adoption.

(iv) Generation of new germplasm: An exploration trip was made by the project scientists to collect the cumin germplasms from remote area's of Nagore, Jodhpur and Jaisalmer (2021-22) resulted in the collection of 150locally adapted germplasms of cumin. In addition, an attempt was made using gamma irradiation to the seeds of fenugreek variety RMt-354, which has resulted in development of 100 new lines of fenugreek, which are being advanced for its homozygosity and characterization.

(v) Technology developed:

(a)Crop production technology

(A) Coriander:

1. For coriander under irrigated condition, a fertilizer dose of 60 kg/N/ha applied in three splits viz. 1/3 at sowing time, 1/3 at 30 DAS and another 1/3 at 75 DAS has been recommended. It produced significantly higher average seed yield.
2. Coriander leaf plucking to the extent of 50% at 75 DAS has been recommended to increase the returns. Plucking of 50% coriander leaf at 75 DAS recorded a return of Rs. 7.433 q/ ha which was an increase of Rs. 2.197 and 1.475/ ha over no plucking and plucking at 60 DAS, respectively.
3. Harvesting of coriander crop at 50% grains turning yellow has been recommended to obtain good luster of grain. Harvesting the coriander at 50% grain turning yellow recorded an average seed yield of 6.88 q/ha which was at par with 7.03 q/ ha obtained at 100% grains turning yellow.
4. Coriander seed yield recorded under the combination of hand weeding once at 50 DAS and herbicidal treatment of fluchloralin @ 0.75 q/ ha (8.05 q/ ha) or oxyfluorfen @ 0.15 kg/ ha (8.17 q/ ha) or pendimethalin @ 1.0 kg/ ha (8.50 q/ ha) or pendimethalin @ 1.0 kg/ ha (8.50 q/ ha) was at par with weed free condition (9.41 q/ ha) and hand weeding twice (7.35 q/ ha).

5. Three years (1997-98, 1998-99, 1999-2000) data on response of coriander to Zn, Fe, Mn and Cu revealed that significantly higher seed yield over control was obtained with soil application of $MnSO_4$ @ 25 Kg/ha (9.22 q/ha) and $CuSO_4$ @ 25 Kg/ha (8.83 q/ha), foliar application $ZnSO_4$ 0.50% (9.09 q/ha) and $CuSO_4$ @ 0.50% (10.0 q/ha) and soil + foliar application of $FeSO_4$ @ 5 Kg/ha + 0.125% (9.03 q/ha), $MnSO_4$ @ 12.5 Kg/ha + 0.25% (8.85 q/ha) and $CuSO_4$ @ 12.5 Kg/ha + 0.25% (8.83 q/ha).
6. In irrigated conditions, the crop should be sown during last week of October at 30 cm rows keeping 10 cm plant spacing.
7. FYM should be applied @ 5.0 ton/ha. It requires 60 kg N/ha which should be applied in three equal splits at the time of sowing, 30 and 75 days after sowing (DAS). Application of Azospirillum @ 1.5 kg/ha and micro nutrients (Fe, Mu, Cu & Zn) also improved seed yield.
8. The crop should be harvested when 50% grain turns yellowish in color to maintain luster and quality of seed.
9. Application of NAA @ 50 ppm or Triacontanol @ 0.1% twice at 40 and 60 days after sowing or thrice at 40, 60 and 80 days after sowing increases growth, yield and economics of coriander.
10. Application of 50% RDF through Vermicompost + 50% RDF through fertilizers give higher productivity, quality of produce and net monetary returns from coriander along with improvement in soil health.
11. Fertigation with water equal to 80% of actual evaporation (0.8 IW/CPE ratio) at an interval of 2-3 days and recommended dose of fertilizers through soluble fertilizers at different growth stages (20, 40, 60 & 80 DAS) is recommended for improving the yield and WUE in coriander in light textured soils of India(2017-18).

B. Cumin:

1. The crop should be sown around in the second fortnight of November in rows at 30 cm apart. 12-15 kg seed per hectare sufficient for maintaining plant population between 7-9 lakh/ha. Seed should be treated with carbendazim @ 2gm/kg seed at least 12 hrs. before sowing.
2. The crop should be fertilized with $N:P_20_5$ @ 30 : 20 kg/ha. Whole amount of phosphorus should be applied at the time of sowing while N should be top dressed in two equal splits at 30-35 and 60-65 days after sowing.
3. Application of 30 kg N/ ha through top dressing in standing cumin crop either all in one single dose at 30 DAS and second at 60 DAS has been recommended. It produced significantly higher mean seed yield of 6.11 to 6.30 q/ ha as against 4.79 q/ ha with no nitrogen.

4. Chemical control of weeds with preemergent terbutryn or oxiadiazone, each at 0.5 to 1.0 kg/ ha or pre plant fluchloralin or preemergent pendimethalin each at 1.0 kg/ ha has been recommended. Pre-emergence application of Terbutryn at 1.0 kg/ ha produced maximum seed yield of 4.05 q/ ha as against 0.72 q/ ha recorded under un-weeded control.
5. Sowing of cumin at 22.5 cm row spacing has been recommended. It produced maximum seed yield of 3.71 q/ ha as against 3.22 q/ ha recorded in broadcast method of sowing.
6. A seed rate of 12 kg/ ha has been recommended. It produced maximum yield of 3.74 q/ ha as against 3.06 q/ ha obtained with 8 kg/ ha seed rate.
7. Application of NAA @ 50 ppm / Triacontanol @ 0.1% twice at 40 and 60 days after sowing increases growth, yield and net monetary returns of cumin.
8. Application of 50% RDF through Vermicompost + 50% RDF through fertilizers give higher productivity, quality of produce and net monetary returns from cumin along with improvement in soil health.
9. Seed coating of cumin with plant growth promoting rhizobacterial bioformulation FK 14 (*Pseudomonas pituda*) or bioformulation FL 18 (*Microbacterium paraoxidans*) or bioformulation FK 14 + FL 18 resulted in higher growth, yield and net monetary returns of the crop
10. Fertigation with water equal to 60% of actual evaporation (0.6 IW/CPE ratio) at an interval of 4 days and 80% recommended dose of fertilizers through soluble fertilizers at different growth stages (10, 20, 40, 50, 70 & 80 DAS) is recommended for improving the yield and WUE of cumin in light textured soils(2018-19)
11. Soil application of 25 Kg/ha Iron sulphate, 15 kg/ha Zinc sulphate, 35 kg/ha Manganese sulphate and 10 kg/ha Borax at the time of sowing along with three foliar spray of 0.5% Iron sulphate, 0.3% Zinc sulphate, 0.5% Manganese sulphhate and 0.2% Borax at 30, 50 & 70 days after sowing according to low micronutrient status in the soil is recommended for obtaining higher yield and returns in cumin crop. Micro nutrients solution for foliar spray should be neutralized with lime solution before spray with half concentration of micro nutrients fertilizer (2021-22).

C. Fennel:

- Application of 90 kg N/ ha three equal splits viz. first as basal, second at 30 DAS and third at 60 DAS with irrigation has been recommended. It produced significantly higher average seed yield of 13.77 q/ha as against 8.30 q/ ha with no nitrogen.
- Harvesting of fennel at half-length size of grain i.e. about 30 days after anthesis has been recommended to produce chewing type (Lucknow fennel). Harvesting at this

stage though resulted in the lowest seed yield but recorded maximum net returns of Rs. 15.077/ ha. as against Rs. 7.102/ ha obtained when the crop was harvested at full maturity of the grains with yellow colour.

- Weed management study in fennel revealed that yield in the weedicide treatment of pendimethalin @ 1.0 kg/ ha supplemented with hand weeding once (8.67 q/ ha) was at par with weed free condition i.e. 10.19 q/ ha.
- Thre years (1997-98, 1998-99, 1999-2000) data on response of fennel to Zn, Fe, Mn and Cu revealed that significantly higher seed yield over control was obtained with soil application of $ZnSO_4$ @ 20 Kg/ha (10.11 q/ha), foliar application $ZnSO_4$ 0.50% (9.27 q/ha), $FeSO_4$ @ 0.25% (9.92 q/ha), $MnSO_4$ @ 0.50 % (9.42 q/ha) and $CuSO_4$ @ 0.50% (9.45 q/ha) and soil + foliar application of $ZnSO_4$ @ 10 Kg/ha + 0.25% (8.89 q/ha), $FeSO_4$ @ 5.0 Kg/ha + 0.125% (9.12 q/ha) and $MnSO_4$ @ 12.5 Kg/ha + 0.25% (9.49 q/ha).
- The crop should be fertilized with FYM (5 ton) + Azospirillum (1.5 kg) and nitrogen 90 kg/ha. N should be applied in three equal splits at sowing, 30 and 60 DAS along with irrigation.
- Pre emergence application of pendimethalin (1.0 kg/ha) along with one hand weeding effectively managed weeds in fennel. To produce chewing type (Lucknow fennel), the crop should be harvested at half-length size of grain i.e. 30 days after anthesis- for obtaining higher income. The crop responded to the application of micro nutrients applied as soil or foliar sprays.
- Application of 50% RDF through Vermicompost + 50% RDF through fertilizers give higher productivity, quality of produce and net monetary returns from fennel along with improvement in soil health.
- Drip irrigation at IW/CPE ratio 0.8 with paired row planting is best for higher productivity, economics and water use efficiency from fennel. This results to 19 per cent saving of irrigation water with yield increase of 107 per cent(2015-16).
- Fertigation with water equal to 80% of actual evaporation (0.8 IW/CPE ratio) at an interval of 2-3 days and 75% recommended dose of fertilizers through soluble fertilizers at different growth stages (20, 40, 60, 80 & 100 DAS) is recommended for improving the yield and WUE in fennel in light textured soils of India(2017-18).
- Drip irrigation at an interval of 3 days with water equals to 80% of actual evaporation of this duration is recommended for fennel. It improves 27.73% crop productivity along with 33.03% water saving as compared to surface irrigation in fennel (2020-21)

D. Fenugreek:

- Sowing of fenugreek during first week of November has been recommended. It produced significantly higher mean seed yield of 12.10 q/ ha as against10.72 and 8.54 q/ ha recorded under the sowing of crop during third and fourth week of November respectively.
- Sowing of fenugreek at 30 cm row spacing has been recommended. It produced average seed yield of 10.81 q/ ha which was an increase of 13.04% over 40 cm row spacing. Yield at 20 cm spacing (11.15 q/ ha) was at par with 30 cm spacing (10.81 q/ ha).
- Seed rate of 25 kg/ ha and application of 40 kg N + 40 Kg P_2 0_5/ ha recorded mean seed yield of 11.12 and 11.45 q/ ha, respectively and has been recommended as package of practices in 1993 ZEREAC meeting Zone 3 (a).
- Irrigation to the fenugreek crop at IW/CPE ratio of 1.00 with an application of 40 kg P_2 0_5/ ha has been recommended as package of practice. It produced an average seed yield of 13.38 q/ ha which was statistically at par with the maximum mean yield of 14.03 q/ ha obtained under the same level of irrigation with 60 kg P_2 O_5/ ha.
- Weed management study in fenugreek revealed that yield in the herbicide treatment of fluchloralin @ 0.75 kg/ ha (16.15 q/ ha) and oxyflurfen @ 0.15 kg/ ha (15/12 q/ ha) both supplemented with hand weeding once was at par with weed free condition (14.68 q/ ha) and hand weeding twice (14.92 q/ ha).
- Three years (1997-98, 1998-99, 1999-2000) data on response of fenugreek varieties to row spacing and date of sowing revealed that fenugreek variety RMt-1 should be sown on 31st Oct. Performance of both the varieties i.e. RMt-1 and UM-305 in response of seed yield received at par with each other under late sowing in 15 and 30 November.
- The crop should be sown during first week of November. Delay in sowing cause reduction in yield. The crop can be sown at a row spacing of 20 or 30 cm. Variety Rmt-1 should be sown on 31st Oct.
- Seed rate should be kept 25 kg/ha. The crop should be fertilized with 40 kg/ ha each of N and $P_2 0_5$. For effectively control of weeds pre-emergence application of oxyfluorfen (0.15 kg/ha) super imposed with one hand weeding. The crop should be irrigated at IW/CPE ration of 1.0.
- Application of NAA @ 50 ppm twice at 40 and 60 days after sowing or thrice at 40, 60 and 80 days after sowing increases growth, yield and net monetary returns of fenugreek.

- Application of 50% RDF through Vermicompost + 50% RDF through fertilizers give higher productivity, quality of produce and net monetary returns from fenugreek along with improvement in soil health of loamy sand soils of Rajasthan.
- Seed coating of fenugreek with plant growth promoting rhizobacterial bioformulation FK 14 (*Pseudomonas pituda*) or bioformulation FL 18 (*Microbacterium paraoxidans*) or bioformulation FK 14 + FL 18 resulted in higher growth, yield and net monetary returns of the crop
- Drip irrigation at IW/CPE ratio 0.6 with paired row planting is best for higher productivity, economics and water use efficiency from fenugreek. This results to 35 per cent saving of irrigation water with yield increase of 49 per cent(2015-16).
- Drip irrigation with water equal to 60% of actual evaporation of this duration at 4 day interval along with fertigation of micronutrient fertilizers in fenugreek at 30, 50 & 70 days after sowing according to soil status of available micronutrient content is recommended for higher yield and economic returns from fenugreek crop.

(b) Plant protection

A. Coriander:

- In coriander seed treatment and soil drenching with Calxin @ 0.1% and foliar spray of the same at 60 DAS for the control of powdery mildew and stem gall at Rajasthan.
- Soil application of vermicompost 5t/ha + seed treatment with NSKE 5% and spray of NSKE 5% at appearance of powdery mildew and aphid at 10 days interval (twice/thrice) was found effective and economic for the organic management of powdery mildew and aphid in coriander. (2013-14).
- Foliar spray of Hexaconazole 5% SC (1.0 ml/litre of water) at the time of initial appearance of disease and second spray should be made after 15 days interval are recommended for the management of powdery mildew disease of coriander(2018-19).
- Foliar spray of Propiconazole 25 EC @ 0.05% (10 ml/10 lit.) (first & second spray) + Two foliar sprays of Acetamiprid 20 SP (0.004%) was economical and effective management of coriander powdery mildew and aphid (2022-23).

B. Cumin:

- Cumin is highly susceptible to pest (aphid) and diseases (wilt, blight and powdery mildew). Use of disease free seed of high yielding varieties like RZ-19, RZ-209, and RZ-223 minimize the losses.
- Adopt three years crop rotation to minimize wilt incidence.
- Incorporate 5.0 ton/ha of mustard residue along with 2.5 kg/ha of *Trichoderma harzianum* during summer for decomposition in soil to manage fusarium population.

- To manage these, the following spray schedule of chemicals has been worked out. 1st spray: Mancozeb @ 0.2% after 30-35 DAS, 2nd spray: Apply Mancozeb @ 0.2% along with Dimethioate 0.03% (if aphid appears) and wettable sulphur @ 0.2% 15-20 days after the first spray, 3rd spray: Spray chemicals used in 2nd spray, If needed sulphur dusting @ 25 kg/ha may be done 10-15 days after the second spray.
- Infection of cumin wilt could be reduced by seed treatment with Carbendazim (2.0 g/ kg of seed) or solarization of the soil during summers.
- A three years crop rotation that is clusterbean-cumin-clusterbean- wheat clusterbean-mustard was found to be the beneficial crop sequence to reduce the wilt menace on cumin.
- Varieties RZ-19 (already released), RZ-223 and GC-4 tolerate the diseases better than most locals. Efforts are being made to use the latter two types in developing wilt resistant variety.
- Soil application of vermicompost 3.2t/ha + soil application of *Trichoderma viride* 10 kg/ ha was found effective and economic for the bio-control management of wilt in cumin(2013-14).
- Soil application of Vermicompost (2t/ha) + seed treatment with *Trichoderma harzianum* (6g/kg) seed along with Neem Seed Kernal Extract spray @ 5% at 40 days after sowing and repeated thereafter at an interval of 15 days is recommended for wilt control of cumin grown with organic nutrient management practices (2018-19).
- Effective and economical management of cumin aphid, first foliar spray of Thiamethoxam 25 WG (25g a.i./ha; 2.5g/10lit. water) should be done at initiation of aphid and second spray of Clothianidin 50 WDG (20 g a.i./ha; 1.0g/10lit. water) should be made after 10 days of the first spray(2018-19).
- Foliar spray of Hexaconazole 5% SC (1.0 ml/litre of water) at the time of initial appearance of disease and second spray should be made after 15 days interval are economical and effective management of cumin powdery mildew(2019-20).
- Three foliar sprays of Kresoxym methyl 44.3 SC @ 0.044% (10 ml/ 10 lit. water) was economical and effective against cumin blight (2021-22).
- Two foliar sprays of thiamethoxam 25WG (0.0084%) was economical and effective against cumin aphid (2022-23).

C. Fenugreek: Soil application of Neem cake 2 t/ ha + soil application of *Trichoderma viride* 2.5 kg/ ha and spray of NSKE 5% at 10 days interval (twice/thrice) was found effective in organic management of powdery mildew and aphid in fenugreek. (2013-14)

D. Fennel: An experiment on efficacy of insecticides/ botanical against seed midge in fennel was conducted and it is recommended that for the control of seed midge in fennel

spray of either Acetamiprid 20 SP @ 0.004% or Thiamethoxam 25 WG @ 0.0084% to obtained higher yield and effective control of seed midge in fennel crop. (2015-16)

Best Center Award:

Jobner center of AICRP on Spices has been conferred best ICAR center for the year 2015-16 and 2022-23 by the Project Coordinator, ICAR-AICRP on Spices, Kozhikode, Kerala for development of high yielding, disease resistant, region specific varieties of Cumin,Coriander, Fennel & Fenugreek and sustainable Agro-techniques for the benefits of the farming community of the state and nation.

Best ICAR center for the year 2015-16

Best ICAR center for the year 2022-23

Dr. Shailesh Marker, P.I, Dr. G. L. Kumawat, Jr. Pathologist, Dr. Ram Kumwar, Asstt. Breeder receiving the best AICRP Centre Award by Dr. S. V. Suresha, Hon'ble Vice Chancellor, UHS, Bagalkot and Dr. Sudhakar Pandey ADG (Hort.), ICAR on 30.10.2023 at COH, UHS Campus, Bangaluru.

Awards/recognitions of project staffs :

S. No.	Name of the Award	Recipient	Sponsoring Agency
1	Fellow of Indian Society for Spices in Dec., 2015	Dr Dhirendra Singh	Indian Society for Spices
2	Fellow for the year 2014 of the Indian Society of Agronomy	Dr. A. C. Shivran	Indian Society of Agronomy, IARI, New Delhi
3	Fellow of Indian Society of Seed Spices in Feb, 2016	Dr Dhirendra Singh	Indian Society for Seed Spices
4	Best oral presentation-2017	Dr. G. K. Mittal	National seminar held at NRCSS, Tabijji- Ajmer
5	Young Scientist Award-2021	G L Kumawat	Samagra Vikas Welfare Society (SVWS), Lucknow, UP, India
6	Best Poster Paper Award in 9th Indian Horticulture Congress 2021	G L Kumawat	Indian Academy of Horticultural Sciences (IAHS), New Delhi
7	Best Poster Presentation Award in IPSCONF-2022	G L Kumawat	Indian Phytopathological Society, New Delhi

5. AICRP on Groundnut , RARI, Durgapura, Jaipur

The research on improvement of groundnut crop was started in the late fifties at Rajasthan Agricultural Research Institute, Durgapura, Jaipur and as a result, two varieties viz., RS-1 and RSB 87 were developed and released for commercial cultivation in the State. Later on an **All Indian Coordinated Research Project on Groundnut came into effect from Ist April, 1987** with research aspects on Breeding and Agronomy. Since the inception of AICRP on Groundnut, this research station has developed **07** varieties viz., one Spanish bunch variety **RG 141** (1990), fivevirginia varieties **RG 382** (2005) recommended for all India, **RG 425** (2011) for Rajasthan by SVRC, **Raj Mungfali 1** (RG 510) released in 2012 for Rajasthan & Punjab, **Raj Mungfali 2** (RG 578) released in 2015 for West Bengal, Orissa, Jharkhand and Manipur, **Raj Mungfali 3** (RG 559-3) released in 2016 for Rajasthan, Uttar Pradesh and Punjab. Recently, **Raj Mungfali 4** (**RG 638**) released in 2022 for Rajasthan, Uttar Pradesh and Punjab. These all varieties are popular and RG 510 has been covered maximum area of groundnut cultivation in Rajasthan.

In agronomy, **18** production recommendations were identified as a tool to achieve higher productivity and these have been included in the package of practices (listed later). The research on organic farming, weed control and yield maximization techniques are underway. It is presumed that with these new production technologies development the productivity of groundnut will enhance.

More than 280 FLDs were conducted to demonstrate the productivity potentials and profitability of the latest and improved groundnut production technologies under real farm conditions in last 10 years. These technologies include improved varieties, IWM, whole practices etc.

About 1200 q Breeder seed is produced of newly released groundnut varieties to further seed production of groundnut by RSSC, NSC and other agencies in last 10 years only.

Varieties released:

S.N.	Variety	Year	Recommended states	Impact
1.	RG 141	1990	Rajasthan	-
2.	RG 382	2005	All India	-
3.	RG 425	2011	Rajasthan	-
4.	RG 510 (Raj Mungfali 1)	2012	Raj. & Punjab	**450 q** breeder seed were produced during last 11 years for further multiplication as seed production program by Seed production agencies. Currently, more than 40 thousand area is covered by this variety.
5.	RG 578 (Raj Mungfali 2)	2015	West Bengal, Orissa, Jharkhand and Manipur	**270 q** breeder seed were produced during last 8 years for further multiply as seed production program by Seed production agencies. Currently, more than 15 thousand area is covered by this variety.

6.	RG 559-3 (Raj Mungfali 3)	2016	Rajasthan, Uttar Pradesh and Punjab.	**260 q** breeder seed were produced during last 7 years to further multiply by seed production program by Seed production agencies. Currently, more than 25 thousand area is covered by this variety and continue to increasing more.
7.	RG 638 (Raj Mungfali 4)	2022	Rajasthan, Uttar Pradesh and Punjab.	**40 q** breeder seed were produced during last 1 year to further multiply by seed production program by Seed production agencies. This variety will be at famers field in 1-2 years. It is having high yield and high shelling % (74 %) by these characters this variety will get popularization shortly.

RG 382

RG 425

RG 510 (Raj Mungfali 1)

RG 578 (Raj Mungfali 2)

RG 559-3 (Raj mungfali 3)

RG 638 (Raj mungfali 4)

Crop production technologies developed

1. For maximization of crop yield application of FYM @ 7.5 t/ha + 100% NPK along with foliar application of urea @ 2 % at 30 and 60 DAS is recommended
2. Drip irrigation in groundnut, drip laterals (having drippers at 30 cm distance and 1.75-2.0 kg/cm^2 pressure and 4 liter/hour discharge rate) should be installed at the interval of three rows (row spacing 30 cm) or keep 90 cm distance between two laterals which should be operated for 50 minutes in the month of June and 30 minutes during rest of the crop period (July to October) on alternate days. This system saves about 60% water and gives higher yield in comparison to surface irrigation systems.
3. Application of hydrogel @ 3.5kg/ha with irrigation water at 0.8 IW/CPE is recommended to improve the productivity and profitability of groundnut in water scarcity conditions
4. Application of DAPG producing fluorescent pseudomonades as seed treatment was found effective for enhancing groundnut pod yield under drought prone conditions
5. Integrated phosphorus management using FYM @ 5.0 t/ha + 50 % P (30 kg/ha) with DGRC-1 was found significantly superior for achieving higher productivity and profitability of kharif groundnut
6. Narrow spacing 30*10 cm (133 kg seed ha-1) is ideal for small seeded verities (HNG-10) whereas wider spacing 45*10 is appropriate for realizing higher crop productivity of spreading habit cultivars (RG 510).

7. Seed treatment with NPK liquid formulation (250 ml ha^{-1})+Zn solubilizing bacteria (125 ml ha^{-1})/ Bio-grow (250 ml ha^{-1})+75% RDF resulted in 25% saving of chemical fertilizers and produced statistically similar pod yield of groundnut with 100% RDF
8. Application of Pendimethalin 30% + Imazathapyr 2% (Ready-mix) @ 1 kg a.i./ha as pre-emergence (PE) followed by 1 hand weeding at 30-35 DAS or Pendimethalin 30 EC @1 kg a.i./ha as PE followed by 1 hand weeding at 30-35 DAS or application of Pendimethlin 30 EC @ 1 kg a.i./ha as PE followed by Imazathapyr 10% SL @ 75 g a.i./ha as post-emergence at 15-20 DAS recommended for effective control of weeds in groundnut
9. For bunch varieties having recommended plant spacing of 30*10 cm and average HKW 40 gm, the seed rate should 100 kg kernel/ha, for spreading and semi spreading varieties having recommended plant spacing of 40-45*10 cm, the optimum seed rate of groundnut should be based on HKW as below

Hundred kernel weight (gr)	Seed rate Kernel kg/ha
40-50	100-110
50-60	120-140
60-70	145-160
70-80	165-185
80-90	190-210

10. Application of Hydrogel @ 2.5 Kg/ha+Mulching with agro-waste @ 5 tons/ha and Endophytic Bacteria or Hydrogel @ 2.5 kg/ha+Mulching with agro-waste @ 5 tons/ha is recommended to augment the productivity, farm profitability and soil health due to more frequent drought like situations under changing climatic conditions
11. Planting of groundnut and wheat on permanent bed system with or without residue retention is recommended to augment the system productivity, farm profitability and soil health in groundnut-wheat rotation
12. Seed treatment with potassium solubilising bacteria @ 6ml per kg kernel alongwith application of 75% recommended dose of potassium (22.5 kg K_2O) can increase the productivity of groundnut with saving of 25% recommended dose of potassium.

6. AICRP on Seed Technology Research, RARI, Durgapura, Jaipur

Seed Technology Research Centre (Rajasthan Agricultural Research Institute, Durgapura) were sanctioned in 1982 by ICAR under the financial support of AICRP-NSP (Crops). The Seed Technology Research intend to maximize hybrid and varietal seed production in different crops, development of biochemical and molecular markers in establishing diagnostic characteristics of different varieties/hybrids, development of improved package of practice for safe storage of seed, development of seed enhancement techniques, development of quick, reliable and repeatable vigor tests, management of major seed borne diseases, identification of disease free locations, biological control of seed borne diseases etc.

Technology /recommendations:

S. No.	Technology/ recommendation	Impact
1.	Under late sown conditions, pre-sowing hydration of wheat seeds (1:1 w/v) followed by air drying at room temperature and thiram dressing @ 0.25%, was recommended for enhancement of seed yield	Produced 6-7% higher yield over existing practice
2.	The mechanical losses of soybean during bulk storage can be minimized by storing seeds in HDPE bags and limiting the number of stacks to 5 only whereas, transportation losses can be minimized by using bubbled HDPE bags	Technology is very effective for mechanical loses during transportation
3.	Eco-friendly control measures of loose smut of Wheat (*Ustilagosegatum*) is developed by treating the seeds with vitavax @ 1.25 g/kg seed and 4 g/kg *Glyocladiumvirens* - use	-
4.	Soybean seeds can be stored safe in polythene bags upto 8 months by treating seeds with thiram @ 4 g/ kg or vitavax 200 WP @ 2.5 g/kg	-
5.	The mixing of dry neem leaf powder @ 100 g/kg with mungbean seeds (seed moisture 8 to 10%) is effective in protecting the seeds from bruchid infestation up to 18 months, maintaining MSCS level of germination	-
6.	Wheat seeds treated with Thiomethoxam 70 W.S. @ 1.4 mg is as good as Deltamethrin 2.5 WP @ 40 mg/kg seed (already recommended) for safe storage in jute canvas bags upto one year under ambient conditions maintaining the seed germination as per Minimum Seed Certification Standard (MSCS)	Improve farmers seed germination and its vigour

7.	Mungbean seeds treated with emamectin benzoate 5 SG at 40 mg/ kg seed can safely be stored for one year in jute bags under ambient conditions, maintaining the seed germination as per minimum seed certification standard	Higherprofitability to growers during storage of seed of mungbean in farmer own save seed condition
8.	Storage bags viz; Jute, Cloth and HDPE bags treated with Emamectin benzoate 5 SG (2 g/l) or Deltamethrin 2.8 EC (3.5 ml/l). As surface application, followed by drying and then storing infestation free wheat seed (9-10% Moisture) in it, effectively protects the seeds from insect infestation without hampering the seed germination upto 9 months of storage period under ambient conditions.	--
9.	Storage bags *viz.*, Jute, Cloth and HDPE bags treated with Emamectin benzoate 5 SG (2 g/l) or Deltamethrin 2.8 EC (3.5 ml/l). As surface application, followed by drying and then storing infestation free (untreated) mungbean seed (9-10% moisture) in it, effectively protects the seeds from insect infestation without hampering the seed germination upto 9 months of storage period under ambient conditions	-
10.	In groundnut application of FYM@7.5ton/ha + recommended dose of NP+ critical nutrients *viz* iron (FeSO4 @ 25.0 kg /ha) and zinc (ZnSO4 @ 25 kg/ha) along with foliar application of urea @ 2% at 30 DAS and 60 DAS gave maximum seed yield (pods)	-
11.	Groundnut seed (off-shell) could be stored for more than 6 months with 86% germinability and better vigour in 700 gauge polythene bags in maximum 5 stocks. The findings are also helpful in easy transportation of ground nut seed with permissible viability	-
12.	Effective management of Cumin blight (*Alterneriaburnsii*) may be achieved by 3 foliar application of Azoxystrobin 23-EC @ 0.025 % at 10 days interval after the appearance of blight disease along with the basic seed treatment with thiram 3.0 g per kg of seed prior to sowing and resulted in minimum disease intensity (18.01) with highest seed yield (592 kg/ha) and consequently minimum post association (3.95) of *Alterneriaburnsii*in harvested cumin seed as compared to control with disease intensity (57.04 %) and seed yield (178 kg/ha) and 62.25 post association of the fungus.	Technology is very effective for fetching higher productivity and profitability over no application
13.	Seed treatment with NPK liquid formulation (250 ml ha^{-1})+Zn solubilizing bacteria (125 ml ha^{-1})/ Bio-grow	Higher productivity, profitability to growers

	(250 ml ha-1)+75% RDF resulted in 25% saving of chemical fertilizers and produced statistically similar pod yield of groundnut with 100% RDF	with improved soil health
14.	Seed treatment with captan 75WS @2.5 gm/kg seed and subsequent two foliar spray of azoxystrobin (18.2%) + difenconazole (11.4%) @ 0.03% at first appearance of disease and second after 10 days has been found best amongst all other treatment and can be recommended for farmer involved in seed production of tomato against alterneria blight disease	Technology is very effective in controlling diseases in tomato and becoming very popular among the tomato growers
15.	Seed dressing with *Trichodermaviride* @ 10 gm/ kg seed followed by 2 foliar sprays of tebuconazole or difenconazole @0.1 % after disease initiation at 10-15 days interval was found to give maximum seed germination and field emergence, minimum percent disease incidence (PDI), and maximum seed yield of onion and both these treatments were at par with each other. Based on BC ratio Tebuconazole is cheaper in comparison to Difenconazole and can be recommended to farmers. Among the three botanicals tested crude leaf extract of neem gave best control of stemphylium blight as compared to *Lantana camara* and *Pongamiapinnata*	Technology is very effective in controlling diseases in onion

7. AICRP on Agro-forestry, ARS, Fatehpur

The objective of this project is to collect and evaluate the multipurpose tree species for their survival and growth and then to develop the recommendations for Agro-forestry. A total of 21 technologies have been developed in this project.

1. **Multipurpose forest tree system:** Khejri (*Prosopis cineraria*) and Rohira (*Tecomella undulata*) were found as slow growing, and desi kikar (*Acacia nilotica*), ardu (*Ailanthus excelsa*) and Anjan (*Hardwickia binata*) were found among fast growing species. Kumat (*Acacia senegal*), Neem (*Azadirachta indica*), Khejri (*Prosopis cineraria*), Ardu (*Ailanthus excelsa*) and Anjan (*Hardwickia binata*) were found suitable for boundary plantation.

2. **Agri-silviculture system:** Agri-silviculture means use of land for the concurrent production of agricultural crops and forest crops. Khejri (*Prosopis cineraria*) and Babul (*Acacia nilotica*) were found suitable trees, and Bajra (*Pennisetum glaucum*) and Guar (*Cymopsis tetragonoloba*) were suitable crops.

3. **Agri-horticulture system:** A combination of horticultural crops/trees and field crops are integrated in this system. Ber (*Ziziphus mauritiana*) and Aonla (*Amblica officinalis*) were found suitable fruit plants in this system. These should be planted in 6x6m distance.
4. **Silvi-pastoral system:** In this system forests are managed for production of wood as well as for rearing of domestic animals. Nutans (*Dichrostachys cinerea*) and Dhaman grass (*Cenchrus ciliaris*) was found a good silvi-pastoral model in wastelands and/or panchayat land. Nutans should be planted in 1 m intra row spacing and 5 m inter row spacing. In between the Nutans row, the *Cenchrus ciliaris* should be planted. This system will control the soil erosion as well as improve the fertility status of the soil.
5. About 5-10% drying of *P. cineraria* was observed during survey in Zone IIA. Drying may be due to an insect attack namely *Celosterna scabrator* fab. with association of fungus *Gynoderma* spp. in water stress conditions. The recovery has been made in such trees with the application of 20 gm Bavistin + 40 gm Blitox + 20 ml chloropyriphos per tree in 20 liter of water. This treatment may be repeated after 30 days.
6. Israili babool (*Acacia tortilis*) were not found suitable for agri-silviculture system. However, it was proved that it is fast growing tree which matured in 15 years and it should be planted in 5x5m for energy plantation.
7. Techniques of moisture conservation by ring ditching around the tree base (30 cm deep in 2 m radius) plus straw mulch have been found to improve soil moisture content.
8. *Hardwickia binata* (Anjan) belongs to family leguminosae having straight bole with palatable fodder leaves was recommended as a silvi-pastoral tree for boundary plantation at 5x5m in irrigated as well as unirrigated conditions. It is also tolerant to harsh environmental condition.

9. Farmers were advised to plant *Ailanthus excelsa* (Ardu) on their farm boundaries where temperature does not fall below -1 ^{0}C to meet their demand for fodder and timber.
10. *Tecomella undulata* and *Prosopis cineraria* were found resistant against cold as well as hot winds.
11. Gola, Sav and Umran varieties of Ber were found better at farmer's fields in the regions.
12. Traditional method plus micro-site improvement transplanting method was suitable pertaining to survival of the trees.
13. Nutrient cycling for sustainable productivity of Agri-silviculture system with application of 10 t FYM/ha gave significantly higher gross returns over no FYM use with *P. cineraria*. Further, significantly higher gross return was found with cluster bean over mung bean, cowpea and moth bean crops.
14. Intercropping of Kharif fodder crop varieties with *Prosopis cineraria* in which highest green and dry fodder was recorded under pearl millet and cluster bean over all other crops.
15. The Aloevera and Sonamukhi were found best medicinal crops in the Zone IIa.
16. Studies on MPTs in block plantation for management of agroforestry system (Agri-silviculture) revealed that *Prosopis cineraria* and *Hardwickia binate* performed better with respect to survival percentage.
17. Studies on evaluation of MPTs in systemic field design (parallel) revealed that growth parameters of *Azadirachta indica* increased with increase in effective areas per plant, however this effect was not much pronounced in *Prosopis cineraria* and *Tecomella undulata*.
18. In agri-horticulture system, Aonla based agroforestry system (Chakaya and NA-7) was performed better at farmer's fields and gives higher returns Rs 12040 in compare to sole cropping system.

19. **Growth performance of *Hardwickia binata* in block plantation**: Under rainfed condition highest volume 0.37m^3/tree and 146.51 m^3/ha recorded at density of 400 tree/ha after 33 years of growth. Thus, it recommended for plantation of this tree species at above density for receiving optimum growth and volume under rainfed condition.

20. **Intercropping of rainfed kharif crops varieties in *Hardwickia binata* based agri-silviculture system:** In rainfed condition after 15 years old *H. binata* based agrisilviculture system yield was observed low (10-32%) in comparison to sole cropping system in all the Kharif crops without pruned tree condition. Thus, it recommended that under this system at 5x5 m spacing intercropping was taken only upto 15 years.

21. **Intercropping of rainfed *kharif* crops varieties in *Prosopis cineraria* based agri-silviculture system:** Under rainfed condition 33 years old P. *cineraria* based agri-silviculture system yield was recorded higher in all the Kharif crops in comparison to sole cropping system and highest increased observed in Cluster bean (23%) followed by Pearl millet (21 %) and Cowpea (21%). Thus, it is recommended that intercropping of above kharif crops is beneficial in khejri based agrisilviculture system in rainfed condition.

Hardwickia binata with clusterbean

Hardwickia binata in agrisilviculture


Prosopis cineraria tree with different kharif crops in rainfed condition at ARS farm Fatehpur

Hardwickia binata in block plantation (5x5m)

Prosopis cineraria in silvipasture (*C. ciliaris*)

Dichrostachys cinerea in silvipasture

Azadirachta indica in silvipasture *with C. ciliaris*

8. AICRP on Arid Zone Fruits, SKNCOA, Jobner

This project was transferred at Jobner from Udaipur in 1984 to work on ber, aonla and pomegranate. The research work of this project is envisaged with the aim to generating appropriate fruit growing technology for the arid regions of the state with particular reference to arid fruits such as ber, aonla, pomegranate etc., with a view to building up a viable

commercial cultivation of fruit crops and thus improve the economic condition of the people, their nutrition and health standards. The significant achievements of this project are as follows:

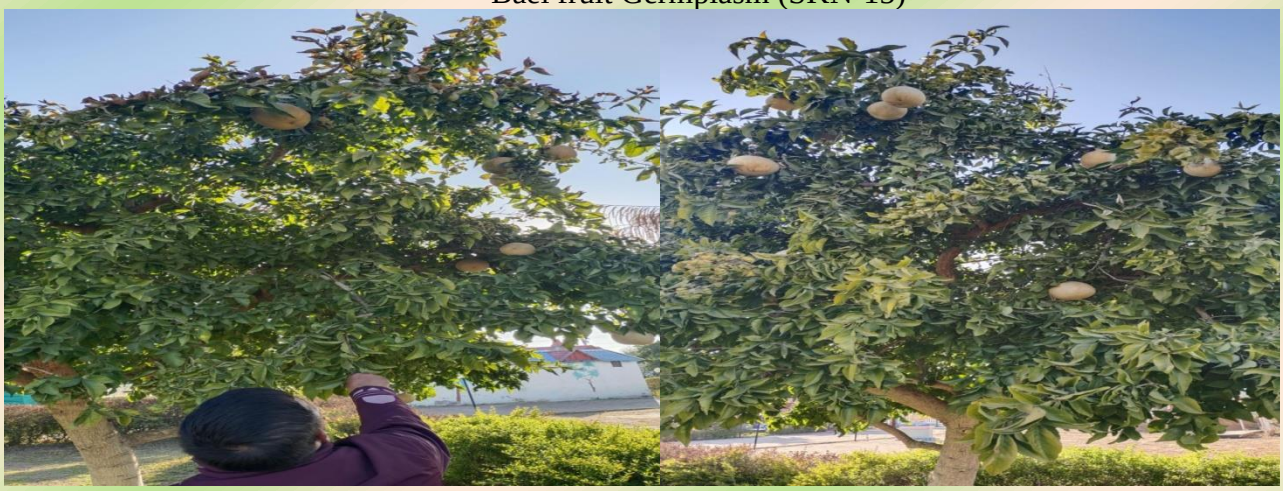
(i) Variety developed: Karan Lasoda

Result: Germplasm JL-07 exhibited highest fruit yield per plant (71.57 kg/plant), which was significantly superior over other germplasm of lasoda.

(ii) Evaluation of ber germplasm: Thirty-four germplasm have been budded on rootstocks of *Z. rotundifolia* at Asalpur Research Farm during July-Aug., 2000. Another 10 germplasm were also budded during *kharif* 2003.

(iii) Evaluation of Beal germplasms: Germplasms SKN-15 exhibited better performance in regards to vegetative growth of the plants. Maximum plant height of 4.89 m was recorded in germplasm SKN-15 which was statistically at par with germplasm SKN-14 (4.26 m). Germplasm SKN-15 exhibited maximum plant spread of 3.97 x 3.88 m followed by SKN-14 (3.86 x 3.55 m). Data further revealed that maximum number of fruits (72) was recorded in SKN-2 germplasm, while maximum weight was observed in SKN-15 (1500 g) followed by 700 g in SKN-6 (600 g). **Furthermore germplasm SKN-15 and SKN-2 also found tolerant to frost even at low temperature of -4.8^{0}C.**

Bael fruit Germplasm (SKN-15)



Bael fruit Germplasm (SKN-02)

(iv) Approved recommendations:

(a) Plant Pathology

1. **Biochemical basis of resistance in ber powdery mildew at different fruit development stages:** The small sized fruits of ber are more prone to infection by the powdery mildew pathogen as compared to advanced stages of fruits due to increased concentration of phenols. Hence, it is recommended to advise farmers to keep intensive watch at early stage of fruit development (i.e. at peanut stage) and take necessary care to apply already recommended fungicides to minimize the yield loss.

25. **Cost effective control of ber powdery mildew:** It is recommended that two sprays of **myclobutanil 10% WP** (@ 0.04%) at an interval of 15 days from disease initiation was found most effective in managing powdery mildew of ber (c**aused by *Microsphaera alphitoides* f.sp. *ziziphi***) as cost effective and alternative to already recommended dinocap & sulphur fungicides.

26. **Management of leaf spot of lasoda (*Cordia myxa*):** It is recommended that two sprays of tebuconazole 50%+ trifloxystrobin 25% (75 WG) (@ 1 g/litre water) at an interval of 20 days from disease initiation during fruit bearing stage (April to May) was found most effective in controlling Alternaria leaf spot of lasoda with increased fruit yield and monetary return.

(b) Entomology

1. **Management of shot hole borer, *Xyleborussp.*onaonla:** For the management of shot hole borer in aonla pasting the imidachloprid 17.8 SL (2.8 ml), carbendazim 50 WP (5 g) and *Geru* (Red Soil) 400 g in one litre of water and applied as paste to tree trunk from ground level to the point of starting branches by cloth made brush in second week of February.

2. **Population dynamics of aonla leaf gall midge, *Asphondyliaphyllanthi*:** Population dynamics study of Aonla Leaf gall midge, *Asphondylia phyllanthi* revealed that the initiation of Aonla leaf gall midge, *Asphondylia phyllanthi* damage was started in the month of February and it was reached at its maximum level in the month of September in all the years. The pest population increase with the increase in temperature and pest population decrease with the increase in relative humidity and rainfall. The meteorological study showed that pest population is positively correlated with the minimum and maximum temperature and negatively correlated with the relative humidity and rainfall.

3. **Estimation of Avoidable losses caused by Leaf gall midge (*Asphondyliaphyllanthi* Felt) and stem capsule borer (*Betousastylophora*Swinhoe) in Aonla:** The leaf damage by leaf gall midge and twig damage by stem capsule caterpillar in aonla can be minimized by the two foliar spray of imidachloprid 17.8 SL@0.3 ml/ltr starting from March at 20 days interval and subsequent two sprays of spinosad 45 SC @ 0.1 ml/lt at monsoon initiation at 20 days interval followed by removal of infested twigs.

4. **Seasonal activity of aonla shot hole borer, *Xyleborus sp*.:** Seasonal activity of aonla shot hole borer, *Xyleborus sp*. indicated its peak activity from August to September with highest infestation level up to 30cm height from the ground level.
5. **Varietal screening of bark eating caterpillar, Inderbellatetraonis on different ber cultivars:** Studies were conducted to see the comparative incidence of bark eating caterpillar, *Inderbella tetraonis* on different cultivars of ber. Pusa Prolific and Ashapuri-II were found least susceptible against bark eating caterpillar, whereas, Chandni Supari was found moderately susceptible and Gola,Umran, Kaithli, Ilaichi and Chomu Local were found highly susceptible at Jobner.

6. **Management of bark eating caterpillar, *Indarbelatetraonis* Moore (Lepidoptera :Metarbelidae) in ber with bio- ecological approaches:** Thrusting of wire + pouring of Neem oil 2 ml + plugging of holes with mud proved very effective for the management of Bark eating caterpiller of ber, *Indarbellatetraonis*

(c) Plant physiology:

1. **Nutritional Survey of Ber orchards (2019)**: It is recommended from Dris Norms datas of this computer software programme that farmers may be profited by getting high yield of ber from their orchard if nutrients status of nitrogen (from 2.66 to 3.08), phosphorus (from 0.34 to 0.42), calcium (from 1.54 to 1.81) and magnesium (from 0.77 to 1.03) is maintained in the plants by applying fertilizers to the soil.
2. **Alleviation of Adverse Effects of Salt Stress in Ber by Foliar Treatment with Antioxidant**: Concluded that the harmful effects of salt stress on ber plants may be alleviated by foliar application of Ascobin at 800 ppm concentration by the farmers under the field areas having saline irrigation water up to EC 16.0 dSm^{-1}.
3. **Transpiration control in ber:** It is concluded that transpiration rate (water loss) of ber plants may be decreased with increase in water content in leaves by the foliar spray of kaolin at the concentration of 6%.

9. AINRP on Soil Arthropod Pests, RARI, Durgapura, Jaipur

The AINP on Soil Arthropod Pests project is going on at Rajasthan Agricultural Research Institute, Durgapura, Jaipur since 1983 to undertake research and development in the field of soil dwelling arthropod pests, such as white grubs, termites, cutworms, wireworms, root bugs, mole cricket, snails, red ant etc. The significant achievements of this project are as under;

(i) The technology under process of commercialization: The pheromone nanogel technology is one of the significant achievements for the management of white grub prominent species *Holotrichia consanguinea* of Rajasthan. However, the already isolated and characterized pheromone methoxy benzene of predominant species of groundnut ecosystem *Holotrichia consenguniea* is aggregating pheromone but it is highly volatile in nature so, daily putting of new septa on host tree does require. To overcome this problem for farmers slow release pheromone lure is prepared by Nano gel technology for beetle management and the

technology has been tested in white grub endemic areas of Rajasthan and perfected, which is ready to release now. This pheromonal Nano-lure is effective in aggregation of beetles up to one month and now daily loading of new septa wouldn't be required upto one month. This technology is under process for commercialization.

Fig: Beetle feeding on Host Tree

Pheromone Nano-lure

Pheromone Nano-lure installed in trap

Attraction of Beetles towards Nano lure

Collection of Beetles

Pheromone Nano-gel Technology

(ii) Crop management package of practices developed and recommended:

The centre was established in 1983 and since then many package of practices have been developed and recommended to the farmers as below till today for the management of soil arthropod pests.

1. Seed treatment in groundnut with Chlorpyriphos 20 EC at 400 g a.i./ha (25 ml./kg seed)was recommended for control whitegrub.
2. Standing crop treatment in groundnut with Chlorpyriphos 20 EC at 800 g a.i./ha was recommended for control whitegrub**.**
3. Seed furrow application of Chlorpyriphos 10 G at 2 kg a.i. /ha has been found vary effective against *Holotrichia consanguinea* in groundnut crop**.**
4. Seed treatment in groundnut with Quinalphos 25 EC at 400 g a.i./ha (25 ml./kg seed)was recommended for control whitegrub.
5. Standing crop treatment in groundnut with Quinalphos 25 EC at 800 g a.i./ha was recommended for control whitegrub**.**
6. Seed treatment in groundnut with imidacloprid 200 SL at 48 g a.i./ha (3 ml./kg seed)was recommended for control whitegrub.
7. Standing crop treatment in groundnut with imidacloprid 200 SL at 60 g a.i./ha was recommended for control whitegrub.
8. New insecticide Clothianidin 50 WDG at 160 g/ha (2 g/ kg seed) was effectively control the whitegrub in groundnut.
9. Use of Fipronil 5 SC at 10.00 ml/kg seed was effectively control the termite in chickpea crops.
10. Seed treatment with Clothianidin 50 WDG at 1.5 g per kg seed has been found good in wheat against termite
11. Recommendation of use of Imidacloprid 17.8 SL as standing groundnut crop treatment at 360 ml/ha, 21 days after sowing is effective for the management of whitegrub, *Holotrichia consanguinea*.
12. The technology of using imidacloprid 600 FS as seed treatment @ 6.5 ml/ kg of seed of groundnut for managing white grub, *H. consanguinea.*
13. For the management of termites in wheat, fipronil 5 SC at 6 ml/ kg seed use as seed dresser was found significantly superior.
14. For the management of termites in chickpea, fipronil 5 SC at 10 ml/ kg seed use as seed dresser was found significantly superior.
15. For the management of termite in Groundnut crop treat the seeds with Imidacloprid 600 FS @ 6.5 ml or Fipronil 5Sc @ 10 ml per kg seed
16. For the management of white grub beetles slow release nanogel of pheromone methoxy benzene (anisole) is effective up to 25 days of installation.

17. For the management of termite in chickpea, seed treatment with Imidacloprid 600FS @ 5 ml per kg seed is most effective.
18. For the management of termite in standing chickpea crop, drenching the crop with Imidacloprid 17.8 SL @ 360 ml or Fipronil 40% + Imidacloprid 40% 500 gram per ha is most effective.
19. For the integrated management of soil arthropod pests in groundnut crop apply Neem cake @ 250 kg/ha in soil before sowing, then treat the seeds with imidacloprid 600FS @ 6.5 ml/kg seed, then apply *Beauveria bassiana* @ 0.5 kg/m^2 at 15 days after sowing followed by application of imidacloprid 17.8 SL @ 300 ml/ha at 21-25 days after sowing.
20. For the management of whitegrub the microbial control agents fungi, *Metarhizium anisopliae* and *Beauveria bassiana* were identified as entomopathogenic to the predominant whitegrub species of the region i.e. *Holotrichia consanguinea*. It is found that fungi, *Metarhizium anisopliae* was more effective, when it placed at soil depth of 10-15 cm.
21. Few species of nematode, *Setainernema glaseri*, *Heterohabditis spp*. and a local strain was found to be pathogenic to several whitegrub species including *Holotrichia consanguinea.* Rearing the local strains of this nematode at department.
22. Inventory of soil arthropods of Durgapura soil was prepared in which about 20 different types of beneficial soil fauna belonging to different order were listed.
23. The effected of insecticides on non- target insects was carried out and it was found that these pesticides are harmful to soil mites, collembolans and other micro soil arthropods . It was found that the population of soil arthropods specially soil mites and collembolans were restored after two months in case of Chlorpyriphos and quinalphos and three months in case of imidacloprid.

10. AICRP on Arid Legumes, RARI, Durgapura, Jaipur

All India Network Research Project on Arid Legume was started in the year 1986 with objectives of development of high yielding varieties resistant to major pests and diseases, development of production and protection technologies and development of guar varieties with high gum content and good gum quality. The significant achievements of this project are as under:

(i) Varieties developed: Following varieties of Cluster bean and Cowpea released under this project.

(a) Cluster bean:

1. RGC 197 (S.O. 386 (E), 15.5.1990): Unbranched, tall, alternate bearing, suitable for inter and mixed cropping eco-systems. Moderately resistance to bacterial blight. Average yield is 10-12 q/ha.
2. RGC 936 (S.O. 793 (E), 22.11.1991): Early maturing (85-90 days), branched, photo and thermo insensitive, grain yield 8-11 q / ha, gum content 29.93-31.65% and high protein content.
3. RGC 471 (S.O. 408 (E), 4. 05.1995). Branched and long duration (110-120 days). High seed yield (10-14 q/ha), good gum content and fodder yield (80-90 q/ha). Highly suitable under low rainfall areas.
4. RGC 1003 (S.O. 425 (E), 8.6. 1999): Branched, medium tall, early maturity (86-90 days), most suitable for sole crop sequences. High seed yield (12-15 q/ha).
5. RGC 986 (S.O. 425 (E), 8.6. 1999): Medium tall, medium maturity (110-115 days) branched and fast growing. High seed yield (10-15 q/ha) and gum content (29.10%). Suitable for sole crop in rain-fed and irrigated situation. Resistant to bacterial blight.
6. RGC 1002 (S.O. 1050 (E), 26.12.1999): Branched, medium height and early maturing (80-90 days). High seed yield (8-12 q/ha) and gum content (30.05-32.55%) with high endosperm content (34.20–37.50). Bold seeded (3.52 gms/100 seed).
7. M 83: Kanchan Bahar (S.O. 1135 (E), 15.11.2001): Released for vegetable purpose and developed through mutation breeding.
8. RGC 1017 (S.O. 937 (E), 4. 09.2002). Early maturing (92-96 days), medium tall and suitable for double cropping eco-systems. High seed yield (10-14 q/ha), gum content (30.05–32.55%).
9. RGC 1031 (S.O. 1566 (E), 5.11.2005). Late maturing, tall, high seed yield, high quality characteristics and suitable for rain-fed areas in the state. Gum content is 28.19 to 30.94%.
10. RGC 1066: Lathi (S.O. 1703 (E), 5.10.2007). It is an unbranched, early, suitable for inter-cropping & mixed-cropping. This variety has seed yield potential ranging from 10.32 –14.51 qt./ha.

11. RGC 1038 (S.O. 449 (E), 11.02.2009): Suitable for semi-arid, sandy loam soils and rain-fed condition of the Northern zone of the country. Medium maturing (95-105 days), branched, medium height, high fodder & seed yield (10.71 to 29.85 qt./ha).
12. RGC 1033 (S.O. 283 (E), 07.02.2011). Medium maturity (100-105 days), branched with medium height with good grain yield potential (12.71 to 26.85 qt./ha). Gum content is 28.19 to 30.94%.
13. RGC 1055 (S.O. 1703 (E), 5.10.2007): Mature in 96-106 days with synchronized maturity. Good yield (10.96-28.81 qt./ha) with high endosperm (35.30-37.23%).
14. RGr 12-1: Karan Guar-1(S.O. 1379 (E) 27.03.2018). Early maturing (87 days), moderately resistance to bacterial blight and Alternaria leaf spot with yield potential of 1058 kg/ha.
15. RGr 18-1: Karan Guar-14 (2022). Medium maturity (90-95 days), moderately resistance to bacterial blight and Alternaria leaf spot with yield potential of 15.0q/ha. Seed are medium bold (2.7-3.3 g/100 grain), good gum content (29.00%) with high viscosity profile (3412 cp).

RGr-12-1

RGC-1033

RGC-1066

RGC-1038

(b) Cowpea:

1. RC 19 (S.O. 165 (E), 6.3. 1987): Seed are red brown , 10.0 g seed weight and mature in 60 days and average yield is 750 kg/ha. Low incidence of pod borer, aphids and leaf hopper.
2. RC 101 (S.O. 92 (E), 2.2. 2001): Moderate plant height (45 cm) with mature in 65 days. Seed are white with 11.18 g seed weight with yield of 6-8 q/ha.
3. CPD 119: Karan Chanwla 1 (S.O. 1379 (E) 27.03.2018): Medium bold (9.11 gm) white seeded variety and mature in 70 days with seed yield of 6.0-80.0q/ha.

(ii) Crop Production/protection technologies developed:

1. Maximum seed yield of cowpea was obtained with 2 sprays of 0.5 % $FeSO_4$ at 25 and 45 DAS, giving 26 % higher yield.
2. In cowpea, 1 or 2 sprays with 0.5 % $FeSO_4$ or 0.5 % $ZnSO_4$ at 25 or / and 45 DAS gave significantly higher seed yield over control, but statistically equivalent to soil application of 25 kg $ZnSO_4$/ha. The effect of Zn spray at all the stages was more pronounced than Fe spray on seed yield of cowpea.
3. In cluster bean, bacterial blight and Alternaria blight incidence drastically reduced with the application of 0.5 % $ZnSO_4$ as foliar spray at 25 and 45 DAS.
4. *Rhizobium* and P.S.B. culture treatments increased grain yield of cluster bean over control with a tune of 20-25 % higher.
5. Two foliar sprays of urea@ 1.0% at pre-flowering (35-45 DAS) and post flowering (55-60 DAS) stages increases seed yield of guar under rainfed coarse textured agro-ecological situation.
6. In cowpea crop at Durgapura centre spray of 2 % urea solution is recommended for higher seed production and net returns.
7. In case of long dry spell, if there is a facility of single irrigation in cluster bean then apply at 50% flowering stage (40-45 DAS). If facility is available for two irrigations then irrigate at vegetative stage (25-30 DAS) and at 50% flowering stage (40-45 DAS).

8. Application of Imazethapyr @40 g/ha or Imazethapyr +Imazemox @40 g/ha at 20 DAS effectively manage weed problem in clusterbean.(kh-2013 –state POP)
9. In standing cowpea crop post emergence application of Imazethapyr 10 %SL @ 37.5 g a.i./ha at 15-20 DAS is recommended for the control of broad leaf & grassy weeds. 2013.
10. Post emergence application of imazethapyr 10% SL @ 37.5 g a.i./ha or imazethapyr + imazamox(Ready mix) 70 WG @ 40 g a.i./ha at 15-20 DAS effectively managed weed problem and improved seed yield of cluster bean . 2015.
11. Foliar spray of NPK @ 1% at vegetative stage resulted higher mean seed yield (1151kg/ha.) and B:C ratio 2.7 in guar (National POP) 2015-2017.
12. Post emergence application of imazethapyr + imazemox 70 WG @ 40 g a.i./ha at 20 DAS is recommended to manage both grassy and broad leaf weeds in cowpea **(2015)**.
13. Application of pre –emergence (pendimethalin @ 0.75 kg a.i /ha PE) + One Interculture operation at 20-25 DAS resulted higher mean seed yield 1136 kg/ha and B:C ratio 2.43 in Guar (National POP) 2015-2017.
14. Foliar application of 2 % urea at 25-30 DAS significantly increased seed yield of rainfed cowpea, which fetches maximum net returns. 2017-18
15. Foliar spray of NPK @ 1% at vegetative stage resulted higher mean seed yield (1151kg/ha.) and B:C ratio 2.7 in guar (National & State POP) 2015-2018.
16. Application of pre –emergence (pendimethalin @ 0.75 kg a.i /ha PE) + One Intercultural operation at 20-25 DAS resulted higher mean seed yield 424kg/ha in cowpea (National & State POP) 2018.
17. Spray of Salvadora leaf extract (2%) at 35 and 49 DAS of guar crop significantly reduced the infection of powdery mildew.
18. Seed dip treatment for 2 hrs. in 250 ppm solution of streptocycline followed by 3 sprays of mixture of streptocycline (150 ppm) and copper-oxy-chloride (0.2%) reduced bacterial blight infection in guar.

19. Losses caused by charcoal rot in guar were estimated with Bavistin (0.1 %) + Thiram (0.2 %), causing loss of 25.39 %, while loss was 82.45 % in control.
20. Extract of bulb of *Allium sativum* checked 100 % growth of the *M. phaseolina* while extract of *Curcuma longa* checked the growth up to 73.77 % in guar.
21. Application of mustard residue in soil followed by summer irrigation and seed
22. Losses caused by charcoal rot were estimated with Bavistin (0.1 %) + Thiram (0.2 %), causing loss of 25.39 %, while loss was 82.45 % in control. Extract of bulb of *Allium sativum* checked 100 % growth of the *M. phaseolina* while extract of *Curcuma longa* checked the growth up to 73.77 % in guar.
23. Management of bacterial leaf blight of clusterbean seed soaking with streptocycline for 1 ½hours + two spray of copperhydroxide (0.2%) (2013-14).
24. Management of root rot in Cluster bean with soil amendment with *Tricoderma viride* 2.5 kg in 100 kg FYM/ha + Seed treatment with *Carbendazim* 2g/kg seed(2014-15).
25. Management of root rot in cowpea with soil amendment with *Tricoderma viride* 2.5 kg in 500 kg FYM/ha + Seed treatment with *Tricoderma viride* 4 g/kg seed (2014-15).
26. Seed soaking with Copper hydroxide (0.2%) + two sprays of Copper hydroxide (0.2%) was found the best against BLB of clusterbean (2014-15).
27. For control dry root rot of cluster-bean induced by *Macrophomina phaseolina* by soil amendments with mustard residue (2.5t/ha) along with seed treatment with *Bacillus thuringensis* (4g/kg seed) and one summer irrigation was best in reducing percent seedlings mortality (pre and post emergence) and increasing seed yield of guar.
28. For the control of leaf blight disease of cluster-bean soak the seed in 0.1% solution of streptocycline (6g streptocycline in 6 litre water for 6kg seed) for one hour and sow after drying under shade for 30-40 minutes. At 55-60 DAS or onset of the disease, spray the crop twice with 150ppm solution of streptocycline + blitox -50(3g/l water) at an interval of 15-20 days.

29. To control bacterial leaf blight of clusrter-bean spray the crop with neem seed kernel powder extract (NSKE 5%) thrice starting from onset of the disease at an interval of 15 days (2016).
30. Seed soaking with streptocycline @500ppm + Seed dressing with cabendazim @2g/Kg seed + seed treatment with fipronil 5% SC @4ml/kg seed and foliar spray with streptocycline @250ppm + copper oxychloride @ 0.2% + foliar spray with thiamethoxam 25WG @ 0.3g/litre followed by spray of acetamiprid 20SP @0.2g/litre at 15days interval was found effective and economical for the management of sucking pests (aphid, Leafhopper and whitefly) and disease (bacterial blight and root rot) in clusterbean and this treatment also gave higher yield at Durgapura (National POP) 2015-2017.
31. To control cowpea root rot/stem blight –Amend the soil with mustard compost (2.5t/ha) + vermi-compost (5t/ha) and sow the seed after treating with Tricoderma harzianum powder (4g/kg seed).

11. AICRP on Taramira, SKNCOA, Jobner

All India Coordinated Research Project on Oilseeds (Taramira) was established at Deptt. of Plant Breeding & Genetics, S.K.N. College of Agriculture, Jobner during April, 1987, The mandates of the project are survey and collection of local ecotypes from different parts of Rajasthan, maintenance of germplasm, screening of germplasm with respect to oil, erucic acid and glucosinolate content and development of package of practices for taramira cultivation. The significant achievements of project are given as under:

(i) Varieties developed: RTM 2002, RTM-314, RTM-1351, RTM-1355 and RTM-1624

RTM-314

RTM-2002

RTM-1355 RTM-1351

RTM- 1624

(ii) Technologies developed: Sixteen package of practices for taramira growing areas have been developed with respect to proper sowing time, fertilizer requirements, integrated nutrient management, micronutrient studies, foliar spray of Agro-chemicals, efficacy of FYM and vermicompost, phosphorus management in taramira and evaluating different farming systems and comparing taramira and mustard.

12. AICRP on Integrated Farming System, RARI, Durgapura, Jaipur

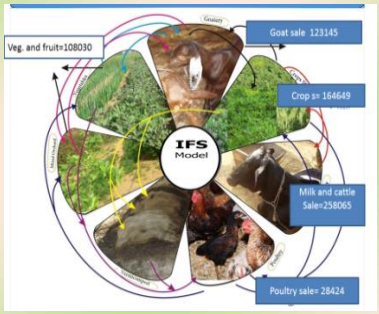
AICRP on cropping system research was established at RARI, Durgapura during 1990 and now it is named as AICRP on IFS with the main objective of generating adequate income and employment for the small and marginal famers and identifying appropriate cropping systems with high productivity which suits to the specific needs of agro-climatic zone IIIA. Based on the past few years research an improved IFS model was designed, tested and validated for 1.45 ha area to support a farm family of seven members. The significant achievements of this project are given as under:

(i) IFS models

- The IFS model of RARI, Durgapura is generating the employment around 1015 Mandays per year.

- Gross return from different components of the IFS model is around Rs. 7,14648/- annually.
- As this model is the integration of different enterprises like crop production, horticulture, dairy, goatry, fisheries, forestry, sericulture, poultry, etc. so it satisfies all the nutritional requirement (minerals, vitamins, protein and carbohydrate) of farm family form the farm itself.
- Adoption of different cropping systems or incorporation of leguminous crops or fodder crops and recycling of crop/farm waste improves the soil health.
- Greenhousegas emission from the model is negative so the model is environmentally safe.
- IFS model, RARI, Durgapura has market dependency only 15.28% as most of the inputs are generated at farm itself as the byproducts of another enterprise.

(ii) Crop management package of practices developed: Based on three crop cycles, ground nut (immaturepods)- Rabi Onion cropping system is recommended for income enhancement of farmers.

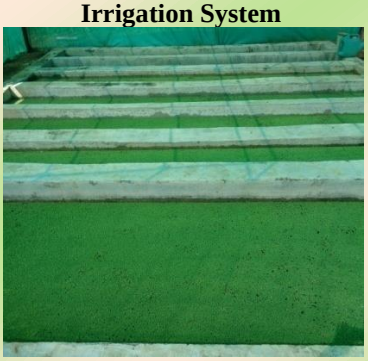


Inter and out flow of resources in small farming model of IFS

Vegetable Block under Drip Irrigation System

Methi as Intercrop within Fruit Plants

Goat unit poultry birds



Azolla Unit

Vermi compost unit

13. AICRP on MULLaRP, RARI Durgapura, Jaipur

All India Coordinated Pulse Improvement Project was started on 01.04.1976 at Agricultural Research Station (ARS), Durgapura, Jaipur. In the financial year 2001-02 Pulse project bifurcated into two AICRP on MULLaRP and AICRP on Chickpea. Now, AICRP on MULLaRP is under the jurisdiction of SKN Agriculture University, Jobner

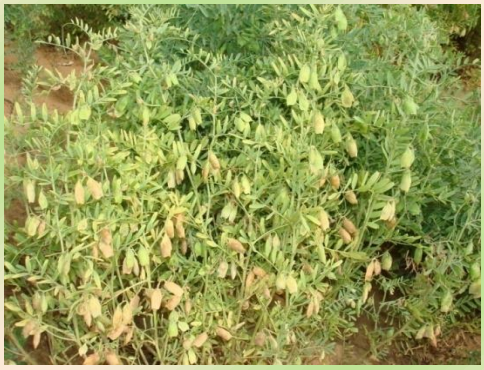
(Raj.) with its head quarter at Rajasthan Agricultural Research Institute, Durgapura, Jaipur. The aim of project is to development of high yielding varieties with wider adaptability, to maintain germplasm and to developed production technologies. The significant achievements of this project are as under:

(i) Varieties developed:

Crop	Varieties
Moong	RMG-62, RMG-492, RMG-975, MSJ-118
Lentil	RLG-5
Fieldpea	RFP-4

RMG 975

RFP 4



RLG 5

MSJ 118

(ii) Production technologies developed: 23

(iii) Crop Protection Technology Developed: 20

14. AICRP on Chickpea, RARI Durgapura, Jaipur

The main objective of this project is to develop high yielding chickpea varieties resistant to major pests and diseases and suitable for irrigated and rain-fed conditions, to

develop varieties for mechanical harvesting and to develop Production and protection recommendations. Achievements of this project are as given below:

(i) Varieties developed:

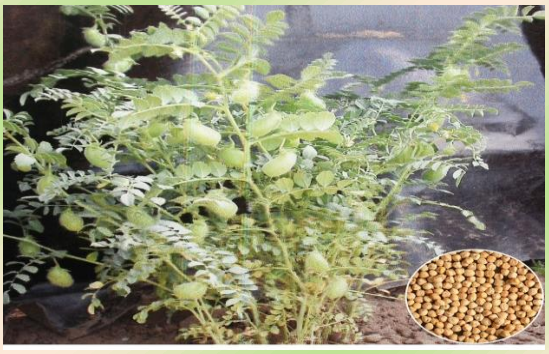
Following varieties of chickpea released after establishment of AICRP Chickpea centre at RARI, SKNAU, Durgapura (Jaipur).

1. RSG-888: ANUBHAV: (S.O..100E dated: 28-1-02): Double podded, high yielding (15-20-q/ha) suitable for rainfed areas of NWPZ.
2. CSJD-884: AKASH (S.O.283 (E) Dated: 12-3-03): High yielding (15-20q/ha) double podded, suitable for rainfed area. It had good resistance level for dry root rot and wilt.
3. RSGK-6: ASAR (S.O.283(E) Dated:12-3-03): Bold seeded kabuli gram variety having high yield (15-20 q/ha).
4. RSG-931: ANVITA (S.O.599(E) Dated: 25-4-06): High yield (20-25 q/ha), released for rainfed conditions of NWPZ.
5. RSG-973: ABHA (S.O.599(E) Dated: 25-4-06): Drought tolerant having high yield (15-20 q/ha) released for rainfed conditions of Rajasthan. It had good resistance level for dry root rot, wilt & nematodes.
6. RSG-807: ABHAR (S.O.599 (E) Dated: 25-4-06): Bold seeded having high yield (20-25 q/ha) under normal condition of Rajasthan with less damage by pod borer.
7. RSG-895: ARPITA (S.O.1566(E) Dated:5-11-05): Having high yield (15-20 q/ha) released for rainfed and irrigated conditions of Rajasthan. It has special marker of white flower double pods. It is suitable for nipping and grazing.
8. RSG-945: ASHA (S.O.1566 (E) Dated:5-11-05): Released for late sown conditions of Rajasthan with seed yield of 20-25 q/ha.
9. RSG-963: AADHAR (S.O.1566(E) Dated: 5-11-05): Suitable for late sown, seed yield of 20-25 q/ha and suitable for NWPZ.
10. RSG-896 : ARPAN (S.O.1703(E) Dated:5-10-07) Suitable for light salinity in water logged area . Double podded high yielding (15-20 q/ha).

11. RSG-902: ARUNA (S.O.1703(E) Dated:5-10-07): Double podded, high yielding suitable for rainfed, late sown, irrigated, high branching and podding chickpea variety suitable for all the growing conditions of Rajasthan.
12. RSG-991: ARPANA (S.O.1703 (E) Dated:5-10-07): Green seeded variety of state under value addition, having high yield (20-25 q/ha) potential under normal sown irrigated condition.
13. RSG-974: ABHILASHA (S.O.1703(E) Dated:5-10-12): The chickpea variety released for normal and late sown conditions,Single podded with high yielding(20-25 q/ha).
14. CSJK-21: ANAND (S.O.1703(E) Dated:5-10-13) The extra large Kabuli ((56-62gm) chickpea known as Dolar in MP. Single podded, high yielding (10-12 q/ha).
15. CSJK- 6 : ANJALI (S.O.1703(E) Dated:5-10-13): Kabuli gram variety having high yield (15-20 q/ha), released for NWPZ.
16. CSJ- 515 : AMAN (S.O. 2238 (E) Dated: 29.06.2016): Drought tolerant chickpea variety CSJ- 515 (AMAN) having high yield (15-20 q/ha), suitable for mechanical harvesting, released for rainfed conditions of NWPZ
17. CSJK 174: Karan Kabuli 4 (S.O. 8 (E) Dated: 24.12.2021): It is recommended for South Zone, higher seed yield (15-20 q/ha). It is moderately resistant against wilt, Stunt disease and pod borer.

CSJ 515

RSG 888



CSJK 174

RSG 973

(ii) Production/Protection technology developed:

Following major technologies developed on chickpea after establishment of AICRP Chickpea.

1. The study of optimization of seed rate and phosphorous levels for bold seeded kabuli gram, 100 kg/ha seed rate and 30 kg/ha phosphorus application resulted in significantly higher grain yield.
2. The soaking of chickpea seed in water for 8 hours significantly increased number of pods per plant, number of grains per pod, 100 seed weight and grain yield.
3. The 2% spray of DAP at flower initiation and 10 days later increases grain yield in Chickpea.
4. Application of 5t FYM/ha has been found useful to increase grain yield of Kabuli Chickpea.
5. Keeping in view the yield and economic advantages of BBF with intercropping, chickpea+ linseed at Durgapura is recommended with broad bed furrows (over flat bed alone, ridge-furrow &BBF alone).
6. Two supplementary irrigation (at branching & pod development) had beneficial effect in terms of CEY was adequate under assured availability of water while single irrigation at pod development was adequate under limited availability of water.
7. Application of crop residues as mulch) @ 2.5 t/ha coupled with conventional tillage is recommended.
8. Pendimethalin 30 EC +Imazethapyr 2% ready mix combination @ 0.75 kg/ha as pre-emergence was adequate in chickpea.

9. Pre emergence application of pendimethalin 30 EC or pendimethalin extra 38.7 CS @ 0.75 kg a,i/ha significantly increased the yield and effectively managed the weeds in chickpea.
10. Foliar application of 0.5% each of $ZnSO_4$ and $FeSO_4$ alongwith slaked lime at pre-flowering and pod formation stage significantly improved seed yield and Fe and Zn content in seed over control. It also fetches higher net returns and B:C ratio.
11. Intercropping of chickpea and Linseed in 5:1 row ratio significantly improved chickpea equivalent yield and caused reduction in percent pod damage which fetches higher net returns and B:C ratio.
12. Based on chickpea equivalent yield (CEY), land equivalent ratio, and economics (net return and BCR), At Durgapura and Shillongani, Chickpea +Linseed in 6:2 row ratio is recommended.
13. Reduced tillage (one harrowing +planking) along with two supplementary irrigations at branching and at pod filling stages through sprinkler is recommended at Durgapura ,Rajasthan.
14. Intercropping of chickpea and Linseed in 6:2 row ratio significantly improved chickpea equivalent yield and land equivalent ratio which fetches higher net returns and B:C ratio
15. The IPM components through seed treatment with Endosulfan 35EC 8ml/kg seed + Carbendazim 1gm/kg seed + Trichoderma 4gm/kg seed + Rhizobium 6.25gm/kg seed and NPV 300LE having $1.5*10^9$ PIB at 80 days followed by 100 days were found best for pod borer control.
16. The most suitable cropping system for nematode control is Bajra-Chickpea.
17. Carbosulfan 25 ST @3% w/w was found most effective for the nematode control followed by Neem Seed Powder @5gm/kg seed.
18. Seed treatment with Bavastin (1gm) +Thirum (2.5gm) per kg seed is most effective to control dry root rot.
19. Seed treatment with *Trichodermaviride* + vitavax (4.1g/kg seed) with linseed mixture cropping system was found effective in minimising the dry root rot incidence of chickpea genotypes.

20. The genotypes RSG-143-1, RSG-973 and CSJ-73 were identified as drought tolerant donor parents with less than 1.0 DSI value.
21. Seed soaking in water for 8-10 hours prior to sowing was found to increase the seedling vigour index by about 9%, which may be helpful for crop establishment under moisture stressed conditions.
22. Spray of 35 E.C. Endosulphan 2.5 liter/ha at the time of flowering on thirty demonstrations showed 12.4 % (8.1 to 19.1 %) increase in seed yield.
23. Spray of NSKE 5%+NPV 250LE at the time of flowering on twenty six demonstration showed 13.9 % (10.1 to 20.2%) increase in seed yield.
24. Use of additional dose of carbofuron @1.5 kg/ha on twenty three demonstrations showed 16.8% (11.7 to 21.3%) increase in seed yield.
25. Seed treatment with 4gm *Trichoderma viridi*/kg of seed showed 14.3 % (10.4 to 21.2%) increase in seed yield.
26. Seed inoculation with potash solublizer @5ml/ kg seed along with application of 20Kg K_2O/ ha significantly increased seed yield of chickpea which fetches higher net return and B:C ratio.

15. AINRP on Onion and Garlic, SKNCOA, Jobner

AINRP on Onion and Garlic" is running at Department of Horticulture, SKNCOA-Jobner as one of the main centres working under AINROG since 2009. Under this project IET and AVT trials of onion and garlic trials conducted as allotted from DOGR, Pune. The significant achievements of this are as under:

(i) Varieties developed: RO-1, RO-59 and RO-252

(ii) Technology developed: The centre has recommended seven production and three protection technologies.

16. AINP on Pesticide Residue, RARI, Durgapura:

Recommendations regarding waiting periods in different crops are as follows:

S. No.	Crop	Pesticide	Dose (g a.i. ha^{-1})	Waiting period (days)
1.	Tomato	Novaluron 9.45% + Lambda-Cyhalothrin 1.9% ZC	750	6
			1500	8
2.	Cabbage	Novaluron 9.45% + Lambda-Cyhalothrin 1.9% ZC	750	8
			1500	11

3.	Onion	Fluopyram 250 g/L+ Trifloxystrobin 250 g/L SC	150+150 g. a.i. ha^{-1}	6
4.	Green Onion	Fluopicolide 6.25% w/v + Propamocarb Hydrochloride 62.5% w/v SC (Infinito)	78.1+781.3	11
			156.25+1562.5	16
5.	Chilli	Imidacloprid 600FS	45	0
		Monocrotophos (36 SL)	625	4
			1250	6
6.	Cucumber	Imidacloprid (17.8 SL)	25	5
		Lambda-Cyhalothrin (5 EC)	15	9
		Spiromesifen (22.9 SC)	96	10
7.	Bitter gourd	Lambda-Cyhalothrin 5 EC	15 g. a.i./ha	10
		Spiromesifen 22.9 SC	120 g. a.i./ha	10
8.	Red gram	Tetraniliprole 200 g/L SC	50g. a.i. ha^{-1}, 250	11
			62.6 g.a.i.	15
9.	Gram	Chlorpyriphos (20 EC)	500	11
			1000	16
		Imidacloprid (600 FS) Gaucho	1.5 g a.i./kg seed	0
			3 g a.i./kg seed	0
		Flubendiamide 240 + Thiacloprid 240 SC (Belt Expert)	78.1+781.3	11
			156.25+1562.5	16
			78.1+781.3	11
			156.25+1562.5	16
10.	Mustard Leaves	Chlorpyriphos (20 EC)	100	16
			200	16
11.	French bean	Chlorpyriphos (20 EC)	600	11
			1200	16
12.	Pea	Lambda-Cyhalothrin 5 EC	15 g. a.i./ha	10
		Spiromesifen 22.9 SC	120 g. a.i./ha	10
		Imidacloprid (17.8 SL)	25 g a.i./ha	5
13.	Maize	Imidacloprid 600FS	1.8 g/ kg seed	0
			3.6 g/ kg seed	0
		Tetraniliprole 480 FS	7.2 g a.i./kg^{-1} seed	0
			9.12 g a.i. kg^{-1} seed	0

Other on going ad-hoc research projects:

- ICRISAT funded project: Genetically enhanced micro-nutrient – dense pearl millet grains for improved human nutrition in the Western Africa region and India" – Harvest-Plus Programme.
- ICAR funded project: New Research initiatives entitled, "Thrust area-1: Development of disease resistant, early maturing hybrids for North-Western Region of India and

Thrust area-2: collection, evaluation, characterization and conservation of pearl millet landraces and farmer's varieties".

- ICAR FUNDED PROJECT: Consortia for Research Platform (CRP) in 'Biofortification in selected crops for nutritional security'.
- Creation of seed hubs for increasing indigenous production of pulses in India by NFSM Govt. of India.
- Evaluation of chickpea germplasm for drought and DRR under CRP Agro biodiversity by NBPGR New Delhi
- DUS Project (AICRP – Wheat and Barley) Total Cost: Rs.1944394.00
- Monitoring of Pesticide Residues at National Level, Dept. of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers welfare, Govt. of India
- 'Forecasting Agricultural output using Space, Agro-Meteorology and Land based observations (FASAL)

Newly sanctioned RKVY Projects

- Establishment of agriculture machines testing centre
- Development of organic package for ber, beal, jamun and pomegranate under semi arid ecosystem of Rajasthan
- Farmer friendly approach for vegetable cultivation under low-cost polyhouse structures

MoUs Signed

S. No.	Date & Year	Collaboration with	Purpose
1	02.11.2023	Barmalt Malting (India) Private Limited, Kotputali, Raj.	Introduce New Malting Barley varieties in the region
2	30.10.2023	Rajasthan State Certified Seed Producers Association, Sri-Ganganagar	For promotion of breeder seed 0f Wheat & Barley Varieties

3	02.02.2023	Agreco Technologies Private Limited, Jaipur (Raj.)	Conduct teaching, research & extension education programme
4	17.02.2023	S. M. Sehgal Foundation (SMSF), Gurugram, Haryana	For hosting the community Radio station Alfaz-e-Mewat FM 107.8 at ARS, Navgaon, Alwar
5	09.02.2023	Wissmo Agventure Private Limited, Gurugramn & PBCs Aero Hub, Pune	For impart training on Drone technology & its application in Agriculture
6	07.01.2022	One Life Foundation, Greater Kailash, New Delhi	For commercialization of Biofortified Pearlmillet hybrid variety RHB-234
7	01.11.2022	National Centre for Organic & Natural Farming (NCONF), Govt. of India	For promotion of Organic & Natural Farming activities
8	11.02.2022	National Institute of Ayurveda (deemed to be University), Jaipur	Promote the growth & development of Ayurveda as a model institute for evolving standards of teaching, training & research
9	04.01.2022	Central sheep & Wool Research Institute (CSWRI), Avika Nagar	Develop co-operation & collaboration in research for development particularly in Animal nutrition, animal breeding & genetics, livestock production & management
10	23.03.2022	South Asia Biotechnology Centre (SABC), Jodhpur (Raj,.)	For cooperation in agricultural research, education & extension
11	26.03.2022	The Alliance of Bioversity International & CIAT, PUSA campus, New Delhi	For cooperation in agricultural research, education & extension
12	24.03.2022	Dhanuka Agritech Limited,	For cooperation in research, education & extension activities
13	01.11.2022	The UN World Food programme, India	Enhancing the nutritional effectiveness of the Pradhan Mantri Poshan Shakti Nirman 9PM Poshan) through establishing school nutrition gardens
14	22.11.2022	ICAR- Indian Institute of Wheat & Barley	For Post-Graduate Research

		Research, Karnal (Haryana)	
15	18.11.2022	ICAR- Indian Institute of Wheat & Barley Research, Karnal (Haryana)	For Foster breeding rights of latest ICAR-IIWBRs wheat & barley varieties
16	28.07.2021 18.08.2021	Indian Council of Agricultural Research, New Delhi	Umbrella MoU
17	17.03.2021	Vivekananda Global University, Jaipur	For Cooperation & collaboration in research for development particularly in Plant biotechnology, nanotechnology, medical microbiology, environmental technology & other related activities
18	23.07.2021	Maharishi Arvind University, Jaipur	To promote cooperation in area of mutual interest for the benefits of both institutions
19	12.08.2021	Career Point University	To promote cooperation in area of mutual interest for the benefits of both institutions
20	17.03.2021	Dr. B. L. Institute of Biotechnology, Jaipur	For Cooperation & collaboration in research for development particularly in Plant biotechnology, nanotechnology, medical microbiology, environmental technology & other related activities
21	01.09.2021	University of Technology, Vatika, jaipur	For scientific & Technical cooperation in the implementation of the project
22	23.07.2021	Jagan Nath University, Jaipur	For Cooperation & collaboration in research for development particularly in Plant biotechnology, nanotechnology, medical microbiology, environmental technology & other related activities
23	25.02.2021	Suresh Gyan Vihar University, Jagatpura, Jaipur	For collaboration in research, teaching & extension activities
24	01.10.2021	Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur	For carrying out collaboration in research, teaching & extension

			activities in relation to improvement of mustard crops
25	14.07.2020	MPUAT, Udaipur	For Academic cooperation
26	25.03.2020	ICAR- NRC on Seed Spices, Tabiji, Ajmer	For cooperation in Seed Spices education, research & extension
27	02.07.2020	Amity University, Jaipur	For cooperation in teaching, research & extension
28	14.07.2020	Agriculture University, Kota	For Academic cooperation
29	19.02.2020	ICAR- National Bureau of Soil Survey & Land Use planning (NBSS&LUP), Nagpur	For Soil monolith
30	13.01.2020	Rajasthan ILD Skill University, Jaipur	For cooperation in agricultural research, teaching & extension
31	16.03.2020	ICAR- Central Soil Salinity Research Institute, Karnal	For cooperation in agricultural research, education & extension
32	18.12.2019	The M/S Horticulture Produce Management Institute (HPMI), New Delhi	For scientific & Technical cooperation in the implementation of the project in Rajasthan
33	28.11.2019	Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur	For carrying out collaboration in research, teaching & extension activities in relation to improvement of mustard crops
34	13.12.2019	ICCRISAT, Patancheru, Telangana, India	For cooperation in agricultural research & extension

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