Major Achievements of Decade (2011-2020) at ICAR-CAZRI RRS, Pali-Marwar

ICAR-Central Arid Zone Research Institute
(ISO 9001:2015)
Jodhpur 342 003 (India)

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Foreword

Agriculture in Rajasthan is confronted with diverse climatic conditions, scanty and low rainfall, extreme temperature, high wind speed and evapotranspiration. Agriculture, including animal husbandry, contributes 24.59% to the State's Gross Domestic Product (GDP). The growth of agriculture has important influence on people of Rajasthan depending on agriculture and improving livelihoods status of farmers. The heavy dependence of agriculture on the monsoon rainfall makes it more vulnerable in the context of the changing climate. The Aravalli hills is a major divide in the state running diagonally forming the climatic boundary of the desert with only one Luni drainage system. The soil characteristics of the semi-arid region varies from region to region even at micro level. The presence of salts in water and soil in some areas is a common feature in Pali region. The ground water is medium to high saline with high concentration of sodium making farming difficult. This situation calls for developing farming system models for the region considering climatic conditions and availability of resources.

The ICAR-Central Arid Zone Research Institute has been making concerned efforts in providing better options in farming. This bulletin on Major Achievements of Decade of ICAR-CAZRI Regional Research Station, Pali is an attempt to document the results of these efforts in crop production, agroforestry, germplasm collection and management, development of crop and water management practices, pastures and production of grasses in recent past. I congratulate the Director and staff of RRS, Pali for bringing out this publication.

(S.K. Chaudhari)
Deputy Director General

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Message

Natural resources in arid and semi-arid Rajasthan are very fragile and hence highly prone to land degradation and desertification due to pressure from human and livestock populations. Rajasthan holds 61% area of the total arid zone in India (31.7 million ha). Harsh climatic conditions viz., inadequate rainfall coupled with high evapotranspiration, extreme temperature fluctuations, and light texture soils make agriculture a challenging task.

Under such constraints, various aspects on integrated farming system, soil and water conservation, salinity management, horticulture, agroforestry, and biodiversity conservation of grasses and shrubs have been focussed in recent past at the ICAR-Central Arid Zone Research Institute (CAZRI) Regional Research Station, Pali. In this direction, efforts of RRS, Pali to develop salinity-based crop management practices, improving crop yields, developing location specific farming system, addressing food security and livelihoods of farmers and promoting sustainable agriculture is highly appreciable.

I am happy that concerned efforts have been undertaken by the team of RRS, Pali to compile the research achievement during the decade 2011-2020 in form of the document. I compliment the authors and editors for the milestones and achievements made in past ten years.

(Rajbir Singh)
Assistant Director General (AAF & CC)

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Dr. O.P. Yadav
Director

Message

The hot arid and semi-arid environments are extremely diverse in terms of their land forms, soils, fauna, flora, water balance and human activities. The regions have low rainfall, extreme temperature variation, high potential evapotranspiration and high wind velocity Transitional plain of Luni basin encompasses district of Jalore, Pali, and some tehsils of Sirohi and Jodhpur districts. Adversity of climatic conditions, saline alkali soils and poor quality groundwater has resulted in fragile agriculture system in the Transitional plains of Luni basin.

ICAR-CAZRI Regional Research Station, Pali-Marwar has addressed the problems of hot arid and semi-arid zone in the form of applied and basic research. The station has made considerable achievements in the management of saline and alkaline soils and water, development of horticulture based agroforestry systems, moisture stress management, germplasm resources of henna and fruit trees, conservation agriculture, grassland management, seed production, development of agroforestry and silvipastoral systems, etc., as a result of intensive research studies.

CAZRI-RRS, Pali-Marwar is documenting has research achievemented during the decade 2011-2020. I would like to congratulate the staff of the RRS Pali for focusing attention on problems of arid agro-ecosystem. The compilation will be a rich source of knowledge and practical information on hot arid and semi-arid regions for researchers, farmers and all other stakeholders who are interested in solving the problems of agro-ecological zone of Luni basin.

(O.P. Yadav)
Director

Contents

Historical Background

The Indian hot arid zone covers about 12% of the country's geographical area. The region is characterized by inhospitable climatic conditions and scarce natural resources. Rainfall varies from 100 mm to 450 mm which is highly erratic and unpredictable. The region experiences extremes of temperature (-2 to 48°C), high solar radiation, high wind speed (35-40 km h^{-1}) and high evapotranspiration (1500-2000 mm $year^{-1}$). Nearly, 41-85% of groundwater is saline in different blocks. Crop yields under natural conditions are low and livestock is the major source of livelihood of the people. These low-yielding systems are perpetually under stress due to ever increasing human and livestock population, frequent droughts and desertification. Hence, to address the location specific problems of arid areas, Central Arid Zone Research Institute (CAZRI) was established in October 1959 by the Government of India and handed over to the Indian Council of Agricultural Research (ICAR) in April 1966. The institute is carrying out systematic research on use and management of natural resources, sustainable farming systems, livestock production and management, rural and farm livelihoods, and innovative methods of dissemination of technologies for over six decades to develop location specific technologies to provide solutions to the problems of arid zone agriculture and to control desertification.

Regional Research Station, Pali-Marwar was established as part of desert afforestation and soil conservation program in 1953. Major thrust was given on field studies and demonstration on forestry aspects in the beginning. The mandates of the station were expanded to include crop husbandry and grassland programs in 1957, sheep husbandry component in 1959 and management of saline soils and water in 1973. From 1986, the station started functioning as a Regional Research Station (RRS).

Thrust Areas

- Management of saline/sodic soils and water.
- Development of location specific farming systems.
- Seed production of grasses, annual crops and trees.

Location

Regional Research Station, Pali-Marwar is located about 6 km away from Pali city on Pali-Jodhpur road. The research station is located between 25°47'-25°49'N and 73°17'-73°18'E at 217-220 m above mean sea level. It receives about 400 mm rainfall per annum and area falls on the transition zone between arid and semi-arid climate. The soils are shallow in depth (30-45 cm) with sandy clay loam to sandy loam texture, 1.35-1.5 Mg m^{-3} bulk density, 7.7-8.4 pH, 0.15-0.55 dS m^{-1} electrical conductivity and a dense underlying layer of murrum (highly calcareous weathered granite fragment coated with lime).

Facilities

Research Farm

The RRS has 248 ha (984.09 bigha) of land in Pali district representing semi-arid area of transitional plain of Luni basin (Fig 1). An area of ~10 ha in the main farm has irrigation facilities from two open wells and irrigation is provided using sprinkler, drip and surface irrigation methods. The EC of water ranges from 2.5-4.5 dS m-1. Besides irrigated area, 24 ha rainfed area is used for cultivation of kharif crops. One goat unit is also available at the station. The farm is moderately equipped with farm machinery like tractors, seed-cum-fertilizer drill, bund maker and multipurpose crop thresher to support the field experiments.

Fig. 1 Google earth image of RRS, Pali-Marwar

Library and ARIS Cell

The station has a collection of over 1465 books on different subjects. The library subscribes to national and international journals related to various disciplines of agriculture and allied sectors. An agricultural research information system, having eight computers with internet facility, is available.

Laboratory

Basic facilities for soil, plant and water analysis are available at the station. The laboratory is moderately equipped with the instruments such as Kjeldahl distillation unit and digestion assembly, spectrophotometer, autoclave, pH meter, conductivity meter, centrifuge, etc.

Meeting Hall

The research station has one meeting hall to conduct scientific meetings and farmers' trainings with a seating capacity of 50 persons and is equipped with state of the art audio visual facilities.

Weather Station

The research station has an IMD sponsored automatic weather station as well as manual weather station to record basic weather parameters like soil and air temperatures, relative humidity, wind speed, sunshine hours, rainfall, etc.

Research Achievements

Biodiversity Conservation and Improvement of Annuals and Perennials

Collection, characterization and preliminary evaluation of sorghum germplasm

Two hundred and twenty-five germplasm of sorghum were collected and maintained at RRS, Pali. On the basis of agronomic scoring during kharif 2013 and kharif 2014, 151 germplasm were selected and trial was conducted in complete randomized block design with three replications under shallow soil condition during kharif 2015. The accessions exhibited good variability for all quantitative traits. Accessions identified as superior for different morphological characters on the basis of kharif 2015 data (Table 1).

Promising genetic resources of henna (*Lawsonia inermis* L.)

Sojat and surrounding area in Pali district of Rajasthan is the major henna cultivation region in India. Around 90% of the total production of henna dry leaves is from Pali district of Rajasthan. From 35,000 ha, annual production is about 35,000 tonnes of dry leaves worth Rs. 70 crores. In Sojat area of Pali district, henna cultivation is being undertaken since more than 70 years. In

Table 1 Superior accessions of sorghum identified on the basis of kharif 2015

Characters	Best entries and their mean
Days to 50% flowering	E-13 (52.7), EJ-54 (55.0), EJ-57 (55.3), GPP-18 (56.0), IS-23599 (57.0) and EJ-59 (57.0)
Days to maturity	GPP-18 (81.0), EJ-71 (82.7), GPP-6 (82.7), GPP-19 (82.7), GPP-22 (82.7),EJ-19 (83.0), GPP-10 (83.7) and EJ-67 (84.0)
Plant height (cm)	EJ-42 (285.0), RAJ-20 (274.8), RAJ-18 (274.2), RAJ-16 (272.8) and SMU-4 (270.3)
Stem diameter (cm)	CSV-15 (1.77), GPU-13 (1.48), IS-11497 (1.45), GPU-17 (1.41) and SMU-4 (1.40)
Number of leaves per plant	RAJ-16 (14.40), RAJ-21 (13.73), EJN-32 (13.00), RAJ-5 (12.73), EJ-48 (12.40) and ERN-7 (12.40)
Panicle length (cm)	GPP-21 (31.8), SMU-4 (28.4), CO FS 29 (27.8), SMU-1 (27.8) and PSC-1 (27.6)
Panicle width (cm)	GPP-21 (22.2), MP Chari (13.6), CO-FS-92 (11.6), FM-94 (11.1) and IS-15664 (10.7)
Leaf area (cm^2)	GPU-4 (502.83), CSV-15 (495.20), GPU-3 (494.76), GPU-38 (490.66), and GJ-37 (490.08)
Fresh weight per plant (g)	GPU-8 (238.8), CSV-22 (231.4), IS-11497(224.8), GPU-13 (220.6) and E-13 (210.9)
Dry weight per plant (g)	GPU-8 (88.4), E-13 (80.7), E-7 (74.7), IS-11497 (74.2) and SMU-4 (69.8)
Grain yield per plant (g)	RAJ-3 (27.7), EG-6 (27.1), GPP-15 (24.9), RAJ-18 (23.6) and GJ-39 (23.4)
1000 seed weight (g)	RAJ-9 (31.9), EJ-28 (31.7), ES-5 (30.2), RAJ-16 (30.2) and IS-11497 (28.6)

spite of large acreage under this crop, there is no released variety of henna and only populations raised from seeds are in existence at farmers' field. Therefore, a study was carried out to identify and select the potential genetic resources of henna population by assessing the existing variability for sustainable production and yield.

Efforts were made to improve existing germplasm as well as to develop improved agro-techniques to augment the production above one t ha^{-1}. Progeny S-25-3 recorded the highest dry leaf weight (38.2 g $plant^{-1}$) followed by S-21-2 (31.7 g $plant^{-1}$). Sojat-22 produced highest dry leaf yield (4.24 t ha^{-1}) under irrigated conditions. Accession S-22 recorded the highest dye content (28.7 mg g^{-1} dry powder). With regard to harvest time, the October cutting showed maximum dye content (28.2 mg g^{-1}) and minimum in June (23.8 mg g^{-1}). The dried leaf powder colour changed from dark reddish brown (June cutting) to green (October cutting) in all the populations.

Further, about 19 superior clonal germplasm of henna were collected based on their morphological characters and lawsone content from farmers' fields of henna growing areas of Rajasthan and evaluated under field conditions at RRS, Pali in the year 2017-20. The clonal germplasms CZ-RSPH-8, CZ-RSPH-15 and CZ-RSPH-16 were identified as superior genotypes in terms of dry leaves production (74.7, 75.3 and 101.3 g $plant^{-1}$ respectively) and lawsone content.

Morphological variation in fruits and seeds of *Balanites roxburghii* planch

Hingota (*Balanites roxburghii* planch), an underutilized wild tree of arid areas, has several medicinal uses. The fruits contain saponin and therefore, are locally used to wash clothes. Its seed has great potential to provide feedstock for biodiesel production. Survey conducted to investigate morphological variation among fruits and seeds in collections from 3 different locations of Pali-Marwar region: Khati khera, RRS Pali farm and rangeland management and soil conservation engineering (RMSE) area revealed high variation in fruit morphological characteristics viz., shape, size, colour and weight of fruits and seeds indicating ample scope for selection, conservation and utilization (Fig. 2).

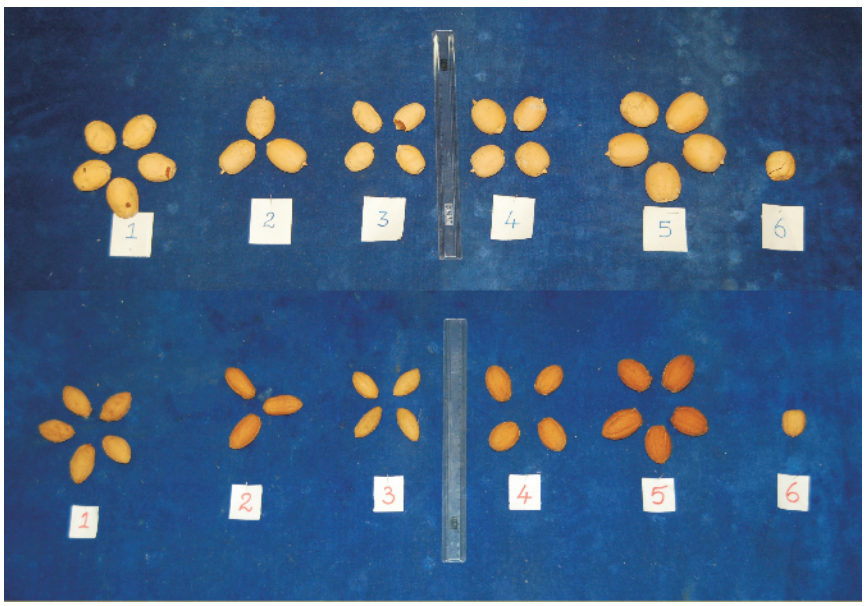

Fig. 2 Variation in Hingota fruit/seed shape in Pali region

Effect of seed morphometric variability on germination and seedling characteristics of *Prosopis cineraria* (L.) Druce

A wide range of variability was observed for various seed morphometric traits viz., size, shape, weight, thickness of *Prosopis cineraria* population among the individuals within population for various seed characters. The seeds were randomly selected and grouped into eight classes (S1 to S8) based on seed characters viz., length, breadth, thickness, shape and weight. The seed length varied from 7.9 (S1) to 4.26 mm (S4). Maximum seed breadth was 4.9 mm (S1) whereas; minimum was 3.33 mm (S7). Thickness of seeds ranged from 1.53 to 1.1 mm, while hundred seed weight varied between 0.64 (S1) to 0.40 g (S7). In pot studies, S1 class of seeds exhibited maximum germination (70%) followed by S2 and S3, whereas S8 class seeds exhibited minimum and poor germination percentage (10%). Maximum shoot length, root length and collar diameter were also recorded in S1 class seeds. Therefore, seed size can be used as a parameter for predicting germination and seedling growth rate both in nursery and field conditions (Fig. 3).

Performance of cactus (*Opuntia ficus-indica* L. Mill) accessions under shade net

Studies on initial survival rate and establishment of cactus accessions under shade net condition at RRS Pali-Marwar revealed that before rainfall 100% to 40% cladodes survived whereas survival was 80% to 31.4% after commencement of rainfall. The highest survival percentage of cladodes before rainfall was recorded in Trunzara Red San Cono, ARL Spineless, Roso Castle Sardo and Algerian (100%). Out of fifteen accessions, seven sprouted in 28 to 49 days and others sprouted after 50 days.

Variability in fruit and seed parameters of *Manilkara hexandra* Roxb.

Manilkara hexandra (Roxb.) Dubard, an indigenous underutilized fruit tree belonging to the family Sapotaceae, locally known as 'khirni' is adapted to semi-arid regions and drought conditions and also thrives well on rocky, saline and sodic soils. It is widely used as rootstock for grafting of sapota plants. A survey on khirni population was made during the fruit ripening stage in the month of May 2017 in the Pali and Sumerpur blocks of Pali district (Fig. 4).

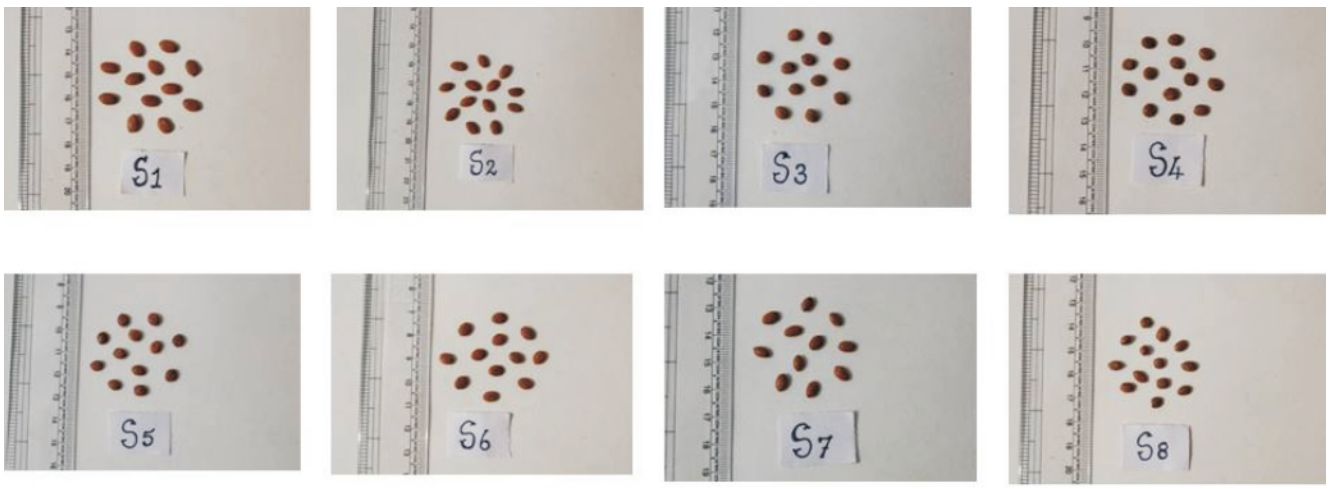

Fig. 3 Variation in seed morphometric traits of *Prosopis cineraria*

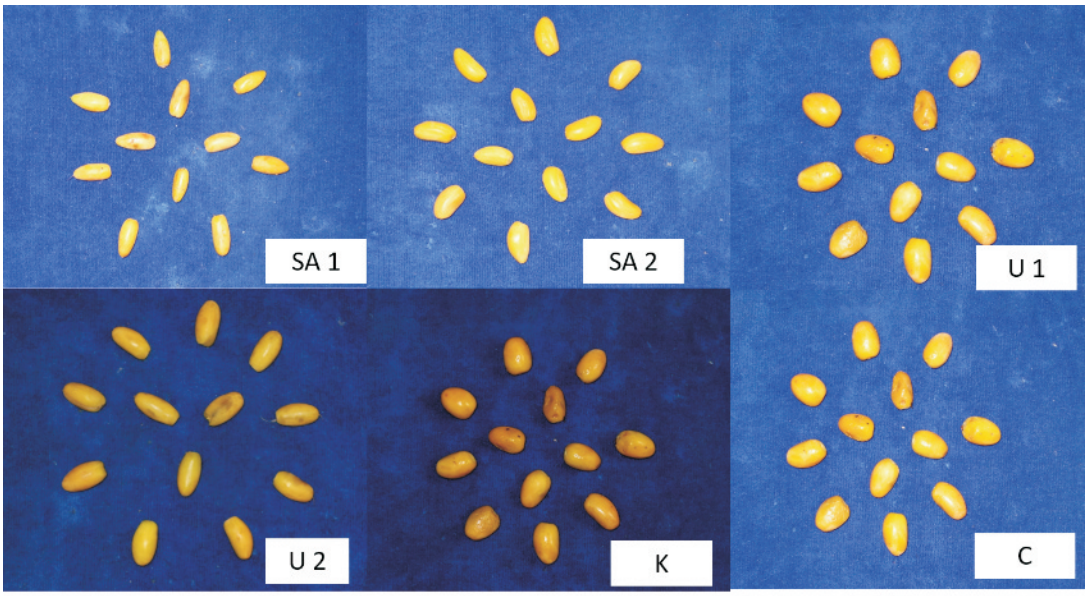

Fig. 4 Variation in fruits of *Manilkara hexandra*

All the parameters i.e., fruit length, fruit width, fruit weight, pulp weight, seed length and seed width varied significantly ($p<0.001$) except for seed weight ($p=0.087$). Highest coefficient of variation (CV) was recorded for pulp weight (43.54%), followed by fruit weight (33.49%) and seed length (19.48%). The germplasm collected from Utharan area was found to be good in all fruit parameters. Thus, these traits may be given importance in selection, improvement and breeding program.

Effect of pre-sowing treatments on seed and seedling quality attributes of an endemic agroforestry tree *Acacia nilotica* subsp. *cupressiformis* (J.L. Stewart) Ali & Faruqi

Acacia nilotica var. *cupressiformis,* an evergreen multipurpose leguminous tree species suitable for agroforestry is mainly distributed in western Rajasthan particularly in Pali and its adjoining areas. The natural germination in wild is very limited due to its hard seed coat and dormancy. Experiments conducted to study the effect of pre-sowing treatments on germination of *A. nilotica* var. *cupressiformis* seeds revealed maximum germination in sand paper scarification with water soaking for 12 hrs followed by mechanical scarification with sand paper, acid scarification (50% for 20 min) and acid scarification (98% for 10 min).

Influence of annual ornamental flowers on relative abundance of honey bee species

Honey bees are an important component of agricultural ecosystem and provide valuable pollination service. A study was conducted to study the influence of commercially cultivated flowering plants of India (*Calendula officinalis*, *Chrysanthemum indicum*, *Glebionis segetum*, *Tagetes patula* and *T. erecta*) on honey bee diversity and abundance in the hot semi-arid environment. The capitulum of these plant species differed significantly in length and diameter of the corolla tube. It was observed that dwarf (*Apis florea*) and giant (*A. dorsata*) honey bee were the most common visitors, however, the abundance of both bee species was significantly different ($p<0.01$) on different plant species. Plants with

relatively longer (15.25-18.9 mm) and wider corolla tube (*T. erecta* and *T. patula*) were visited by both the bee species (Fig. 5). However, plants having short (5.0-6.5 mm) and narrow (1.0-1.33 mm) corolla tubes (*C. officinalis, C. indicum, G. segetum*) were dominantly visited by only *A. florea*. Promoting the cultivation of *T. patula* and *T. erecta* may enhance the population and conservation of both *A. florea* and *A. dorsata.*

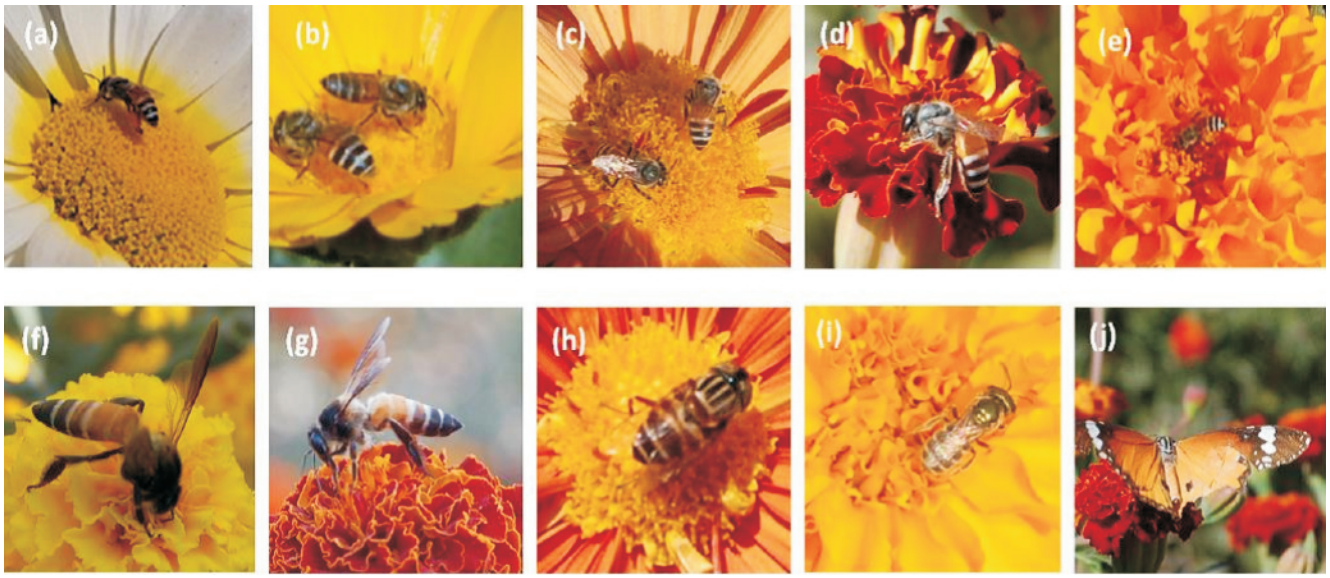

Fig. 5 Insect visitors on ornamental flowering plants: (a) *Apis florea* foraging on *Glebionis segetum*, (b) *Calendula officinalis*, (c) *Chrysanthemum indicum*, (d) *Tagetus patula* (e) *Tagetus erecta* respectively; (f) *Apis dorsata* foraging on *Tagetus patula*, (g) *Apis dorsata* foraging *Tagetus erecta*; (h) Syrphid fly foraging on *Chrysanthemum indicum*; (i) megachile bee foraging on *Tagetus erecta* and (j) butterfly foraging on *Tagetes patula*

Allelopathic effect of Eucalyptus on germination and growth of marigold and calendula

Eucalyptus (*Eucalyptus camaldulensis* Dehnh.) is known to have allelochemicals which reduces the yield and productivity of understory crops. An experiment was carried out to study the allelopathic effect of Eucalyptus extracts of leaf, bark and roots on marigold and calendula seed germination. It was observed that the germination percentage reduced significantly with increasing concentration of eucalyptus leaf, bark and root leachates in both calendula and marigold. The highest germination percentage was recorded in control with no leachates and there was no germination in 75% and 100% bark leachates of Eucalyptus in both species. Higher shoot length, root length and vigour index were recorded in control and lowest values were in 100% leaf leachates in both marigold and calendula.

Integrated Arid Land Farming Systems Research

Sustainable land management through silvi-pasture system

Growing of fodder trees with grasses can ensure availability of fodder for livestock round the year. Spacing between fodder trees should be optimum for getting higher yield of inter spaced grown grasses. It was found that grasses when intercropped between trees species spaced at 5m × 5m gave a dry forage yield of 1.25 to 2.0 t ha^{-1} depending upon rainfall distribution and had no adverse effect on growth of tree.

The grasses grown in interspaces should have synergistic or least adverse effect on growth and development of fodder trees grown in silvi pasture system. In *Grewia tenax* and *Ziziphus nummularia* planted at 10 m × 4 m and 10 m × 2.5 m, respectively, intercropping of *Cenchrus ciliaris* was found optimal for enhancing the productivity of silvi-pastoral system. Annual increment in plant height was 14.3 cm for *G. tenax* and 48.9 cm for *Z. nummularia.* Grass production was maximum under *Prosopis cineraria* and *Eucalyptus camaldulensis*. Soil moisture conservation in different silvi-pastoral systems was better with *P. cineraria*, *Azadirachta indica*, *Acacia nilotica* and *Albizia lebbeck*; while *Acacia tortilis* and *Eucalyptus* sp. exhausted soil moisture fast and adversely affected grass production.

Horticulture based production systems for transitional plain of Luni basin

Incorporation of horticulture component in farming systems can provide sustainable livelihoods and improve farm income. Therefore, horticulture based farming system models for transitional plain of Luni Basin were studied.

Ber based production system

One hectare model was developed with ber as main component intercropped with mung bean, clusterbean and okra during kharif season and mustard, fenugreek and cabbage during rabi season. Ber based production system with variety Gola and spacing of 12 m × 6 m was established in 2015. The mean system productivity production system was 4919.3, 4380.8 and 7906.8 kg ha^{-1} for clusterbean, mung bean and okra, respectively (Fig. 6.1-6.3). Maximum profit was obtained from ber + okra-cabbage system (B:C ratio of 1.8).

Pomegranate based production system

One hectare model with pomegranate as main component, intercropped with mung bean,

Fig. 6.1 Ber + clusterbean

Fig. 6.2 Ber + mustard

Fig. 6.3 Ber + fenugreek

clusterbean and okra during kharif season and mustard, fenugreek and cabbage during rabi season with variety Bhagwa and spacing of 8 m × 3 m was established during 2015 (Fig. 6.4-6.6). The system productivity for clusterbean, mung bean and okra was 2480.3, 2041 and 6560.6 kg ha^{-1}, respectively. Maximum profit was obtained from pomegranate + clusterbean-fenugreek (B:C ratio of 1.16).

Fig. 6.4 Pomegranate + mung bean

Fig. 6.5 Pomegranate + mustard

Fig. 6.6 Pomegranate + fenugreek

Henna based agroforestry system

Henna cultivated in Sojat, Marwar and Raipur tehsils of Pali districts accounts for 90% of henna cultivation in India and produce best quality henna. Henna is cultivated as rainfed crop during drought years, its leaf yield may be less. Intercropping with leguminous crop clusterbean was studied (Fig. 7) and it was observed that during establishment period (3 years), intercrop yield is complementary, whereas in established henna fields, intercrop competes for moisture, nutrients, and light and henna has adverse effect on intercrop resulting in its very low yield.

Strip cropping (2.4 m wide) was second best option after sole henna cultivation. Highest henna dry leaf yield (1039-1741 kg ha^{-1}) was recorded in sole henna crop followed by henna + clusterbean strip (2.4 m) (483-1671 kg ha^{-1}) dry leaf equivalent yield.

Water use (WU) of clusterbean ranged from 410 to 412.2 mm and henna WU ranged 496.9 to 493.9 mm. Sole henna treatment has water use efficiency (WUE) of 2.72 kg ha^{-1} mm^{-1}, 2.53 kg ha^{-1} mm^{-1} in 2.4 m wide strip cropping and lowest in sole clusterbean (0.29 kg ha^{-1} mm^{-1}). Maximum land equivalent ratio of 1.27 was in treatment of

Fig. 7 Henna intergcropping with clusterbean

2.4 m wide strip cropping followed by in 3 m wide henna alley (1.13) and lowest (0.37) in henna: clusterbean in 1:3 strip cropping.

Effect of spacing on growth of *Hardwickia binata* Roxb.

Hardwickia binata Roxb. is a multipurpose and is considered to be a good nitrogen fixing tree in semi-arid conditions of India. Spacing is one of the most important considerations in plantations to avoid competition and for effective utilization of resources among the crops and trees. An experiment was conducted to determine the effect of spacing on growth and increment of 30 year old *H. binata* with two tree spacings i.e. closer spacing (666 tree ha^{-1} with 5 m × 3 m spacing) and wider spacing (333 tree ha^{-1} with 10 m × 3 m spacing). Among different spacings, wider spacing of 3 m ×10 m resulted in better tree height, DBH, tree circumferences, number of branches, clear bole height, crown width, crown length and tree volume. In general, DBH, tree circumference, crown width and crown length and tree volume was more in wider spacing with less tree density while lesser in closer spacing with high tree density.

Carbon sequestration potential of *Hardwickia binata* Roxb. based agroforestry system

Agroforestry is a promising option for climate change mitigation through carbon sequestration which depends on various factors like type of tree species, tree density, system age, soil and climate. This study estimated impact of tree density (low= 333 tree ha^{-1} and high = 666 tree ha^{-1}) on carbon sequestration potential of 30-year-old *H. binata* + *Cenchrus setigerus* silvipasture system in hot semi-arid region of Rajasthan. The carbon sequestered in tree biomass was estimated by reported allometric equations, whereas in soil it was determined by Walkley and Black method. Results indicated that the average biomass carbon sequestered by a tree was significantly more (44.5%) in low density compared to high density system. However, total biomass carbon sequestered per hectare land was significantly more (40.8%) in high density system (31.6 ± 12.6 Mg C ha^{-1}). Carbon sequestered in soil organic matter was higher in both the systems compared to control (sole *C. setigerus* field). It ranged from 19.93 ± 0.31 Mg C ha^{-1} in control to 22.94 ± 0.65 Mg C ha^{-1} and 23.25 ± 0.78 Mg C ha^{-1} in low and high density, respectively.

Database of wood specific gravity of arid zone trees

The wood specific gravity (WSG) of trees was determined to estimate the biomass carbon stock of trees. The WSG of sampled trees ranged from 0.42±0.04 to 0.74±0 g cm^{-3} in different species.

Allometric equation for determining wood specific gravity (WSG)

WSG of stem and branches showed linear relationship and branches were found to be a good predictor of stem WSG (R^2 -0.83). The developed model can be directly used to estimate WSG of main stem from pieces of primary or secondary branches. It will avoid the tedious process of wood core sampling and tree harvesting.

Biomass carbon stock of different land use systems in Pali

Tree density on agricultural lands in Pali district varied from 7 to 44 trees ha^{-1}. The highest tree DBH was recorded in northwest Pali (36.5 cm) and south Pali (31.9 cm) while it ranged from 24.3-28.8 cm in central and eastern Pali. The above ground biomass and below ground biomass carbon stock in traditional agroforestry system of

Pali district ranged from 0.42 to 8.96 t ha^{-1} and 0.11-5.54 t ha^{-1} respectively. Among identified agroforestry systems, highest total biomass-C stock (AGB-C+BGB-C) was found in *Prosopis cineraria* + *Lawsonia inermis* system (14.5 t ha^{-1}) followed by *P. cineraria* + arable crop (4.3 t ha^{-1}) and *Acacia nilotica* var *cupressiformis* + arable crops (3.1 t ha^{-1}).

Rooting pattern and biomass potential of henna (*Lawsonia inermis* L.) in different agroforestry systems

The knowledge of rooting pattern and structural development of roots are prerequisite to improve and optimize the productivity of any agroforestry systems. A study was conducted to observe the rooting pattern and distribution of henna roots in different intercropping combinations in relation to leaf production. The mean of horizontal root length increased from 76.7 cm in henna + clusterbean (H:CB) in1:1 row ratio to 111.6 cm (alley cropping; 6 m) while vertical root length varied from 62.3 cm (H:CB in 1:2 ratio) to 99.7 cm in sole henna. The maximum root spread (98.9 cm) was recorded in alley cropping (6 m) and minimum root spread (61.22 cm) was in H:CB in 1:1 ratio followed by sole henna. The maximum above ground biomass was recorded in alley cropping (6 m) while minimum was in alley cropping (3 m). Maximum below ground biomass was recorded in H:CB (1:2) followed by strip cropping and sole henna and minimum was in H:CB (1:1). Considering the economical part of henna and root parameters, sole henna is more suitable among the systems in Pali conditions under rainfed conditions. Considering the other best parameters, alley cropping (6 m) is the next best intercropping system among all the systems tested. The maximum above ground biomass (0.998 kg $plant^{-1}$) was recorded in alley cropping (6 m) while minimum (0.613 kg $plant^{-1}$) was in alley cropping (3 m). Maximum below ground biomass (0.437 kg $plant^{-1}$) was recorded in H:CB (1:2) followed by strip cropping (0.429 kg $plant^{-1}$) and sole henna (0.356 kg $plant^{-1}$) and minimum (0.223 kg $plant^{-1}$) was in H:CB (1:1).

Response of coriander (*Coriandrum sativum* L.) varieties to nitrogen levels

An experiment comprising of four nitrogen levels (0, 40, 60, 80 and 100 kg ha^{-1}) and three coriander varieties (ACr-1, RCr-728 and RCr-446) was conducted for evaluation of economically optimum dose of nitrogen and most suitable variety of coriander for transitional plain of Luni Basin for diversification of existing cropping system. The higher grain yield of 1.27 and 1.02 t ha^{-1} was recorded in RCr-728 and RCr-446, respectively under 60 kg N ha^{-1} and there was no significant increase in yield with increase in level of nitrogen but in case of ACr-1, significant increase in yield upto 80 kg N ha^{-1} was observed and further increase in N level did not showed considerably higher yield. All the three varieties responded to increasing level of nitrogen. ACr-1 is a long duration coriander variety, thus flowering was late as compared to other varieties. Therefore, under good management situation with favourable long growing season and good fertility soil, ACr-1 variety of coriander was better for getting higher yield and under normal growing season with average soil fertility RCr-728 and RCR-446 varieties of coriander were better for exhibiting higher yield of coriander.

Land and Water Resource Management

Fodder production in *Pongamia pinnata* L. (Panigrahi) based silvi-pastoral system

Forage and dry fodder yield of *Cenchrus setigerus* in *Pongamia pinnata* based silvi-pastoral system (Fig. 8) was significantly higher in deep tillage (Td) (8.5 and 2.6 t ha^{-1}) compared to conventional tillage (Tc) (7.9 and 2.4 t ha^{-1}). Forage and dry fodder yield of *C. setigerus* in *P. pinnata* based silvipastoral system was significantly higher (8.5 and 2.6 t ha^{-1}) in tree spacing of 8 m × 4 m over tree spacing of 5 m × 4 m (7.8 and 2.4 t ha^{-1}). Forage and dry fodder yield of *C. setigerus* in *P. pinnata* based silvipastoral system was significantly higher with FYM application @ 5 t ha^{-1} (8.5 and 2.6 t ha^{-1}) over no FYM application (7.8 and 2.4 t ha^{-1}).

Suitable plant species for growing on textile effluent affected agricultural land near Bandi river

Agricultural lands near Bandi River in Pali are affected by textile effluents and are not under cultivation for last 30 years. The affected soil was found to contain high sodium and bicarbonate and very low Ca + Mg content. The water collected from the wells near bank of the Bandi river had high pH, Na and bicarbonate while very low Ca+Mg content resulting in high SAR (SAR 8.6) as compared to wells one km away from the river bank (SAR=3.8). Soil was alkaline in nature with high sodium and bicarbonate content and very low Ca+Mg content. Heavy metal content (As, Cr, Cu, Mn, Ni, Pb, etc.) was below threshold value for health risk. The biological activity of affected soils was less as indicated by lower hydrogenase activity, soil CO_2 flux and organic matter content as compared to unaffected soils.

Performance of seven plant species on the textile effluent affected soil was evaluated for two years in the pots (Fig. 9). Out of these plant species, *Diplachne fusca* (Karnal grass), *Vetiveria zizanioides* (vetiver), *Lawsonia inermis* (henna) and *Cymbopogon martinii* (palmarosa) performed best in terms of plant growth. The highest mean plant biomass of 74.15 g $plant^{-1}$ was recorded in kernel grass followed by vetiver grass (42.6 g $plant^{-1}$) and henna (10.9 g $plant^{-1}$) on textile effluent affected soil treated with Ammonium sulphate fertilizer @ 60 kg N ha^{-1}.

Fig. 8 *Pongamia pinnata* with *Cenchrus setigerus*

Fig. 9 Plant species grown on the textile effluent affected soils

Yield and yield related traits of wheat genotypes as affected by saline irrigation water

The study was conducted to identify suitable wheat genotypes for salt affected soils of Pali. Eleven wheat genotypes (KH-65, KRL-19, KRL-210, KRL-377, KRL-370, KRL-386, KRL-384, DBW-246, DBW 247, DBW-248 and WH-1316) were screened for their growth and yield performance at 4.6 dS m^{-1} EC levels of irrigation water and pH of 8.3 (Fig. 10). The results of different genotypes in respect to germination, plant height, spike length, seed index, number of grain $spike^{-1}$, effective tiller m^{-2}, grain yield, biological yield, harvest index and economics significantly varied. The days to heading, days to maturity, number of grains per spike, grain yield, seed index and biological yield of wheat crop were low irrespective of wheat varieties.

The wheat varieties KRL-377, KRL-370 and KRL-210 (2.22-2.34 t ha^{-1}) were highly susceptible and KH-65, KRL-384, WH-2434, DBW-246 and DBW-247 (2.38-2.54 t ha^{-1}) were medium susceptible to salinity stress while KRL-19, DBW-248 and KRL-386 (2.56-2.76 t ha^{-1}) maintained their growth and yield under stress conditions. Out of eleven wheat genotypes, five genotypes (KRL-19, DBW-248, KRL-386, DBW-246 and DBW-247) performed better in terms of yield and economics under saline/alkaline environment.

Effect of foliar application and seed treatment with decomposer on growth and yield of cumin

A field study was carried out at main research farm of CAZRI-RRS, Pali during rabi 2017 and 2018 to evaluate the appropriate time of foliar spray and seed treatment with decomposer on growth, disease and pest incidence, and yield of cumin under saline condition. Groundwater was used for irrigation throughout the experiment with EC of 4.6 dS m^{-1}. Seed treatment and three foliar sprays of decomposer at 45, 60 and 75 DAS showed significant effect on seed germination, plant height, number of seed per umbel, number of umbellets per umbel and 1000 seed weight on the basis of pooled data of two years, but no significant effect on secondary branches and number of umbel per plant. Seed treatment along with foliar

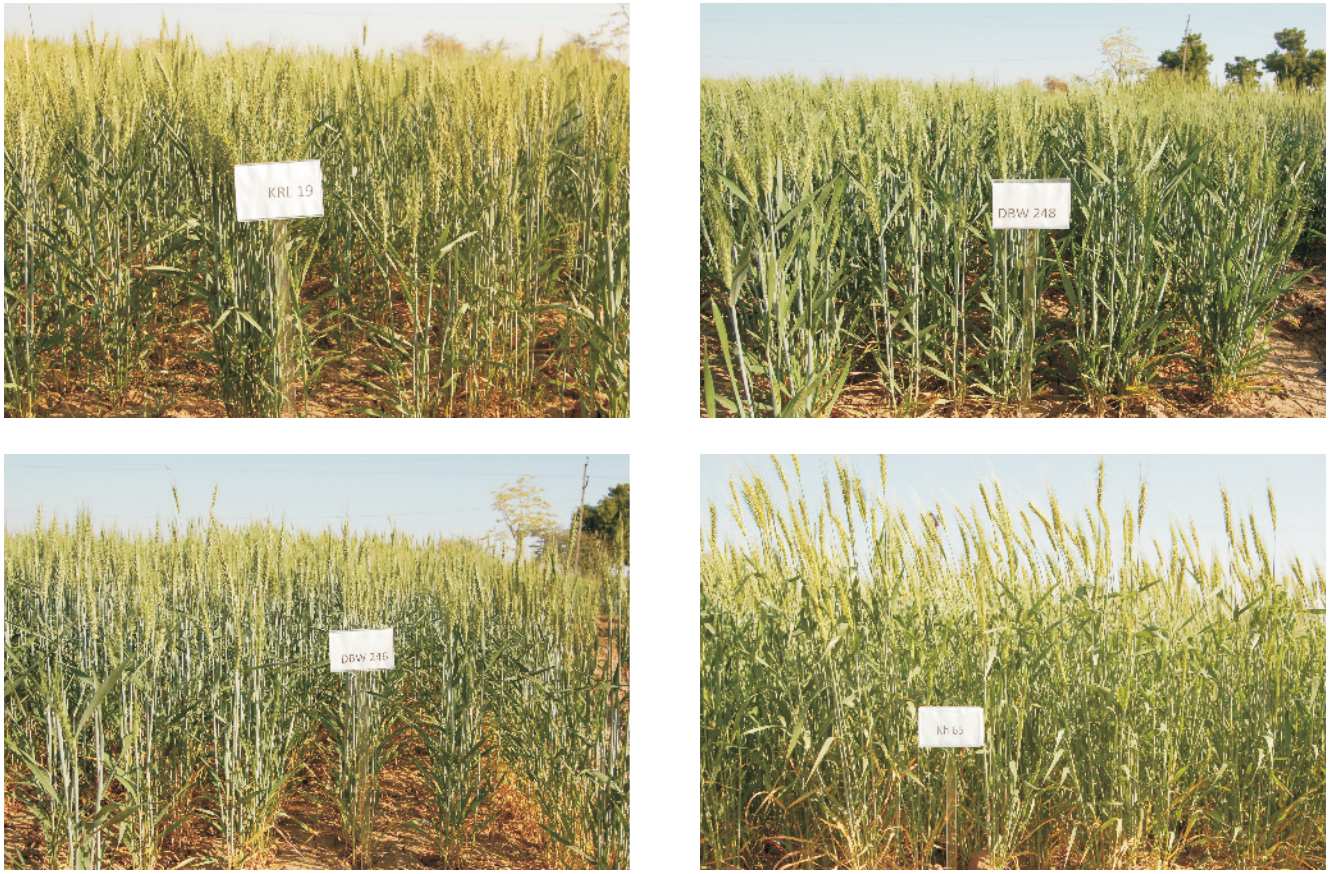

Fig. 10 Evaluation of wheat varieties under saline irrigation conditions

spray of decomposer at 45, 60 and 75 DAS produced significantly higher seed yield (581and 659 kg ha^{-1}) and straw yield (1129 and 1472 kg ha^{-1}) during 2017 and 2018, respectively.

The highest net return and B:C ratio was recorded under the seed treatment and three foliar spray of decomposer at 45, 60 and 75 DAS (Rs. 60,834 ha^{-1} and 2.2) followed by seed treatment and two foliar sprays with decomposer at 45 and 60 DAS (Rs. 56,068 ha^{-1} and 2.1) compared to Rs.19,431 ha^{-1} and 1.4 in control. Seed treatment and foliar application of decomposer at 45, 60 and 75 DAS exhibited higher yield of cumin which was at par with rest of the treatments with decomposer. However, all the treatments of decomposer were superior over the control.

Effect of bioformulation CSR-Bio on growth and yield of cumin under saline condition

Study on effect of bioformulation CSR-Bio on growth and yield of cumin was conducted during 2019-20 and 2020-21 at research farm of CAZRI-RRS Pali (Fig. 11). The CSR bio was applied as soil application, soil drenching, seed treatment and foliar spray in different combinations. The highest grain yield (841 kg ha^{-1}), straw yield (1690 kg ha^{-1}) and biological yield (2531 kg ha^{-1}) of cumin was recorded under soil treatment with CSR-Bio @ 25 kg ha^{-1}+ seed treatment @ 100 g kg^{-1} seed with soil drenching and foliar spray at 50 DAS followed by application of T-6 and T-5 treatment (Table 2). All the combinations of treatment of CSR-Bio resulted higher, grain, straw and biological yield over the control.

Table 2 Effect of CSR-Bio on grain, straw and biological yield and harvest index of cumin

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T-1: Control	494	1212	1706	29.0
T-2: Soil treatment with CSR-Bio @ 15 kg ha^{-1}	461	1195	1656	28.0
T-3: Soil treatment with CSR-Bio @ 25 kg ha^{-1}	567	1440	2006	28.3
T-4: Soil treatment with CSR-Bio @ 45 kg ha^{-1}	638	1572	2210	29.2
T-5: Seed treatment with CSR-Bio @100 g kg^{-1} seed with Soil drenching at 10 days interval	670	1566	2236	30.1
T-6: Seed treatment with CSR-Bio @ 100 g kg^{-1} seed with soil drenching + Soil treatment @ 25 kg ha^{-1}	739	1639	2378	31.2
T-7: One Foliar spray with CSR-Bio 3% at 25 DAS	561	1472	2032	27.7
T-8: Two foliar sprayswith CSR-Bio 3% at 25 DAS and 50 DAS	578	1614	2191	26.8
T-9: Three foliar sprays with CSR-Bio 3% at 25 DAS, 50 DAS and 75 DAS	655	1674	2328	28.1
T-10: Soil treatment with CSR-Bio @ 25 kg ha^{-1} + Seed treatment @ 100 g kg^{-1} seed with soil Drenching + Foliar spray at 50 DAS	841	1690	2531	33.2
SEm±	**17**	**105**	**100**	**1.66**
CD (p=0.05)	**50**	**312**	**297**	**4.94**

Fig. 11 Bioformulation CSR-Bio trials on cumin crop

Effect of foliar spray and seed treatments of organic culture on yield of wheat

A field experiment was conducted to evaluate the effect of seed treatment and foliar sprays of decomposer on growth, yield, and disease and insect-pest incidence in wheat crop during rabi season 2018-19 at RRS Pali (Fig. 12). Seeds were treated with organic cultural and kept in shade for half an hour for drying and then used for sowing. Spray of organic cultural (ratio of water to organic cultural was 10:1) were applied at 30, 60 and 90 days after sowing. The results revealed that spray and seed treatments of organic cultural on wheat improved yield and some growth parameters during study period as compared to

check. The highest grain yield 5.23 t ha^{-1} was recorded with the application of organic cultural as seed treatment along with two foliar sprays at 30 and 60 DAS followed by seed treatment and three foliar application of organic cultural (5.13 t ha^{-1}) and lowest in control treatment (3.72 t ha^{-1}).

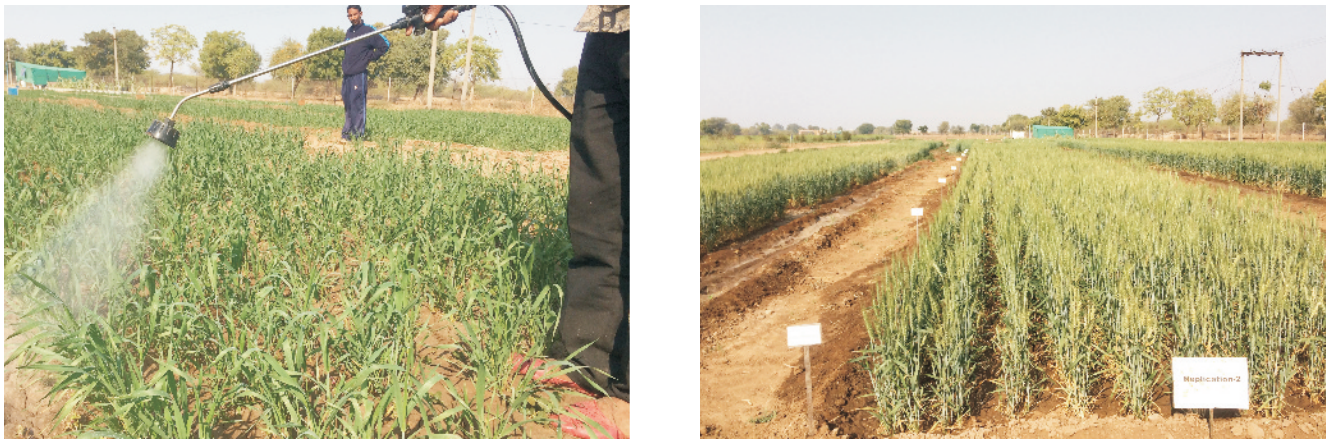

Fig.12 Evaluation of organic culture on wheat crop

Socio-economic Investigation and Evaluation

Livelihood and nutritional improvement of tribal farmwomen through horticulture

A socioeconomic survey was conducted among the tribal farmwomen in selected villages (Peepla, Lunava and Latada) of Bali block of Pali district with the sample size of 100 households. The average age of tribal farmwomen was 46.8 years, most of them were married, illiterate (85%), and majority having joint family (55%) with average family size of 10 members. Majority of them (70%) had tiled houses, all owned a house although only 45% houses were electrified. The drinking water facility was available to most of the families (80%), while toilet/drainage facilities were not available to anyone. Average annual family income was Rs. 1,29,850, major contributor being farm income (55%) with majority (60%) belonging to marginal farmer category. Majority of them (55%) reported radio as source of information followed by TV (45%). The decision making pattern was found to be male dominated (100%). Regarding innovativeness, majority (60%) reported that they preferred to adopt new technologies after they had seen it adopted by other members successfully (late majority).

The gender roles in horticultural production/ processing in tribal farmwomen were assessed using the schedule having the listing of various activities and participation and responsibility/decision making. In the selected villages, participation/responsibility/ decision making for operations like land preparation (70%), manure applications (95%), sowing of seeds for rootstocks (95%), selection of crops (100%), procurement of plants (100%), and marketing of fresh produces (100%) etc. were male dominated while operations like ploughing (100%), clod breaking (100%), levelling (85%), planting (95%), weeding (95%), intercultural operations (95%), planting of intercrops (85%), insect-pest control by traditional methods (70%) and harvesting (100%) etc. were performed jointly.

The food habits and nutritional status in selected villages revealed that roti was consumed daily by all respondents (100%), while rice was consumed very rarely by half of the respondents (50%), followed by once in a week (30%). Dal is a part of daily food for 75% of households, while 25% consumed 4-5 days in a week. Leafy vegetables were consumed by majority of households (60%) 2-3 days in a week, while seasonal vegetables were consumed by most households (90%) 4-5 days a week. Seasonal fruits were consumed weekly/monthly by 1/3rd of the respondents. Milk is part of daily food for 40% and 50% took it for 4-5 days in a week. Eggs were consumed by 50% once in a week, chicken/mutton 2-3 days in a week by 40% and once in a week by 30%.

Ridge gourd, carrot, peas and tomato were the most preferred vegetables as they were 'liked very much' by all (100%) the respondents. The other preferred vegetables were bottle gourd, cauliflower, cowpea, sem (beans), onion and sponge gourd as they were 'liked very much' by 85, 80, 75, 70 and 60% respondents, respectively.

Almost all the respondents (95%) fully agreed with the statement that 'food in any kind is available to us throughout the year', indicating that they had food security. The majority of respondents (60%) only 'partially' agreed with the statement that 'the quality of food available is good', while only 20% endorsed it fully, indicating that the quality of food is partially satisfying. A three-fourth majority (75%) 'partially' endorsed the statement that 'a balanced food to all family members is affordable with my income', indicating that limited income was preventing them from expenditure on quality food which may be

addressed by producing some fruits and vegetables in backyard nutrition gardens, for which fruit saplings and training were provided (Fig. 13). Only 25% respondents 'fully' endorsed the statement that 'I need to reduce the expenditure for food, as I have to meet other family needs', while 75% 'partially' endorsed that statement, indicating that they were not able to freely spend on food due to limited income.

Income is directly related to employment and to assess the income security, statements related to employment were used and perception of respondents was recorded. Majority of respondents (60%) replied 'Yes' for the question 'Are you forced to migrate for job?', indicating that they were not getting job round the year at the place of residence. Half of the respondents (50%) perceived that they have job according to their qualifications and all the respondents (100%) were satisfied with the working environment.

Adoption and impact of pressurized irrigation systems

A study was conducted on the adoption of pressurized irrigation systems (PIS) (drip and sprinkler) in Pali and Jalore districts involving farmers (adopters and non-adopters), extension functionaries/ officials and dealers/retailers. The sample of respondents was drawn from Pali and Jalore districts using the list of beneficiaries of PIS in the districts during 11th plan period while covering various crop production systems.

In the transitional plain of Luni basin of Rajasthan, PIS adopter farmers had average age of 46.4 years with average 7.3 years of schooling, 80% of them had nuclear family with average family size of 6 members, had average land holding of 5.8 ha and 70% were medium category farmers. The PIS was adopted on 10 to 100% of owned land, however, 90% adopted on more than 50% of owned land.

The adopter farmers cultivated cotton, wheat, cumin, mustard, fennel with average area of 2.52, 1.35, 0.96, 0.92 and 0.49 ha, respectively using PIS. Knowledge of adopter farmers about installation, operation and maintenance of PIS was found to be of medium to high. Majority of the PIS adopter farmers (96.7%) continued adoption due to saving in various inputs (100%), reduction of drudgery (100%), better quality produce (90%) and increased production (77%).

All adopter farmers were trained by PIS supplier for operation and maintenance; however, majority (60%) still perceived training needs. Whereas most of non-adopter farmers (80%) perceived training needs for PIS. Three-fourth majority (75%) of farmers expressed that training should be organized off-campus, during crop season, for 2-5 days duration. The adopter perceived damage of PIS by squirrels (40%) as major constraint while the non-adopter perceived fragmented land holdings (90%), large number of shareholders in irrigation water source (90%), high cost of system (60%), and lack of knowledge about subsidized purchase procedure (50%).

Fig. 13 Distribution of planting material to tribal farm women in village Peepla

All India Coordinated Research Projects (AICRP)

AICRP on "Salinity/Alkalinity Wheat Tolerance Screening Nursery (SATSN)" in collaboration with ICAR-CSSRI, Karnal

Under AICRP, 32 varieties of wheat were screened in RCBD design with two replications to evaluate the performance of these lines under saline irrigation water (EC 4.6 dS m^{-1}) at RRS, Pali during rabi season of 2016-17 (Fig. 14). LBP-2016-3 variety produced highest grain yield (3820 kg ha^{-1}), followed by WH-1622 (3632 kg ha^{-1}), RAJ-4506 (3582 kg ha^{-1}), KRL-390 (3295 kg ha^{-1}), KRL-393 (2902 kg ha^{-1}), LB-2016-1 (2855 kg ha^{-1}), HD-2009 (2790 kg ha^{-1}), RAJ-4498 (2770 kg ha^{-1}), KH-65 (2715 kg ha^{-1}), KRL-19 (2650 kg ha^{-1}), NW-7017 (2537 kg ha^{-1}) KRL-210 (2530 kg ha^{-1}), KRL-394 (2595 kg ha^{-1}), NW-7019 (2527 kg ha^{-1}) and RWP-2016-3 (2505 kg ha^{-1}). Out of 32 entries, 15 wheat varieties performed better under saline condition of irrigation as compared to other varieties.

Salinity/alkalinity tolerance screening nursery in collaboration with ICAR-IIWBR, Karnal

A genotype screening trial of wheat for salinity/alkalinity tolerance under AICRP on wheat and barley improvement project was conducted at RRS, Pali during 2017-18 (Fig. 15). Total 24 coded entries (SAN-1 to SAN-24) along with four national checks (C-1 to C-4) were sown in augmented block design having eight blocks

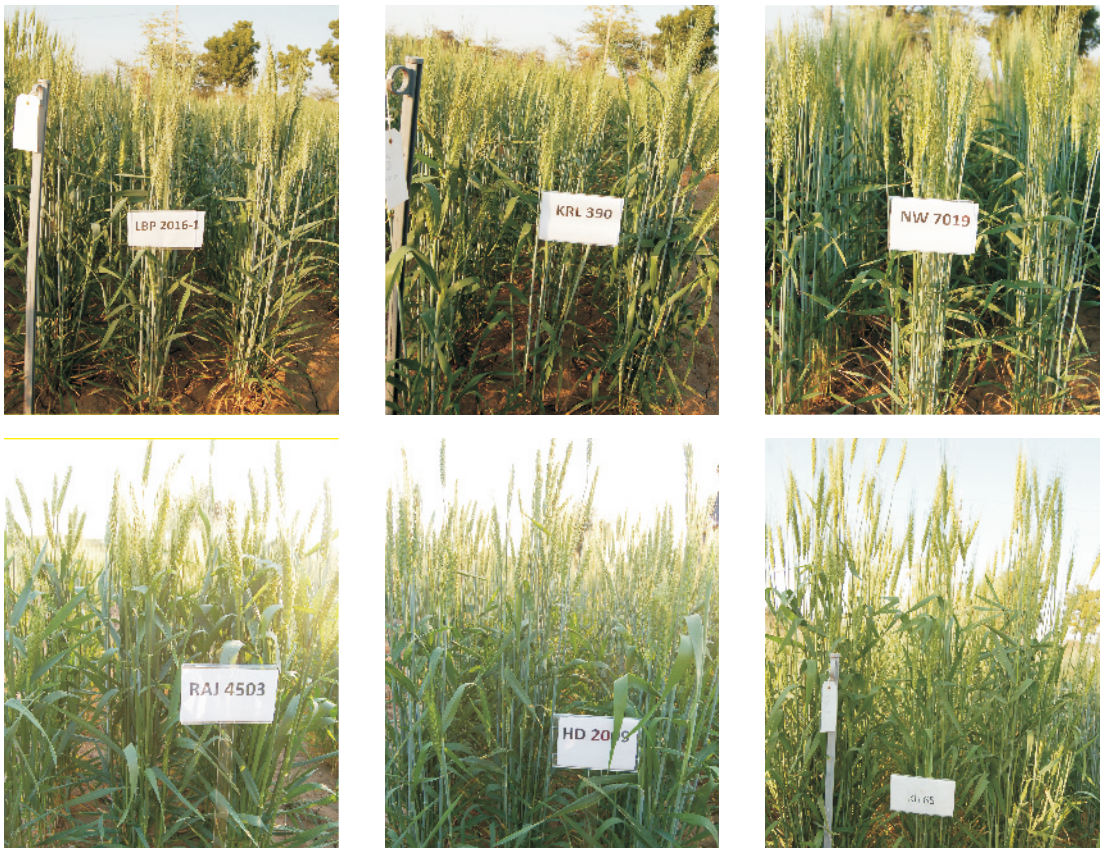

Fig.14 Wheat varieties screened for salinity tolerance

Fig.15 Wheat genotypes under saline irrigation conditions

and EC of irrigation water was 4.5 dS m^{-1} and pH was 8.5. Maximum plant height (96.6 cm) was observed in line C-3 (check), followed by SAN-22 (94.2 cm), SAN-14 (94.1cm), SAN-10 (87.4 cm) and minimum plant height was recorded in SAN-15 (64.7 cm). The maximum tillers per plant (7.1) was recorded in entries SAN-22 followed by C-4, SAN-22 (6.3), SAN-21 (6.1), SAN-14 (6.0) and lowest value was observed in SAN-18 (4.4) and SAN-19 (4.4). The highest grain yield was recorded in SAN-12 (4260 kg ha^{-1}), stover and biological yields was highest in SAN-22 (7313 and 1147 kg ha^{-1}). Lowest grain yield was obtained in SAN-5 entry (1408 kg ha^{-1}), straw and biological yield was least in SAN-15 (1093 and 3257 kg ha^{-1}). Out of 24 coded lines/including checks,12 wheat varieties performed better under saline conditions.

Under the AICRP, thirty cultivars/lines of wheat were screened along with four national checks to evaluate the performance of these lines under saline soil and saline irrigation water at RRS, Pali during rabi season of 2018-19. Germination, growth and yield response of cultivars/lines of wheat were determined at EC of 4.6 dS m^{-1} of irrigation water. The maximum plant height recorded was 92.8 cm in K-1702 followed by 91.0 cm in Raj-45 and 90.7 cm in LBP-2018-23 cultivars, whereas LBP-2018-21 (70.2 cm) and KRL-19 (66.3 cm) were the lowest in plant height. The highest grain yield was recorded in SANSAR-5 (5617 kg ha^{-1}) followed by LBP-2018-24 (5353 kg ha^{-1}), SANSAR-4 (5250 kg ha^{-1}) and lowest grain yield was obtained in KRL-1714 (2340 kg ha^{-1}).

During 2019-20, thirty two wheat coded lines (SATSN-1 to SATSN-32) were screened in an augmented design with two replications (Fig. 16). Performance of these lines was evaluated in nursery under saline irrigation water (EC 4.2 dS m^{-1} and pH 7.8). Soil and water samples were collected before sowing and after harvesting of nursery crop for analysis of physical and chemical properties (soil texture, EC, pH, and available N, P, K) at 0-15 and 15-30 cm soil depths. The mean value of plant height was maximum in SATSN-11 (98.3 cm) followed by SATSN-07 (93.9 cm) and SATSN-23 (92.7 cm). The mean value of grain yield in SATSN-06 (4000 kg ha^{-1}) followed by SATSN-20 (3950 kg ha^{-1}), SATSN-04 (3800 kg ha^{-1}) and lower grain yield was recorded in SATSN-19 coded line (1333 kg ha^{-1}) respectively. The highest mean value of germination was recorded in SATSN-06 (94.5%) followed by SATSN-20 (94%), SATSN-11 (92%). Out of 32 lines of wheat, SATSN-06, SATSN-20, SATSN-11, SATSN-04, SATSN-23, SATSN-07 performed better under saline conditions.

Fig. 16 Wheat trials under saline condition

AICRP on 'Salinity/Alkalinity Tolerance Wheat Trial' in collaboration with ICAR-IIWBR, Karnal

A field experiment was conducted on SPL-salinity and alkalinity tolerance wheat trials under AICRP in collaboration with ICAR-IIWBR, Karnal during *rabi* season of 2018-19 for screening seven wheat germplasm (SPL-AST 101 to SPL-AST 107) for their performance under saline soil and saline irrigation water at RRS, Pali. The highest grain yield (4.8 t ha^{-1}) and biological yield (11.0 t ha^{-1}) was observed under SPL-AST -103 followed by in SPL-AST -101(4.4 and 10.9 t ha^{-1}), while lowest grain (3.4 t ha^{-1}) and biological yields (8.6 t ha^{-1}) were found in SPL-AST-102. The maximum plant height was recorded in SPL-AST-103 (102.1cm) followed by 94.8 cm in SPL-AST-107, 91.4 cm in SPL-AST-101.

AICRP on MULLaRP, Lentil Special Trial on Salinity Condition in collaboration with ICAR-IIPR, Kanpur

Salinity tolerance and agronomic performance (growth and yield performance) of 23 coded entries of Lentil (SL 20-601 to SL 20-623) was evaluated (Fig. 17) with irrigation water of 4.67 dS m^{-1} EC and 7.8 pH in RBD design with three replications. The maximum seed yield of lentil was recorded in SL20-623 (1030 kg ha^{-1}) followed by SL20-604 (999.1 kg ha^{-1}), SL20-609 (937.9 kg ha^{-1}), SL20-606 (835.2 kg ha^{-1}), SL20-602 (832.4 kg ha^{-1}), SL20-614 (794.4 kg ha^{-1}), SL20-615 (784.2 kg ha^{-1}) and SL-20 608 (774.1 kg ha^{-1}). The performance of 12 accessions of lentil (SL20 603, 604, 609, 606, 602, 614, 615, 608, 617, 612, 620 and 621) was found better under saline stress condition on the basis of seed index and seed yield.

Fig. 17 AICRP-Lentil trial under salinity condition

Outreach Activities

Scientist-farmers' interface meeting at village Rupawas

Scientist-farmer's interface meeting was organized on June 01, 2017 at Rupawas village of Pali district in collaboration with a NGO *Sarv Mangal Gramin Vikas Sansthan* on 'Soil Salinity: Problems and Solutions' in which 35 farmers participated. Farmers shared many problems being faced in crop cultivation due to salinity. Farmers and scientists visited salinity affected areas of the village. During field visit and interaction meeting; scientists suggested some approaches viz., testing of soil and water, application of gypsum, FYM, organic fertilizers, green manuring using dhaincha, and cultivation of salt tolerant crops and trees for improving physico-chemical properties of the soils.

Scientist-farmer's interface meeting on 'crop diversification' at RRS, Pali-Marwar

Scientist-farmer's interface meeting on 'Crop diversification for Transitional Plain of Luni Basin' was organized at ICAR-CAZRI, RRS, Pali-Marwar in collaboration with ITC and Sarv Mangal Gramin Vikas Sansthan, Pali on February 20, 2018. The meeting was attended by more than sixty farmers from six villages viz., Rupawas, Vayad, Binja, Rakhana, Chenda and Kulthana. During the interaction session, farmers' queries on crop production were addressed by scientists of RRS and KVK, Pali. In technical session, scientists provided technical inputs to farmers and suggested several improved technologies suitable for the region. Field visit of the farmers was also conducted to Research Farm of the station covering various blocks viz., nursery, crop cafeteria, henna germplasm and experimental block. Seed of different crops, trees, spices, flowers, fruits, vegetables and live samples of improved varieties were also displayed in an exhibition for farmers.

Scientist-farmer's interface meeting at RRS, Pali-Marwar

Two-day scientist farmer's interface meeting was organized at the RRS in collaboration with Agricultural Technology Management Agency (ATMA) during July 16-17, 2018. The meeting was attended by more than twenty farmers from five villages viz., Pali, Raipur, Jaitaran, Sojat and Desuri. Farmers' queries on crop production were addressed by scientists of RRS, Pali and scientists provided technical inputs viz., appropriate sowing methods, pests and disease control, dosage of nutrients and fertilizer management, establishment of orchard and its management, agroforestry models, nursery management practices and other improved technologies. Field visit of the farmers was also conducted to Research Farm of the station covering various blocks *viz.*, nursery, henna germplasm and reclamation of textile effluent affected soils.

Agricultural officers' training

Four days agricultural officers' training was organized at RRS Pali in collaboration with Agricultural Technology Management Agency (ATMA). The trainings were conducted in two batches, 23-24 and 25-26 July 2018 for agricultural officers of Pali and Sojat under National Food Security Mission (NSFM) with special focus on oilseeds. More than twenty agricultural officers participated in both the batches. Head and scientists of the RRS provided technical inputs about organic farming for oil seed production, horticulture based farming for sustainability, integrated nutrient management in oilseed crops, impact of climate change on oilseed crops, tree-based oilseeds in agroforestry, henna based agro-techniques and technology dissemination through extension.

Implementation of Scheduled Caste Sub Plan

The scheme is being implemented in 7 villages of Pali district. The demonstration of improved varieties of cereals, pulses, oilseeds, horticultural crops; crop protection technologies; nutrient management and harvesting implements were given. Four scientists-farmers interaction meetings and 2 field days were conducted on improved production technologies of kharif, rabi and horticultural crops for human resource development for enhancing crop productivity and income of farmers.

The team distributed improved seed of crop varieties viz., mung bean (IPM 2-3): 800 kg, moth bean (CZM-2): 200 kg, sesame (RT-351): 50 kg and fertilizers namely DAP (3700 kg) during the kharif 2019 season to the beneficiary SC farmers in Dari and Godawas villages. During the rabi season of 2019-20, seed inputs of wheat (Raj-4120): 3000 kg, gram (GNG-1581): 3000 kg, mustard (NRCHB-101): 300 kg and DAP fertilizer (3700 kg) were distributed and demonstrated to the beneficiary farmers in Latada, Sadra, Dari, Godawas and Baldo ki Dhani villages of

Pali district. Improved package of practices in demonstration of different crops resulted in 25, 15 and 20% higher yields of mung bean (IPM 2-3), moth bean (CZM-2) and sesame (RT-351) respectively over the farmers' practices.

The RRS distributed certified seed of mung bean (IPM-205-07, MH-421 and GAM-05), clusterbean (RGC-1033) and sesame (RT-351) during the kharif 2020 season to 406 beneficiary farmers of scheduled caste in Baldo ki Dhani, Dhabar Kalan, Dhabar Khurd, Dudiya, Kanawas, Latra and Sadra villages. In rabi season, certified seeds of wheat (Raj-4238), gram (CSJ-515), mustard (NRCHB-101) and fenugreek (AFG-03) were distributed to 175 farmers in Latada and Sadra villages. Demonstration of improved crop varieties and technologies resulted in yield increase by 26, 15 and 20% in mung bean, clusterbean and sesame respectively over farmers' practices.

Field demonstrations on improved grafted varieties of mango (150 saplings), grafted sapota (70 saplings), grafted jamun (100 saplings) and grafted ber (150 saplings) were conducted at SC farmers' fields in Latra and Sadra villages in Bali block of Pali district during 2020-21. Total numbers of beneficiaries were 85.

Crop Cafeteria

Sixty seven improved varieties/hybrids/entries of five major arid region *kharif* crops viz., pearl millet (XMT-1497, AHB-1269, JBV-2, AHB-1200 and MP-7792); sorghum (CSV-15, CSV-23); mung bean (ML-832, IPM-2-3, ML-2056, GAM-5, IPM-2-14, GM-4, RMG-62, IMP-205-07, MH-421, Pusa Ratna, IPM-99-125, SML-668, HUM-12, RMG-268, PUSA Vishal, ML-818, Samrat, Pant Mung-5 and MH-2-15); clusterbean (CAZG-16-12, CAZG-17-4, Maru Guar, RGC-166, RGC-1038, RGC-936, RGC-1033, RGC-

986, HG-365, HG-563, GG-1, GG-2, RGC-155, RGC-1002, RGC-1017, RGC-197, RGC-15-5-8, RGM-112, HG-2-20, and HG-884); moth bean (CZM-1, CZM-2, CZM-3, RMO-40, RMO-225, RMO-257, RMO-423, RMO-457, GMO-2 and RMB-25); and sesame (RT-46, RT-346, RT-54, TKH-122, RT-125, RT-103, RT-127, RT-351, C-50 and GT-10) were demonstrated for the farming community of arid zone during 2018 and 2019.

Similarly, 50 improved varieties/hybrids of *rabi* crops viz., rapeseed/mustard (NRCHB-506, RH-406, NRCDR-2, NRCDR-601, NRCHB-101, DMR 15-31, PBR-357, PM 27, PM-21, PM-26, RH-749, RNG 229, RLC-3, Karan Rai, GSC-06, Pant Pilli Sarson, YSH-401, OVS-16, GP-74 and NRCYS-05-02); fenugreek (AFG-1, AFG-2, AFG-3, AFG-4, AFG-5, Hisar Methi, RMT-1, RMT-305, Pant Ragni and GM-3); Isabgol (GI-2, GI-3, GI-4, RI-2, RI-3025, Niharika, Mayari, HI-5 and DPO-01); cumin (RZ-223, RZ-209, RZ-19 and GC-4); and safflower (A-1, A-2, ISF-764, DSH-185 and PBNS-112) were demonstrated along with improved package of practices for arid region farming community during rabi season of 2018-19 and 2019-20.

Seed production of pulse crops under Seed hub project

Under seed hub project, seed production program of mung bean variety IPM-2-3 was taken up in 20 ha area during kharif 2018 at RRS Pali. The seed production program was taken on produce share contract basis. Total 9.7 t seed was produced which was shared between institute and contractor as per terms and conditions of contract. Share of farmers' seed was purchased by the institute on minimum support price decided by the Govt. of India.

Production of planting material under Mega Seed Project

Under the Mega Seed Project, seed production program on sesame (var. RT-351) and *Cenchrus setigerus* was taken up in 5 and 10 ha, respectively during kharif 2018. Seed production program of sesame was taken up on produce share contract basis and seed collection of *C. setigerus* was done on per kg basis. Total 721 kg seed of sesame was produced.

Farmers' Trainings Organized

Period	Title of training	No. of farmers	Sponsoring agency
April 09, 2012	Stakeholders meet on introduction of fodder beet in Pali district	19	CAZRI RRS, Pali
October 25, 2016	Off-campus training for tribal farmwomen on 'Backyard garden for nutritional security' at Peepla village	20	CAZRI RRS, Pali
May 30-31, 2018	Farmers training on horticultural crops	30	ATMA (Agriculture), Pali
October 03-04, 2018	Farmers training on horticultural crops	30	ATMA (Horticulture), Pali
October 05-06, 2018	Farmers training on horticultural crops	30	Department of Horticulture, Pali
October 11-12, 2018	Farmers training on oilseed production under National Food Security Mission	30	Department of Agriculture, Pali
October 17-18, 2018	Farmers training on Improved technology of crop production	30	ATMA, Pali
October 22-23, 2018	Farmers training on oilseed production under National Food Security Mission	30	Department of Agriculture, Pali

Period	Title of training	No. of farmers	Sponsoring agency
October 25-26, 2018	Farmers training on oilseed production under National Food Security Mission	30	Department of Agriculture, Pali
October 29-30, 2018	Farmers training on oilseed production under National Food Security Mission	30	Department of Agriculture, Pali
November 01-02, 2018	Farmers training on horticultural crops	30	Department of Horticulture, Pali
March 14, 2019	Farmers training on 'Effect of climate change on crop production'	50	ITC through Sarva Mangal Gramin Vikas Sansthan, Pali
March 14-15, 2019	Farmers training on Soil Health Card	30	Department of Agriculture, Govt. of Rajasthan
August 26-27, 2019	Farmers training on oilseed production under National Food Security Mission	40	Department of Agriculture, Sojat, Pali
September 9-10, 2019	Farmer training on oil seed production under National Food Security Mission	40	Department of Agriculture, Pali
September12-13, 2019	Farmers training on oil seed production under National Food Security Mission	40	Department of Agriculture, Pali
September 16-17, 2019	Farmers training on improved technology of crop production	40	ATMA, Pali
September 23-24, 2019	Farmers training on oil seed production under National Food Security Mission	40	Department of Agriculture, Sojat, Pali
September 25-26, 2019	Farmers training on improved technology of crop production	40	ATMA, Pali

Officers training programs organized

Date	Title and venue	No. of participants	Sponsoring agency
August 29-30, 2017	Officers training on oilseeds and oil palm	30	Department of Agriculture, Pali
September 11-12, 2017	Officers training on oilseeds and oil palm	30	Department of Agriculture, Pali
August 01-02, 2018	Officers training on oilseed production under National Food Security Mission (NFSM)	30	Department of Agriculture, Pali
August 09-10, 2018	Officers training on oilseed production under National Food Security Mission (NFSM)	30	Department of Agriculture, Sojat, Pali
March 14-15, 2019	Officers training on Soil Health Card	30	Department of Agriculture, Pali

Model Training Course organized

Date	Training course, organizers and venue	Participants
February 22-29, 2016	Model Training Course (MTC) on Horticulture based farming system for arid region, organized by ICAR-CAZRI RRS, Pali. Sponsored by Directorate of Extension, Department of Agriculture, Cooperation and Farmers Welfare, MoA&FW, Govt. of India	20 officers and extension functionaries of state line departments of agriculture/ horticulture, Govt. of Rajasthan and Uttar Pradesh

International Webinar Organized

Date	Conference	Organizers
July 29-30, 2020	International webinar on urban and peri-urban agriculture for livelihood	ICAR-CAZRI RRS, Pali-Marwar, Rajasthan in collaboration with Dr. Ram Avatar Shiksha Samiti (DRASS)

Scientist-Farmer's interaction meeting organized

Date	Title and venue	Sponsoring agency
December 29-30, 2014	Scientist-farmers' interface meeting organized at RRS, Pali	CAZRI-RRS, Pali, ATMA, State Agriculture Department
March 25, 2017	Scientist-farmers' interface meeting on 'Soil Salinity: Problems and Solutions'	Sarv Mangal Gramin Vikas Sansthan (NGO)
June 01, 2017	Scientist-farmers' interface meeting at Rupawas, Pali	CAZRI-RRS, Pali
February 20, 2018	Scientists-farmers' interface meeting on crop diversification for transitional plain of Luni basin	CAZRI-RRS, Pali
February 28, 2018	Scientist-farmers' interface meeting on crop diversification for transitional plain Luni basin	CAZRI-RRS, Pali
March 08, 2018	Field day on GRAM organized at Vayad village, Pali	CAZRI-RRS, Pali
March 28, 2018	Field day on wheat crop at Rupawas village, Pali	CAZRI-RRS, Pali
July 16-17, 2018	Scientist-farmers' interaction meeting at CAZRI-RRS, Pali	Deputy Director (Agriculture), Pali
April 2, 2019	Field day cum scientist-farmers' interface meeting on rabi crops held at Lakhana village	ITC through Sarva Mangal Gramin Vikas Sansthan, Pali
June 28, 2019	Scientist-farmers' interface meeting at Dari Godavas village in Pali tehsil under SCSP	CAZRI, Jodhpur
September 16, 2019	Kisan Mela and Kisan Navachar Diwas, Kisan Vaigyanik Diwas	CAZRI, Jodhpur
September 26-27, 2019	Improved production technology of rabi crops held in conference hall of ATMA, Pali	Department of Agriculture, Pali
October 18, 2019	Field day on kharif season crop production at Dari Godawas village in Rohat tehsil of Pali under SCSP	CAZRI, Jodhpur
October 20, 2019	Field day on kharif crop production at Baldo ki Dhani under SCSP	CAZRI, Jodhpur
March 28, 2020	Field visit cum farmers training on rabi crop plant protection at Latra and Sadra villages in Bali tehsil under SCSP	CAZRI, Jodhpur
January 24, 2020	Field day on rabi season crop production at Latra and Sadra villages of Bali tehsil under SCSP	CAZRI, Jodhpur

Farmers' Fair and Field days

Date	Event
March 08, 2018	Field days in Vayad in collaboration with ITC and Sarva Mangal Gramin Vikas Sansthan
March 28, 2018	Field day on wheat crop at Rupawas village of Pali district in collaboration with Sarva Mangal Gramin Vikas Sansthan
May 2, 2018	Kisan Kalyan Karyashala and Kisan Gosthi at Raipur, Pali district, organized by Assistant Directorate of Agriculture, Pali
March 28, 2019	Kisan Mela and Kisan Gosthi held at CAZRI, KVK, Pali

Meetings and Events Organized

Model Training Course on 'Horticulture-based Farming System for Arid Region'

National Level Model Training Course on 'Horticulture-based Farming System for Arid Region', sponsored by Directorate of Extension, DoAC, Ministry of Agriculture, was organized during February 22-29, 2016 at RRS, Pali. Twenty participants from Rajasthan and Uttar Pradesh attended the training program. The course composed of lectures and practical sessions conducted by resource persons from different ICAR institutes viz., CAZRI, Jodhpur and its RRS of Bhuj, Bikaner and Jaisalmer, CIAH, Bikaner, NRCCS, Ajmer and KVK, Pali. Training covered various aspects of arid horticulture viz., horticulture based integrated farming systems, integration of livestock in horticulture based farming systems, efficient resource and nursery management, production technology of arid horticultural crops, disease and pest management, organic farming and certification, conservation of genetic resources and improvement of arid horticulture crops through various techniques, post-harvest measures and value addition in arid fruits and vegetables.

Parthenium Awareness Week

Parthenium weed, locally known as gajar or congress ghas is noxious and causes skin allergy, fever and respiratory problems in animals and human beings. Parthenium awareness week was organized from August 25-31, 2020. During the program, the hazardous effects of Parthenium on animals, human health and crop productivity were highlighted and it was emphasized that it should be uprooted before it starts flowering and then burned.

Digital India Week

Digital India Week was observed at RRS, Pali on July 07, 2015. Government of India has launched 'Digital India Campaign' that aims at bringing good governance through digitally empowered society and knowledge economy for co-ordinated engagement of entire government. The program was inaugurated by

Dr. A.K. Shukla, Head, in presence of chief guests from District Information Office, Mr. Anil Kumar Purohit and Mr. Kapil Ujawal. The officials from Department of Electronics and Information Technology (DeitY) created awareness about 'Digital Locker System' and its importance, usage and benefits for the staff of the station.

World Environment Day

World Environment Day was observed at RRS, Pali on June 05, 2015 on the theme 'Seven Billion Dreams, One Planet: Consume with Care'. During the program, the need to protect environment in a sustainable way and the factors responsible for greenhouse gas emissions were highlighted. Awareness was created among the staff of the station for protecting environment by showing a short film on global warming and its consequences. Each staff member planted neem saplings around the campus and pledged to adopt and take care of the saplings planted by them.

Institute Development

Repair and Renovation of Office Building and Office Premises

Civil works of approximately Rs. 65 lakhs were executed for the repair of office building, two laboratories, committee hall, rooms, residential quarters and roads



Development of New Area for Rainfed Crop Cultivation

During this period, additional 15 ha new area was developed and utilized for cultivation of rainfed kharif season crops. The seed production program of mung bean under Seed Hub Project and production of *Cenchrus ciliaris* and sesame under Mega Seed Program was taken up in this area.


Linkages and Collaborations

- ICAR-Indian Institute of Millet Research, Hyderabad
- ICAR-Directorate of Mustard Research, Bharatpur
- ICAR-Indian Institute of Wheat and Barley Research, Karnal
- ICAR-Indian Institute of Pulse Research, Kanpur
- ICAR-Central Soil Salinity Research Institute, Karnal
- ICAR-Central Soil Salinity Research Institute, Regional Research Station, Lucknow
- Department of Agriculture and other line departments, Government of Rajasthan
- Sarva Mangal Gramin Vikas Sansthan and other NGOs
- ICAR-National Bureau of Plant Genetic Resources, Regional Station, Jodhpur

Capacity Building

Participation in Trainings and Summer and Winter Schools

Date	Title of Training Course	Name of the participants
January 10-15, 2011	NAIP on Strengthening of Statistical Computing for NARS, MPUAT, Udaipur	S.P.S. Tanwar
February 15-March 7, 2011	Institutional Changes for Inclusive Agricultural Growth, IARI, New Delhi	Khem Chand
November 01-21, 2011	Training on Management Development Program on Leadership Development at NAARM, Hyderabad	S.M. Deb
July 17-August 06, 2012	Summer School Training Program on Forecast Modeling in Crops at IASRI, New Delhi	Monika Shukla
September 17-26, 2012	ICAR Short Course on Efficient Use of Organic Wastes for Sustainable Agriculture and Enhancing Soil Health in Low Rainfall Areas at CAZRI, Jodhpur	B.L. Jangid
May 15-24, 2013	Short Course on Managing IP and PVP and PGR at Directorate of Sorghum Research (DSR), Hyderabad	Vikas Khandelwal
August 12-16, 2013	APO event 13-AG-16-GE-WSP-B Workshop on Developing Farming System for Climate Change Mitigation at Colombo, Sri Lanka	S.P.S. Tanwar
September 20, 2013	Short Course on Training cum Awareness Program on PPV&FRA at AICPMIP, Mandore, Jodhpur	Vikas Khandelwal
October 02-November 13, 2013	Training Course for Mobile from Development- A Massive Open Online Course (MOOC) at IIT, Kanpur	B.L. Jangid
December 20-27, 2013	Model Training Course on Integrated Farming System for Enhancing Resource Use Efficiency and Livelihood Security of Small and Marginal Farmers at IARI, New Delhi	Monika Shukla
February 03-15, 2014	Refresher Course on Agricultural Research Management at NAARM, Hyderabad	S.P.S. Tanwar
December 08-17, 2014	Short Course on Climate Change Mitigation and Adaptation under Arid and Semi-Arid Regions at CAZRI, Jodhpur	D.K. Gupta
August 5-25, 2015	Summer Training Program on Geospatial Technologies on Mapping, Monitoring and Management of Natural Resources at ICAR-NBSS&LUP, Nagpur	D.K. Gupta
October 06-26, 2015	Winter School on Multistoried Cropping System and Canopy Architecture Management in Horticulture Crops at College of Horticulture, Sirsi, Karnataka	M.B. Noor Mohamed
November 18-December 08, 2015	Winter School on Managing Natural Resources for Sustainable Rural Livelihood Security at SHIATS, Allahabad	Keerthika, A.
September 04-24, 2018	Winter School on Advances in Salinity and Sodicity Management under different Agro-Climatic Regions for Enhancing Farmers Income at ICAR-CSSRI, Karnal	Kamla K. Choudhary
November 27-December 17, 2018	Winter School on Recent Approaches in Horticultural Development for Enhancing Farm Income in Environmentally Constrained Ecosystems at ICAR-CAZRI, Jodhpur	M.B. Noor Mohamed

Participation in Conference/Seminar/Symposia/ Workshop/Meetings

Date	Title, name of organizers and venue	Name of Participants
March 22, 2011	Workshop on Inventorization and Documentation of Location Specific Problems requiring S&T Intervention, organized by DST, Govt. of Rajasthan, Jodhpur and KVK, CAZRI, Pali at KVK, Pali	B.L. Jangid Khem Chand P.L. Regar S.M. Deb S.P.S. Tanwar S.S. Rao
May 30, 2011	Planning Commission Sub Group Meeting on Management of Natural Resources at CRIDA, Hyderabad	Khem Chand
June 18, 2011	National Conference on Clean Technologies and Green Business for 21stcentury at AIT, Kaushalganj district, Rampur, Uttarakhand	S.P.S. Tanwar
July 19, 2011	Workshop on Forest in an Expanding Economy at AFRI, Jodhpur	Khem Chand
September 10-11, 2011	National Symposium on Forage Resource and Livestock for Livelihood, Environment and Nutritional Security, organized by RMSI and ICAR-IGFRI, Jhansi	S.P.S. Tanwar S.S. Rao
October 16, 2011	Workshop on Right to Food for All, GRAVIS, held at Nirali Dhani, Jodhpur	Khem Chand
October 17, 2011	Planning Commission Sub Group II Meeting on Agriculture, Education, Prioritization with Special Focus on Rainfed Farming, held at MPUAT, Udaipur	Khem Chand
November 09-12, 2011	International Conference on Innovative Approaches for Agricultural Knowledge Management-Global Experiences, organized by ISEE, Nagpur, and ICAR, New Delhi, at Vigyan Bhawan and NASC Complex, New Delhi	B.L. Jangid
December 20-22, 2011	National Symposium on Resource Utilization through Integrated Farming System and Biodiversity Conservation in Dry Lands, held at Bhuj, Gujarat, India	B.L. Jangid Khem Chand S.P.S. Tanwar
February 18-19, 2012	Brain Storming Workshop: Fodder for Sustainable Livestock Production and Environmental Security, held at ARS, SKRAU, Keshwah, Jalore	Khem Chand
February 29, 2012	Workshop on Targeting Agri-Based Technological Interventions in Arid Western Rajasthan, sponsored by Project Directorate of MPOWER Project, Jodhpur and Organised by ICAR-CAZRI, Jodhpur	Khem Chand
April 12-18, 2012	5th IFIP World IT Forum (WITFOR) on Sustainable Human Development, held at Vigyan Bhawan, New Delhi, India	B.L. Jangid
October 9-11, 2012	20th Annual Conference of Agricultural Economics Research Association (India), held at IARI, New Delhi	Khem Chand
November 26-30, 2012	Third International Agronomy Congress on Agricultural Diversification, Climate Change Management and Livelihoods, held at New Delhi	Monika Shukla S.P.S. Tanwar
December 01-02, 2012	Symposium on Managing Stress in Dry Lands Under Climate Change Scenarios, held at ICAR-CAZRI, Jodhpur	Vikas Khandelwal Khem Chand Monika Shukla B.L. Jangid

Date	Title, name of organizers and venue	Name of Participants
January 22, 2013	Biodiversity Workshop Program: CRP 1.1 on Dry Land Systems, held at ICAR-CAZRI, Jodhpur	Khem Chand
February 23, 2013	Sensitization Program on Protection of Plant Varieties and Farmers' Rights Act 2001, held at KVK, Pali	Vikas Khandelwal B.L. Jangid P.L. Regar
March 14-15, 2013	Workshop on Targeting Climate Resilient Agricultural Technologies in Arid Western Rajasthan, held at ICAR-CAZRI, Jodhpur	Khem Chand B.L. Jangid
March 19-20, 2013	National Seminar on Agribusiness Potential of Rajasthan, held at SKRAU, Bikaner	Khem Chand
March 22-24, 2013	48th AICRP (Pearl millet) Annual Workshop, held at JAU, Junagarh	Vikas Khandelwal
July 19, 2013	National Brainstorming Workshop on Managing Resources for Optimizing of Land Productivity in Thar Desert, held at CAZRI, Jodhpur	B.L. Jangid Monika Shukla
October 23-26, 2013	78th Annual Convocation of Indian Society of Soil Science and National Symposium on Agro-ecozone based Land Use Planning, held at ICAR-CAZRI, Jodhpur	Monika Shukla
December 09, 2013	International Conference on Extension Educational Strategies for Sustainable Agricultural Development – A Global Perspective, heldat UAS, Bangalore	B.L. Jangid
February 04, 2014	Workshop on Managing Arid Agriculture in Changing Climate, held at ICAR-CAZRI, Jodhpur	Vikas Khandelwal
November 06-09, 2014	6th Indian Horticulture Congress, organized by The Horticulture Society of India and Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu	A.K. Shukla
November 25-26, 2014	International Symposium on Peri-urban Agriculture for Improving Livelihood Opportunities, organized by Samagra Welfare Vikas Society (SWVS), Lucknow, U.P, India	A.K. Shukla
December, 18-19, 2014	National Seminar on Rural Youth in Family Farming: Needs and Challenges, RYFF 2014 organised by DEE, BAU, Sabour, Bhagalpur, Bihar	B.L. Jangid
February 03-06, 2015	XII Agriculture Science Congress, held at ICAR-NDRI, Karnal	B.L. Jangid
August 19-22, 2015	National Symposium on Sustaining Agricultural Productivity in Arid Ecosystem: Challenges and Opportunities, held at ICAR-CAZRI RRS, Leh	A.K. Shukla
January 09-10, 2016	International Seminar on Indigenous Technologies for Sustainable Agriculture and Better Tomorrow, organized by SVWS, Lucknow, U.P.	A.K. Shukla D.K. Gupta
February 18-20, 2016	International conference on Natural Resource Management: Ecological Perspectives, organized by Indian Ecological Society and SKUAST, Chatha-Jammu (J&K).	M.B. Noor Mohamed
February 26, 2016	Workshop on Climate Change: Mitigation and Adaptation in Hot Arid Region held at RRS, CAZRI, Bikaner	D.K. Gupta
June 25-26, 2016	IJTA 3rdInternational Conference on Agriculture, Horticulture and Plant Sciences, organized by Academic Research Journals, held at New Delhi	M.B. Noor Mohamed
April 3-7, 2017	XIX Commonwealth Forestry Conference on Forest for Prosperity and Posterity, organized by Common Wealth Association, FRI, ICFRE and MoEF&CC, Govt. of India, held at Dehradun	Keerthika, A M.B. Noor Mohamed

Date	Title, name of organizers and venue	Name of Participants
November 08-11, 2017	3rd International Conference on Bio-resource and Stress Management, organized by RKM Foundation, Kolkata, Visva Bharati University Santiniketan, West Bengal, ICAR and SIAM, Jaipur, Rajasthan	D.K. Gupta Keerthika, A M.B. Noor Mohamed
May 28-31, 2018	National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development, DRPCAU, Pusa, Bihar	A.K. Shukla
October 27-29, 2018	National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment, ICAR-CIAH and Indian Society for Arid Horticulture, Bikaner, Rajasthan	A.K. Shukla M.B. Noor Mohamed
February 11-14, 2019	13th International Conference on Development of Drylands: Converting Dryland Areas from Grey to Green, organized by AZRAI and ICAR-CAZRI, Jodhpur	A.K. Shukla R.S. Mehta P.L. Regar S.R. Meena D.K. Gupta M.B. Noor Mohamed Kamla K. Choudhary
September 27-29, 2019	2nd International Conference on Recent Advances in Agricultural, Environmental and Applied Sciences for Global Development (RAAEASGD-2019), organized by AEDS, U.P.	M.B. Noor Mohamed
March 05-06, 2020	National Agroforestry Symposium on Climate Resilient Agroforestry Systems to Augment Livestock Productivity Ensuring Environmental Biodiversity, by CAFRI, Kattupakkam, Tamil Nadu	Keerthika, A

Publications

Research papers in Journals

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Awards and Recognitions

- Dr. A.K. Shukla, Dr. Dipak Kumar Gupta and Dr. Akath Singh were awarded Rajbhasa Gaurav Award-2020 for the Hindi Book entitled "फल विज्ञान एवं प्रबंधन" by Department of Official Language, Ministry of Home Affairs, Govt. of India.
- Dr. A.K. Shukla received Eminent Scientist Award by Samagra Vikas Welfare Society (SVWS) and Amulya Sanchay Producer Ltd. Company during International Seminar on Indigenous Technologies for Sustainable Agriculture and Better Tomorrow, held at CSIR-NBRI, Lucknow January 09-10, 2016.
- Dr. A.K. Shukla was conferred with 'Fellow of the Indian Society of the Arid Horticulture' at ICAR-CIAH, Bikaner on October 28, 2018.
- Dr. A.K. Shukla was conferred with 'Fellowship of International Society for Noni Science' in the Workshop at University of Madras, Chennai on March 24, 2019.
- Dr. A.K. Shukla was conferred with 'IAHS Fellowship-2019' by Indian Academy of Horticultural Sciences, New Delhi.
- Dr. A.K. Shukla was conferred with 'Dr. Rajendra Prasad Excellence Award-2019' by the Society of Tropical Agriculture, New Delhi.
- Dr. Dipak Kumar Gupta was awarded 3rd Prize in photography competition (2016) during International Conference on Natural Resource Management: Ecological Perspectives at Sher-e-Kashmir University of Agriculture and Technology, Jammu during February 18-20, 2016.
- Dr. Dipak Kumar Gupta was awarded Best Oral Presentation Award in International Seminar on Indigenous Technologies for Sustainable Agriculture and Better Tomorrow, organised by Samagra Vikas Welfare Society (SVWS) and Amulya Sanchay Producer Ltd. Company at CSIR-NBRI, Lucknow, January 09-10, 2016.
- Dr. Dipak Kumar Gupta was awarded Best Thesis Award during International Seminar on Agriculture and Food for Inclusive Growth and Development, organised by Samagra Vikas Welfare Society and Annapoorna Life Organic Food Pvt. Ltd., Lucknow at CSIR-NBRI, Lucknow, U.P., January 14-15, 2017.
- Dr. Dipak Kumar Gupta was awarded 'ICAR Jawaharlal Nehru Award for Outstanding Doctoral Thesis Research in Agricultural and Allied Science 2016' during 89th Foundation Day of ICAR at IARI, New Delhi on July 16, 2017.
- Dr. Dipak Kumar Gupta was given 'Best Young Scientist Award 2018' by Science & Tech. Society for Integrated Rural Improvement, in 2nd National Conference on Doubling Farmers Income for Sustainable & Harmonious Agriculture 'DISHA-2018' at Thorrur, Warangal, August 11-12, 2018.
- Dr. M.B. Noor Mohamed was awarded the best Ph.D. student in forestry (Gold medal) sponsored by Seshasayee Paper and Board Ltd. and TNAU, 2015.
- Dr. M.B. Noor Mohamed was awarded Young Scientist Award during IJTA 3rd International Conference on Agriculture, Horticulture and Plant Sciences, organised by Academic Research Journals, New Delhi, June 25-26, 2016.

- Dr. M.B. Noor Mohamed was awarded Best Oral Paper Presentation Award during IJTA 3rd International Conference on Agriculture, Horticulture and Plant Sciences, organised by Academic Research Journals, New Delhi, June 25-26, 2016.
- Dr. M.B. Noor Mohamed was awarded Innovative Scientist Award during 3rd International Conference on Bio-resource and Stress Management, organized by RKM Foundation, Kolkata, Visva Bharati University, Shantiniketan, West Bengal, November 08-11, 2017 at SIAM, Jaipur, Rajasthan.
- Dr. M.B. Noor Mohamed conferred with Scientist of the Year-2019 in 2nd International Conference on Recent Advances in Agricultural, Environmental and Applied Sciences for Global Development (RAAEASGD-2019) by AEDS, UP.
- Dr. M.B. Noor Mohamed was awarded Best Oral Presentation Award at 2nd International Conference on Recent advances in Agricultural, Environmental and Applied Sciences for Global Development (RAAEASGD-2019), on September 27-29, 2019
- Dr. M.B. Noor Mohamed was awarded the Young Scientist award-2020 at International Webinar on Urban and Peri-Urban Agriculture for Livelihood, organized by Dr. Ram Avatar Shiksha Samiti (DRASS) in collaboration with ICAR-CAZRI, RRS, Pali, Marwar, Rajasthan on July 29-30, 2020.
- Dr. R.S. Mehta was awarded with 'Krishi Vigyan Gaurav-2018' for Best Research paper in Hindi in Bhartiya Krishi Anusandhan Patrika by Bhartiya Krishi Anusandhan Samiti and Agricultural Research Communication Center, Karnal.
- Dr. R.S. Mehta received the Eminent Scientist Award at International Webinar on Urban and Peri-Urban Agriculture for Livelihood, organized by Dr. Ram Avatar Shiksha Samiti (DRASS) in collaboration with ICAR-CAZRI, RRS, Pali, Marwar, Rajasthan on July 29-30, 2020.
- Dr. S.P.S. Tanwar and Er. P. L. Regar were awarded Foundation Day Award-2014 for the Best Research Paper: Tanwar, S.P.S., Rao, S.S., Regar, P.L., Datt Shiv, Kumar Praveen, Jodha, B.S., Santra, P., Kumar, R, Ram, R. 2014. Improving water and land use efficiency of fallow wheat system in shallow lithic calciorthid soils of arid region: Introduction of bed planting and rainy season sorghum legume intercropping. *Soil and Tillage Research* 138: 44-55.
- Ms. Keerthika, A. received first prize for oral presentation in the National Agroforestry Symposium (NAFS 2020) on 'Climate Resilient Agroforestry Systems to Augment Livestock productivity Ensuring Environmental Biodiversity' held at Institution of Animal Nutrition, PGRIAS Campus, Kattupakkam, Tamil Nadu Veterinary and Animal Sciences University during March 5 & 6, 2020.

Medals/Awards in Sports

- Ms. Keerthika A, Scientist (Agroforestry) received silver medal in discuss throw during ICAR West Zone Sports Meet 2014, organized by ICAR-CAZRI, Jodhpur.
- Ms. Keerthika A, Scientist (Agroforestry) received gold medal in shot put during ICAR West Zone Sports Meet 2014, organized by ICAR-CAZRI, Jodhpur.
- Dr. Kamla Kumari Chaudhary, Scientist (Soil Science) received gold medal in badminton (women) during ICAR West Zone Sports Meet 2017, organized by ICAR-IGFRI, Jhansi.
- Dr. Kamla Kumari Chaudhary, Scientist (Soil Science) received bronze medal in shot put during ICAR West Zone Sports Meet 2017, organized by ICAR-IGFRI, Jhansi.

Distinguished Visitors

- Dr. Daniel McMillen, Agriculture Advisor, Govt. of Afghanistan visited on November 20, 2010.
- Dr. Purbi Bose, Gender and Forestry, IUFRO, Mumbai, India on November 21, 2013.
- Dr. O.P. Gill, Vice Chancellor, Maharana Pratap University of Agriculture and Technology, Udaipur, visited on July19, 2013 at CAZRI-KVK Pali.
- Dr. Han Van Djik, Sociology of Development and Change Group, Wageningen University, The Netherlands on November 21, 2013.
- Dr. J.S. Samra, Chairman, Research Advisory committee of CAZRI-Jodhpur visited on April 9, 2016.
- Dr. P.L. Saroj, Director, ICAR-CIAH, Bikaner on June 20, 2019.
- Dr. Vishal Nath, Director, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar on January 20, 2019.
- Dr. L.N. Harsh, Former Vice Chancellor of Agriculture University, Jodhpur, Rajasthan on September 7, 2020.

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