Farmer FIRST

Empowering Farmers through Selective Interventions in Salt-affected Agroecosystems of Ghaghar Plains

ICAR-Central Soil Salinity Research Institute
Karnal, Haryana - 132 001

Empowering Farmers through Selective Interventions in Salt-affected Agroecosystems of Ghaghar Plains

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PREFACE

The Farmer FIRST (Farm, Innovations, Resources, Science, and Technology) Programme, launched by the Indian Council of Agricultural Research (ICAR) in 2016, is a groundbreaking initiative aimed at tackling the diverse challenges encountered by Indian farmers. This programme promotes collaboration among farmers, scientists, and extension workers to connect scientific research with field oriented agricultural solutions through participatory technology development, integration of modern technology, capacity building and knowledge sharing, and institutional linkages.

The Farmer FIRST initiative fundamentally operates as a collaborative endeavour, engaging farmers as integral participants while scientists contribute advanced research, fostering a mutually beneficial relationship. Such an innovative and localized solutions are not only scientifically robust but also contextually appropriate, catering to the varied agro-ecological zones of the country. The initiative has effectively amalgamated technological advancements, agronomic methodologies, and capacity-building programs, resulting in improved agricultural productivity and increased income for the farmers involved. The outcomes are evident, and the favourable responses from the field underscore the project's success.

We are delighted to present a technical bulletin summarizing the information from the ICAR-CSSRI led Farmer FIRST project for the years 2016-2021, which outlines our accomplishments, the obstacles encountered, and our strategic approach to address these challenges.

This project would not have been possible without the steadfast support and guidance of Dr. A.K. Singh, Former DDG (Agril. Extension) at the Division of Agricultural Extension, and Dr. V.P. Chahal, National Convenor of the Farmer FIRST Project, whose visionary leadership and strategic direction were crucial in achieving the desired outcomes. We extend our heartfelt gratitude to the former Directors, Dr. D.K. Sharma and Dr. P.C. Sharma, for their continuous encouragement and guidance throughout the planning and execution of the project. We would like to express our sincere appreciation to our committed project and office personnel, particularly Dr. Raman Sharma (SRF), Sh. Raj Kumar, Mahesh, and everyone else who made valuable contributions in various roles during the execution of project activities. The authors are also deeply grateful to the Indian Council of Agricultural Research (ICAR) for their financial assistance, which enabled the successful implementation of project activities and the preparation of this bulletin.

We wish that the project outcomes and suggested policy implications would open up new initiatives for sustainable management of salt-affected soils and improved livelihood of distressed farming community.

As we delve into the details of this technical bulletin, we encourage you to witness the transformative impact of the Farmer FIRST project and join us in envisioning a future where Indian agriculture thrives through sustainable, farmer-centric innovations.

Authors

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Farmer FIRST

भाकृअनुप
ICAR

केन्द्रीय मृदा लवणता अनुसंधान संस्थान
1969
CSSRI

1 FARMER FIRST PROGRAMME

The Farmer FIRST Programme (FFP) was conceived and implemented by ICAR to involve the practising farmers in research problem identification, prioritization and conducting experiments in farmers' fields utilizing the resources available with the farmers. The acronym FIRST emphasizes the focus on Farmer's Farm, Innovations, Resources, Science, and Technology. In the Indian context, the terms 'enriching knowledge' and 'integrating technology' encapsulate the essence of Farmer FIRST. Enriching knowledge highlights the mutual learning process between the research system and farmers. This involves understanding the existing farm environment, perceptions, and interactions with the various sub-systems established around them. Technology integration is viewed as adapting scientific outputs from research institutions to fit into farmers' conditions. This may require alterations and adaptations at the field level to ensure acceptance, adoption, and success. The Farmer FIRST program focuses on key elements such as innovations, technology, feedback mechanisms, and the active participation of multiple stakeholders. The program recognizes and addresses various realities in agriculture, employing diverse methodological approaches. Furthermore, it considers vulnerability and livelihood interventions to create a comprehensive framework for sustainable agricultural development.

Objectives of Farmer FIRST Programme (FFP)

The Farmer FIRST programme aims to strengthen the interface between farmers and scientists for the development and application of technology. This objective will be realized through a focus on innovations, technology, feedback mechanisms, participation of multiple stakeholders, acknowledgement of various realities, utilization of diverse methods, and interventions addressing vulnerability and livelihoods. The specific objectives are:

- To enhance the farmer-scientist interface, enrich knowledge and facilitate continued feedback;
- To identify and integrate economically viable and socially compatible technological options as adoptable models for different agro-ecological situations;
- To develop modules for farm women to address drudgery reduction, income enhancement and livelihood security;
- To study the performance of technologies and the perception of the farmers about agriculture as a profession in rural settings;
- To build a network of linkages of organizations around the farm households for improving access to information, technology, input and market; and
- To institutionalize the Farmer FIRST process.

Components of Farmer FIRST Programme

Enabling involvement of researchers for continuous interaction with farm conditions, problem orientation, exchange of knowledge between farmers and other stakeholders, prioritization of problems and setting up of research agenda.

Enhancing Farmer–Scientist Interface

Technology Assemblage, Application and Feedback

Integrating components of technology for application in different agro-ecosystems with a focus on innovations and feedback.

FFP COMPONENTS

Building partnerships involving different stakeholders, development of rural-based institutions, agro-ecosystem and stakeholders' analysis and impact studies.

Partnership and Institution Building

Content Mobilization

Using the platform of the project having institutions as partners to develop specific content for e-enabled knowledge sharing.

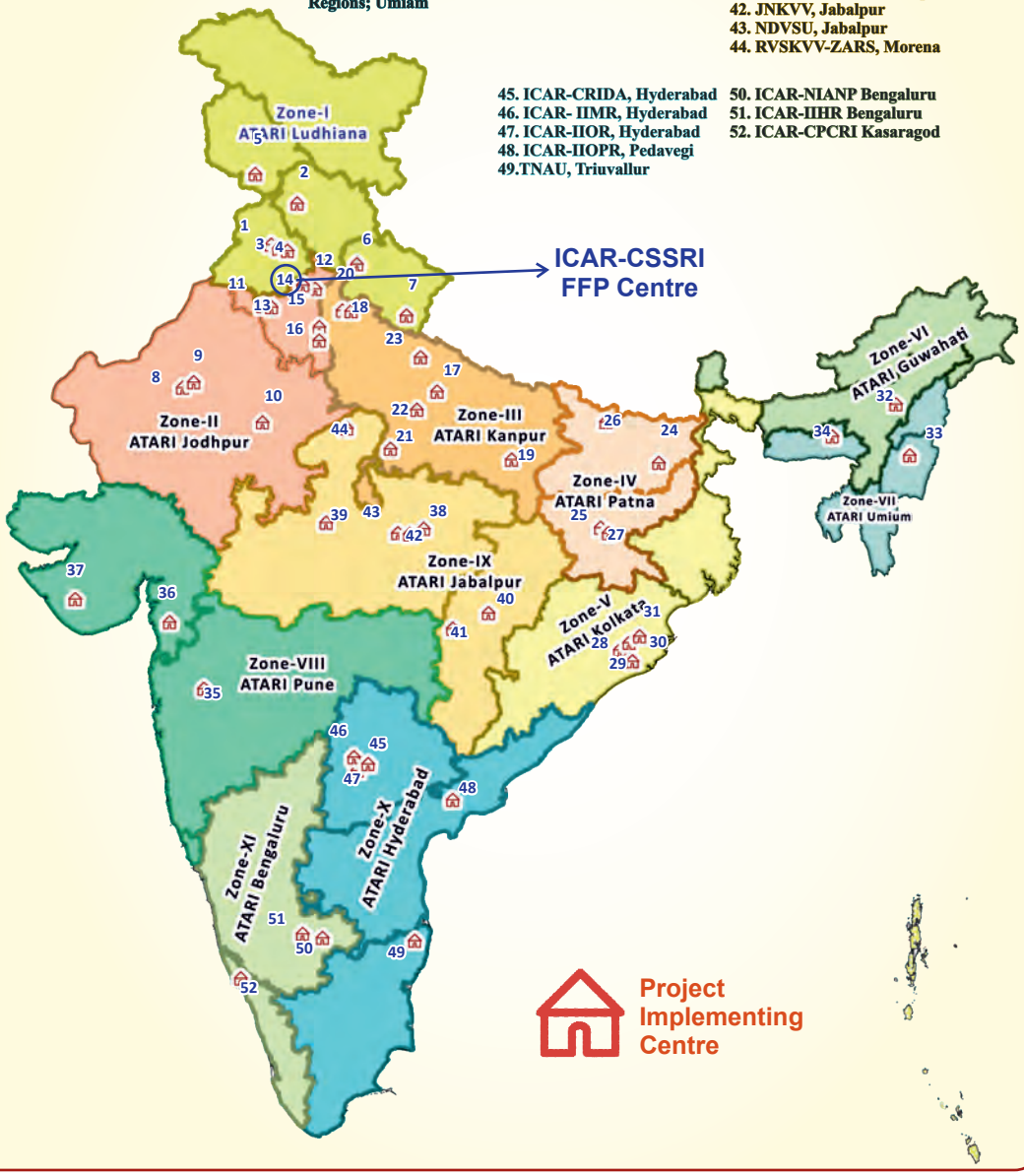
In essence, the Farmer FIRST Programme seeks to strengthen the farmer-scientist interface, promoting a collaborative and adaptive approach to technology development and application in the agricultural sector.

The ICAR has sanctioned 52 Farmer FIRST Projects by establishing FFP centres in State Agricultural/ Veterinary Science Universities and ICAR Institutes. The zone-wise location of FFP centres is depicted in the map as follow :

1. GADVASU, Ludhiana
2. CSKHPKV, Palampur
3. ICAR-CIPHET, Ludhiana
4. PAU, Ludhiana
5. SKAUST, Jammu
6. ICAR-IISWC, Dehradun
7. GBPUA&T, Pantnagar
8. CAZRI, Jodhpur
9. AU, Jodhpur
10. CSWRI, Avikanagar
11. CIRB, Hisar
12. NDRI, Karnal
13. CCSHAU, Hisar
14. CSSRI, Karnal
15. IARI, New Delhi
16. ICAR-NIAP, New Delhi
17. ICAR-CISH, Lucknow
18. ICAR-IIFSR, Meerut
19. ICAR-IIVR, Varanasi
20. ICAR-CIRC, Meerut
21. ICAR-IGFRI, Jhansi
22. ICAR-IIPR, Kanpur
23. ICAR-IVRI, Bareilly
24. BAU, Sabour
25. BAU, Ranchi
26. ICAR-MGIFRI, Motihari
27. ICAR-RCER, FSRCHPR, Plandu

28. OUAT, Bhubaneswar
29. ICAR-CIFA, Bhubaneswar
30. ICAR-IIWM, Bhubaneswar
31. ICAR-NRRI, Cuttack
32. AAU, Jorhat
33. CAU, Imphal
34. ICAR RC for NEH Regions; Umiam
35. MPKV, Rahuri
36. NAU, Navsari
37. JAU, Junagadh
38. ICAR-DWR, Jabalpur
39. ICAR-IISS, Bhopal
40. ICAR-NIBSM, Baronda
41. SKS CARS, IGKV Raipur
42. JNKVV, Jabalpur
43. NDVSU, Jabalpur
44. RVSKVV-ZARS, Morena

45. ICAR-CRIDA, Hyderabad
46. ICAR- IIMR, Hyderabad
47. ICAR-IIOR, Hyderabad
48. ICAR-IIOPR, Pedavegi
49.TNAU, Triuvallur
50. ICAR-NIANP Bengaluru
51. ICAR-IIHR Bengaluru
52. ICAR-CPCRI Kasaragod



ICAR-CSSRI

2 ICAR-CSSRI Farmer FIRST Project

In the present scenario, neither the farmers nor the scientific community and/or policy makers in isolation are capable enough to devise and manage the agro-ecological stressors caused by ecological, climatic, technological, socio-economic and institutional factors. The era has come up requiring changed setup from 'centric to poly-centric approach' where decisions about managing agricultural resources and devising and scaling-up agricultural technologies are to be pursued in reciprocal manner where farmers are treated as knowledge partner instead of only adopters. Globally, now the scholars of socio-ecological science have well recognized the value of stakeholders (in our case farmers) participation in generation or co-production of adaptive knowledge. Small and marginal farmers of marginal environments (salt-affected soils, poor quality water and poor resource base) have limited options to cope up with and adapt various stressors. They mostly depend on their locally available resources to a great extent, traditional knowledge and practices, social capital and informal institutional networks, and make refinements in their formal knowledge systems to withstand the existing vulnerabilities.

In the past, the participation of multiple stakeholders was also not taken up in perspective for technology development, integration and adoption. Now the situation has changed drastically in terms of increased number of smallholders, growing proposition of women-led agriculture, need for higher return per unit area and addressing the changing socio-economic environment, etc. External farming technologies offered by formal institutions to farmers inhabiting complex and fragile agro-ecosystems for managing agricultural resources and securing livelihoods are based on general recommendations (developed from a macro-ecological base) which needs location-specific refinements and farmers' knowledge based value addition to better suit the existing or predicted stressed situations. Yet, the agro-ecological vulnerability is often more localized; hence, location-specific adaptive practices are needed for specific microclimates. This situation highlights the need to integrate and combine such practices with scientific approaches to enhance adaptations of small and marginal farmers against various agro-ecological stressors. Adaptive knowledge co-produced and/or refined, and scaled-up may provide insights and technological solutions for multiple outcomes, including adaptation and sustainability. Therefore, a complementary relationship, integrating formal and informal knowledge in synergistic manner can be best accommodated and promote adaptive practices through scaling-up and refinement as advocated and supported through UNDP projects. We need to understand in what ways agricultural knowledge can be combined, integrated, refined and incorporated with formal science and policy to make it even more effective and viable. This necessitates new approach for project development involving innovation and technology development with the strong partnership of the farmers for developing location specific, demand driven and farmer friendly technological options.

This ICAR-CSSRI initiative through FFP provides an opportunity to privilege the smallholder agriculture and complex, diverse and risk prone realities of distressed farming community in salt affected agro-ecosystems. Streamlining, validation and developing evidence based best bet technologies would be of immense use in devising ecosystem-based sustainable approach viewing optimal resource use, improved soil and crop resilience with socio-economic development and eventually achieving the goals of land degradation neutrality, food security and environmental protection.

Project conceptualization

Title of the project	When	Where	By whom
Empowering farmers through selective interventions in salt-affected agroecosystems of Ghaghar Plains.	July 2016	• The project was conceptualised by ICAR-CSSRI Scientists Team as a part of Farmer FIRST Programme. • This project has been extensively implemented in farmers' participatory mode in sodicity-affected Ghaghar Basin of Haryana, India during October 2016 -March 2021.	• Dr. Parvender Sheoran, Principal Scientist (Agronomy), ICAR-CSSRI as Principal Investigator • The project involves multi-disciplinary team of Scientists (Breeder, Agronomist, Physiologist, Extensionist, Economist, Dairy scientists)

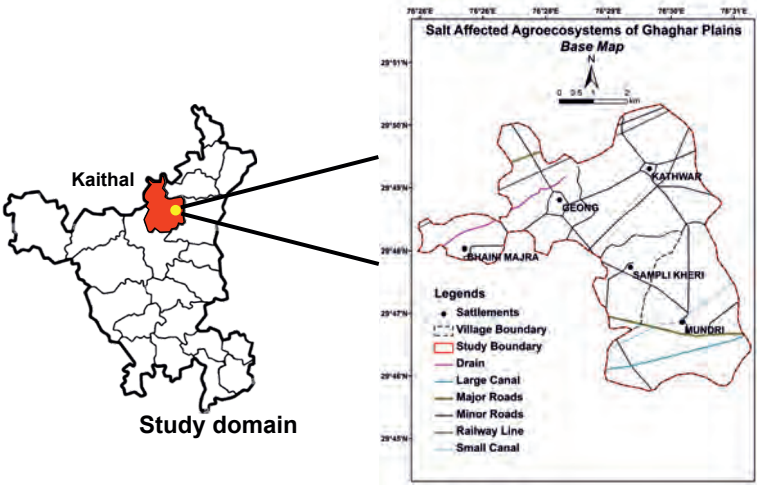
Objectives

In spite of significant technological breakthroughs to productively utilize salt-affected soil and water resources, farmers in the area still show poor adaptive capacity due to several socio-economic, ecological and technological factors which limit the scope for sustainable adaptations against multiple stressors. Therefore, the proposed study was carried out with following three objectives:

- To diagnose the socio-economic and agro ecological stressors, prioritize and experiment upon in the marginal salt affected environment.
- Refining and upscaling the identified technological interventions.
- Capacity building of stakeholders and evaluate the performance of technologies.

Problem identification and research prioritization

A diagnostic survey "Farmers' Adaptation Strategies to Perceived Multiple Stressors (climate, ecological and socioeconomic) in Sodic Agro-ecosystems" using participatory rural appraisal (PRA) techniques, participant



observations and informal interactions in five villages (Mundri, Kathwar, Geong, Sampli Kheri and Bhaini Majra) of Kaithal district in Haryana (29°45' to 29°51' N and 76°26' to 76°31' E) was undertaken to select the Farmer FIRST Project (FFP) site(s) during April-June 2016 involving 125 farmers (25 from each village) of diverse age groups (25-80 years). Farmer centric problem identification and prioritization was used to identify and prioritize the agriculture and livestock related research problems. For this purpose, 30 farmers were identified representing different socio-economic strata and well informed about the agricultural enterprises to get unbiased and first-hand information using the snowball technique. From the three key informants (progressive farmers), 21 problems in different crops/animal husbandry sectors were listed down, and 10 major problems were selected based upon the perception of majority of the identified farmers. All the 30 farmers were asked to rank the problems one by one based upon the severity of problem. Likewise, the procedure was repeated till 30 farmers ranked the most common agricultural problems of the village; Rank 1 for most important. For a crop, the estimation was done on the basis of acreage affected, whereas for livestock, the problem was assessed based on the number of animals affected in the village. Further, the constraints in agriculture were ranked based on Rank based Quotient (RBQ) as given below:

$$RBQ = \sum_{i}^{n} \frac{f_i\left(n+1-i\right)}{N \times n} \times 100$$

Where,

f_i = frequency of farmers for the ith rank of the attribute

N = number of farmers contacted for factor identification

n = the maximum number of ranks given for various factors.

I = rank of the attributes

Sr. No.	Problem identified	Rank										RBQ	Rank
		1	2	3	4	5	6	7	8	9	10		
1.	Soil sodicity and poor quality water	21	4	3	2	-	-	-	-	-	-	94.1	I
2.	Labour s.carcity during critical period	14	5	4	4	4	2	-	-	-	-	75.6	V
3.	Increased incidence of diseases in rice	7	5	4	3	3	2	2	2	2	-	68.8	VII
4.	Imbalanced fertilization	10	5	4	2	1	1	2	2	3	-	73.3	VI
5.	Spurious pesticides	9	4	5	4	-	-	4	2	1	1	60.4	VIII
6.	Gypsum availability	18	5	2	-	4	1	-	-	-	-	90.3	II
7.	Unfilled (Chaffy) grains in rice	12	4	3	3	2	2	2	1	1	-	76.1	IV
8.	Phalaris minor in wheat	14	3	4	3	-	4	2	-	-	-	80.7	III
9.	Residue management	5	4	4	3	2	2	4	3	1	1	51.5	IX
10.	Animal problems- mastitis, repetitive breeding, infertility, ecto-parasites, milk yield	4	5	5	-	4	3	2	2	4	1	49.2	X

Others problems:

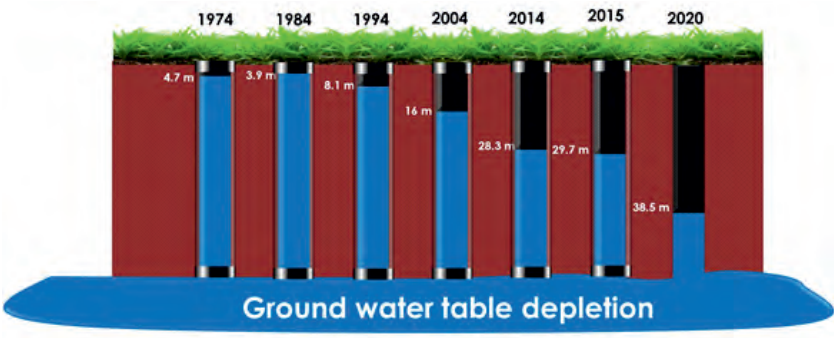
General: Drainage problems and general cleanliness/sanitation/waterlogging in common areas.

Livestock related: Prolaps, Mastitis, Repetitive breeding, Fever, Cold, Haemorrhagic Septicaemia, Foot & Mouth Disease etc.

Agro-ecological characteristics of the study domain

On average, two-third of the total farmers were small and marginal having farm size <2 ha. The sodic soils were predominantly alluvial and posed physical (reduced soil aeration and water intake) and nutritional (low nitrogen and organic carbon and) constraints to the growing plants. Majority of farm water supply was served by poor (RSC) quality groundwater causing sodicity problems and adversely affecting crop productivity.

Sr. No.	Parameters	Farmer FIRST adopted villages				
		Mundri	Geong	Kathwar	Sampli Kheri	Bhaini Majra
1.	Total number of farm families	1124	1008	657	185	193
2.	Farmers' classification					
	Small farmers (<2 ha)	72.4	65.8	75.6	78.9	69.9
	Medium farmers (2-4 ha)	1.6	1.0	3.8	3.2	14.6
	Large farmers (>4 ha)	0.7	0.5	1.5	1.6	-
	Landless	25.3	32.7	19.1	16.3	15.5
3.	Cultivable Land (ha)	936	490	946	278	216
4.	Net Sown Area (ha)	920	480	946	270	210
5.	Total Area (ha)	1084	550	1039	340	234
6.	Cropping Intensity (%)	196	188	191	193	191
7.	Irrigated (%)	100	100	100	100	100
8.	Soil types	Alluvial normal to sodic soils				



Continuous use of underground water resulted in the build-up of soil sodicity/alkalinity problems posing physical (reduced soil aeration and water intake) and nutritional (low nitrogen and organic carbon and) constraints to growing plants. Groundwater assessment reports indicated indiscriminate use of groundwater resources led to fast depletion of water table at the alarming rate of about of 0.9 m per year during the last 40 years (1974-2020); however, the groundwater depletion remained almost 1.3 m per year during the last 10 years.

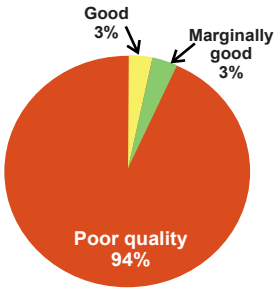
Pre-dominant cropping systems and yield scenario

Rice-wheat is the major cropping system occupying nearly 85-90% of total arable lands followed by sugarcane-wheat sequence. The survey on varietal adoption pattern and farmers' reported yields (prior to inception of FFP) revealed that majority of the farmers prefers to grow CSR 30 Basmati and PB 1121 in rice, HD 2697 in wheat and CO 238 and CO 119 in sugarcane. Fodder crops; sorghum during *kharif* and berseem during *rabi* seasons are normally grown to serve domestic livestock requirements.

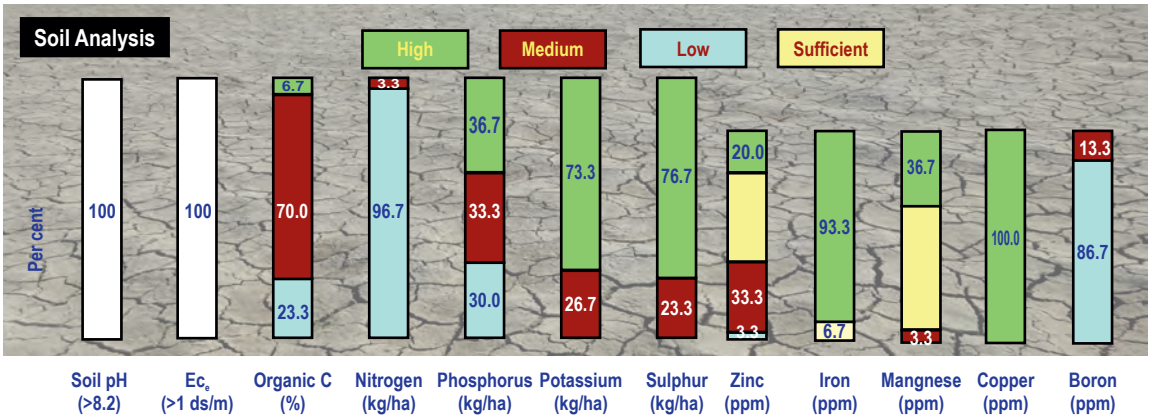
Crop	Parameters	Variety	FFP adopted villages				
			Mundri	Geong	Kathwar	Sampli Kheri	Bhaini Majra
Rice	Varieties (% area)	CSR 30	75-80	45-50	15-20	65-70	55-60
		Pusa 1121	10-15	25-30	60-65	10-15	40-45
		Pusa 1509	4-5	8-10	10-12	8-10	-
		PR 114	1-2	3-5	2-3	5-7	-
		PR 111	-	3-5	2-3	1-2	-
	Productivity (q/ha)	CSR 30	30-32	25-30	20-25	25-30	20-25
		Pusa 1121	40-42	35-40	30-35	40-45	30-35
		Pusa 1509	50-55	45-50	40-45	55-60	-
		PR 114	60-65	55-60	50-60	60-65	-
		PR 111	-	55-60	50-60	60-65	-
Wheat	Varieties (% area)	HD 2967	80-85	65-70	75-80	70-75	80-85
		WH 1105	5-7	8-10	8-10	3-5	5-10
		WH 711	5-7	8-10	-	-	5-10
		PBW 343	-	3-5	5-7	-	-
		PBW 550	-	3-5	3-5	-	-
		DPW 17	-	-	-	10-15	-
		KRL 210	3-4	2-3	1-2	2-3	-
	Productivity (q/ha)	HD 2967	40-42	42-45	40-45	40-45	40-42
		WH 1105	38-40	40-42	42-45	38-40	35-40
		WH 711	38-40	38-42	-	-	35-40
		PBW 343	-	35-40	38-40	-	-
		PBW 550	-	35-40	38-40	-	-
		DPW 17	-	-	-	35-40	-
		KRL 210	42-43	42-45	45-50	42-45	-

Soil and water quality

A total of 25 composite soil samples (0-15 cm depth); five each from selected villages were collected, analyzed and characterized for soil (EC, pH), nutrient status and water quality. Soil sodicity (pH>8.5) and bicarbonate dominated high residual alkalinity in in irrigation water (RSCiw >2.5 me L^{-1}) were found to be the major constraints affecting agricultural productivity in the area.



Water Quality Status



Soil health and nutrient status

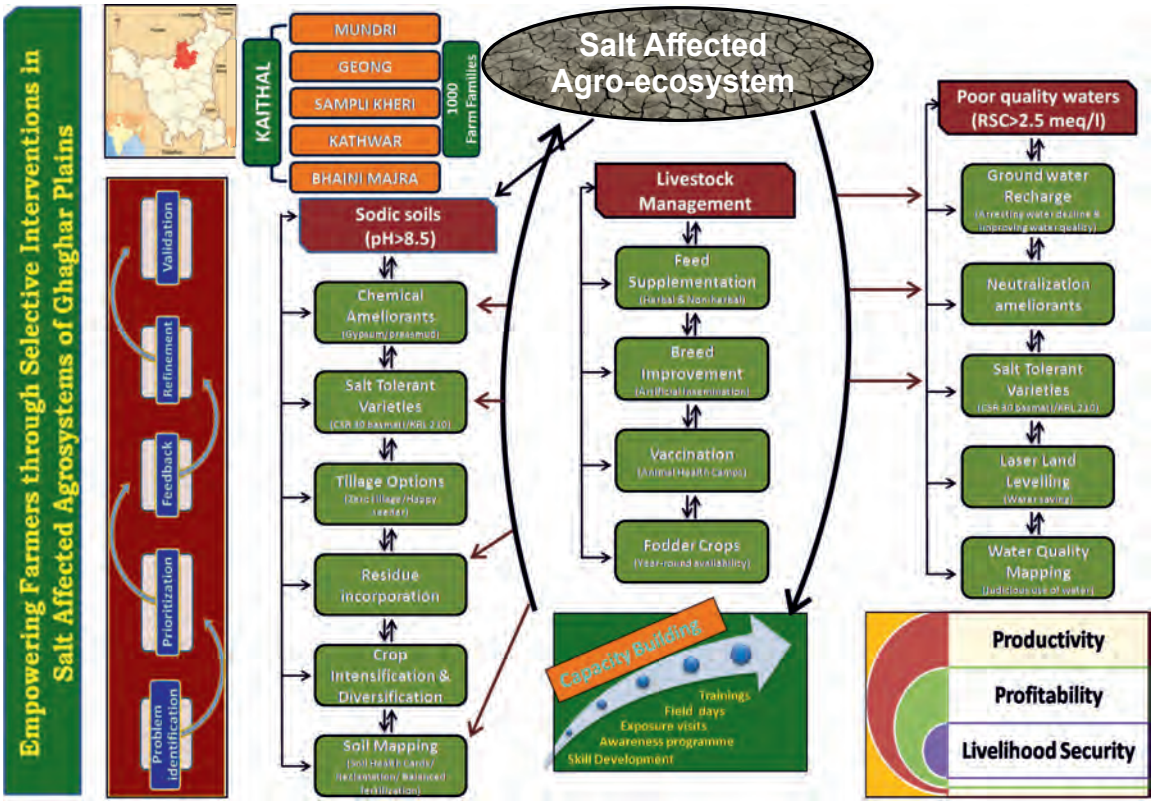
Farmers' perception about agricultural stressors

Farmers' experienced increased agricultural vulnerability compounded by climate, ecology and socio-economic stressors. Poor governance, weak farmers' adaptive capacity together with other socio-economic, and institutional policies (shortage of quality gypsum) acted as compounding factors to agricultural vulnerability in the area.

Particulars (perception statements of farmers-exploratory)	Perception % (multiple)
Exposed to high RSC water/soil sodification	84.3
Impact on wheat germination	91.6
Reduced crop growth and establishment (e.g. yellowing of leaves in wheat)	73.5
Increased seedling mortality in rice	78.4
Farm input requirements relative more and costlier than normal ones	62.4
Labour cost increased (applying gypsum, intercultural operations etc.)	70.2
Irrigation mismatch and faulty irrigation ractices	48.5
Longer dry spell/drought, seedling mortality and sterility in rice	65.8
Lack of knowledge and access to salt tolerant crops varieties	90.7
Socio-economic (subsidy, inputs supply, technological availability etc) and other factors makes livelihood vulnerable	60.7

3 METHODOLOGICAL FRAMEWORK

To develop location specific, demand driven and farmer friendly technological options, a 4-way approach was successfully implemented at the project location to improve the soil and crop resilience, bridge yield gaps and increase social, economic and ecological sustainability in sodicity-affected Ghaghar basin of Haryana. These approaches aimed at deciphering the synergy of adaptive (crop management) and mitigation (land reclamation) strategies for innovation and technology development with strong partnership of the farmers. In addition, livestock-based technological modules were also implemented to address their problems and suggest potential solutions to achieve dairy-based livelihood security.



Conceptual Framework of ICAR-CSSRI led FFP

Mustard: CS 54

Wheat: KRL 210

Rice: CSR 30 Basmati

4 ENHANCING FARMER-SCIENTIST INTERFACE

Multi-stakeholders' convergence through regular trainings, farm visits, sensitization workshops, field days, kisan gosthies, travelling seminars and other extension activities was ensured for continuous exchange of ideas between the farmers and other stakeholders, prioritization of field level problems and setting up of research agenda and development of location-specific appropriate technologies and human resource development in the prioritized area of interest.

Sr. No.	Title	Venue	Duration	Beneficiaries
1.	Farmers-Scientist Interface Meeting on 'World Soil Day'	Mundri	5 Dec, 2016	125
2.	Training Programme on 'Scientific Interventions in Dairy farming'	ICAR-NDRI, Karnal	27-29 Dec, 2016	33
3.	Training Programme on 'Sustainable Agriculture in Salt-affected Agroecosystems: Problems and Solutions'	ICAR-CSSRI, Karnal	11-13 Jan, 2017	41
4.	Skill Development Programme on 'Importance of Spray Technique in Crop Production'	KVK, Kaithal	Sept 6-8, 2017	57
5.	Skill Development Programme on 'Marketing of Agricultural Produce'	ICAR-CSSRI, Karnal	26-28 Feb, 2018	29
6.	Awareness-cum-Training Camp on 'Animal Health management'	Geong	Jan 27, 2018	70
7.	Awareness-cum-Training Camp on 'Animal Health Management'	Kathwar	Aug 11, 2017	170
8.	Farmers-Scientist Interface Meeting-cum-Field Day on "Farmers' participatory CSSRI's Technological Adaptation in Sodic Agroecosystems'	Kathwar	27 Feb, 2018	200
9.	Field Day on 'Rice Residue Management'	Kathwar	Oct 2, 2017	80
10.	Exposure Visit to 'Krishi Unnati Mela'	IARI, New Delhi	Mar16-18, 2018	44
11.	Seed Day on 'Basmati CSR 30'	Kathwar	May 10, 2018	300
12.	Field Day on 'Quality Seed Production'	Mundri	Sept 19, 2018.	100
13.	Creation of Women Self Help Group (SHG) under FFP	Kathwar	Sept 19, 2018.	40
14.	Field Day on 'Rice Residue Management'	Mundri	Oct 20, 2018	120
15.	'Kisan Diwas'	ICAR-CSSRI, Karnal	Dec 23, 2018	42
16.	Training programme on 'Preparation of Value Added Dairy Products' for Women Farmers	Kathwar & Sampli Kheri	Dec 26, 2018	40
17.	National Group Meeting on 'Impact Assessment of Technological Modules under Farmer FIRST Projects'	ICAR-CSSRI, Karnal	Feb 12-14, 2019	37

Sr. No.	Title	Venue	Duration	Beneficiaries
18.	Skill Development Programme on 'Quality Seed Production and Crop Intensification'	ICAR-CSSRI, Karnal	Jun 21-22, 2018	25
19.	CSSRI Karnal organized Kharif Kisan Goshti and Seed distribution Programme under Farmer FIRST Project	Sampli Kheri	May 15, 2019	100
20.	Field Day on "Wheat Varieties in Sodic Agro-ecosystems"	Sampli Kheri	Mar 21, 2020	180
21.	'Krishak Goshthi' under FFP	Geong & Kathwar	Mar 7, 2020	150
22.	Skill Development Programme for SC farmers of Kathwar, Mundri and Geong villages	ICAR-CSSRI, Karnal	Feb 10, 14 & 25, 2020	23+25+25= 73
23.	Pre-Kharif Kisan Goshthi under FFP	Kathwar	May 25, 2020	120
24.	Pre-Rabi Kisan Goshthi under FFP	Geong & Kathwar	Oct 31, 2020	85
25.	'Farmers-Scientist Interface Meeting' and ' Seed Distribution of Salt Tolerant Wheat Varieties'	Kathwar	Oct 28, 2020	50
26.	Stakeholders Meeting for 'Participatory Project on Sub-surface Drainage System'	Lakhan Majra, Gohana	Sept 15, 2020	35
27.	Farmers-Scientists Interface Meeting for Managing Waterlogged saline Soils'	Kathura	Mar 24, 2021	80
28.	'Kharif Kisan Goshti' and "Farm Inputs Distribution Programme'	Kathura	Jun 23, 2021	70
29.	'Kharif Kisan Goshti' and "Farm Inputs Distribution Programme'	Kathwar, Geong, Mundri & Sampli Kheri	Jun 24, 2021	200
30.	Skill Development Programme on "Scientific Dairy Farming'	ICAR-NDRI, Karnal	Mar 8-10, 2021	16
31.	Training programme on 'Agriculture and Animal Health Management' in Waterlogged Saline Soils	Kathura	Sept 01, 2021	150

Exposure visit_
IARI Kisan Mela_March 16-18, 2018

Field Day_Residue Management_02.10.2017

Awareness-cum-Training Camp
Animal Health Management_11.08.2017

DDG (Agril. Ext.) interacting with FFP farmers_27.02.2018

Deputy Commissioner, Kaithal visited FFP _10.05.2018
Distribution of farm inputs and Scientist Interaction

Field Day_Quality Seed Production_19.09.2018

Skill Development Programme
Marketing of Agricultural Produce_26-28 Feb 2018

Women Training Programme_Value Added Dairy Products_26.12.2018

Enhancing farmer–scientist interface..... March towards Excellence

Pre-Kharif Kisan Goshthi & Input Distribution_25.05.2020

National Group Meeting
Impact Assessment of Technological Modules under FFPs_Feb 12-14, 2019

Skill Development Programme_SC Farmers_10.02.2020_14.02.2020_25.02.2020

ADG (Agril. Extn.), Director, ATARI, Jodhpur & Director, CSSRI
FFP field visit, Kisan Goshti and Input Distribution Programme_21.03.2020

Field Day_Rice Residue Management_20.10.2018_
ADG (Agril. Extn>)_SSMS Rice harvesting_Happy seedet Wheat Sowing

Skill Development Programme
Quality Seed Production_June 21-22, 2018

Kharif Kisan Goshti & Seed Distribution
_15.05.2019

Farmers_Scientist Interaction & Input Distribution Programme
Gypsum 28.10.2020, Mineral mixture and Prill fat _31.10.2020

Enhancing farmer–scientist interface..... March towards Excellence

5 TECHNOLOGY ASSEMBLAGE AND APPLICATION

Economically viable and socially compatible technological options as adoptable NRM, crop, horticulture, enterprise, livestock-based modules were developed for increasing the soil and crop resilience, bridging the yield gaps, improving animal health, and ultimately food and livelihood security of distressed farming community in sodicity-affected Ghaghar basin of Haryana. Depending on the fields problems related to crops and livestock components, different technological modules and prioritized activities are discussed below.

A) NRM BASED MODULES

Activity-1 Delineation and assessment of sodic soils, irrigation water quality and soil nutrient status in salt-affected Ghaghar Basin of Haryana using GIS technique

Bicarbonate dominated residual alkalinity in irrigation water was the major constraint adversely affecting agricultural productivity in the area. Précised irrigation water (sodic) management strategies with soil reclamation techniques are the key management issues need to be strongly addressed to further control land degradation (soil sodicity) trends and secure sustainable land management in salt affected agro-ecosystems.

Grid based (0.5 x 0.5 km) 354 soil samples (0-15 cm depth) and 283 water samples were collected in the FFP adopted villages covering the entire 3247 ha area in adopted five villages. The spatial variability was estimated using geo-statistics tool in ArcGIS 9.2 for windows. The structure of the spatial variability was assessed by calculating sem-variograms by the formula:

$$\gamma(\mathrm{h}) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} [Z(x_i + \mathrm{h}) - Z(x_i)]^2$$

Where,

γ(h) is the experimental semivariance value for all pairs at a lag distance h;

$Z(x_i)$ is the soil salinity at point i;

$Z(x_i+h)$ is the soil salinity at other points separated from xi by a lag distance h;

x_i is the geo-referenced positions where $Z(x_i)$ values were measured; and

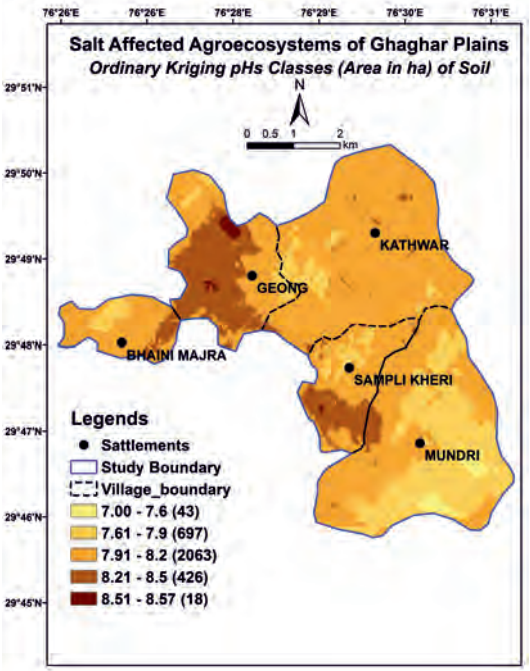
n is the number of pairs of observations separated by the distance h.

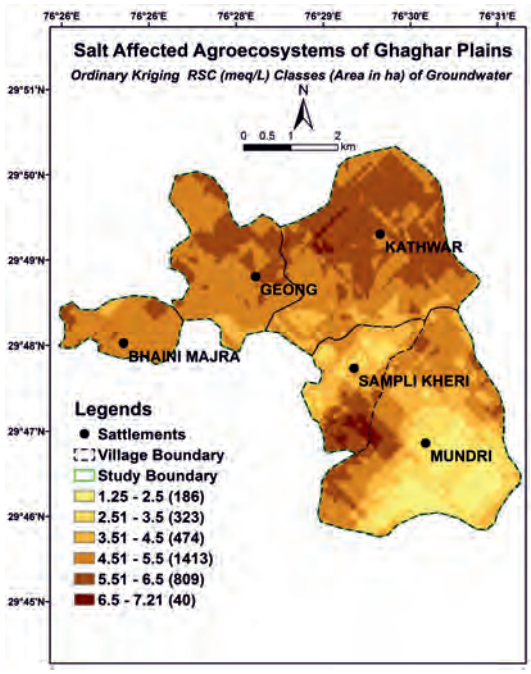
Spatial variability in terms of soil sodicity, water quality and nutrient status were mapped (1:50,000 scale) by Ordinary Kriging interpolation method based on spherical model. Geo-referenced digital stratified thematic maps delineating soil sodicity (soil pH), residual alkalinity in irrigation waters (RSC), macro (N, P, K, S) and micro (Zn, Fe, Mn, Cu, B) nutrients were prepared.

An account of soil, crop and livestock-related field problems and prioritized technological solutions in sodic environments.

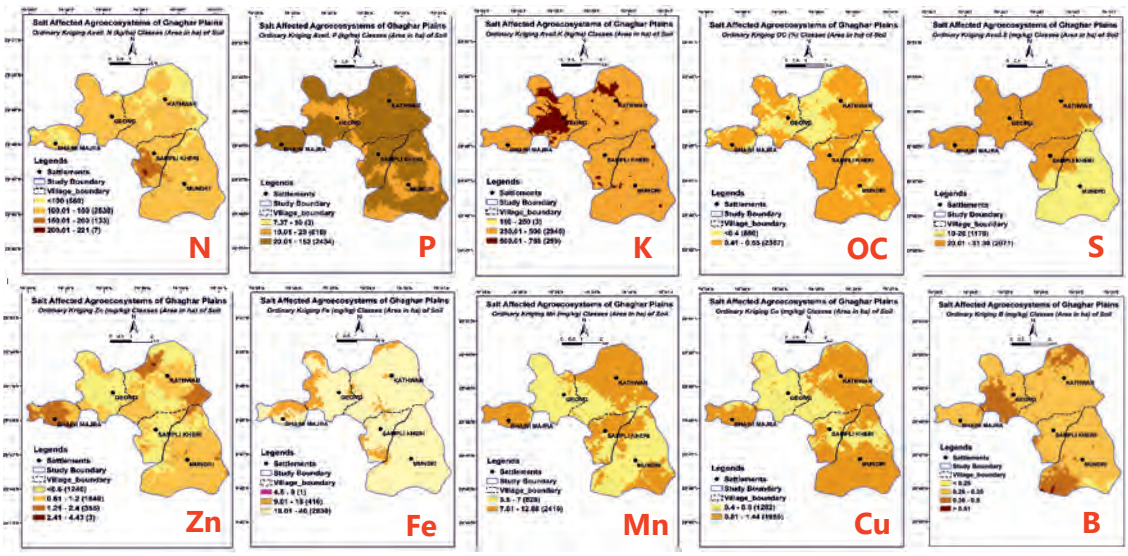
Sr. No.	Problem encountered	Module	Intervention	Villages covered	Area covered (ha/no.)	No. of households covered
1.	Lack of awareness regarding soil health and balanced fertilization	NRM based	Delineation and assessment of salt-affected soils and ground-water quality using GIS technique	5	3247 ha	354+283=637
		NRM based	Mapping and characterization of soil nutrient status using GIS technique	5	3247 ha	354
		NRM based	Distribution of Soil Health Cards (SHCs)	5	-	334
2.	Prolonged water stagnation drastically reduces crops productivity in low lying sodic lands	NRM based	Drainage-cum-recharge structure for augmenting groundwater and improving its quality by harvesting excess rain water into aquifer and sustainable crop production	3	300 ha	250
3.	Non-availability of quality gypsum during peak demand hampers the pace of sodic soil reclamation process	NRM based	Management strategies for reclamation of sodic soils and neutralization of high residual alkalinity in irrigation water using-			
			Gypsum	5	38 ha	94
			Pressmud	5	50 ha	125
			Integrat.ed use of gypsum and pressmud	5	74 ha	185
4.	Lack of knowledge and use of salt tolerant varieties	Crop based	Crop/Varietal diversification for sustainable yield under sodic environments using slat tolerant varieties-			
			CSR 30 Basmati in rice	5	232 ha	580
			KRL 210 in wheat	5	123 ha	308
5.	Reproductive sterility in rice	Crop based	Managing reproductive sterility through boron application in rice	5	40 ha	99
6.	Seedling mortality and crop establishment in rice	Crop based	Optimum plant population for better resource use and sustainable rice production	1	6 ha	15
7.	Phalaris minor infestation in wheat	Crop based	Herbicide based weed management for managing resistant P. minor in wheat	5	62 ha	156

Sr. No.	Problem encountered	Module	Intervention	Villages covered	Area covered (ha/no.)	No. of households covered
8.	Imbalance use of fertilizers	Crop based	Leaf Colour Chart (LCC) and Nano-urea based N management in rice-wheat system	4	48 ha	65
		Crop based	Role of foliar K-nutrition and sagarika (granular and liquid formulation) in enhancing rice-wheat yields	5	35 ha	84
9.	Residue management in rice	Mechanization based	SSMS-based rice residue management and direct wheat seeding with Happy Seeder in rice-wheat cropping system	4	315+55 ha	446
10.	Stagnant/declining yield trends and depleting groundwater table with rice-wheat monoculture	Horticulture based	Vegetable-based crop diversification for sustainable yields and enhanced farm profitability	1	25 ha	15
		Enterprise based	Entrepreneurship through brackish water aquaculture	1	2 ha	1
11.	Mastitis, repetitive breeding, infertility, ecto-parasites, lower milk yields in animals	Livestock based	Amelioration of heat stress for enhancing growth and milk production through supplementation of betaine, astaxanthin, prill fat and their combination	4	124 No.	124
		Livestock based	Enhancement of reproductive performance during heat stress using proven bull semen and supplemental mineral mixture	4	1038 No.	735
		Livestock based	Enhancing conception rate in dairy animals using good quality semen	4	2170 No.	1000+
12.	Lack of knowledge and awareness regarding adaptation and mitigation strategies for crop-livestock system in salt-affected argoecosystems	Knowledge based	Organizing need-based capacity building programme related to crop and animal component & strengthening HRD	31	-	2862
		Knowledge based	Mobile enabled Decision Support System including repository of best bet technologies and related agro-advisory and related queries for sodic agroecosystems		1000+ subscribers	





Out of total 3247 ha area, about 40.1% area was affected with sodicity problem having soil pHs >8.2. Village-wise sodicity was observed in the order of Sampli Kheri (53.5%) >Geong (42.6%) >Kathwar (40.9%) >Bhaini Majra (40.2%) >Mundri (33.5%). Bicarbonate dominated residual alkalinity in irrigation water was the major cause adversely affecting agricultural productivity in the area. Only 10.1% area was found with good quality underground water while 90% area was confirmed with RSC>2.5 me L^{-1} (62.7% alkali, 17.4% marginally alkali and 9.2% highly alkali). Irrigation water salinity was not a major problem in area with only 0.6% total area was found saline in nature



(ECiw >2 dS m^{-1}). Majority (43.6%) of the area was dominated with RSCiw ranging between 4.5-5.5 me L^{-1}, being maximum in Bhaini Majra (84%) followed by Geong (65.5%) and Kathwar (44.5%).

Geo-referenced spatial variability maps depicting nutrient status revealed that soil available nitrogen was deficient (<250 kg ha^{-1}) in whole of arable area while 27.1% area had deficient organic carbon (<0.4%). Soil available phosphorus was in medium to high (10-20 kg ha^{-1}) range while available K status was high (>110 kg K ha^{-1}). Half of the area was deficient in available zinc (<0.6 ppm Zn). Iron (>18 ppm Fe), Manganese (>3.5 ppm Mn) and copper (>0.4 ppm Cu) was found in sufficient to high range. B deficiency (<0.5 ppm) was prevalent in about 87% of the sampled area.

Deliverable output: Delineation of soil management zones (SMZs) based on soil quality index (soil sodicity and fertility status) enhanced farmers' acceptability towards implementing site-specific reclamation strategies and balanced fertilization. Thematic maps depicting soil test based gypsum requirements may provide a base for systematic allocation and distribution of mineral gypsum for sodic land reclamation and management curtailing wasteful expenditure. Fertilizer recommendations for dominant rice-wheat cropping system in different SMZs using soil test crop response (STCR) equation ensured balanced fertilization, resource saving and reduced environmental footprints. This zone-specific advocacy for gypsum application (as soil ameliorant) and balanced fertilization could be quite helpful in policy implications for sustainable rehabilitation of sodic lands while improving soil health and reconciling environmental protection with socio-economic development.

Reference: Paper published in Journal of Environmental Management; https://doi.org/10.1016/j.jenvman.2021.113243

The success story 'Spatial variability assessment of soil and water quality status in salt-affected soils' has been published in 'Annual Report 2018-19' of Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers' Welfare, GOI at page No. 135.

Activity-2 Distribution and digitization of Soil Health Cards (SHCs)

The Soil Health Cards (SHCs) were prepared and distributed among 354 farmers of adopted villages on World Soil Day held on Dec 5, 2016. A total of 12 soil parameters; soil sodicity (EC, pH), organic carbon, macro (N, P, K, S) and micro (Zn, Fe, B, Mn, Cu) nutrients, and 3 water quality parameters (pH, EC and RSC) were analyzed and characterized for collected soil and water samples.

A total of 354 Soil Health Cards (SHCs) comprising the farmer's details, soil and water quality status have been digitized in the form of an ICT-based user friendly innovative mobile app 'Salinity Expert' under caption 'Miiti evum Jal Prikshan Vishleshan'. The farmers can also access their soil and water related information by login ID through their Mobile or Aadhaar ID.

Deliverable output: These SHCs would be of immense use in assessing the time series change in soil nutrient status and irrigation water quality in response to farm level management practices at the project site. The database generated herein and providing soil health cards to farmers with crop-specific recommendations may sensitize and change their perception towards soil reclamation, balanced fertilization, nutrient recycling and environmental protection.

Activity-3 Management strategies for reclamation of sodic soils and neutralization of residual alkalinity in groundwater

Most farmers apply mined gypsum ($CaSO4.2H2O$) for reclamation of sodic soils. In recent years, the dwindling availability and declining quality of agricultural grade gypsum has impeded sodic land reclamation projects in many parts of the country; fuelling interest in alternative amendments like pressmud. Effectiveness of pressmud, an environmentally benign amendment, seems to be an affordable solution to lessening pressure on limited gypsum reserves with appreciable reductions in sodicity related problems and concomitant improvements in crop yields.

Activity 3.1 Sugarcane pressmud: an economically viable alternative amendment for reviving the productivity of sodic soils

Effects of pressmud application were assessed through participatory research in FFP adopted villages for two years (2017-18 and 2018-19) in rice-wheat sequence at 125 locations covering non-sodic (NS), slightly sodic (SS) and moderately sodic (MS) soils. Depending on the individual farmers' landholding, the study plots varied between 2000 m^2 (small and marginal farmers) and 4000 m^2 (medium and large farmers). The farmers were

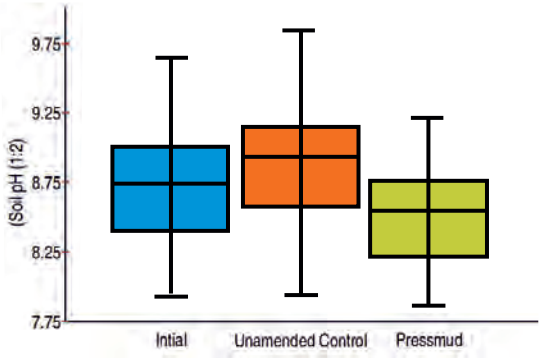
involved in each of the activities including soil sampling, planning of research, laying out different treatments, and monitoring and evaluation of interventions made. Each trial had two paired plots; (a) farmers' practice/without pressmud application (-PM), and (b) pressmud application at 10 t/ha on dry weight basis (+PM).

Pressmud ameliorated soils displayed enhanced resilience to irrigation-induced soil sodification and supported healthier plant growth, better physiological relations, and higher rice and wheat yields. On an average, rice and wheat yields were increased by 15.8 and 14.6% in SS and 18.9 and 16.7% in MS soils, respectively with pressmud application. Significant correlations among highly weighted variables including physiological (plant water status, gas exchange parameters, ionic balance etc.) and yield-related traits was observed influencing rice-wheat productivity with PM addition in SS and MS soils. Regardless of soil type, PM application at 10 t/ha

Effect of pressmud application (10 t/ha) on grain yields and economic returns in rice-wheat system.

Treatments	Non-sodic (NS) soils	Slightly sodic (SS) soils	Moderately sodic (MS) soils
Number of farmers	38	61	26
		Rice yield (t ha^{-1})	
Without pressmud (-PM)	3.00±0.25	2.53±0.18	2.33±0.14
With pressmud (+PM)	3.37±0.27	2.93±0.21	2.77±0.15
Pr<t	0.0002	<0.0001	0.0007
		Wheat yield (t ha^{-1})	
Without pressmud (-PM)	4.30±0.30	3.77±0.25	3.35±0.20
With pressmud (+PM)	4.79±0.25	4.32±0.28	3.91±0.24
Pr<t	<0.0001	0.0012	<0.0001
		Economic indicators	
% increase over the existing practice (-PM)	11.8	15.1	17.6
Incremental yield due to PM application (t/ha)	0.86	0.95	1.00
Added returns due to PM application (Rs/ha)	24233	26588	28380
Returns over variable cost (Rs/ha)	15880	18085	19742
Incremental input-output ratio	3.60	3.95	4.22

values with ± represent standard deviation in mean values; price of produce: Rice-36830 Rs./t; wheat-18333 Rs./t (mean of two years)



entailed total expenditure of 6730 Rs/ha including material, labour and transportation costs. Benefit: cost analysis revealed that incremental benefits of PM application were much higher in MS soils than in NS soils i.e., Rs 19742 and Rs 15880 ha^{-1}, respectively (Table 4). Pressmud application further showed incremental input-output ratios of 3.60 for NS, 3.95 for SS and 4.22 for MS per unit extra amount invested towards soil amelioration.

Deliverable output: Pressmud- a sugar industry waste- can be used as an affordable sodic soil ameliorant from cost and availability standpoints, and its agricultural use needs to be scaled-up for sustainably harnessing the potential of degraded sodic (slight to moderate) soils. The policy initiatives on Land Degradation Neutrality (LDN) and Sustainable Development Goals (SDG Goal 15, life on land) can gain insights from such locally available organic resources while prioritizing solutions for sustainable management of degraded sodic lands and strengthening farmers' livelihoods.

Reference: Success story published in Indian Farming, 60(05)18-20; Paper published in Indian Journal of Agricultural Science, 90(1): 206-211 and Land Degradation and Development; https://doi.org/10.1002/ldr.3953 .

Activity 3.2 Integrated use of gypsum and pressmud for reclaiming sodic lands and sustaining rice-wheat productivity in sodic environments

Sustainable management of agricultural ecosystems in stress-prone areas requires climate-smart production systems with effective and affordable management practices. Most farmers use gypsum for sodic soil reclamation, which is accessible only through land reclamation government agencies (eg. HLRDC in Haryana). Pressmud, a compressed sugar industry by-product, is another effective amendment but seldom used in agricultural fields for soil reclamation.

A total of 44 on-farm trials including 2 treatments (i) unamended control and (ii) 25 % of gypsum requirement on soil test basis and gypsum required to neutralize residual alkalinity in irrigation water + sugarcane pressmud at 5 t/ha (Gyp+PM) were carried out to assess the reclamation potential of gypsum (chemical) and pressmud (organic) amendments applied together in reducing the sodicity build-up, improving rice productivity and their economic feasibility. Depending on the field variability, gypsum requirements were calculated in system perspective and treatment-wise amendments were applied in plough layer 10-15 days

before rice transplanting. The succeeding wheat grown in annual rotation was raised as such with residual effects of soil amendments applied in rice only.

Complementary effects of applying gypsum and pressmud together (Gyp+PM) proved their effectiveness as reclamation/neutralization ameliorants in sodic soils. The relative advantage of Gyp+PM application increased with increasing sodicity stress compared to farmer's practice (unamended control) and the yield reduction was relatively lesser in plots where amendments were applied. On average, Gyp+PM application resulted in nearly 16% yield advantage in both rice and wheat crops compared to the situations when where no amendment was applied (farmer's practice).

Economic analysis revealed an overall added returns of 20224 Rs./ha as against the added cost of 6998 Rs./ha incurred towards integrated use of Gyp+PM application (including material cost, labour cost and transportation charges). There was an incremental input-output ratio of 2.89 for each rupee invested towards the amendments used.

Soil pH	No. of farmers	Rice			Wheat		
		Control	Gyp+PM	% increase	Control	Gyp+PM	% increase
<8.25	2	3167	3451	8.97	4814	5194	7.89
8.25-8.50	3	3022	3287	8.76	4707	5109	8.54
8.50-8.75	8	2594	2954	13.86	4191	4787	14.22
8.75-9.00	17	2385	2753	15.43	3804	4515	18.70
9.00-9.25	7	2166	2576	18.91	3592	4375	21.79
>9.25	7	2113	2595	22.83	3316	4153	25.23
Wt. mean	**44**	**2409**	**2797**	**16.11**	**3823**	**4433**	**15.96**

Soil pH	No. of farmers	Added Returns (Rs/ha)	Added Costs (Rs/ha)	Incremental Income (Rs/ha)	Incremental Input-Output Ratio
<8.25	2	14533	3365	11168	4.32
8.25-8.50	3	14198	3365	10833	4.22
8.50-8.75	8	19433	5343	14090	3.64
8.75-9.00	17	20443	6779	13664	3.02
9.00-9.25	7	21845	8287	13558	2.64
>9.25	7	23182	10728	12454	2.16
Wt. mean	**44**	**20224**	**6998**	**13226**	**2.89**

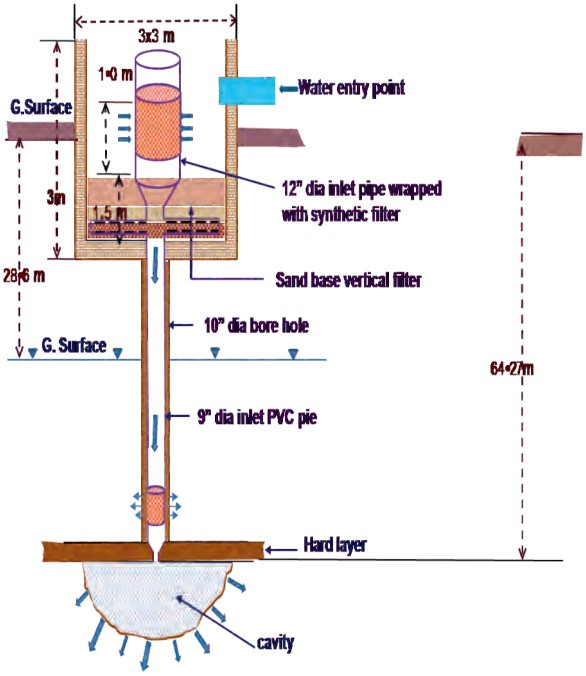
Deliverable output: Rehabilitation of degraded lands and improved crop resilience with gypsum and pressmud-mediated land reclamation showed tremendous potential for closing the yield gaps, stabilizing rice-wheat production and increasing farmers' income in stress-prone areas. Agricultural use of sugar industry waste material 'pressmud' compensating 25% gypsum requirement would be an affordable alternative while addressing the competing issues of shrinking gypsum availability and quality concerns, pressmud disposal problems and associated environmental hazards.

फार्मर फर्स्ट परियोज

Reference: Paper published in Field Crops Research, 270, 108192 https://doi.org /10.1016/j.fcr.2021.108192 and Land Degradation and Development https://doi.org/ 10.1002/ldr.4047.

Activity-4 Drainage-cum-recharge structure: a localized farm based option for augmenting groundwater and improving its quality by harvesting excess rain water into aquifer

ICAR-CSSRI designed, developed and installed six cavity type individual farmer's based recharge structure as localized drainage option and sustain crop production in low lying areas. The groundwater table rose to an extent of 2-3 m beneath the structure during monsoon months compared to summer months. The improvement in groundwater quality was also observed in surrounding areas as a consequence of reduction in RSC by 2-3 me/l compared to the values at the time of installation of the structure. A heavy rainfall (~150 mm) resulted in 35-40% crop damage in open-fields which was reduced down to 5-15% due to recharge structure, significantly decreasing the additional cost towards re-transplanting and compensated the yield loss. Though the structure did not have any influence on groundwater quality beyond 30 m from the actual recharging point; but their effect on groundwater resources is directly associated with number and amount of recharging event taking place during the monsoon months. Benefit-cost ratio of 1.93 and internal rate of return of 145% indicated economic feasibility of the investment on recharge structure.



Flood condition due to heavy downpour on 29.06.2018

Crop condition on 27.08.2018 after receding of flood water with drainage-cum-recharge structure

Economic analysis of drainage-cum-recharge structure

Sr. No.	Particulars	Unit	Without Recharge structure	With Recharge structure	Difference (%)
1.	Capital cost of recharge structure (including installation cost)	Rs	-	2,50,000	-
2.	Annual operational & maintenance cost	Rs	-	5,000	-
3.	Life of recharge structure	Years	20*	20	-
4.	Crop damage due to intense rainfall	%	35-40	5-15	-
5.	Yield reduction due to delayed re-transplantation in rice crop considering 5 ha vulnerable area	%	15-20	2-5	-
6.	Harvested yield @ soil pH2~9				-
	a. Rice cv. Pusa 1121	q/ha	24.00	28.95	20.63
	b. Wheat cv. KRL 210	q/ha	40.00	40.00	Nil
7.	Market price @ 2017-18				-
	a. Rice cv. Pusa 1121	Rs/q	3,250	3,250	Nil
	b. Wheat cv. KRL 210	Rs/q	1,735	1,735	Nil
8.	Discount rate	%	10	10	Nil
9.	Cost of cultivation	Rs/ha/annum	80,250	78,750	-1.87
10.	Gross returns	Rs/ha/annum	1,49,838	1,63,488	9.11
11.	Net returns	Rs/ha/annum	69,588	84,738	21.77
12.	Discounted total cost	Rs	34,16,067	36,02,216	5.45
13.	Discounted total benefit	Rs	63,78,256	69,59,306	9.11
14.	Net present value (NPV)	Rs	29,62,188	33,57,091	13.33
15.	Benefit cost ratio (BCR)	-	1.87	1.93	3.21
16.	Internal rate of return (IRR)	%	-	145	-
17.	Pay Back period (PBP)	Years	-	2	-

Deliverable output: Installation of drainage-cum-recharge structures was quite advantageous in providing the localized drainage option in low lying and land locked areas where runoff gets accumulated and adversely affected the crop production. These structures were quite effective in saving the submerged crops particularly during the periods of intense rain in addition to augmenting groundwater and improving its quality. Economic analysis revealed the beneficial effect of installing recharge structure under sodic environments with higher benefit:cost ratio (1.93), internal rate of return (145%), net present value (Rs. 33,57,091) and lesser payback period (2 years). Therefore, the installation of recharge structure can be an effective strategy for sustainable crop production in low lying and land locked areas of sodic environments by facilitating point drainage option, diverting rain water to aquifer, diluting the high RSC groundwater.

Reference: Paper published in Indian Journal of Agricultural Sciences, 90(1): 219-2019.

The success story 'Managing localized water stagnation and improving groundwater quality by harvesting excess rain water' was published in 'Annual Report 2018-19' of Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers' Welfare, GOI at page No. 136 and also on ICAR Website at link 'https://icar.org.in/content/managing-localized-water-stagnation-and-improving-ground-water-quality-harvesting-excess'.

B) CROP BASED MODULES

Activity-5 Crop/Varietal diversification for sustainable yields in sodic environments

Management of marginal salt-affected lands through stress tolerant varieties has massive potential to transform the environmental burdens into economic growth through substantial improvement in crop productivity. This plant-assisted adaptive approach is quite remunerative and suits well to resource poor farmers inhabiting these lands, for whom chemical amendment-based land reclamation is costly enough without government support.

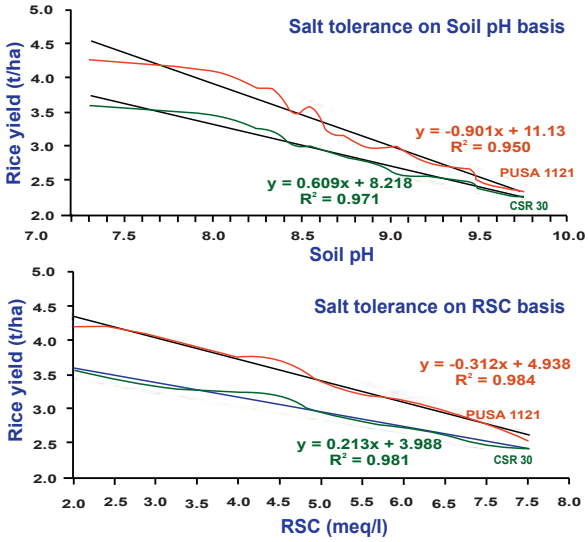
Activity-5.1 Popularization and adaptation of salt tolerant rice variety CSR 30 Basmati

Varietal demonstrations conducted over 580 locations in farmers' participatory mode though revealed an overall yield advantage of 15.8% with Pusa 1121 compared to CSR 30 Basmati, but the aromatic nature

Soil pH2	N	Rice yield (t/ha)			RSC (me/l)	N	Rice yield (t/ha)		
		CSR 30 Basmati	Pusa 1121	Difference			CSR 30 Basmati	Pusa 1121	Difference
<8.00	65	3.39	4.06	-0.67*	<3	80	3.37	4.08	-0.70°
8.00-8.50	120	3.29	3.94	-0.65*	3-4	86	3.23	3.86	-0.64*
8.50-8.75	131	2.92	3.42	-0.50*	4-5	110	2.99	3.50	-0.51*
8.75-9.00	146	2.70	3.09	-0.39*	5-6	153	2.78	3.19	-0.40*
9.00-9.25	76	2.59	2.84	-0.25"	6-7	127	2.57	2.86	-0.29*
9.25-9.50	27	2.46	2.62	-0.16^{ns}	>7	24	2.48	2.54	-0.06^{ns}
>9.50	15	2.43	2.37	0.06^{ns}					

of CSR 30 Basmati fetched more market price resulting in better monetary returns compared to Pusa 1211. Economic returns with Pusa 1121 were significantly better only upto pH~8.2 and RSC~3.5 me/l, thereafter both the varieties remained at par between soil pH~8.3-9.0 and 5^{-1}.

Yield reduction of 0.73-0.92 t/ha/unit equivalent to 28863-36611 Rs/ha for each unit increase in soil pH was recorded in CSR 30 Basmati. The corresponding decrease in yield was estimated to be 1.30-1.45 t/ha with 45127-49293 Rs/ha/unit in Pusa 1121 with the validation limit



of soil pH of 8.0-9.5. Similarly, for assessing the relative decline in crop yields in response to rice irrigated with RSC water without neutralization with any amendment, lesser economic loss of 7278-8456 Rs/ha/unit (yield reduction of 1.82-2.09 t/ha/unit) in CSR 30 Basmati in comparison to 11241-13404 Rs/ha/unit (yield reduction of 3.26-3.83 t/ha/unit) in Pusa 1121 was observed in field trails with rice irrigated with RSC of 2.0-7.5 me/l.

Deliverable output: Farmers should be advocated for cultivation of salt tolerant CSR 30 Basmati in problematic soils having soil pH ≥8.3 and irrigation water with RSC ≥3.5 me/l for sustainable yield production and profitability margins. Compared to traditionally grown rice variety PB 1121, better plant morpho-physiological adjustments and lesser yield reduction with increasing sodicity stress in salt tolerant CSR30 Basmati offered better opportunity to harness the potential of sodic soils irrigated with alkali water. Defining the critical limits of sodicity tolerance will help address the farmers' acceptance and importance of selecting suitable variety to enhance crop resilience, stabilize production, and generate higher income in sodicity affected areas. These evidence based information will certainly help generating useful insights for convincing the developmental agencies and receive government attention while formulating the policy guidelines for varietal developmental program in salt-affected ecologies.

Reference: Paper published in Field Crops Research; https://doi.org /10.1016/j.fcr. 2021.108192

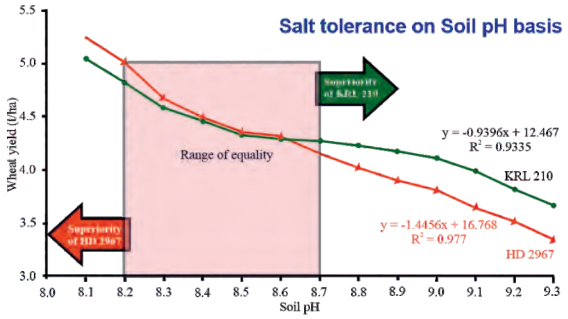
Activity-5.2 Popularization and adaptation of salt tolerant wheat variety KRL 210

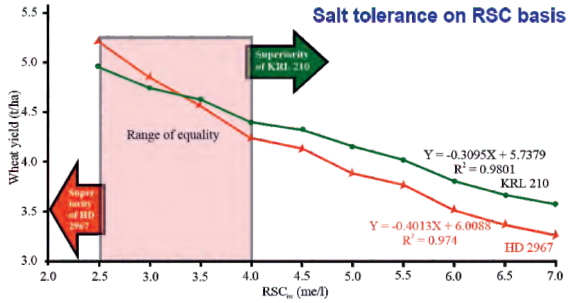
Varietal demonstrations conducted over 308 locations at farmers' fields during 3 years (2017-18, 2018-19 and 2019-20) revealed an overall yield advantage of 4.13% with salt tolerant KRL 210 compared to most cultivated variety HD 2967 (4.12 t/ha). Wheat variety HD 2967 significantly outyielded KRL 210 upto soil pH ≤8.0;

Soil pH2	N	Wheat yield (t/ha)			RSC (me/l)	N	Wheat yield (t/ha)		
		KRL 210	HD 2967	Difference			KRL 210	HD 2967	Difference
<8.0	23	4.75	4.81	-0.06^{ns}	<3	22	4.76	4.81	-0.05*
8.0-8.5	72	4.57	4.54	0.03^{ns}	3-4	51	4.73	4.70	0.03^{ns}
8.50-8.75	86	4.39	4.20	0.19*	4-5	71	4.41	4.25	0.15*
8.75-9.00	62	4.13	3.87	0.26*	5-6	62	4.23	3.97	0.26*
9.00-9.25	39	4.01	3.69	0.31"	6-7	69	3.95	3.66	0.29*
>9.25	26	3.65	3.37	0.28*	>7	18	3.82	3.51	0.31*

however, there was non-significant differences in grain yield for both varieties at soil pH~8.0 to 8.5. Thereafter, superiority of KRL 210 was observed with significant yield difference of 0.26-0.31 t/ha at soil pH ≥8.75. With the increase in residual alkalinity in irrigation water (RSC>4 me/l), KRL 210 significanlty outyielded HD 2967 attaining pooled gain of 0.15 t/ha at RSC ranging between 4-5 me/l to 0.31 t/ha at RSC >7 me/l.

Lesser yield reduction i.e. 0.77-1.1 t/ha was observed with KRL 210 for each unit increase in soil pH in comparison to 1.3-1.59 t/ha/unit in HD 2967 for the evaluated field trials conducted at soil pH between 8.1-9.3.





Preference score of variety traits in wheat

Variables	Preference score[±] (mean±SE)	
	KRL 210	HD 2967
Biomass production	4.28±0.45	4.40±0.50
Tillering capacity	3.58±0.50	3.35±0.48
Sodicity tolerance	4.15±0.39	3.50±0.51
Lodging score	4.78±0.42	4.08±0.35
Disease resistance	4.13±0.61	4.18±0.71
Grain boldness	3.78±0.59	3.98±0.35
Grain quality	4.35±0.48	4.13±0.33
Maturity duration	4.73±0.45	4.45±0.50

[±]*Preference Scale (1-5), 1: least preferred; 5: most preferred.*

Similarly, for RSC water, yield reduction of 0.29-0.33 t/ha/unit for KRL 210 as against the yield reduction of 0.37-0.48 t/ha/unit in HD 2967 was observed in field trials conducted at wheat irrigated with groundwater RSC ranging between 2.5-7.5 me/l.

Farmers further highlighted KRL 210 as remunerative one in terms of early maturity (5-7 days earliness), higher per day productivity, better factor (fertilizer N) productivity and chapatti quality as well as tolerance to water stagnation under sodic conditions.

Deliverable output: Varietal intervention through inclusion of salt tolerant varieties can be an important strategy to counter yield reduction under salty environments. Significant change in farmers' perception has

been noted towards cultivating salt tolerant wheat variety KRL 210 over the traditional HD 2967 in the problematic sodic soils having soil pH ≥8.7 irrigated with high RSC waters (RSC ≥4.0 me/l). Defining the critical limits of sodicity will help address the farmers' acceptance and importance of selecting suitable variety to enhance crop resilience, stabilize production, and generate higher income under the existing or predicted levels of sodicity stress. The information contained herein will certainly help generating useful insights for convincing the developmental agencies and receive government attention while formulating the policy guidelines for wheat developmental program in salt-affected ecologies.

Reference: Paper published in Sustainability; https://doi.org/10.3390/su13063378.

Activity-6 Managing herbicide resistant Phalaris minor in wheat

Herbicide resistance in annual grassy weed 'Phalaris minor' is a serious biological constraint to sustainable wheat production. Consistent application of selected herbicides [clodinafop (ACCase inhibitors), sulfosulfuron (ALS inhibitors) and fenoxaprop (grass meristem destroyers)] for more than two decades without following proper herbicide rotations and spray techniques has led to multiple resistance in P. minor with concomitant reduction in wheat yields.

Participatory Learning for Action (PLA) methodological approach was applied to record the response of 105 farmers for managing herbicide resistant P. minor in wheat. Nearly 21% of total farmers switched to alternative options of using pre-emergence (PE) herbicides either exclusively or in sequence with post-emergence (PoE) herbicides for narrow leaf weed 'P. minor' management in wheat. None of the farmer opting PoE weed control, had gone for recommended use of herbicides; even they applied 3.5-times higher than recommended dose,

Farmers' perceptions and practices for Phalaris minor management in wheat

Parameters	Small & marginal (<2 ha)	Medium (2-4 ha)	Large (>4 ha)	Sample mean	*p*-value
†Number of respondents (% farmers)	38.0	38.0	24.0	n=105	0.0318
‡Time of herbicide application (% farmers)					
Applying PE only	7.7	-	5.9	4.3	<0.0001
Applying PE fb PoE	7.7	25.9	17.6	17.1	<0.0001
Applying PoE only	84.6	74.1	76.5	78.6	<0.0001
‡Dose of PoE herbicide (multiple of recommended dose)					
When PE herbicide was applied	0.88b	1.21a	1.13a	1.10	<0.0001
When PoE herbicides were applied	3.41b	3.23c	4.05a	3.49	<0.0001
Recommended (x) dose	-	-	-	-	
1-2x dose§	-	1.31	1.50a	1.37 (10.9%)	0.0021
2-3x dose	2.45	2.10	2.40	2.38 (27.3%)	0.0168
3-4x dose	3.47	3.15	3.25	3.25 (25.5%)	0.0038
>4x dose	4.69	5.33	5.72	5.19 (36.4%)	<0.0001
‡Nozzle used for spray (% farmers)					
Flat fan nozzle	-	-	5.9	1.4	<0.0001
Cut nozzle	88.5	85.2	76.5	84.3	0.0041
Hollow nozzle	11.5	14.8	17.6	14.3	0.0337
‡Volume of water for spray (litres/ha)	124.6	118.1	125.3	122.3±17.3	0.0428
‡Total expenditure incurred (Rs/ha)#					
When PE herbicide was applied	3614	3654	3868	3727±313	0.0457
When PoE herbicides were applied	2993	3026	3714	3173±655	<0.0001
‡Weed control efficiency (%)					
When PE herbicide was applied	91.3	86.4	85.0	87.3±5.3	<0.0001
When PoE herbicides were applied	70.2	71.5	73.1	71.4±11.4	0.0617
‡Grain yield (t ha^{-1})					
When PE herbicide was applied	4.80	4.93	4.99	4.91±3.7	0.0426
When PoE herbicides were applied	4.65	4.65	4.81	4.69±5.4	0.0128

values with ± indicates standard deviation; §figures in parentheses indicate % farmers; †data analysis subjected to Chi-Square test; ‡data analysis subjected to ANOVA.

mixed different group herbicides, and had repetitive (2-3 times) and extended usage (up to 75 days) resulting in substantially lower herbicide efficacy (70-73%) and resultant wheat yields (4.65-4.81 t/ha). Apparently, sequential use of recommended PE and PoE herbicides though increased approximately 554 Rs/ha additional expenditure, but provided better weed control (87% efficacy) and higher wheat yields (4.91 t/ha). Large farmers attainted proportionately higher yields with better resource availability spending more on herbicides and had better market opportunities.

To compare the exiting farmers' practices of using higher dose of post-emergence herbicides (WMFP) with

improved management practices involving sequential use of pre (PE)- and post (PoE)- emergence herbicides (WMIP), a total of 184 comparison trials were conducted in farmers' participatory mode over a period of four years (2016-17 to 2019-20). Individual farmers', except for weed control as defined used their own practices for growing the wheat crop. Sequentially applied herbicides (WMIP) ascertained better herbicide efficacy (17%

Weed management practices for Phalaris minor control in wheat.

Variables	WMFP	WMIP	Pr(>t)
Weed population (0.25 m^{-2})			
30-35 DAS	6.17±0.28	1.76±0.11	<0.0001
115-120 DAS	3.80±0.47	1.12±0.18	<0.0001
Weed control efficiency (%) at harvest	71.6±9.8	83.8±4.6	<0.0001
Grain yield (t/ha)			
2016-17 (n=30)	3.89	4.13	0.0128
2017-18 (n=70)	3.80	4.02	<0.0001
2018-19 (n=49)	4.37	4.59	0.0119
2019-20 (n=28)	4.48	4.76	0.0317
Mean	4.07	4.30	<0.0001
Economic indicators#			
Added cost (US$/ha)	627		-
Returns over variable cost (US$/ha)	3281		-
Incremental input-output ratio	5.23		-

n: number of demonstration; DAS: days after sowing; WMFP: weed management through farmers' practice- tank mix application of 2-4 times higher dose of PoE (clodinafop/pinoxaden/metribuzin) at 35-75 DAS; WMIP: weed management through improved practice-pendimethalin (stomp 30% EC) at 1.5 kg/ha immediately after sowing followed by clodinafop 60 g/ha /pinoxaden 50 g/ha at 35-40 DAS; values with ± indicates standard deviation; n=number of trials.

higher weed control efficiency) and yield gains (5.6% higher) as compared to existing farmers' practice (WMFP) without considering their rotational use, compatibility and timings. Economic analysis revealed that an additional cost incurred towards alternative herbicides in WMIP resulted in 6.2 times higher returns for each unit invested towards herbicide use leading to better farm profitability.

Deliverable output: Sequential use of herbicides using pendimathalin 1.5 kg as pre-emergence fb clodinafop 60 g/pinoxaden 50 g/ha as post-emergence could be cost-effective options to avoid antagonism, effectively manage resistant P. minor, delay the development of resistance and bridge yield gaps in wheat.

Activity-6 Balanced fertilization in rice-wheat system

Activity 6.1 Assessing farmers' knowledge, aptitude and practices towards N management in rice-wheat system

Farmers' knowledge, aptitude and practices towards N management in rice-wheat system and how far it deviates from the general recommendations were assessed through stratified random sampling framework. The survey data revealed that farmers mostly tend to use 29% higher N (97 kg/ha) for CSR 30 Basmati and 33% higher N (150 kg/ha) for PB 1121 compared with the recommended rates (75 and 112.5 kg/N/ha, respectively) under stress conditions. The N rates differed significantly across categories of farmers; with small and marginal farmers (17 and 12%) applying even higher N (>120 kg/ha for CSR 30 basmati and >180 kg/ha for PB 1121) to enhance their yields. The time of N topdressing was significantly earlier even with the increase in N-dose; 33 days in CSR 30 Basmati and 37 days in PB1121 compared to the recommended scheduling upto 42 days. N topdressing was more frequent (2.53 splits) than the recommended practice of 2 splits in CSR 30 Basmati; but almost matched that of PB 1121 (3.04 splits) for recommended 3 splits. The small and marginal farmers preferred less N-splits compared to medium and large farmers. Mostly farmers prefer applying first N dose 7-10 days after transplanting instead of basal. Farmers' reported that yields remained either stagnate or even decline when they apply more than 90 kg/ha of N for CSR 30 Basmati and 150 kg/ha for PB 1121.

In wheat, the farmers apply ~18% higher N in comparison to recommended N for sustaining wheat yields; variations being ~10% (soil pH <8.5) to ~38% (soil pH >9.25). About 9% farmers belonging to soil pH <9.0 preferred less N-splits and applied lower N than recommended. Majority (81%) farmers top-dressed 177 kg N/ha in 3 splits within 57 days of wheat sowing. It is interesting to note that mostly farmers scheduled their N top dressing in accordance with irrigation application; topdressing first N dose with first irrigation 28-35 days after sowing (DAS); second N in between first and second irrigation (40-45 DAS) and third N with second irrigation (55-60 DAS). Farmers reported wheat yields and associated NUE followed declining trend with increasing sodicity stress.

To validate the farmers N-use pattern and optimize N requirements in rice-wheat system, two genetically diverse varieties; salt tolerant (CSR 30 Basmati and KRL 210) and highly adapted varieties (PB 1121 and HD 2967) in rice and wheat crops were raised with variable N application in farmers' participatory mode. On-farm assessment at farmers' fields and further validation through Curve Expert model revealed genotypic variation in N requirements attaining economic optima at 90 kg N/ha in CSR 30 Basmati, 140 kg N/ha in PB 1121, 173 kg N/ha in KRL 210 and 188 kg N/ha in HD 2967.

Farmers' perception towards N-scheduling in wheat under sodic conditions (n=105).

Parameters	Soil pH					Sample mean	p-value
	<8.50	8.50-8.75	8.75-9.00	8.75-9.00	>9.25		
†Total farmers (%)	12.9	28.6	35.7	15.7	7.1	n=105	<0.0001
‡Dose of N (kg/ha)	164.8d	171.5c	174.8c	187.5b	203.6a	176.6±22.5	0.0142
‡N application (kg/ha) based on splits§							
2 splits	126.0a (22.2)	126.0a (10.0)	126.0a (8.0)	-	-	126.0 (8.6)	0.8103
3 splits	175.9 (77.8)b	176.5 (90.0)b	177.9b (88.0)	187.57a (81.4)	190.7a (40.0)	177.2 (81.4)	0.0214
4 splits	-	-	203.6b (4.0)	220.9a (10.0)	212.3a (60.0)	217.7 (10.0)	<0.0001
‡Completion of N dose	53.9d	54.5cd	56.4c	60.0b	65.0a	56.7±6.47	0.0187
‡Days to N splits							
First split25.6e	28.3d	30.2c	31.4b	33.0a	29.4±2.8	<0.0001	
Second split	41.7c	41.6c	43.0b	42.7b	44.4a	42.5±1.1	0.0211
Third split	54.3b	55.3b	55.7b	57.2a	57.0a	55.8±1.2	0.0386
Fourth split	-	-	60.0	65.0	68.3	65.0±4.1	<0.0001
‡Grain yield (t/ha)	4.97a	4.95a	4.68b	4.46c	4.31d	4.73±0.46	0.0284
‡NUE (kg grain/kg N applied)	30.5a	29.2b	27.3c	24.1d	21.4e	27.3±4.96	<0.0001

values with ± indicates standard deviation; §figures in parentheses indicate the % farmers; †data analysis subjected to Chi-Square test; ‡data analysis subjected to ANOVA

Deliverable output: Farmers' perspective of enhanced N use with augmented rice and wheat yields established necessary inputs for upward revision of existing fertilizer N recommendations under sodic conditions to synchronize the crop N demand in high RSC water irrigated sodic soils. Further, the institutionalized and locally-driven support mechanisms should be consolidated for enriching farmers' knowledge and scaling up impact-driven participatory research and developmental activities while arresting the sodicity-induced land degradation and strengthening rural livelihoods.

Reference: Paper published in Field Crops Research; https://doi.org /10.1016/j.fcr. 2021.108192.

Activity 6.3 Leaf Colour Chart (LCC) based N management in rice-wheat system

Leaf Colour Chart (LCC) is an instant, easy to use and low cost visual and subjective indicator for the crop's nitrogen status and need for N fertilizer application. To demonstrate the use of LCC based N management in rice-wheat system, the farmers were provided the LCC plates (purchased from PAU, Ludhiana) and were trained on "how to match the leaf colour using LCC plate vis-à-vis fertiliser N application". A total of 35 demonstrations in

Farmers' perception towards N-use and reported rice yields under sodic conditions in project area.

Parameters	CSR 30 Basmati (n=110)						PB 1121 (n=100)					
	N applied (kg/ha)				Sample mean (n)	p-value	N applied (kg/ha)				Sample mean (n)	p-value
	Upto 60	60-90	90-120	>120			90-120	120-150	150-180	>180		
# Total farmers (%)	3.6	32.7	54.6	9.0	n=110	<0.0001	10.0	18.0	66.0	6.0	n=100	<0.0001
¥Dose of N (kg/ha)	51.8[d]	79.0[c]	104.2[b]	132.3[a]	96.7(±18.9)	<0.0001	103.5[d]	129.7[c]	158.7[b]	189.8[a]	149.8(±22.4)	<0.0001
¥Average no. of N splits	2.00[b]	2.39[b]	2.57[ab]	3.00[a]	2.53(±0.50)	0.0384	2.80c	3.00[b]	3.03[b]	3.67[a]	3.04(±0.28)	0.0001
#Splitting of N (% farmers)												
2 splits of N	100.0	61.1	43.3	-	n=52	0.0004	80.0	-	-	-	n=8	-
3 splits of N	-	38.9	56.7	100.0	n=58	0.0002	20.0	100.0	97.0	33.3	n=86	<0.0001
4 splits of N	-	-	-	-	-	-	-	-	3.0	66.7	n=6	0.4142
¥Time taken to N top dressing (DAT)	27.5[b]	30.3[b]	33.4[ab]	39.0[a]	32.7(±6.37)	0.0250	35.0	36.7	37.8	38.6	37.3(±5.54)	0.7225
¥Grain yield (t/ha)	2.25[c]	2.90[a]	2.97[a]	2.75[b]	2.90(±0.51)	0.0357	3.73[ab]	3.82[a]	3.69[b]	3.25[b]	3.69(±0.62)	0.0017
¥NUE (kg grain/kg N applied)	43.5[a]	36.0[a]	28.6[b]	20.6[c]	31.1(±8.21)	<0.0001	36.0[a]	29.5[b]	23.3[c]	17.3[d]	25.3 (±6.23)	<0.0001

'n' represents number of interviewed farmers; #Variables tested for goodness of fit through Chi-Square Test; ¥Variables tested for comparison of means through ANOVA. Data followed by different lowercase letters within row differ significantly (p?0.05) using least significant difference test. Values with ± represent standard deviation in mean values.

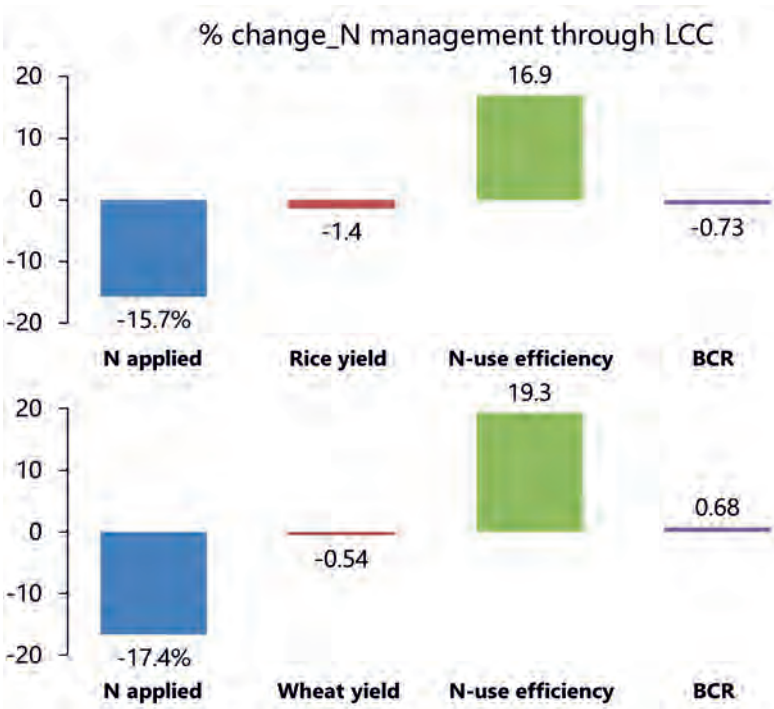
rice and 30 demonstrations in wheat were carried out in farmer's participatory mode over a period. of 2 years (2019-20 and 2020-21). Under farmer's practice, the total N applied during the crop growing season ranged between 195.0-252.5 kg/ha in rice and 165.0-223.7 kg/ha in wheat. While LCC based N management resulted in 172.5 and 159.1 kg/ha with 17.4 and 18.9% N savings in rice and wheat, respectively.

LCC based N management resulted in NUE of 40.9 and 30.4 kg/kg N applied as against the 35.0 and 25.5 kg/kg N applied compared to farmer's practice in rice and wheat, respectively. Crop yields remained at par; however,

Comparison of farmers' practice and LCC base N management in rice-wheat system.

Parameters	Rice (n=35)		Wheat (n=30)	
	LCC based N management	Farmer' practice	LCC based N management	Farmer's practice
N applied (kg/ha)	165.05	195.68	162.48	194.91
Grain yield (kg/ha)	67.54	68.49	49.41	49.68
Nitrogen use efficiency (kg grain/kg N applied)	40.92	35.00	30.41	25.50
Cost of cultivation ('000 Rs/ha)	40.84	41.18	31.47	31.97
Gross returns ('000 Rs/ha)	111.84	113.44	92.37	92.83
Net returns ('000 Rs/ha)	71.1	72.25	60.87	60.93
B:C ratio	2.73	2.75	2.93	2.90

n= number of farmers



better monetary benefits and BCR were observed under LCC based N management practice. The farmers were convinced about the potential saving of N (urea) through LCC based N management.

Deliverable output: The farmers were convinced about the potential saving of N (urea) through LCC based N management. The outcome results showing enhanced NUE and similar crop yields improved the decision-making process of the farmers and also provided an economic package in application of N fertilizer on the basis of LCC management practice.

Activity 6.4 Role of foliar K-nutrition in enhancing wheat yields under sodic conditions

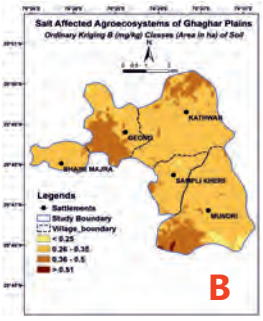
Diagnostic surveys indicated that farmers occasionally apply potassic fertilizers in wheat. On an average, merely 11% of the interviewed farmers applied 32 kg K/ha as basal dose. Unfortunately, none of the farmer had even gone for foliar K-nutrition in wheat during the peak grain development. To showcase the potential benefits of K application under sodic conditions, 50 field trials in participatory mode were conducted during winter seasons of 2018-19 and 2019-20 comprising two treatments; farmers' practice as no-K application (K0) and foliar application of 1 kg K/ha each at 5-10% heading and 15-20 days thereafter (improved practice; K_{fol}).

With increasing sodicity stress from soil pH <8.5 to >9.25, relatively lesser reduction in yield attributes such as effective tillers (17%), grains per earhead (27%), and grain weight (12%) was observed under Kfol when compared with corresponding reductions of 19%, 30% and 14% in K0 treatment. Higher K uptake with K_{fol} treatment resulted in lower Na/K in leaf tissues with variable sodicity stress. Although foliar nutrition with K increased production cost by 524 Rs/ha, but the added costs were compensated by getting higher grain yields (0.12-0.21 t/ha) and better monetary returns (1521-3217 Rs/ha) in comparison to farmers' practices across variable sodicity stress. In nutshell, the wheat yields improved by 3.5% due to K_{fol}, realizing 5.7 times incremental benefit for each unit invested towards K-use.

Deliverable output: Beneficial role of K application in plant nutrition and osmo-regulation helped in mitigating the salinity stress, and also maximized opportunities for better resource-use and increased wheat yields in alkali-water irrigated sodic soils. Farmers' participatory technology evaluation also enhanced farmers' knowledge and adoption use of K-nutrition in wheat.

Activity 6.5 Managing reproductive sterility through boron application in rice

In salt-affected (sodic) soils, reproductive sterility is a common phenomenon impacting rice productivity to a greater extent. Boron plays an important role in plant system particularly during reproductive phase and helps in better pollination, and fruit and seed development. To determine the available boron (B) nutrient status and decision making



Reproductive sterility in rice

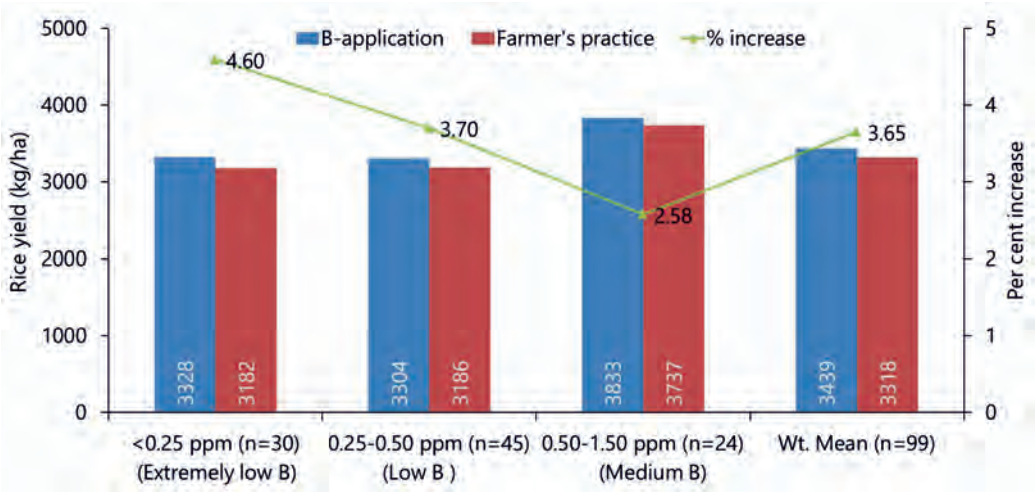
Comparison of farmers' practice and K-application on the performance of wheat.

Parameters	Soil pH					Sample mean	p-value
	<8.50	8.50-8.75	8.75-9.00	8.75-9.00	>9.25		
Total number of trials	14	7	7	12	10	-	-
Leaf Na/K composition[§]							
Farmers' practice (K_0)	0.232	0.243	0.282	0.327	0.336	0.284A	pH=0.0028
Improved practice (K_{foi})	0.203	0.220	0.255	0.278	0.284	0.248B	K=0.0329
Mean	0.218[a]	0.232[a]	0.269[b]	0.303[c]	0.310[c]		pH×K=0.6184
Grain yield (t/ha)							
Farmers' practice (K_0)	4.88	4.84	4.31	4.26	3.92	4.46B	pH=0.0052
Improved practice (K_{foi})	5.00	4.99	4.49	4.46	4.13	4.62A	K=0.0027
Mean	4.94[a]	4.92[a]	4.40[b]	4.36[b]	4.03[c]		pH×K=0.1129
Economic indicators[‡]							
Added cost (US$/ha)	524	524	524	524	524	524	-
Added returns (US$/ha)	2045	2679	3174	3516	3741	2984	-
Incremental income	1521	2155	2642	2992	3217	2460	-
Incremental input-output ratio	3.89	5.08	6.02	6.07	7.1	5.66	-

K_0: no K /farmers' practice; K_{foi}: two sprays of 1 kg K/ha at 5-10% heading and 15-20 days of first spray; means with different letters (uppercase for K application and lowercase for soil pH) are statistically significantly ($p \leq 0.05$) using Least Significant Difference

support system for balanced fertilization, geo-referenced surface (0-15 cm depth) soil sampling was done in the project areas were collected. Thematic maps indicated boron deficiency as one of the major challenge in the adopted villages with 90% of the total area (3247 ha) was found deficient with B level<0.5 ppm; critical limit for B deficiency.

To demonstrate the benefits of B application in managing the reproductive sterility and sustaining rice yields under sodic conditions, a total of 99 demonstrations (25 during 2018, 35 during 2019 and 39 during 2020) were carried out



in farmers' participatory mode. Soil application of boron @ 2.5 kg/ha through borax was done at the time of final field preparation before rice transplanting. With the increase in B deficiency, the yield advantage due to B application increased from 2.6% (medium) to 4.6% (extremely low) with a mean advantage of 3.7% compared to farmer's practice (no B application). The spikelets sterility also increased with increasing B deficiency.

A monetary benefit of 4147 Rs/ha against the added cost of 600 Rs/ha incurred towards boron application indicated an incremental input-output ratio of 6.91 for each rupee invested towards the cost of boron application. The incremental input-output ratio due to soil application of B was relatively higher under extremely low B concentration (8.33) compared to soils having medium B concentration (5.49).

Monetary returns with B application in comparison to farmers' practice.

Economic parameters	Extremely low B (<0.25 ppm)	Low B (0.25-0.50 ppm)	Medium B (0.5-1.5 ppm)	Overall mean
Added cost (Rs/ha)	5000	4035	3292	4147
Added returns (Rs ha)	600	600	600	600
Incremental income	4400	3435	2692	3547
Incremental input-output ratio	8.33	6.72	5.49	6.91

Deliverable output: Farmers' tendency to use boron had increased manifold in the area owing to its role in managing spikelets sterility, improving rice performance, and maximizing the net economic returns. Even the farmers have started using boron at flowering stage.

C) HORTICULTURE BASED MODULES

Activity-7 Diversifying rice-wheat system through vegetables for sustainable yield under sodic agro-ecosystems

For enhancing farmer's income on marginal sodic lands irrigated with alkali water, vegetable based partial crop diversification module was synthesized at farmer's field under Farmer First Project. A farmer from Kathwar village of Kaithal district Shri Pyarelal Singh (58 years old) was selected as a part of pilot project study. Mr. Singh owns 1.8 ha of land and cultivating field crops such as rice, wheat, fodder sorghum and berseem along with 3 milch animals. Despite of risk-taking capabilities and eagerness to learn something new, Mr. Singh lacked technical approach towards vegetable cultivation. Therefore, to improve his skills further, he was trained at specialized training centers (NHDRF, Salaru, Karnal and Center of Excellence for Vegetables, Gharaunda, Karnal) through short-term capacity building programmes.

Out of total 1.8 ha land area, only 0.4 ha was converted into vegetable and fodder based

diversified cropping systems depending on the farmer's resource base and family size/labour availability. Two crop sequences including short duration vegetables in cereal (rice-garden pea-onion) and fodder (sorghum-cauliflower-okra) based cropping systems enhanced productivity and profitability margins with an additional income of Rs. 1,11,903 and incremental benefit cost ratio of 3.74 for each rupees incurred towards the cultivation of vegetable crops compared to traditional rice-wheat system. The productivity of partially diversified system remained 6.32 t/ha as against the 4.36 t/ha with traditional farming practice.

The production efficiency was quite high (1.86 q WEY/ha/day) compared to 0.86 q WEY/ha/day under the traditional rice-wheat system.

Economic analysis of traditional farming and diversified cropping systems.

Crop/ Activity	Area (ha)	Crop	Total yield (t)	Cost of cultivation	Gross returns	Net returns	B:C ratio
				(x 10^3 Rs/ha)			
Traditional system							
Rice (Basmati CSR 30)-	1.6	Rice	4.8	60.0	201.6	141.6	3.36
Wheat (HD 2967)		Wheat	8.0	38.8	138.8	100.0	3.58
Sorghum*-Berseem*	0.2	Sorghum		----------Fodder purpose----------			
		Berseem		----------Fodder purpose----------			
Total	**1.8**			**98.8**	**340.4**	**241.6**	**3.45**
Diversified system							
Rice (PB 1509)-Pea-Onion	0.2	Rice	1.0	8.8	27.0	18.3	3.09
		Pea	1.25	7.3	20.3	13.0	2.78
		Onion	5.0	20.0	86.3	66.3	4.32
		Onion nursery	-	6.7	15.0	8.3	2.23
Sorghum*-Cauliflower-Okra	0.2	Sorghum		----------Fodder purpose----------			
		Cauliflower	4.0	6.9	30.0	23.1	4.36
		Okra	1.75	8.5	34.1	25.6	4.02
Rice (CSR 30)-Wheat (HD 2967)	1.2	Rice	3.6	45.0	151.2	106.2	3.36
		Wheat	6.0	29.1	104.1	75.0	3.58
Rice (CSR 30)-Berseem*	0.2	Rice	0.6	7.5	25.2	17.7	3.36
		Berseem		----------Fodder purpose----------			
Total	**1.8**		**-**	**139.7**	**493.2**	**353.5**	**3.53**

***Fodder for animal component, not considered while calculating the system economics**

Comparison of diversified and traditional copping systems.

Cropping system	Productivity (t WEY/ha)	Production efficiency (t WEY/ha/day)	Net returns (x10^3 Rs/ha)
Traditional	4.36	0.081	242
Partially diversified including vegetables	6.32	0.186	354

Deliverable output: Most of the cultivated vegetables are sold at the farm itself to the retail vendors besides meeting household requirements. An additional expenditure of Rs. 40,885 was incurred towards diversifying one acre area under vegetables as against the traditional farming of cultivating rice and wheat. Continuous farmer-scientist interaction and capacity building boosted his confidence to further increase area under vegetable crops upto one hectare. In addition, he has also opted for raising onion nursery and earning good profit. The fellow farmers and the farmers in the neighboring villages have also started growing vegetables depending on their resource base and labour availability.

D) ENTERPRISE BASED MODULES

Activity-8 Residue management in rice-wheat system: 'Super Straw Management System (SSMS)' based rice straw management and direct wheat seeding with 'Happy seeder'

Rice-wheat system (RWS) generates 7-10 tonnes of residues on hectare basis. More than 90% of the rice and wheat crops in the adopted villages were mechanically harvested. The in-situ disposal of paddy straw was a huge challenge in the adopted villages due to short time span (hardly 10-15 days) between rice harvesting and wheat seeding, enforcing farmers to opt for open-field burning of crop residues. Furthermore, crop intensification, lack of traditional use of crop residues and buyers for rice straw further aggravates the situation generating huge amount of surplus residues. Therefore, residue management was of utmost important as it not only contains valuable plant nutrients but its incorporation also helps to improve soil physical, chemical and biological health.

FFP sponsored SSMS fitted to combine harvester

During conversation with the combine owners in the area, it was observed that they were reluctant to attach SSMS to existing combine harvesters considering its high initial and running (fuel charges) cost. Taking into consideration, a SSMS was provided and attached to one of the already existing combine. A total of 295 ha of rice fields (185 ha during 2017 and 110 ha during 2018) were harvested with FFP sponsored SSMS equipped combine harvester with an estimated savings of 10 ton N, 0.9 ton P_2O_5, 6 tons K and 0.9 ton S. In addition, 3015 tons of CO_2, 124 tons of CO, 4 tons of SO_2 and 6 tons of particulate matter might have generated if not harvested by the SSMS equipped combine harvester.

A field day on 'Rice Residue Management' was organized to acquaint the farmers on situation based rice straw management options., the usefulness of combine harvester equipped with Super Straw Management System (SSMS) and direct wheat sowing with Happy Seeder in uniformly spreaded rice straw. To demonstrate the direct wheat seeding with 'Happy Seeder' in SSMS equipped combine harvested rice fields, a total of 55

Residue management with FFP sponsored SSMS system and estimated nutrient savings and greenhouse gas emission.

Parameters	Nutrient saving			
	N	P_2O_5	K	S
% nutrient composition in rice straw	0.61	0.18	1.38	0.07
Total nutrients (t)	12.60	3.72	28.50	1.45
% loss during burning	80	25	21	60
Nutrient saving (t) through SSMS fitted combine harvester	10.08	0.93	5.98	0.87
	Gas Emission			
	CO_2	CO	SO_2	PM
Gas emission (kg/t) of rice straw burning	1460	60	2	3
Total savings through SSMS fitted combine harvester	3015	124	4	6

demonstrations (30 during 2018 and 25 during 2019) were carried out in FFP adopted villages. Mean yield data indicated 4361 kg/ha with Happy Seeder sown wheat as against the 4228 kg/ha yield with 3.1 per cent yield advantage over the conventional wheat sowing. In addition, the farmers perceived lesser incidence of resistant Phalaris minor, 5-10% water saving in first irrigation and lesser crop lodging under aberrant weather situations where wheat sowing was done with Happy Seeder.

Activity-9 Entrepreneurship through aquaculture in sodic environments

Fish production in India has great potential and proves to be holding more offers in generating employment opportunities, especially in rural areas. Aquaculture is an appropriate alternative land use option in less favourable areas where low production of the other cropping systems is less remunerative.

Frequent discussions with Mr. Naseeb Singh, a 38 year old farmer from Sampli Kheri, Kaithal having 1.8 ha of land motivated himself to take up fish farming as a mean of crop diversification and entrepreneurship development. The selected area had relatively lesser yields (40% of normal) because of the excavated 8-10 feet top soil and native soil sodicity probems and associated hazards. The available land area was designed in such a way that the reoriented smaller ponds could serve as nursery ponds and the large one as grow-out pond. The

farmer constructed three ponds covering an area of about 0.64 ha (2 small of size 0.16 ha and 1 large of 0.32 ha). Apart from constant monitoring and suggestions, the farmer was also trained at ICAR-CIFE Regional Station, Rohtak (Haryana) to get acquainted with suitable fish farming practices.

The farmer sold about 2231 kg of fish (Rs. 1,78,500) and seed (Rs. 53,000) over a period of one year. The net revenue generated from the diversified farming system was Rs. 54,692 with a B:C ratio of 1.3. If the same area had been cultivated with the traditional rice-wheat system with business as usual, it would have generated an income of about Rs. 52,000-60,000 owing to its low productivity. Economically, the returns from fish farming matched the traditional cropping system in the first year of technological inception.

Economics of fish culture over a period of one year.

Particulars	Total cost (Rs.)
Fixed cost (construction, pipelines etc. including other charges)	1,11,700
Variable cost (Fish seed, fertilizer, feed etc.)	1,76,808
Gross revenue (fish + seed)	2,31,500 (1,78,500 + 53,000)
Net revenue	54,692
B:C ratio	1.3

Deliverable output: Switching from traditional farming (rice-wheat system) to successful aquaculture practice, resulted in productive utilization of sodic land and getting similar profit margins in the first year of the culture. It is envisaged that production and profitability margins in future will certainly be more by culturing more diversified and more than two species. Enhanced farmers-scientist interaction and linkages with line departments encouraged farmers for adopting integrated aquaculture with different components like livestock, poultry and horticulture along with aquaculture.

E) LIVESTOCK BASED MODULES

Activity-10.1 Amelioration of heat stress for enhancing growth performance of buffalo heifers through betaine supplementation during hot humid season

To ameliorate the adverse effect of heat stress and to improve the growth rate of growing buffaloes, 44 growing buffaloes (8-10 months) were selected from adopted village under farmers FIRST and equally divided into two groups i.e. farmer's practice (control group) and supplemented betaine supplementation @ 25 g/day/animal during August-September (treatment group). Blood samples were collected at fortnight intervals for biochemical parameters.

Betaine acted as a potent growth promoter by reducing the concentration of stress markers in betaine supplemented buffalo heifers. Betaine supplementation significantly lowered the skin and rectal temperature, stress biomarkers and improved the feed intake and average daily gain indicating its beneficial effect in ameliorating the heat stress in buffalo heifers. Positive correlation was observed between temperature humidity index (THI) and stress markers, physiological responses and negatively correlated with average daily gain (ADG), dry matter intake (DMI) and growth hormone. The DMI showed positive correlation with GH, ADG, BW and body measurements and negative correlation with THI, RT, ST, PR, NEFA and cortisol.

Comparison of farmers' practice and betaine supplementation for managing heat stress.

Group	Input cost (Rs)	Expected average	Output (Rs) age at puberty	Cost Benefit Ratio
Farmers' practice (control)	No Betaine feeding	756 days	Cost of 28 days milk production as puberty is expected to be achieved 28 days earlier than control (Min. Avg. milk production @ 5 kg per day (Rs.40/kg milk)= 5 x 28 x 40 = Rs.5600/-	1:6.86
Betaine @ Rs.440/kg	Betaine feeding @ 25 g/ day/ animal for 2 months= 25 x 60 x 0.44 = Rs. 660 Extra DMI feed cost= Rs. 155.28 Total cost=660+155.28 = Rs.815.28	728 days		

Deliverable output: Supplementation of betaine reduced the age of puberty by 28 days compared to farmers' practice (control group) and also improved the cost benefit ratio by 6.9 times compared to farmers' practice (control group).

Reference: Paper published in Indian Journal of Animal Sciences; 90(3), 416-423.

Activity-10.2 Enhancement of reproductive performance using proven bull semen and supplementing mineral mixture to breedable bovines

A total of 1145 breedable bovine (Cattle-193 and buffalo-952) were inseminated at the proper time of estrus (heat) using the NDRI, Karnal bull semen. These animals were also supplemented mineral mixture @ 50-60 g day^{-1} animal^{-1}. Inseminated cow and buffaloes were checked through rectal palpation after three months of

Particulars	2017-18	2018-19	2019-20	2020-21	Overall
Total no. of inseminated animals	107	308	335	395	1145
Cattle	13	49	58	73	193
Buffaloes	94	259	277	322	952
No. of pregnant animals	52	149	170	202	573
Conception rate (%)	48.6	48.3	50.7	51.1	50.0

insemination. The overall conception rate was 50%. In addition, different awareness and interaction programme including animal health camps were also organized in adopted villages from time to time and inputs were distributed for the experimental trials to the dairy farmers.

Deliverable output: Conception rate improved by >15% over the existing conception rate under field conditions.

Activity-10.3 Effect of astaxanthin and prill fat supplementation on energy metabolites, stress markers and milk production of buffaloes during summer season under field conditions

The study was conducted in summer season (June to September) on 64 healthy lactating murrah buffaloes (first to fourth parity) under Farmer FIRST Project. These animals were equally divided into four groups i.e. group-I as control, group-II as astaxanthin supplementation @ 0.25 mg/kg body wt/day), group-III as prill fat supplementation @ 100 g/animal/day and group-IV as combination of astaxanthin@ 0.25 mg/kg body wt./day and prill fat @ 100 g/animal/day.

The results indicated that there was significant increase in milk yield whereas stress levels were reduced by different supplementation over the control group (farmers' practice). Supplementation of astaxanthin, prill fat and their combination to lactating buffaloes enhanced the milk yield by 5.4%, 13.8% and 15.6% respectively over the control group. Astaxanthin supplementation helped in alleviating effects of heat stress whereas prill fat worked as dense energy source to maintain the energy balance in lactating buffaloes. The combinations of both the products were more effective as far as stress markers and increase in milk production was concerned but higher price of astaxanthin led to lower cost benefit ratio than prill fat supplementation alone. Therefore, farmers preferred to feed prill fat to lactating buffaloes during summer conditions.

Effect of dietary supplementation on milk yield (kg/day) of buffaloes during summer season.

Fortnight interval	Control (Group-I)	Supplementation		
		Astaxanthin (Group-II)	Prill fat (Group-III)	Astaxanthin +Prill fat (Group-IV)
I	8.22^{Xa}±0.37	8.29^{Xab}±0.35	8.25^{Xa}±0.44	8.33^{Xa}±0.30
II	8.00^{Xa}±0.38	8.54^{XYab}±0.35	8.91^{XYa}±0.40	9.33^{Yb}±0.26
III	7.84^{Xa}±0.21	8.75^{Yb}±0.42	8.96^{Ya}±0.14	9.16^{Yab}±0.27
IV	7.55^{Xa}±0.56	8.08^{XYab}±0.40	9.33^{Ya}±0.61	9.41^{Yb}±0.39
V	7.62^{Xa}±0.45	8.17^{XYab}±0.25	9.20^{XZa}±0.52	9.50^{Zb}±0.21
VI	7.87^{Xa}±0.31	7.95^{Xab}±0.11	8.88^{Xa}±0.39	8.83^{Xab}±0.37
VII	7.54^{Xa}±0.24	7.70^{Xa}±0.11	8.70^{Ya}±0.31	8.66^{Yab}±0.12
Mean±S.E	7.81^{X}±0.13	8.23^{Y}±0.12	8.89^{Z}±0.15	9.03^{Z}±0.12

Values are mean ± S.E of seven observations on six animals; Values with different superscripts a, b, c... within a column and X, Y and Z within a row differed significantly (P<0.05) within treatment and among treatment groups, respectively.

Economics of different supplementation with farmers' practice.

Group	Input (Cost in Rs)	Output (Milk yield in (kg/day/animal)	Profit (Rs/day)	C:B ratio
Astaxanthin (12,500 Rs/kg)	1.25 g/day = 15.6 Rs/day	0.420 l day-1=21 Rs	5.4	1:1.35
Prill fat (80 Rs/kg)	100 g/day = 8 Rs/day	1.080 l day-1=54 Rs	46.0	1:6.75
Astaxanthin + Prill fat	23. Rs/day	1.220 l day-1=61 Rs	37.4	1:2.58

Comparison of milk yield (kg/day) and profit margins with dietary supplementation of prill fat (n=25 in each category)

Treatments	Parity-1	Parity-2	Parity-3	Parity-4	Mean	Profit (Rs day^{-1})	C:B ratio
Farmers' practice (control)	7.80±0.16	7.53±0.14	7.61±0.20	7.92±0.13	7.72	-	-
Prill fat @ 100 g/day	8.35±0.20	9.28±0.35	8.92±0.14	8.21±0.14	8.69 (12.6%)	41.0	1:6.13

Deliverable output: Cost benefit ratio indicated the better returns with prill fat supplementation, suggesting as a cost-effective option for enhancing milk production in lactating buffaloes during heat stress.

Reference: Paper published in Biological Rhythm Research; https://doi.org/10.1080/09291016.2019.1658426; Journal of Agrometeorology, 23(3): 243-248 and Indian Journal of Animal Sciences, 90(1): 55-60.

6 PARTNERSHIP AND INSTITUTION BUILDING

ICAR-CSSRI, Karnal has developed affordable technologies for the management of salt-affected soils and poor quality water. To disseminate the demand driven impact-oriented transferable technologies in the sodic areas, the Farmer FIRST Project encompassed suitable platform building network of linkages with related organizations as partners and improved farmers' access to information, technology, input and market.

Organization/Institution	Role
ICAR-National Dairy Research Institute (NDRI), Karnal	Conduct of livestock-based technological interventions, training & capacity building
State Department of Agriculture & Krishi Vigyan Kendra (Kaithal)	Out-scaling potential technologies, farmers' awareness for government schemes
Haryana Land Reclamation Development Cooperation (HLRDC)	Supply of gypsum
District Cooperative Sugarmill, Kaithal	Supply of pressmud
Indian Farmers Fertilizer Cooperative Limited (IFFCO)	Supply of quality pesticides
National Horticultural Research and Development Foundation (NHRDF)	Vegetable based module
Regional Station, Indian Agriculture Research Institute, Karnal	Crop-based plant protection measures
District Fishery Department, Kaithal	Fish fingerlings/seed
National Bank for Agriculture and Rural Development (NABARD)	Financial support for promotion of community based enterprise, and formation of FPO/SHGs

7 CONTENT MOBILIZATION

A mobile enabled knowledge sharing platform has been created by developing a Decision Support System 'Salinity Expert' for faster dissemination and greater impact of demonstrated technologies which includes digitized Soil Health Cards, technological package for rice, wheat and mustard in salt-affected areas, gypsum calculator, updated agro-advisories, a query handler etc. for faster dissemination and greater impact of transferable agricultural knowledge. A repository of affordable salinity management technologies relevant to project location and similar agro-ecology has been developed through participatory research, and documented in the form of research publications, success stories, extension articles, success stories, training manuals, leaflets, brochures, video clips etc.

A) Project platform for e-enabled knowledge sharing: Development of Mobile App 'Salinity Expert'

'Salinity Expert' is an ICT-based initiative towards 'Digital India' with aim to fast track the dissemination of doable salinity management technologies to the farmers. It seeks to provide the farmers and other stakeholders pertinent information supplemented with pictorial illustrations for reviving the productivity of salt affected lands. This App has been developed under the 'Farmer FIRST' project. This is a user friendly innovative digital tool compatible with android mobile operating systems. The entire information in the app is available in Hindi language for ease in learning to the beneficiary farmers. The App has been designed in such a manner that only onetime internet connection is required to download it.

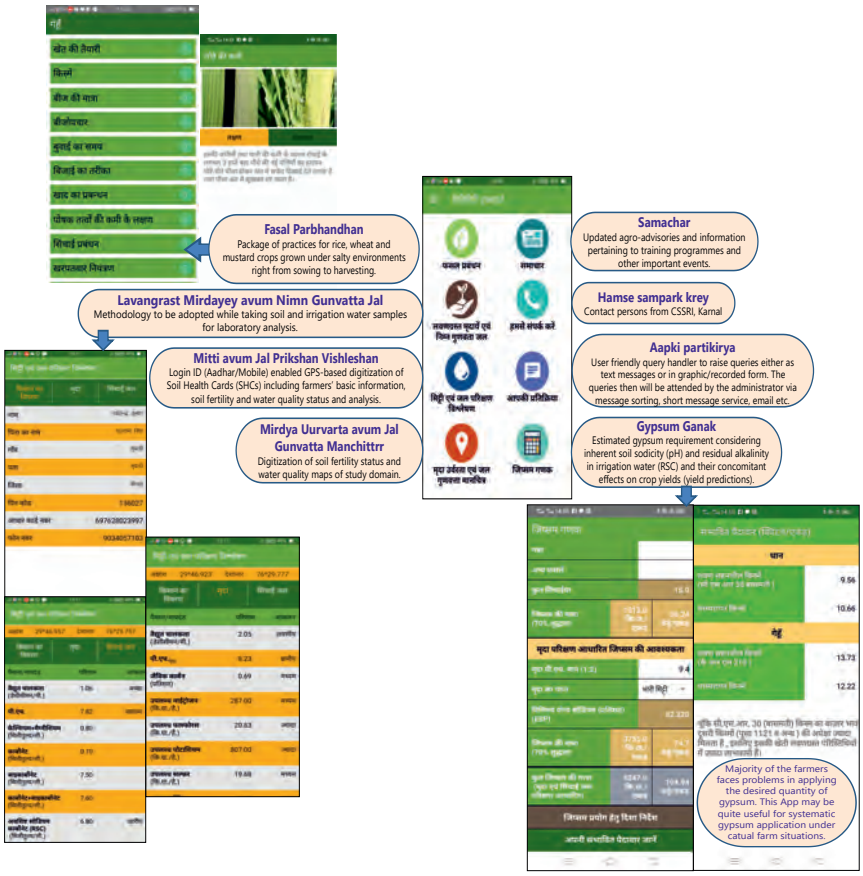
The main features of the App include static as well as dynamic platforms including:

- Mitti avum Jal Prikshan Vishleshan
- Lavangrast Mirdayey avum Nimn Gunvatta Jal
- Fasal Parbhandhan
- Gypsum Ganak
- Aapki Partikirya
- Samachar
- Mirdya Uurvarta avum Jal Gunvatta Manchittrr

This mobile app 'was launched by Shri Radha Mohan Singh, Hon'ble Union Minister for Agriculture and Farmers Welfare during the Golden Jubilee Kisan Mela organized by ICAR-Central Soil Salinity Research Institute, Karnal on March 10, 2018.

B) Data base of soil fertility and water quality

Data base for 388 farmers including farm level precise information on nature of soil salinity (pH/EC), fertility status including macro (N, P, K, S) and micro (Zn, Fe, Mn, Cu, B) and irrigation water quality (pH/EC/RSC) has been generated and uploaded in mobile app 'Salinity Expert' under the head 'Mitti avum Jal Prikshan Vishleshan- Login ID (Aadhar/ Mobile) enabled GPS-based digitization of Soil Health Cards'. The specific information includes farmers' basic information, soil fertility and water quality status and analysis and will be quite helpful in creating awareness and taking up cost-effective farm management practice curtaining input costs.



मिट्टी एवं जल परिक्षण विश्लेषण

किसान का विवरण	मृदा	सिंचाई जल
नाम		सलिन्द्र कुमार
पिता का नाम		सुल्तान सिंह
गाँव		मुंदडी
पता		मुंदडी
जिला		कैथल
पिन कोड		136027
आधार कार्ड नंबर		697628023997
फोन नंबर		9034057103

मिट्टी एवं जल परिक्षण विश्लेषण

अक्षांश 29°46.923' देशान्तर 76°29.777'

किसान का विवरण	मृदा	सिंचाई जल
पैमाना/मापदंड	परिणाम	आंकलन
वैद्युत चालकता (डेसीसीमन/मी.)	2.05	लवणीय
पी.एच.-एस.	8.23	क्षारीय
जैविक कार्बन (प्रतिशत)	0.69	मध्यम
उपलब्ध नाईट्रोजन (कि.ग्रा./हे.)	287.00	मध्यम
उपलब्ध फास्फोरस (कि.ग्रा./हे.)	20.83	ज्यादा
उपलब्ध पोटाशियम (कि.ग्रा./हे.)	807.00	ज्यादा
उपलब्ध सल्फर (कि.ग्रा./हे.)	19.68	मध्यम

मिट्टी एवं जल परिक्षण विश्लेषण

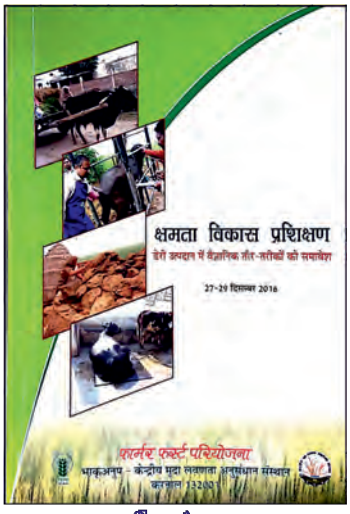
अक्षांश 29°46.957' देशान्तर 76°29.757'

किसान का विवरण	मृदा	सिंचाई जल
पैमाना/मापदंड	परिणाम	आंकलन
वैद्युत चालकता (डेसीसीमन/मी.)	1.06	अच्छा
पी.एच.	7.82	सामान्य
कैल्शियम+मैग्नीशियम (मिलीतुल्य/ली.)	0.80	
कार्बोनेट (मिलीतुल्य/ली.)	0.10	
बाइकार्बोनेट (मिलीतुल्य/ली.)	7.50	
कार्बोनेट+बाइकार्बोनेट (मिलीतुल्य/ली.)	7.60	
अवशिष्ट सोडियम कार्बोनेट (RSC) (मिलीतुल्य/ली.)	6.80	क्षारीय

C) Content management platform enabling online access

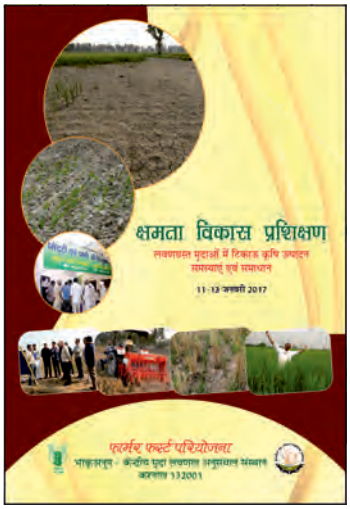
Village-level WhatsApp Groups have been created to provide weather based agro-advisories, farm management practices, government schemes related to agriculture and livestock etc. and other project related activities like scheduling of farm goshthies, distribution of farm inputs etc.

D) Preparation of knowledge models, content management platform enabling offline access



प्रशिक्षण मैनुअल

के. पोन्नुसामी, प्रवेन्द्र भ्योराण, नईम अली, लक्ष्मीकांत त्रिपाठी, रंजय कुमार सिंह एवं प्रबोध चन्द्र भार्मा. 2016. डेरी उत्पादन में वैज्ञानिक तौर तरीकों का समावे ा. प्र िक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 47.

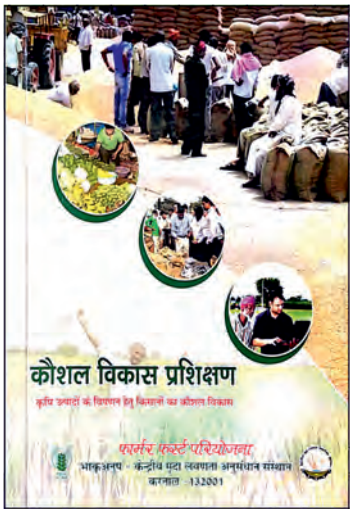


प्रशिक्षण मैनुअल

प्रवेन्द्र भ्योराण, अरविंद कुमार, सत्येन्द्र कुमार, रंजय कुमार सिंह, सती ा कुमार सनवाल एवं प्रबोध चन्द्र भार्मा. 2016. लवणग्रस्त मृदाओं में टिकाऊ कृषि प्रबन्धन : समस्याएं एवं समाधान, प्र िक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 157.

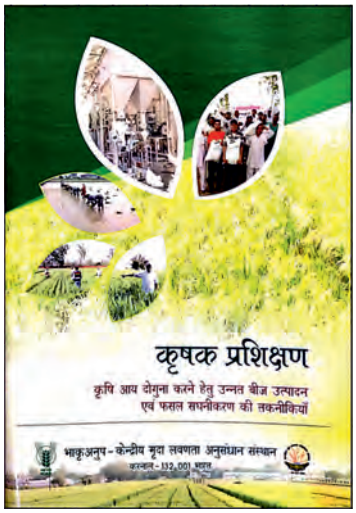
तकनीकी फोल्डर

बाबू लाल मीणा, प्रवेन्द्र भ्योराण, मुरलीधर मीणा, एम. जे. कलेढोणकर, रंजय कुमार सिंह एवं प्रबोध चन्द्र भार्मा. 2017. मिट्टी परीक्षण हेतु नमूने लेने की विधि. तकनीकी फोल्डर, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 6.



प्रशिक्षण मैनुअल

राजू आर., कैला ा प्रजापत, प्रवेन्द्र भ्योराण, नवीन कुमार, रंजय कुमार सिंह, अनिल कुमार एवं प्रबोध चन्द्र भार्मा. 2018. कृषि उत्पादों के विपणन हेतु किसानों का कौ ाल विकास प्र िक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, 26–28 फरवरी 2018. पृष्ठ 83.

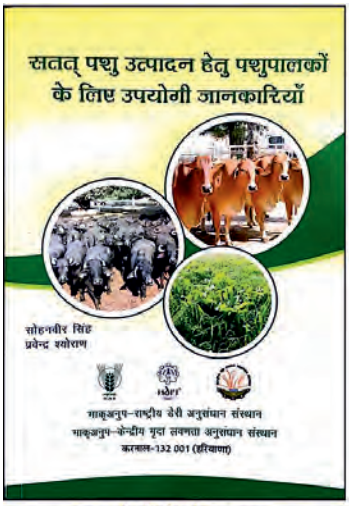


प्रशिक्षण मैनुअल

प्रवेन्द्र भ्योराण, कैला ा प्रजापत, अ वनी कुमार, अनीता मान, नवीन कुमार एवं प्रबोध चन्द्र भार्मा. 2018. कृषि आय दोगुना करने हेतु उन्नत बीज उत्पादन एवं फसल सघनीकरण की तकनीकियाँ, प्र िक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, 21–22 जून 2018. पृष्ठ 49.

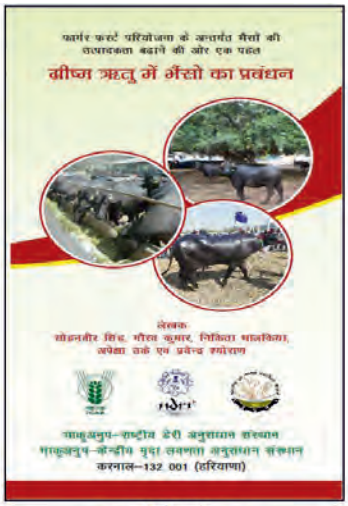
प्रशिक्षण मैनुअल

प्रवेन्द्र भ्योराण, आर. राजू, नवीन कुमार, रमे ा वर्मा, रंजय कुमार सिंह एवं प्रबोध चन्द्र भार्मा. 2017. फसल उत्पादन में छिड़काव तकनीक का महत्व, प्र िक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, 6–8 सितम्बर 2017. पृष्ठ 70



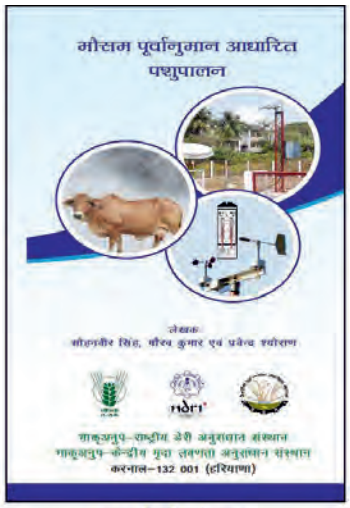
तकनीकी हिंदी पुस्तक

सोहनवीर सिंह एवं प्रवेन्द्र श्योराण. 2020. सतत् पशु उत्पादन हेतु पशुपालकों के लिए उपयोगी जानकारियाँ. भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान एवं केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 104.



तकनीकी फोल्डर

सोहनवीर सिंह, गौरव कुमार, निकिता भालकिया, अपेक्षा उके एवं प्रवेन्द्र श्योराण 2021. ग्रीष्म ऋतु में भैंसो का प्रबंधन. तकनीकी फोल्डर, भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान एवं केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 6.



तकनीकी फोल्डर

सोहनवीर सिंह, गौरव कुमार एवं प्रवेन्द्र श्योराण 2021. मौसम पूर्वानुमान आधारित पशुपालन. तकनीकी फोल्डर, भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान एवं केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 6.

प्रसार बुलेटिन

कैलाश प्रजापत, प्रवेन्द्र श्योराण एवं प्रबोध चन्द्र शर्मा 2019. फसलों में पोषक तत्वों की कमी एवं प्रबंधन मार्गदर्शिका। प्रसार बुलेटिन. भाकृअनुप–केमृलअनुस/2019/03. पृष्ठ 28.

तकनीकी फोल्डर

E) Farmer FIRST project activities in NEWS and Print Media

मिट्टी, पानी की जांच, तैयार किए मृदा स्वास्थ्य कार्ड

बीज दिवस

रासायनिक खाद का न करें अंधाधुंध प्रयोग

फसल अवशेष मृदा स्वास्थ्य की रीढ़ तथा पर्यावरण बदलाव में कारगर

फसल अवशेष मृदा स्वास्थ्य की रीढ़

खबर है...

सिंचाई योग्य जल में 12% कमी की आशंका

बंद न किया जाए फार्मर फर्स्ट प्रोजेक्ट

किसान जांच करवाकर वैज्ञानिकों द्वारा की सिफारिश अनुसार खाद डालें

कृषि की नई तकनीक अपनाकर बढ़ाएं आमदनी

परिशिक्षण कैंप में किसानों को दी आधुनिक तकनीक की जानकारी

वैज्ञानिकों की सिफारिशों को किसान मानें आधार : वर्मा

केयर केसरी

जीरी की सीधी बिजाई किसानों के लिए फायदेमंद : डा. श्योराण

धान की सीधी बिजाई किसानों के लिए फायदेमंद : डा. प्रमिंद्र श्यौराण

किसानों को दिए जमीन उपजाऊ बनाने के टिप्स

नए साल से ऑनलाइन होगी खाद की बिक्री

वैस्टीन से उपचार के बाद ही लगाए नर्सरी

किसानों को सरसाद व बाढ़ के पानी के संरक्षण के बारे में दी जानकारी

उत्पादन में सहनशील प्रजातियां कारग

गेहूं की केआरएल 210 किस्म लवणीय भूमि के अनुकूल

वैज्ञानिकों ने किसानों का किया मार्गदर्शन

बेहद खतरनाक है सरसों में मरगोजा

नमी मापक यंत्र बताएगा, किसान कब करें सिंचाई

'देश में 6.73 मिलियन हेक्टेयर भूमि लवण ग्रस्त'

परिशिक्षण शिविर में किया 80 पशुओं का उपचार

कुल 140 मिलियन भूमि पर ही की जाती है कृषि: डा. सिंह

जमीन की तासीर को समझते हुए करें सुधार : डॉ. सिंह

जीरी बुवाई कार्य बोर्ड- किसान अपनाएं वैज्ञानिक तकनीक और बच्चों को सिखाएं

जिले के 5 गांवों में फार्मर फर्स्ट प्रोजेक्ट शुरू

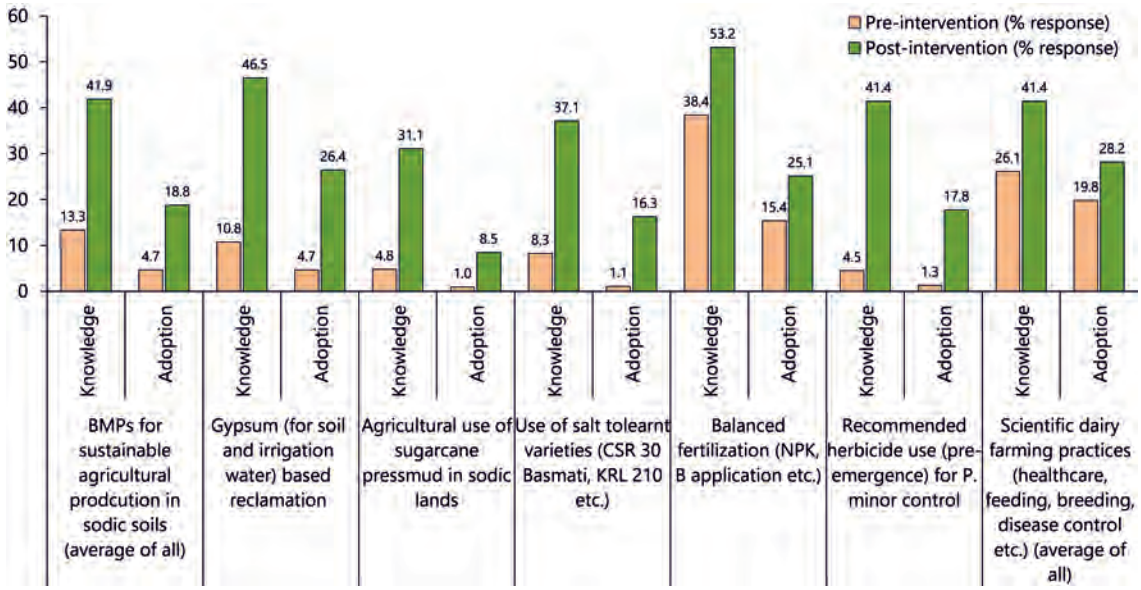
8 IMPACT ASSESSMENT

The social organizations/Institutions like village panchayats, cooperative societies, farmers groups, religious committees, self-help groups, farmers producer organizations (FPOs), banks, political gatherings etc. plays an important role in extending the social, economic and political benefits to the farmers. The participation of concerned farmers in these social organizations/institutions increased by 31% over the initial level.

Impact of project towards farmers' social participation and communication behavior.

Variables	Pre-intervention (%)	Post-intervention (%)	Per cent increase
Social participation	23.26	30.43	30.8
Mass media exposure	16.26	23.13	42.3
Extension networking	26.42	34.54	30.7

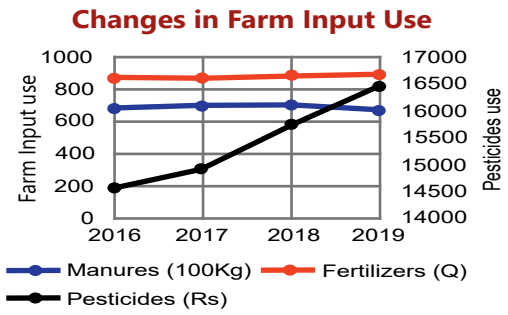
A) The impact of the project on the knowledge, skill, attitudes and adoption rate of recommended technologies by the target group.

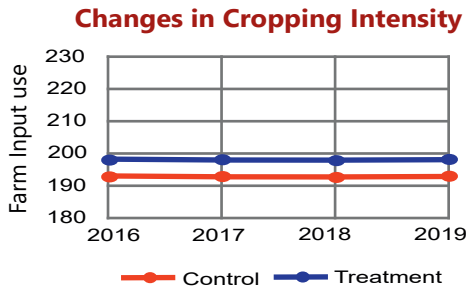


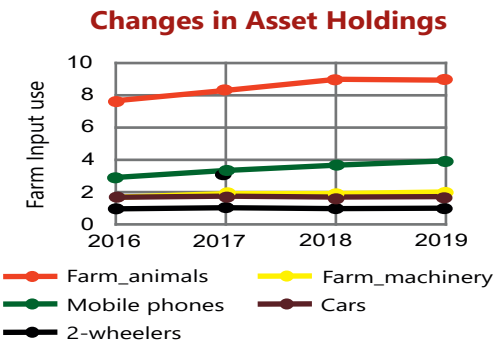
The communication behavior of farmers is an important socio-psychological profile to judge farmer's response (knowledge, attitude and practices) towards farm management. Herein also, an increase of 42% was recorded in response to mass media exposure; making them more cosmopolite to acquaint information from different sources of mass media. This will certainly help in sustaining their agricultural productivity, profitability margins and secure livelihood in stress-prone areas.

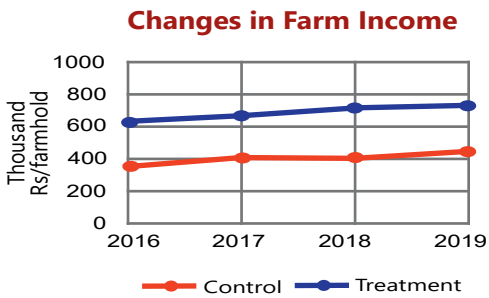
Organization of different programmes including farmers-scientists interface meetings, field days, kisan gosthies, kisan melas, travelling seminars, and regular visits of project staff, extension functionaries from District KVK and State Agricultural Departments, sugar mill personnel and people from other line departments enhanced extension networking of concerned farmers from 26% to 35% within a period of 4 years of project implementation.

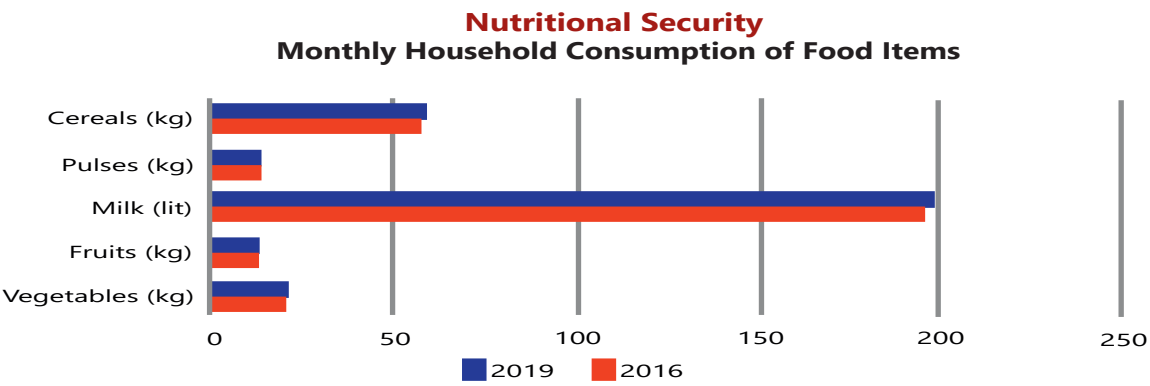
B) The impact of the project on the production, productivity, profitability and sustainability of the relevant agricultural production systems.









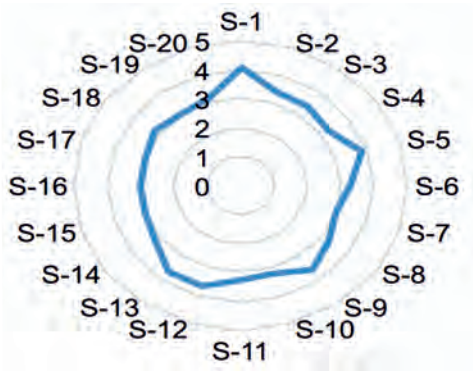


Impact of technological intervention through FFP

The effect of technological intervention through FFP was assessed using Propensity Score Matching (PSM) method.

S.No.	Indicators	D-i-D*	P>|z|
1.	Manures (t/ha)	-0.23	0.179
2.	Fertilisers (kg/ha)	17.42***	0.002
3.	Pesticides (Rs/ha)	1272.73***	0.001
4.	Milk (lit/day/animal)	0.13*	0.059
5.	Family labour (mandays/yr)	0.30	0.305
6.	Nutritional security (CEQ kg/capita/month)	0.40	0.122

Difference in difference # CEQ- Cereal Equivalent Quantity *, ** & *significance at 1%, 5% & 10%*



S-1. Increase in the income substantially
S-2. Improvement in nutrition
S-3. Reduced health hazards
S-4. Helped you to network with other farmers
S-5. Helped you to network with extension workers
S-6. Helped you to gain self-esteem/ social status
S-7. Helped in shifting to commercial crops
S-8. Helped in getting quality food
S-9. Enhanced livelihood security
S-10 Improved the education level in household
S-11 Increased spending on comforts
S-12. Increased investment on agriculture
S-13. Increased investment on other items
S-14. Increased expenditure on clothing
S-15. Drudgery reduction for rural women
S-16. Increasing employment for rural women
S-17. Income enhancement for rural women
S-18. Access to market
S-19. Diversification of farming system
S-20. Agri-preneurial ability of farmers

Comparison on selected intervention and their impact on the overall income of farmers.

Technological interventions	Net returns (Rs/ha)		Per cent increase in income
	Farmer's practice (control)	Demonstrated technology	
Groundwater recharge structure (considering 5 ha vulnerable area)	69,588	84,738	21.8
Gypsum (GR50) based management of sodic soils irrigated with high RSC waters in rice-wheat system	97,816	1,14,556	17.1
Pressmud (10 t/ha) based management of sodic soils irrigated with high RSC waters in rice-wheat system	85,545	1,05,769	23.6
Gypsum (GR50) + Pressmud (5 t/ha) based management of sodic soils irrigated with high RSC waters in rice-wheat system	93,261	1,10,907	18.9
Popularization of salt tolerant wheat variety KRL 210 in sodic agroecosystems (soil pH2<8.7)	40,327	44,839	11.2
Popularization of salt tolerant rice variety CSR 30 Basmati in sodic agroecosystems (soil pH2<8.5)	62,951	70,838	12.5
Managing reproductive sterility through boron (B) application in rice	82,477	86,314	4.7
Herbicide based weed management for the control of resistant Phalaris minor in wheat	43,526	45,185	3.8
Foliar application of potassium (K) in wheat	52,230	54,333	4.0
Amelioration of heat stress for enhancing milk production through herbal supplements	391*	428*	9.6

C) Diffusion of the technological interventions to nearby contacties

- Seeing the potential agricultural benefits of individual farm level recharge-cum-drainage structure in augmenting the groundwater and improving its quality, the nearby village panchayats have also taken the initiative to install few recharge structures.

Recharge structures improve water table of affected Kaithal villages

PARVEEN ARORA

KARNAL, NOVEMBER 6.

The water recharge structures, designed, developed and installed by the Central Soil Salinity Research Institute (CSSRI), Karnal, in villages of Kaithal district which had highly sodic water-affected soil, has helped in improving the water quality and groundwater table.

As per farmers and scientists, the groundwater table rose upto 2-3 metres beneath the structures during the period of intense rain. Besides, these structures also improved the water quality by reducing the residual sodium carbonate (RSC) in the underground aquifers from 4.5-5.5 to 3.5-4.0 milli equivalent/liter. The improvement in groundwater quality has also been observed in the surrounding areas, the scientists claimed. These structures were installed in 2016 under the CSSRI led 'Farmer Farm, Innovation, Resources, Science, and Technology' (Farmer FIRST) project.

The groundwater data indicates that the indiscriminate use of groundwater resources led to fast depletion of water table at an alarming rate of almost 1.3 metres per year during the last 10 years in the Kaithal block. Dr PC Sharma, Director, CSSRI, said the scientists of the institute — Dr Parvender Sheoran, Principal Scientist and project incharge, Dr Satyendra Kumar, Principal Scientist, along with their team of scientists — installed these six recharge structures in low lying areas of adopted villages, including Mundri, Kathwar, Sampli Kheri and Geong in Kaithal district, where nearly 40 per cent of cultivable lands were sodic and 80 per cent groundwater was of poor quality. "The low infiltration capacity of sodic soils and poor quality groundwater are the main limiting factors for sustaining crop production in these areas, so the CSSRI took this initiative and installed water recharging systems, which contributed in improving the water table and its quality," the Director said. Dr Sheoran said the field assessments at recharge structure sites (2016-20) revealed rise in groundwater table beneath the structure to the extent of 2-3 metres. Besides, the water quality also improved considerably in the surrounding areas due to dilution effects as observed by the reduction in RSC. Dr Sheoran said the installed structures were quite effective in saving the submerged crops, particularly during the period of intense rainfall.

Seeing the benefits of the recharge structures, the nearby village panchayats have also taken initiative to install a few structures at different locations. Under the 'Mera Pani Meri Virasat' scheme of the Haryana government, over 1,000 structures will also be installed across the state to save crops in low-lying areas, he added. Dr Satyendra Kumar said the total cost of the structure remains Rs 1,000-1,200/rt depending on the quality of material used and the lithology of the area. "We are thankful to the scientists of the CSSRI who chose our village under this initiative. We had to re-transplant the crops due to heavy rainfall that led to water stagnation, but now, the structure has helped us in eradicating the water stagnation problem," said Chandi Ram, a farmer.

These water recharge structures were installed in 2016 under the CSSRI-led 'Farmer farm, Innovation, Resources, Science, and Technology' (Farmer FIRST) project. FILE PHOTO

1,000 STRUCTURES TO BE INSTALLED IN STATE

- Seeing the benefits of recharge structures, the nearby village panchayats have also taken initiative to install a few structures at different locations.
- Under the 'Mera Pani Meri Virasat' scheme of the Haryana government, over 1,000 structures will also be installed across the state to save crops in low-lying areas, Dr Parvender Sheoran, Principal Scientist and project incharge said.

SODIC SOILS ONE OF THE LIMITING FACTORS

"The low infiltration capacity of sodic soils and poor quality groundwater are the main limiting factors for sustaining crop production in these areas, so the CSSRI took this initiative and installed water recharging systems. Dr PC Sharma, DIRECTOR, CSSRI

The Tribune Sun, 07 November 2021 https://epaper.tribuneindia.com/c/64195156

DEPARTMENT OF AGRICULTURE, HARYANA

Department of Agriculture and Farmers Welfare
District Kaithal, Haryana

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To Whom It May Concern

This is certified that in a participatory research work under Farmer FIRST Project, a team of scientists namely: **Drs. *Parvender Sheoran, Ranjay K. Singh, Satyendra Kumar, Arijit Barman, Kailash Prajapat, Arvind Kumar, Ashwani Kumar and PC Sharma*** from ICAR-Central Soil Salinity Research Institute, Karnal, Haryana has mobilized the farming community (2017 to 2020) and installed 6 ground water recharge structures in five adopted villages (Sampli Kheri, Mundri, Kathwar, Geong and Bhaini Majra) in Kaithal District. This initiative has shaped in establishing **Climate-cum-Ecologically Smart Villages.** The intervention could enhance Climate-cum-Ecologically Smart irrigation water in these villages in terms of mitigating the water induced sodicity stress and climate variability. The increased resilience led to rise in groundwater table beneath the structure to the extent of 2-3 meters whenever the accumulated rain water recharged the aquifers during intense rains. In addition, the water quality also improved considerably in the surrounding areas by reduction in residual sodium carbonate from 4.5-5.5 to 3.5-4.0 milli equivalent/liter. In absence of recharge structure, the rice crop was totally damaged in nearly 5 ha area (normally partial transplantation is done upto 12-15 ha) with 10-20% potential yield penalty under delayed transplanting. The tangible benefit through direct saving remains approximately Rs. 30000-35000/- in lieu of transplanting (enhanced nursery + labour cost). This participatory initiative on Climate-Cum-Ecologically Smart Village has motivated others farmers to contact State Department and installing ground water recharge structures in nearby villages also.

Deputy Director Agriculture
KAITHAL

- Taking note of the project outcome and usefulness of recharge structures, the Haryana Government has taken the initiative to install 100 recharge structures in water stressed and flood-prone areas on pilot basis. A total of 1177 farmers have so far applied for the construction of under the '*Mera Pani Meri Virasat*' scheme aimed at protecting the depleting groundwater table through crop diversification and saving crops in water stress and flood prone areas low lying areas.

Hindustan Times
https://www.hindustantimes.com › ... › chandigarh news

Haryana: Over 1100 farmers apply for construction of water ...

14 Jul 2020 — In Haryana, **1,177 farmers have so far applied for the construction of recharge shafts** under the 'Mera Pani Meri Virasat' scheme aimed at protecting the depleting groundwater table...

- Increased knowledge and awareness regarding soil and water testing in reclaiming sodic lands instigated fellow farmers to apply gypsum on the basis of inherent sodicity (soil pH) and underground water quality (RSC levels); thereby attained relatively higher yields than what they were getting while applying gypsum based on soil sodicity (pH) only.

- Enhanced seed exchange and participatory seed production of good quality seed of salt tolerant varieties significantly ensured timely availability at farmers' doorsteps improving their crop yields and rural livelihood where irrigation induced sodicity stress was the limiting crop production.
- Field applicability of sugar industry waste by-product 'pressmud' provided an affordable alternative to gypsum application (gypsum, the most popular amendment) in reclaiming the sodic soils and sustaining agricultural productivity. The farming community is really convinced with the introduction of this technology, which otherwise disposed off unsafely raising environmental concerns.

Sugar industry waste helps revive productivity of sodic soil: Experts

TRIBUNE NEWS SERVICE

KARNAL, DECEMBER 22

In a major achievement in reviving the productivity of degraded soils with the help of sugar industry waste — pressmud— scientists of the Central Soil Salinity Research Institute (CSSRI), have been successful in the trial on sodic soil in the fields of five villages in Kaithal district. The scientists used pressmud, which is considered an environmental hazard, not only revived the productivity of sodic soils, but also reduced soil sodification, claimed the scientists.

As per the scientists, gypsum is generally used by farmers for reclaiming their sodic land, but the organic waste material from sugar industries has the potential to improve the sodic land and also increase crop yield in degraded environment.

Under the Farmer FIRST project, the CSSRI scientists led by Dr Parvender Sheoran, Principal Scientist, had started trial of pressmud on sodic soil of five affected villages — Mundri, Kathwar, Sampli Kheri, Geong and Bhaini Majra in 2016, where around 40 per cent of total land was sodic and 90 per cent underground water had residual alkalinity problems. After a four-year experimentation, they have now received good results and the productivity of the sodic land has been revived, said Dr PC Sharma, Director, CSSRI.

Dr Parvender Sheoran said the field assessments of more than 125 locations in rice-wheat system revealed positive influence of pressmud in alleviating the sodicity stress with appreciable reductions in soil pH and exchangeable sodium percentage, with better plant salt tolerance and enhanced grain yields. The economic analysis indicates that pressmud seems to be an affordable solution to lessening pressure on limited gypsum reserves, Dr Sheoran added. He claimed that the technology had potential agricultural benefits and paybacks with effective reclamation of degraded lands. The farmers are also elated with this technology as it has reduced sodicity in soil significantly. "The pressmud application gives more greenness to crop and requires less urea application and also improve soil health," said Raj Kumar, a farmer.

The trial being conducted at a village in Kaithal district. FILE PHOTO

The Tribune Thu, 23 December 2021
https://epaper.tribuneindia.com/c/65132675

- 'Seeing by believing' and 'learning while doing' approach helped many farmers started using boron (soil and foliar application) in managing reproductive sterility in rice, and foliar K nutrition in rice-wheat system for sustaining crop yields where the sodicity stress is limiting crop production to a greater extent.
- Promising spill-over effects led to significant change in farmers' perception and practices towards using pre-mergence herbicides for managing resistant Phalaris minor (mandoosi, gulli danda) in wheat within the selected village as well as neighbouring farmers of surrounding villages.
- Increased awareness and realizing the potential benefits of residue incorporation for improved soil health and environmental quality, and subsequent yield advantage in system perspective helped in motivating the fellow farmers to stop rice residue burning, and opting no-till wheat seeding in anchored rice residues.
- Evidence based participatory assessments successfully motivated neighbours of the direct contacties to supplement mineral mixture and prill fat in routine diet of animals for enhancing milk production and ameliorating heat stress during summer season. in addition, farmers inclined more towards getting their animals artificially inseminated realizing better conception rate in breedable bovines and repeat breeders.

Greening the Sodic Soils

Gypsum Application

Sodic Soils

9 PROBLEMS ENCOUNTERED & SOLUTIONS FOUND

Problems encountered	Solutions found
Prolonged water stagnation drastically reduces crops productivity in low lying sodic lands.	Poor infiltration capacity of sodic soils and poor quality groundwater were the main limiting factors for sustaining crop production. The extreme rainfall events further aggravate the chances of crop failure due to prolonged water stagnation. Six recharge structures were installed in low lying and land locked areas of adopted villages. These installed structures proved quite effective in saving the submerged crops particularly during the periods of intense rains and also augmented groundwater (2-3 meter) and improved its quality (reduction in RSC) also. The tangible benefits were estimated to be Rs. 30000-35000/- as against the income loss of approximately Rs. 80,000-90000/- in absence of recharge structure. The payback period of 2-3 years with BCR of 1.25 and internal rate of return (IRR) of 19% indicated desired its economic feasibility and farmers' acceptance on investing on drainage-cum-recharge structure. Seeing the potential agricultural benefits, the nearby village panchayats have also taken initiative to install few structures. Furthermore, the State Government has taken the initiative to install 100 recharge structures under 'Mera Pani Meri Virasat' scheme for protecting the depleting groundwater table, improving water quality, and saving crops in water stress and flood prone areas low lying areas.
Farmers' poor perception towards \agricultural use of sugar industry waste 'pressmud' in sodic agro-ecosystems.	Farmers' regular visits were organized to the participatory field trials on pressmud application in rice-wheat system for experiencing the 'believing by seeing' and farmer to farmer extension (F2FE). Strong farmers-scientist interface including participation of research scientists and sugar mill personnel led to enriching the farmers' knowledge and better understanding for technology integration and application. Increased knowledge and adoption towards potential agricultural benefits and paybacks with effective reclamation of degraded soils and neutralize residual alkalinity in irrigation water strongly convinced the farming community in out-scaling its agricultural use. This location specific adaptive strategy served as an affordable alternative amendment for reviving the productivity of sodic soils, and reducing the total dependence on chemical amendment (gypsum) in land reclamation process. The concerned farmers were really convinced with the introduction of this technology, which otherwise disposed off raising disposal problems and environmental concerns.
Sodic soils ameliorated through gypsum application yields lesser crop harvest than the anticipated ones.	Mostly farmers were applying gypsum based on soil sodicity (pH basis) for reclamation purpose without giving due consideration to the poor quality nature of irrigation water. Field variability mapping revealed that continued use of bicarbonate rich water in 90% of selected area having residual alkalinity (RSC>2.5 me L-1) problems caused soil sodification further limiting crop production to the extent of 10-25%.

Problems encountered	Solutions found
	Increased awareness among farmers towards soil and water testing, preparation of soil health cards, regular interface meetings and on-site visits to the demonstration plots convinced them to apply reclamation amendments based on both soil sodicity (soil pH) and irrigation water quality (RSC levels). This approach led to potential agricultural benefits and paybacks in better managing the sodicity led stress, plant acclimatization and incremental yields compared to earlier approach of applying gypsum on soil pH basis.
Poor awareness regarding use of salt tolerant varieties and non-availability of good quality seeds.	Participatory comparison trials including the popular varieties of the area and salt tolerant varieties (rice-CSR 30 Basmati, wheat-KRL 210) at large scale were initiated to show case their potential benefits and getting sustainable yields in problematic areas. Spatial variability assessment maps for extent and distribution of sodic soil and poor quality underground water in the selected area, and defined threshold (critical) limits for sodicity tolerance (soil and irrigation water) helped farmers in selecting suitable salt tolerant varieties instead of traditional ones for getting sustainable yields in problematic areas. To provide quality seeds at the farmer doorsteps, farmers' training programmes were organized to acquaint them regarding recommended farm practices, technical know-how and maintaining quality standards for seed production. Key progressive farmers were identified and breeder seed of salt tolerant varieties was provided for multiplication and distribution among the fellow farmers for timely seed availability. Farmers were able to get quality seed either through purchase or exchange basis; which significantly promoted the usefulness of quality seed in improving the crop yields and rural livelihood.
Lack of awareness regarding soil health and balanced fertilization.	Delineation and assessment of 3247 ha area in selected villages helped in mapping the extent and distribution of soil sodicity, nutrient status and water quality. In response, a total of 375 Soil Health Cards (SHCs) were prepared, distributed and also digitized as a part of Digital platform 'Salinity Expert' so that the farmers may assess the time series change in soil fertility status in response to the management practices. Considering all, management zones were prepared by developing the soil quality index (SQI) which helped in addressing the systematic allocation and distribution of gypsum for land reclamation and balanced fertilizer scheduling while reducing environmental footprints, stabilizing crop yields and improving farm economy. Convincing farmers towards précised irrigation water (sodic) management and reclamation techniques strongly helped in devising location-specific reclamation measures, improving soil health and reconciling environmental protection with socio-economic development.
Reproductive sterility in rice in sodic agro-ecosystems.	Soil analysis revealed nutritional deficiency of boron in majority area, a possible cause of reproductive sterility in rice due to ponded poor quality (RSC) water in sodic soils. Farmers' participatory trials with soil/foliar B

Problems encountered	Solutions found
	application revealed its positive influence in managing the sterility problem and in turn, enhancing the crop yields and getting better economic returns. Field visits and the reciprocal learning of concerned farmers further helped in convincing the neighboring farmers to manage this problem and opt for B application in rice.
Poor control of notorious Phalaris minor weed infestation in wheat.	Training progarmme were organized to enhance farmers knowledge and practices and aptitude (KAP) regarding application of pre-emergence herbicides, corrective spraying techniques (timings, dose, method of application etc.), purchasing quality herbicides, rotational use of herbicides, using recommended spray volume and nozzles in enhancing the herbicide efficacy and better weed control. Realizing the farm level impact of demonstrated sequential (pre- and post-emergence) herbicide use in maintaining adequate weed control, better resource-use and profitability margins compared to traditional practice (earlier using 2-3 times higher dose), the fellow farmers also started using pre-emergence herbicides for managing the resistant P. minor in wheat curtailing farmers' dependency on post-emergence herbicides only.
Imbalance use of fertilizers.	• Synchronizing crop nutritional requirements with Leaf Colour Chart (LCC) and Nano-urea based N management. • Matching crop demand through foliar K-nutrition and Sagarika (liquid formulation) application during reproductive phase.
Farmers' ignorance and knowledge towards in-situ rice residue incorporation and soil health management, and unavailability of the desired farm implements.	• Awareness campaigns were organized to sensitize farmers regarding the ill effects of rice residue burning and importance of residue incorporation in managing the soil health. • One Super Straw Management System (SSMS) and two Happy Seeders were provided from the FFP for uniform spreading of the rice straw and direct wheat seeding in the anchored residues. • Regular visits and field days were also organized at the project sites to showcase the farm level impact of demonstrated technologies vs traditional practices.
Healthcare management, mastitis, repetitive breeding, infertility, ecto-parasites, lower milk yields in animals.	• Increased farmers' awareness and knowledge by organizing need-based capacity building programme and regular animal health camps in the selected villages helped farmers in enriching their knowledge towards animal healthcare, breeding, feeding, and related animal problems and management practices. • Supplementation of betaine and prill fat helped in ameliorating the heat stress, and enhanced animal growth and milk production. • Reproductive performance during stress period (summer months) was enhanced by feeding mineral mixture to cattle and buffaloes and using proven bull semen. • Artificial insemination by trained person and using good quality semen procured from NDRI, Karnal helped in enhancing the conception rate by 15% in dairy animals.

10 POLICY IMPLICATIONS

- Policy interventions for strengthening the participatory Strategic Research and Extension Plans (SREPs) with private and public agencies in the existing/new modules of transferring sustainable technology packages with more emphasis on demand driven technology linkage to new market access; skill enhancement among farmers; and local-level accountability of extension workers to farmers.
- Establishing impact-oriented agricultural services (governmental, private sector, NGOs etc.) for upscaling the tested technological interventions, improving access to relevant agricultural services and sustainably increasing the agricultural productivity.
- Decentralize decision-making through "bottom-up" planning procedures that would directly involve farmers in planning and implementing extension programs at the village, block and district-levels.
- Specific policy implications for sustainable rehabilitation of degraded lands, improving soil health and reconciling environmental protection addressing location-specific optimal resource use with socio-economic development of distressed farming community and eventually achieving the UN-SDGs of land degradation neutrality, food security and environmental protection.
- Groundwater Policy and Regulatory Mechanism for optimal groundwater management, rainwater harvesting and water recharge for future groundwater development.
- Formulating agricultural policies prioritizing the agricultural use of sugarcane 'pressmud' in sustainably managing the irrigation induced sodicity stress with enhanced ecological resilience, addressing the competing issues of shrinking gypsum availability and quality concerns, pressmud disposal problems and associated environmental hazards.

11 PUBLICATIONS

A) Research papers: 14

1. Sheoran, P., Kamboj, P., Kumar, A., Kumar, A., Singh, R.K., Barman, A., Prajapat, K., Mandal, S., Yousuf, D.J., Narjary, B. and Kumar, S. 2023. Matching N supply for yield maximization in salt–affected wheat agri–food systems: On-farm participatory assessment and validation. Science of The Total Environment, 875, 162573. https://doi.org/10.1016/ j.scitotenv. 2023.162573 (NAAS Rating: 14.20)
2. Sheoran, P., Sharma, R., Kumar, A., Singh, R.K., Barman, A., Prajapat, K. Kumar, S. and Sharma, P.C. 2022. Climate resilient integrated soil–crop management (CRISCM) for salt affected wheat agri–food production systems, Science of The Total Environment, 837, 155843. https://doi.org/10.1016/ j.scitotenv.2022.155843 (NAAS Rating: 14.20)
3. Basak, N., Sheoran, P., Sharma, R., Yadav, R.K. Singh, R.K., Kumar, S., Krishnamurthy, T. and Sharma, P.C. 2021. Gypsum and pressmud amelioration improve soil organic carbon storage and stability in sodic agroecosystems. Land Degradation and Development, 32(15): 4430-4444. https://doi.org/10.1002/ ldr.4047 (NAAS Rating: 9.60)
4. Sheoran, P., Kumar, A., Sharma, R., Barman, A., Parjapat, K., Singh, R. K., Kumar, S., Sharma, P.C., Ismail, A.M., Singh, R.K. 2021. Managing sodic soils for better productivity and farmers' income by integrating use of salt tolerant rice varieties and matching agronomic practices. *Field Crops Research,* 270, 108192. https://doi.org/10.1016/j.fcr.2021. 108192 (NAAS Rating: 11.60)
5. Sheoran P., Kumar A., Singh A., Kumar A., Parjapat K., Sharma R., Singh R.K., Yadav R.K., Dang, Y.P. and Sharma P.C. 2021. Pressmud alleviates soil sodicity stress in a rice-wheat rotation: Effects on soil properties, physiological adaptation and yield-related traits. *Land Degradation and Development*, https://doi.org/10.1002/ldr.3953. (NAAS Rating: 9.60)
6. Barman, A., Sheoran, P., Yadav, R. K., Abhishek, R., Sharma, R., Prajapat, K., Singh, R.K. and Kumar, S. 2021. Soil spatial variability characterization: Delineating index-based management zones in salt-affected agroecosystem of India. *Journal of Environmental Management*, 296, 113243. https://doi.org/10.1016/j.jenvman. 2021.113243. (NAAS Rating: 14.0)
7. Sheoran P., Kumar A., Sharma R., Prajapat K., Kumar A., Barman A., Raju R., Kumar S., Dar, Y.J., Singh R.K., Sanwal S.K., Yadav R.K., Chahal V.P., and Sharma P.C. 2021. Quantitative Dissection of Salt Tolerance for Sustainable Wheat Production in Sodic Agro-Ecosystems through Farmers' Participatory Approach: An Indian Experience. *Sustainability,* 13(6):3378. https://doi.org/10.3390/su13063378. (NAAS Rating: 9.30)
8. Sheoran P., Basak N., Kumar A., Yadav R. K., Singh R., Sharma R., Kumar, S., Singh, R. K. and Sharma P. C. 2021. Ameliorants and salt tolerant varieties improve rice-wheat production in soils undergoing sodification with alkali water irrigation in Indo-Gangetic Plains of India. *Agricultural Water Management*, 243, 106492. https://doi.org/10.1016 /j.agwat. 2020.106492. (NAAS Rating: 11.9)
9. Sheoran, P., Kumar, A., Kumar, A., Raju, R., Sharma, R., Parjapat, K., Barman, A., Singh, R.K., Kumar, S., Sharma, P. C/ and Singh. A.K. 2020. Impact of pressmud application in reclamation of highRSC irrigation water induced soil sodification and sustaining rice (*Oryza sativa*)-wheat (*Triticum aestivum*) production in Indo-Gangetic Plains. *Indian Journal of Agricultural Sciences*, 90(1): 206-211. (NAAS Rating: 6.3)

10. Kumar, S., Raju, R., Sheoran, P., Sharma, R., Yadav, R.K., Singh, R.K., Sharma, P.C. and Chahal, V.P. 2020. Techno-economic evaluation of recharge structure as localized drainage option for sustainable crop production in sodic agro-ecosystems Plains. *Indian Journal of Agricultural Sciences*, 90(1): 212-219. (NAAS Rating: 6.3)
11. Yallappa M.S., Singh, S.V. Deshpande, A., Sheoran, P. and Chahal, V.P. 2020. Physiological responses, energy metabolites and prolactin levels of buffaloes supplemented with dietary astaxanthin, prill fat and their combination during heat stress. *Indian Journal of Animal Sciences*, 90(1): 55-60. (NAAS Rating: 6.3)
12. Deshpande, A., Singh, S.V., Somagond, Y.M., Sheoran, P., Naskar, S., and Chahal, V.P. 2020. Physio-biochemical responses and growth performance of buffalo heifers to betaine supplementation during hot humid season under field conditions. *Indian Journal of Animal Sciences*, 90(3): 416-423. (NAAS Rating: 6.3)
13. Yallappa M.S., S.V. Singh Deshpande, A., Sheoran, P., Naskar, S., and Chahal, V.P. 2021. Effect of dietary supplementation of astxanthin, prill fat and their combination on antioxidants and immunity status of lactating buffaloes during heat stress. *Buffalo Bulletin*, 40 (3): 451-463. https://kuojs.lib.ku.ac.th/index.php BufBu/article/view/3720. (NAAS Rating: 6.20)
14. Sheoran, P., R.K. Singh, R.K. Yadav, S. Kumar, S.K. Sanwal, A. Kumar, A. Barman, R. Raju, K. Ponnuswamy, S. Singh, A. Singhand P.C. Sharma. 2018. Salinity Expert: Mobile Enabled Decision Support System for Sodic Agroecosystems. *Journal of Soil Salinity and Water Quality*, 10(2): 289-291. (NAAS Rating: 5.03)

B) Papers presented in Seminars/Conferences/Symposia etc.: 14

1. Barman, A., Sheoran, P., Kumar, S., Singh, R.K. and Tripathi, L.K. 2017. Characterization and mapping of groundwater in salt affected agroecosystems of Ghaghar plains. In: 82nd Annual Convention of The Indian Society of Soil Science held at Amity University, Kolkata, India during December 11-14, 2017. pp. 8 (oral presentation).
2. P Sheoran, A Kumar, SK Sanwal, K Parjapat, R Raju, A Barman, S Kumar, RK Singh, RK Yadav and PC Sharma. 2019. Dissection of salt tolerance in wheat: Mainstreaming soil sodicity and residual alkalinity in irrigation water for agricultural sustainability. In: Proceedings of 4th International Group Meeting on "Wheat Productivity Enhancement through Climate Smart Practices" held at CSKHPKV Palampur during 14-16 February 2019. pp. 81 (oral presentation).
3. P Sheoran, N Basak, RK Yadav, R Singh, S Kumar, RK Singh and K Thimmappa. 2019. Quantifying yield response and management strategies to continuous use of sodic irrigation in rice-wheat production system. In: Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities" held at ICAR-CSSRI, Karnal during February 7-9, 2019. pp. 82-83 (oral presentation).
4. P Sheoran, R Sharma, K Parjapat, A Kumar, R. Raju, R K Singh and P C. Sharma. 2019. Efficacy of pressmud amelioration in reclamation of sodic soils: From waste to wealth. In: Golden Jubilee International Conference on "New Millennia Agriculture: Novel Trends and Future Scenario (GINMA-2019)" held at CCSHAU, Hisar during November 6-8, 2019. pp. 119-120 (oral presentation)..
5. A Barman, P Sheoran, RK Yadav, RK Singh and VP Chahal. 2019. Spatial variability assessment of salt affected soils in Ghaghar Plain of Haryana. In: Abstract Book of Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities" held at ICAR-CSSRI, Karnal during February 7-9, 2019. pp. 25-26.

6. S Kumar, R Raju, P Sheoran, RK Singh, RK Yadav and VP Chahal. 2019. A localized drainage option to avoid crop submergence in sodic environment under climate change scenario. In: Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities" held at ICAR-CSSRI, Karnal during February 7-9, 2019. pp. 191.
7. K Ponnusamy, S Singh, R Chakravarty and P Sheoran. 2019. Building resilience of dairy farmers in saline environment under extreme climatic conditions. In: Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities" held at ICAR-CSSRI, Karnal during February 7-9, 2019. pp. 202-203.
8. Yallappa MS, SV Singh, A Deshpande and P Sheoran. 2019. Effect of supplementation of astaxanthin, prill fat and their combination on physiological parameters, milk yield, composition and thermal imaging of lactating buffaloes during heat stress under saline affected villages. In: Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities" held at ICAR-CSSRI, Karnal during February 7-9, 2019. pp. 211.
9. S V Singh, A Deshpande, MS Yallappa, and P Sheoran. 2019. Enhancement of reproductive performance during heat stress using proven bull semen and supplanting mineral mixture to cattle and buffaloes in salt affected villages under Farmer FIRST Programme. In: Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities" held at ICAR-CSSRI, Karnal during February 7-9, 2019. pp. 229.
10. A Despande, S V Singh, Yallappa, M S, P Sheoran, S Naskar and V P Chahal. 2019. Effect of betaine supplementation on stress biomarkars and growth performance of buffalo heifers during hot humid season under field conditions. Paper presented during "2nd Annual meeting of APA & National Conference on Issue and Strategies for Physiological Capacity Building in Animals" held at SVVU, Tirupati from October14-15, 2019. pp.159.
11. Yallappa, M S, S V Singh, A Despande, P Sheoran and V P Chahal. 2019. Effect of dietary supplementation of astaxanthin and prill fat to lactating buffaloes for amelioration and sustained productivity during heat stress. Paper presented during "2nd Annual meeting of APA & National Conference on Issue and Strategies for Physiological Capacity Building in Animals" held at SVVU, Tirupati from October14-15, 2019. pp.164.
12. Yallappa, M S, S V Singh, A Despande, P Sheoran and V P Chahal. 2020. Physiological responses, energy metabolites and prolactin levels of buffaloes with dietary astaxanthin, prill fat and their combination during heat stress. Presented during National Seminar on "Agrometeorological interventions for enhancing farmers' income" (AGMET-2020) Organized by Association of Agrometeorologists, Anand & KAU, Thrissur, Kerala from 20-22 January, 2020. pp. 287 (oral presentation).
13. A Despande, S V Singh, Yallappa M S and P Sheoran. 2020. Effect of betaine supplementation on physiological responses, hormonal levels and growth performance in buffalo heifers (Bubalis bubalis) during hot humid season under field condition. In: Souvenir of 48th Dairy Industry Conference-Dairying for Health and Wealth" at B.M. Birla Auditorium, Jaipur from 18-19 February, 2020. pp. 212.
14. Yallappa, M S, S V Singh, A Despande, P Sheoran and V P Chahal. 2020. Infrared thermography: A potential non- invasive tool for maping of surface temperature of buffaloes during summer season. Presented during "Approaches for enhancing the productivity and health of dairy animals" In: Souvenir of 48th Dairy Industry Conference-Dairying for Health and Wealth" at B.M. Birla Auditorium, Jaipur from 18-19 February, 2020. pp. 217-218.

III. Success stories: 7

1. Parvender Sheoran, R. Raju, Kailash Parjapat, Arvind Kumar, Arijit Barman, P C Sharma and V P Chahal. 2019. Pressmud a potential ameliorant for greening the sodic lands. Indian Farming, 69(05): 18-20.
2. Parvender Sheoran, Arijit Barman, Ranjay K Singh, R K Yadav and P C Sharma. 2019. Waste to wealth- Pressmud as potential ameliorant for sodic soils. In: Singh RK, Singh A and Sharma PC (eds.), Successful Adaptations in Salt Affected Agroecosystems of India. ICAR-Central Soil Salinity Research Institute, Karnal, Haryana, India, pp. 20-23.
3. Satyenda Kumar, Parvender Sheoran, Ranjay K Singh, Kailash Parjapat, R K Yadav and P C Sharma. 2019. Rain water harvesting through drainage-cum-recharge structure for managing water stagnation. In: Singh RK, Singh A and Sharma PC (eds.), Successful Adaptations in Salt Affected Agroecosystems of India. ICAR-Central Soil Salinity Research Institute, Karnal, Haryana, India, pp. 115-116.
4. Parvender Sheoran, Arvind Kumar, Raman Sharma, Mansukh Singh, Kailash Parjapat, Ranjay K. Singh, P C Sharma and V P Chahal. 2020. Better resilience of wheat variety KRL 210: a boom for salt affected ecologies. Indian Farming, 70(12): 8-9.
5. Raman Sharma, Kailash Parjapat, Parvender Sheoran, S K Sanwal, P C Sharma and V P Chahal. 2020. Vegetable based diversified farming enhanced farm profitability under sodic environments: A success story. Indian Farming, 70(12): 40-42.
6. Success story on "Spatial variability assessment of soil and water quality and soil fertility status in salt affected areas" published in DARE Report 2018-19 (Page No. 135).
7. Success story on "Managing localilized water stagnation and improving ground water quality by harvestiong excess rain water" published at ICAR Website and DARE Report 2018-19 (Page No. 136).

IV. Training manuals: 5

1. प्रवेन्द्र श्योराण, अरविंद कुमार, सत्येन्द्र कुमार, रंजय कुमार सिंह, सतीश कुमार सनवाल एवं प्रबोध चन्द्र शर्मा. 2016. लवणग्रस्त मृदाओं में टिकाऊ कृषि प्रबन्धन : समस्याएं एवं समाधान, प्रशिक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 157.
2. के. पोन्नुसामी, प्रवेन्द्र श्योराण, नईम अली, लक्ष्मीकांत त्रिपाठी, रंजय कुमार सिंह एवं प्रबोध चन्द्र शर्मा. 2016. डेरी उत्पादन में वैज्ञानिक तौर तरीकों का समावेश. प्रशिक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 47.
3. प्रवेन्द्र श्योराण, आर. राजू, नवीन कुमार, रमेश वर्मा, रंजय कुमार सिंह एवं प्रबोध चन्द्र शर्मा. 2017. फसल उत्पादन में छिड़काव तकनीक का महत्व, प्रशिक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001. पृष्ठ 70.
4. राजू आर., कैलाश प्रजापत, प्रवेन्द्र श्योराण, नवीन कुमार, रंजय कुमार सिंह, अनिल कुमार एवं प्रबोध चन्द्र शर्मा. 2018. कृषि उत्पादों के विपणन हेतु किसानों का कौशल विकास प्रशिक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, 26–28 फरवरी 2018. पृष्ठ 83.

5. प्रवेन्द्र श्योराण, कैलाश प्रजापत, अश्वनी कुमार, अनीता मान, नवीन कुमार एवं प्रबोध चन्द्र शर्मा. 2018. कृषि आय दोगुना करने हेतु उन्नत बीज उत्पादन एवं फसल सघनीकरण की तकनीकियाँ, प्रशिक्षण मैनुअल, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, 21–22 जून 2018. पृष्ठ 49.

6. के. पोन्नुसामी, एस. एस. लठवाल, नईम अली, नवीन कुमार एवं प्रवेन्द्र श्योराण. 2017. थनेला रोगः लक्षण एवं उपचार. तकनीकी फोल्डर, केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001.

V. Book: 1

1. सोहनवीर सिंह एवं प्रवेन्द्र श्योराण. 2020. सतत् पशु उत्पादन हेतु पशुपालकों के लिए उपयोगी जानकारियाँ. भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान एवं केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 104.

VI. Extension Bulletin/Folder/leaflets: 9

1. कैलाश प्रजापत, प्रवेन्द्र श्योराण एवं प्रबोध चन्द्र शर्मा 2019. फसलों में पोषक तत्वों की कमी एवं प्रबधंन मागर्दशिका। प्रसार बुलेटिनः भाकअृनपु–केमृलअनुस / 2019 / 03. पृष्ठ 28.

2. बाबू लाल मीणा, प्रवेन्द्र श्योराण, मुरलीधर मीणा, एम. जे. कलेढोणकर, रंजय कुमार सिंह एवं प्रबोध चन्द्र शर्मा. 2017. मिट्टी परीक्षण हेतु नमूने लेने की विधि. तकनीकी फोल्डर, भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 6.

3. सोहनवीर सिंह, गौरव कुमार, निकिता भालकिया, अपेक्षा उके एवं प्रवेन्द्र श्योराण. 2021. ग्रीष्म ऋतु में भैंसो का प्रबंधन. तकनीकी फोल्डर, भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान एवं केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 6.

4. सोहनवीर सिंह, गौरव कुमार एवं प्रवेन्द्र श्योराण. 2021. मौसम पूर्वानुमान आधारित पशुपालन. तकनीकी फोल्डर, भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान एवं केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001, पृष्ठ 6.

5. के. पोन्नुसामी, एस. एस. लठवाल, नईम अली, नवीन कुमार एवं प्रवेन्द्र श्योराण. 2017. दुधारू पशुओं के लिए संतुलित आहार. तकनीकी फोल्डर, केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001.

6. के. पोन्नुसामी, एस. एस. लठवाल, नईम अली, नवीन कुमार एवं प्रवेन्द्र श्योराण. 2017. डेरी पशुओं की सामान्य बीमारियाँ. तकनीकी फोल्डर, केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001.

7. के. पोन्नुसामी, एस. एस. लठवाल, नईम अली, नवीन कुमार एवं प्रवेन्द्र श्योराण. 2017. पशुओं में नस्ल सुधार हेतु कृत्रिम गर्भाधान को अपनाए. तकनीकी फोल्डर, केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल–132001.

VII. Radio Talks: 2

Category	Title	Date	Broadcaster
Radio Talk	Crop Production in Salt Affected Soils	Jan 12, 2019	AIR, Rohtak
Radio Talk	Importance of Soil and Water Testing	Apr 9, 2019	AIR, Rohtak

सुस्वागतम
स्वर्ण जयंती किसान
मार्च, 2018

सुस्वागतम
स्वर्ण जयंती किसान मेला

94वां भा.कृ.अ.प.
स्थापना दिवस एवं
पुरस्कार वितरण समारोह
94th ICAR

12 AWARDS & RECOGNITIONS

1. Swami Sahajanand Saraswati Outstanding Extension Scientist Award 2021, National Award for Application of Agricultural Technologies to Dr. Parvender Sheoran, presented by Indian Council of Agricultural Research, New Delhi.
2. Best poster presentation award for the paper entitled "Sustainable rehabilitation, bridging yield gaps and increasing farmers' income in salt affected rice-wheat agroecosystems: A farmers' participatory assessment" authored by Parvender Sheoran, Raman Sharma, Arvind Kumar, Ranjay K. Singh, Arijit Barman, Kailash Parjapat, R. Raju, Yousuf Jaffer Dar and Satyendra Kumar during the Global Symposium on Salt Affected Soils-GSAS21 organized by Food and Agricultural Organization (FAO) of the United States during October 20-22, 2021.
3. Best oral presentation award for the paper entitled "Physiological responses, energy metabolites and prolactin levels of buffaloes with dietary astaxanthin, prill fat and their combination during heat stress" authored by Yallappa, M.S., S.V. Singh, Aditya Despande, Parvender Sheoran and V.P. Chahal during National Seminar on "Agro-meteorological interventions for enhancing farmers' income" (AGMET-2020) organized by Association of Agro-meteorologists, Anand & KAU, Thrissur, Kerala from 20-22 January, 2020.
4. Best poster presentation award for the paper entitled "Effect of dietary supplementation of astaxanthin and prill fat to lactating buffaloes for amelioration and sustained productivity during heat stress" authored by Yallappa, M.S., S.V. Singh, Aditya Despande, Parvender Sheoran, and V.P. Chahal. 2019. presented during "2nd Annual meeting of APA & National Conference on Issue and Strategies for Physiological Capacity Building in Animals" held at SVVU, Tirupati from October 14-15, 2019.
5. Best poster presentation award for the paper entitled "Infrared thermography: A potential non- invasive tool for maping of surface temperature of buffaloes during summer season" authored by Yallappa, M.S., S.V. Singh, Aditya Despande, Parvender Sheoran and V.P. Chahal during the 48th Dairy Industry Conference on Dairying for Health and Wealth" held at B.M. Birla Auditorium, Jaipur from 18-19 February, 2020. pp. 17-18.
6. Best Thesis award to Yallappa M. Somagond by Animal Physiologists Association in recognition of accomplishment of his Ph.D. research work "Effect of astaxanthin and prill fat supplementation on the energy metabolites, stress markers and milk production in rural buffaloes during summer season" during "2nd Annual meeting of APA & National Conference held at SVVU, Tirupati from October14-15, 2019.
7. Innovative Farmer Award to Shri Chandi Ram, village Kathwar, Distt. Kaithal by Secretary DARE and DG, ICAR at NAARM, Hyderabad.
8. Farmer's Awards to Shri Rajkumar (Mundri), Shri Pyare Lal (Kathwar) and Shri Charan Singh (Sampli Kheri) in recognition of dissemination of CSSRI technologies to stakeholders.
9. Five farmers form CSSRI led Farmer FIRST project participated in Workshop on 'Doubling Farmers Income by 2022' at NAARM, Hyderabad.

10. Coordinated two Field Experience Training (FET) Programme for ARS Scientists Probationers from NAARM, Hyderabad in the Farmer FIRST adopted villages.
    - 101st FOCARS in Farmer FIRST village Mundri (Kaithal) from Feb 19-Mar 11, 2015.
    - 110th FOCARS in Farmer FIRST village Kathwar (Kaithal) from Feb 25-Mar16, 2020.

11. Project outcome in terms of research work undertaken in Farmer FIRST project
    Three students (one Ph.D. and two M.Sc.) have completed their degree programme by submitting their dissertation/thesis based on research work undertaken as a part of Farmer FIRST project. One more Ph.D. student in animal science is pursuing his research work at the project site.

EFFECT OF ASTAXANTHIN AND PRILL FAT SUPPLEMENTATION ON ENERGY METABOLITES, STRESS MARKERS AND MILK PRODUCTION IN RURAL BUFFALOES DURING SUMMER SEASON

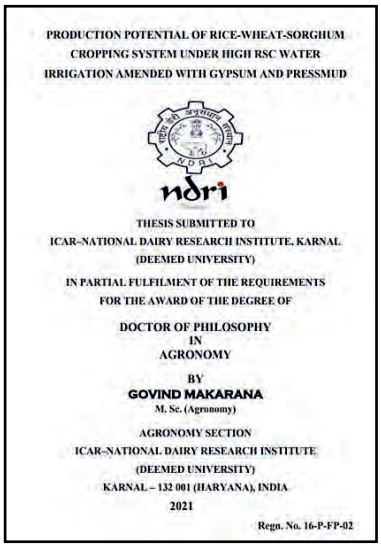
ndri

THESIS SUBMITTED TO THE
ICAR-NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

MASTER OF VETERINARY SCIENCE
IN
ANIMAL PHYSIOLOGY
BY
Dr. YALLAPPA MALLAPPA SOMAGOND
(B.V.Sc. & A.H.)

ANIMAL PHYSIOLOGY DIVISION
ICAR-NATIONAL DAIRY RESEARCH INSTITUTE
(DEEMED UNIVERSITY)
KARNAL-132001 (HARYANA), INDIA

2019


PRODUCTION POTENTIAL OF RICE-WHEAT-SORGHUM CROPPING SYSTEM UNDER HIGH RSC WATER IRRIGATION AMENDED WITH GYPSUM AND PRESSMUD

ndri

THESIS SUBMITTED TO
ICAR–NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY
IN
AGRONOMY
BY
GOVIND MAKARANA
M. Sc. (Agronomy)

AGRONOMY SECTION
ICAR–NATIONAL DAIRY RESEARCH INSTITUTE
(DEEMED UNIVERSITY)
KARNAL – 132 001 (HARYANA), INDIA
2021

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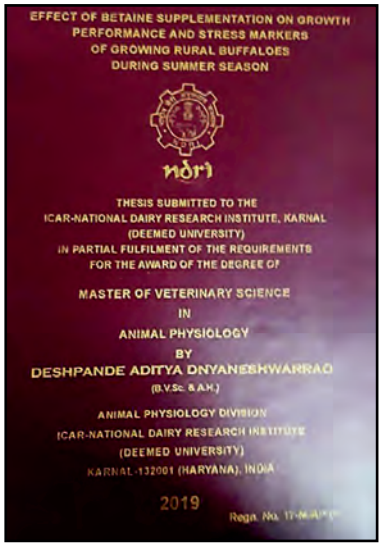
EFFECT OF BETAINE SUPPLEMENTATION ON GROWTH PERFORMANCE AND STRESS MARKERS OF GROWING RURAL BUFFALOES DURING SUMMER SEASON

ndri

THESIS SUBMITTED TO THE
ICAR-NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

MASTER OF VETERINARY SCIENCE
IN
ANIMAL PHYSIOLOGY
BY
DESHPANDE ADITYA DNYANESHWARRAO
(B.V.Sc. & A.H.)

ANIMAL PHYSIOLOGY DIVISION
ICAR-NATIONAL DAIRY RESEARCH INSTITUTE
(DEEMED UNIVERSITY)
KARNAL-132001 (HARYANA), INDIA

2019

13 TECHNOLOGIES CERTIFIED BY ICAR

The project outcomes in terms of 5 technologies has been duly certified by ICAR, New Delhi. The details are as under:

Technology ID	Title	Developer(s)	Proof
ICAR-NRM-CSSRI-Technology-2024-023	Conjuctrive use of gypsum and press-mud: Low cost eco-resilient strategy for mitigating irrigation induced sodicity hazards and sustaining farm productivity	Lead Developer: Parvender Sheoran Associate Developer: R.K. Yadav, N. Basak, Satyendra Kumar, K. Thimmappa, Ranjay K. Singh, Ashwani Kumar, Arvind Kumar, Arijit Barman, Kailsah Parjapat, P.C. Sharma	
ICAR-AEXT-CSSRI-Product-2024-077	Salinity expert: mobile enabled decision support system for sodic agro-ecosystems	Lead Developer: Parvender Sheoran Associate Developer: Ranjay K. Singh, R.R. Yadav, Satyendra Kumar, S.K. Sanwal, Arvind Kumar, Arijit Barman, R.Raju, K. Ponnuswamy, Sohanvir Singh, Anshuman Singh, P.C. Sharma	
ICAR-NRM-CSSRI-Technology-2023-058	Sodicity tolerance limit based management for sustainable wheat production	Lead Developer: Parvender Sheoran Associate Developer: Arvind Kumar, R.K. Yadav, Satyendra Kumar, R.Raju, Arijit Barman, R.K. Singh, S.K. Sanwal, Kailash Prajapat, Ashwani Kumar, Y. J. Dar, P.C. Sharma	

Technology ID	Title	Developers	
ICAR-NRM-CSSRI-Methodology-2024-024	Index-based zoning for location specific management of salt-affected soils	Lead Developer: Arijit Barman Associate Developer: Parvender Sheoran, R.K. Yadav, R.K. Singh, Satyendra Kumar, Kailash Prajapat, Arvind Kumar, Ashwani Kumar, S.K. Sanwal, R.Raju, Yousuf Jaffer Dar	 INDIAN COUNCIL OF AGRICULTURAL RESEARCH Certified that Arijit Barman (Lead Developer) Associate Developers Parvender Sheoran, R.K. Yadav R.K. Singh, Satyendra Kumar Kailash Parjapat, Arvind Kumar Ashwani Kumar, S.K. Sanwal R. Raju, Yousuf Jaffer Dar of ICAR-CSSRI, Karnal has developed the technology Index-based zoning for location specific management of salt-affected soils
ICAR-AEXT-NAARM-Model-2024-083	Impactful model for farmer FIRST progrmme implementation	Lead Developer: Ashok Kumar Singh Associate Developer: Udham Singh Gautam, Ved Parkash Chahal, Rajarshi Roy Burman, P. Venkatesan, N. Sivaramane, Ch. Srinivasa Rao, Rajbir Singh, S.K. Singh, S.S. Singh, Y.G. Prasad, M.J. Chandre Gowda, Lakhan Singh, Anupam Mishra, A.K. Tripathi, B.C. Deka, Venkatasubramanian Anjani Kumar, J.P. Mishra, Shantanu Kumar Dubey, S.R.K. Singh, S.K. Roy, Saik N. Meera, K. Govindaswamy, Parvender Sheoran, Amulya Kumar Mohanty, Pradip Kumar Dey, Shiv Kumar, Mukesh Kumar, Mitali Ghosh Ray, Bommu Kalyani, Arvind Kumar, P.P. Rohilla, A.R. Reddy, K.S. Das, Arun Kumar Singha, Pragya Bhadauria, D.V. Kolekar, Rajesh T., Harish M.N., Bagish Kumar	 INDIAN COUNCIL OF AGRICULTURAL RESEARCH Certified that Ashok Kumar Singh (Lead Developer) Associate Developers Udham Singh Gautam, Ved Parkash Chahal, Rajarshi Roy Burman P. Venkatesan, N Sivaramane, Ch. Srinivasa Rao, Rajbir Singh, S.K. Singh S.S. Singh, Y.G. Prasad, M.J. Chandre Gowda, Lakhan Singh Anupam Mishra, A.K. Tripathi, B.C. Deka, Venkatasubramanian Anjani Kumar, J.P Mishra, Shantanu Kumar Dubey, S.R.K. Singh S.K. Roy, Shaik N. Meera, K. Govindasamy, Parvendar Sheoran Amulya Kumar Mohanty, Pradip Kumar Dey, Shiv Kumar, Mukesh Kumar Mitali Ghosh Ray, Bommu Kalyani, Arvind Kumar, P.P. Rohilla, A.R. Reddy K.S. Das, Arun Kumar Singha, Pragya Bhadauria D.V. Kolekar, Rajesh T, Harish M.N., Bagish Kumar of ICAR-National Academy of Agricultural Research Management (NAARM), Rajendranagar, Hyderabad has developed the technology Impactful model for farmer FIRST programme implementation

DIGNITARIES VISIT

DIGNITARIES VISIT

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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