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Reorientation of All India Coordinated Crop Improvement Projects:
The Case of Rice

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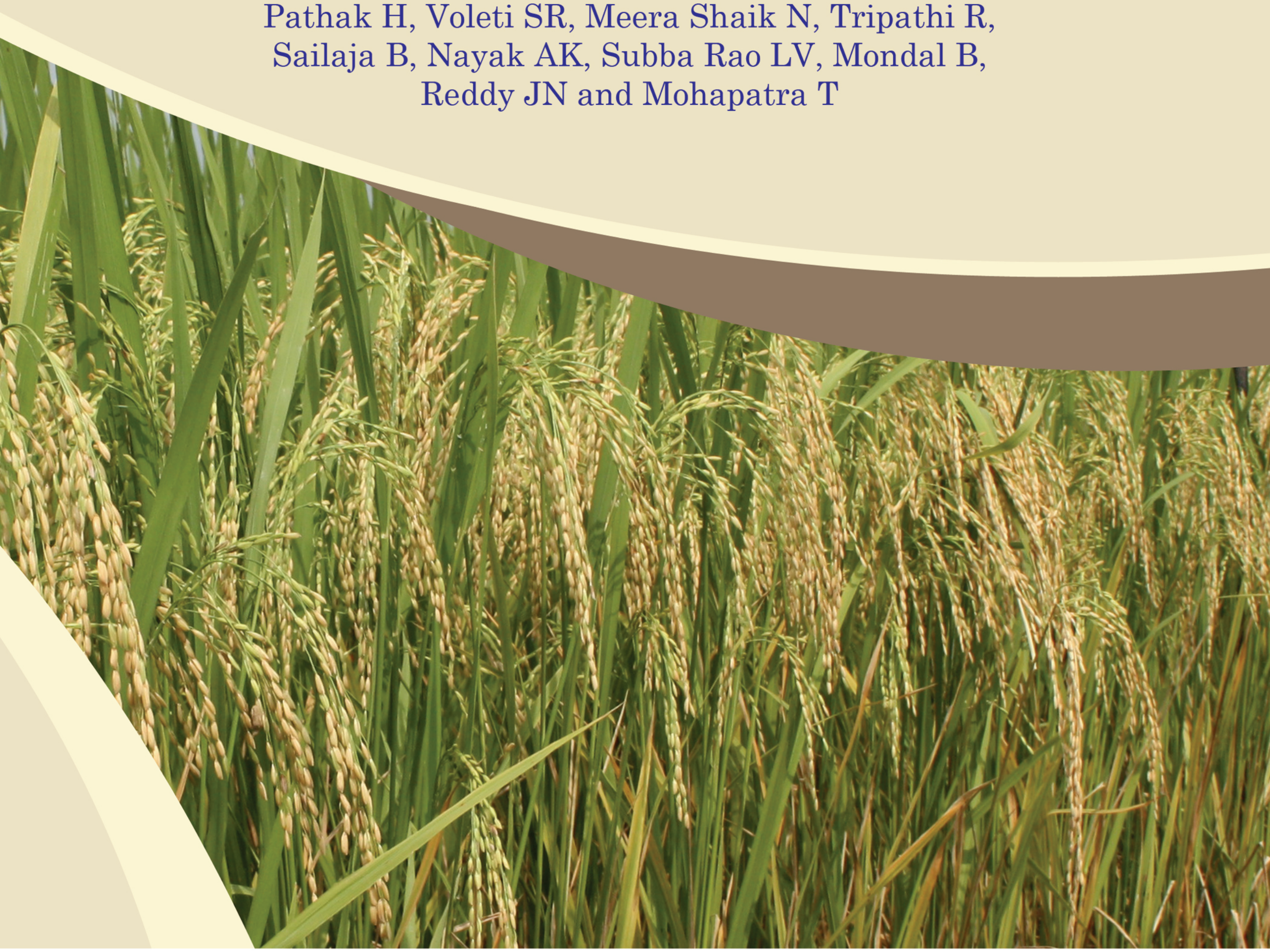

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सचिव एवं महानिदेशक

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FOREWORD

Rice, the most widely grown and consumed cereal crop, is the lifeline for more than half of the world's population. It is the staple food for more than 65% of Indian population contributing approximately 40% to the total food grain production, occupying a pivotal role in the food, nutrition and livelihood security of people. It is extensively cultivated in diverse agroclimatic zones. Average productivity of rice in the country, however, is low because of the limitations imposed by the ecosystem complexities, poor management practices, diverse insect pest and disease problems.

To address these challenges, Indian Council of Agricultural Research (ICAR) initiated All India Coordinated Rice Improvement Project (AICRIP) in 1965 for increasing the productivity and sustainability of rice. The AICRIP has contributed significantly towards India's food security over the years. Currently there are 45 funded centres and more than 100 voluntary centres of AICRIP all over the country.

The transformation of the rice sector is startling, with India becoming the largest rice exporter in the world. Yet there are challenges like multiple risks from uncertain climate, degraded soil, water shortage, underdeveloped markets, labour shortage, increasing cost of cultivation, declining profit margin and greater demand for reduced environmental footprint. For improving food, nutrition and income security of rice farmers while addressing environmental sustainability and coping with climate change, rice research and development need a reorientation.

Reorientation of the AICRIP in terms of relocating the centres and improving their mandate and mode of functioning will be, among many others, a positive step forward to strengthen the rice research and development in the country.

The bulletin on "Reorientation of All India Coordinated Crop Improvement Projects: The Case of Rice" is an attempt to provide a comprehensive scientific methodology for reorienting the AICRIP on rice. It will help improving the efficiency of the AICRIP and eventually reorienting the All India Coordinated Crop Improvement Projects of other crops in the country.

I appreciate the efforts made by the authors in bringing out this bulletin and hope that the researchers, planners and other stakeholders will find this publication useful.

(T. Mohapatra)

PREFACE

Rice is the staple food for about half of the world population. Grown for more than 6000 years, it is economically, socially, and culturally important for most of the Asian countries. Globally, it provides 27% of dietary energy, 20% of dietary protein and 3% of dietary fat. In India, rice is staple food for more than 65% of Indian population, playing a major role in food, economy and employment. However, rice farming faces multiple risks from uncertain climate, degraded soil, water shortage, prone to the attack of weeds, several insect pests and diseases leading to low average productivity.

Systematic rice improvement efforts in India started in early years of 20th century and Central Rice Research Institute (CRRI) at Cuttack, Odisha was established in 1946. To solve the problems such as tall plant stature, lodging, photoperiod sensitivity, late maturity, narrow adaptability, and non-responsiveness to fertilizers led to the formation of a nation-wide cooperation and was a prelude to the establishment of All India Coordinated Rice Improvement Project (AICRIP) in 1965.

The AICRIP has contributed in development and release of rice varieties for different ecologies. Currently there are 45 funded centres and about 100 voluntary centres spread across the country. Though the AICRIP has contributed significantly over the years, there is a strong need to reorient it based on scientific allocation of the centres in different regions of the country and improve their functioning to address the emerging challenges in rice farming. The objective of the bulletin on "Reorientation of All India Coordinated Crop Improvement Projects: The Case of Rice" is to provide a comprehensive scientific methodology for reorienting the AICRIP.

We hope that this bulletin would help all the stakeholders concerning the AICRIP programme and provide useful information for other AICRIPs for their reorientation.

Authors

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1. Introduction

Rice is the staple food for about half of the world population. Grown for more than 6000 years, it is economically, socially, and culturally important to a large number of people across the globe. More than 100 countries grow rice with the third highest worldwide production of 740 million tons (Mt) of rough rice, after sugarcane and maize. It accounts for 35-75% of the calories for more than 3 billion Asians. Globally, it provides 27% of dietary energy, 20% of dietary protein and 3% of dietary fat. Rice fields cover around 160 million hectare (Mha), the third largest cereal, and most important food of majority of global poor. It is grown in a wide range of climatic conditions spanning from 44°N latitude in North Korea to 35°S latitude in Australia. It is cultivated from 2 meter below sea level in Kerala, India to 2700 m above sea level in the Jumla Valley, Nepal. Most of the rice in tropical countries is produced in irrigated and rainfed lowland areas. Irrigated rice systems account for 78% of all rice production and 55% of total harvested rice area, mostly concentrated in alluvial floodplains, terraces, inland valleys, and deltas in the humid and sub-humid subtropics and humid tropics of Asia. The crop occupies largest area in India followed by China and Indonesia. China has the highest production but Australia has the highest productivity (Pathak et al., 2018).

In India, rice plays a major role in diet, economy, employment, culture and history. It is the staple food for more than 65% of Indian population contributing approximately 40% to the total food grain production, thereby, occupying a pivotal role in the food and livelihood security. The country has the world's largest area under rice i.e., about 44 Mha and the second highest production i.e., about 165 Mt at productivity of 3.65 t ha^{-1}. Production of rice has increased more than five times since 1950-51 (Fig. 1). The source of growth is mostly increase in yield, which has increased by 3.6 times and marginally area which has increased by 1.4 times during the period (Pathak et al., 2018). The crop is cultivated round the year in one or the other parts of the country. The leading rice producing states are West Bengal, Uttar Pradesh, Punjab, Odisha, Andhra Pradesh, Bihar and Chhattisgarh. Irrigated rice area is the most widespread ecosystem in India. Around 24 Mha of rice area is irrigated, accounting for about 55% of the total rice area (GOI, 2014). Irrigated rice is grown in Punjab, Haryana, Uttar Pradesh, West Bengal, Bihar, Odisha, and parts of Andhra Pradesh, Tamil Nadu, and Karnataka. The remaining area under rainfed rice which is about 40% and more than 70% of which is in eastern India. Out of the total rainfed rice area, 23% are rainfed upland and 77% are rainfed lowland. Irrigated and shallow lowland rice are favourable production systems contributing nearly 85% to total rice production. The entire

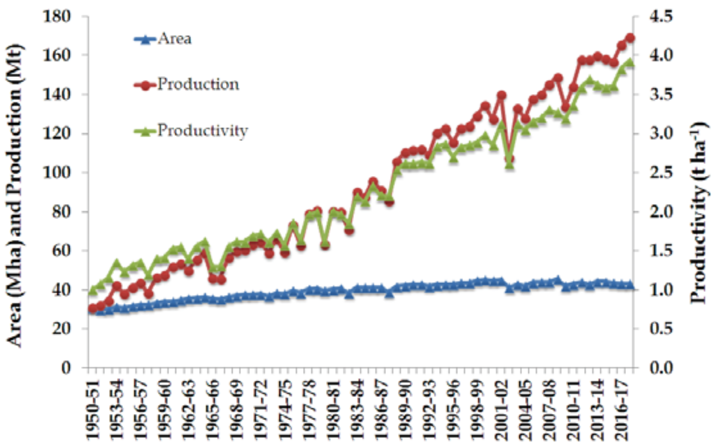

Fig. 1. Trends in area, production and productivity of rice in India.

Source: Ministry of Agriculture & Farmers' Welfare, Government of India (2019) rainfed upland and 50% rainfed lowlands, however are drought prone and about 20% of rainfed lowlands are flood prone (Pathak et al., 2018). The crop ranks first in the use of land, water resources as well as other inputs. It uses 29% of irrigation water, 37% of fertilizers and 17% pesticides used in Indian agriculture. It also contributes to environmental pollution, groundwater depletion and emission of greenhouse gases such as methane (annually 3.5 Mt of methane i.e., 18% of total emission from agriculture) and nitrous oxide causing global warming and climate change.

Wide patterns of rainfall distribution, differences in soils, heterogenity in agro-climatic situations, as well as photo-sensitive and photo-insensitive nature of rice genotypes have created a large diversity of germplasms resulting in release of about 1200 varieties and hybrids throughout India. Cultivation of these varieties in ecological diverse situations is also one of the causes for low productivity of rice in India. Rice is the only cereal that is consumed as whole grain; its quality preferences too are diverse. Rice crop is prone to the infestation of weeds, attack of several insect pests and diseases causing crop losses to the extent of 30-40%, which further adds to the complexity to achieve high yield.

Global demand of rice is likely to increase from the current 740 Mt to about 825 Mt in 2030. However, rice farming, particularly in the rainfed situations, faces multiple risks from uncertain climate, degraded soil, water shortage and underdeveloped markets. It has come under increasing pressure from intense competition for land and water, a more difficult growing environment because of climate change, higher price for energy and fertilizers, labour shortage, increasing cost of cultivation, declining profit margin and greater demand for reduced environmental footprint (Pathak et al., 2018). Most rice production systems have witnessed increasing yield risk because of erratic weather patterns and emerging biotic and abiotic stresses. Frequent occurrence of abiotic stresses (i.e., drought and submergence) has been identified as the most important reason for the low productivity across the ecosystems. The socio-economic dynamics and changing food habits are also adding other dimensions to the already complex challenges of rice farming. Therefore, the goal of rice research and development should be at improving yield, nutritional quality and income security of rice farmers while addressing the challenges of environmental sustainability and coping with climate change. As rice is the major crop in India with diversified ecosystems and climatic conditions, location specific technologies need to be generated for achieving required production targets to feed increasing population. It is imperative to develop location-specific technologies and strategies that can sustain higher levels of production without adverse effects on the environment. Reorientation of the All India Coordinated Rice Improvement Project (AICRIP) in terms of relocating the centres and improving their mandate and mode of functioning will be a positive step forward to strengthen the rice research and development in the country. The objective of the bulletin is to provide a comprehensive scientific methodology for reorienting the AICRIP for making it more comprehensive, inclusive and effective.

2. All India Coordinated Rice Improvement Project

2.1. Genesis and evolution of AICRIP

After the “Great Bengal Famine” of 1943, the need for rice research for a food-secured India became imminent. In view of this, a systematic rice improvement efforts in India were taken up by the Government of the day. A national institute for rice research was subsequently established as Central Rice

Research Institute (CRRI) at Cuttack, Odisha in 1946. By 1950, there were 82 rice research stations in the country and breeding efforts to increase yields were confined to pure line selections. The concept of regional approach to solve the rice production problems arises from its traits like tall plant stature, lodging, photoperiod sensitivity, late maturity, narrow adaptability, non-responsiveness to fertilizers led to the formation of a nation-wide cooperation and was a prelude to the establishment of the AICRIP.

Realizing the limitations imposed by the ecosystem complexities, destabilizing insect pests and disease problems as well as requirement of better grain quality of different types of rice consumed, Indian Council of Agricultural Research (ICAR) came up with the concept of All India Coordinated Crop Improvement Projects way back in 1960s. The AICRIP was established with its headquarter at Rajendranagar, Hyderabad in 1965 with the mandate of development of an integrated national network of cooperative experimentation on all aspects of rice production to accelerate breeding efforts with semi-dwarf varieties. The objectives of the AICRIP was to all India testing of promising breeding materials (varieties, hybrids, composites, agronomical practices and other input use) to identify the most stable, high-yielding and superior genotypes suited for different agro-climatic conditions and possessing the required level of resistance to the targeted insect pest and diseases.

The Rockefeller Foundation, International Rice Research Institute (IRRI) and US Agency for International Development (USAID) extended technological and financial supports to AICRIP to enhance the pace of rice research in the country. With the responsibility to organize multi-disciplinary, multi-location testing and develop suitable varietal and production technologies, AICRIP capitalized upon the available research infrastructure in different states of India and successfully introduced a national perspective to rice research. AICRIP became a model for IRRI to start the International Rice Testing Program (IRTP). This program evaluates international rice nurseries and facilitates access to and use of exotic germplasm of value for either direct introduction or use as a donor source in breeding in participating countries. Many varieties (IR8, IR20, IR36, IR64, IR70, IR72) with high yield, multiple pest resistance, and better grain quality have come to India through IRTP nurseries, as have hundreds of valuable germplasm accessions that continue to add strength to the country. Many varieties (IR8 and IR20, for example) were introduced in India from IRRI and brought about stability and incremental growth in rice production and productivity.

To begin with, AICRIP work was carried out in 7 zones, each under the responsibility of a Zonal Coordinator. The zonal headquarters were Khudwani, Jorhat, Faizabad, Patna, Hyderabad, Cuttack and Coimbatore. Twelve regional stations *viz.* Palampur, Pantnagar, Kapurthala, Chinsurah, Sambalpur, Raipur, Maruteru, Karjat, Nawagam, Mandya, Aduthurai and Pattambi were established in the major rice growing states of the country. Upper Shillong, Kalimpong and Imphal were identified as testing centres making a total of 22 centres.

Considering the progress and future challenges, during the V five year plan (1974-79), ICAR provided 23 additional centres, raising the number to 45. These centres were classified into single cropped (24) and double cropped units (21). Centres at Imphal, Upper Shillong, Agartala, Pondicherry, Kohima and Varanasi were fully financed by ICAR. Cuttack centre was a part of Central Rice Research Institute (CRRI). The rest were financed on a 75:25 basis with State Agricultural

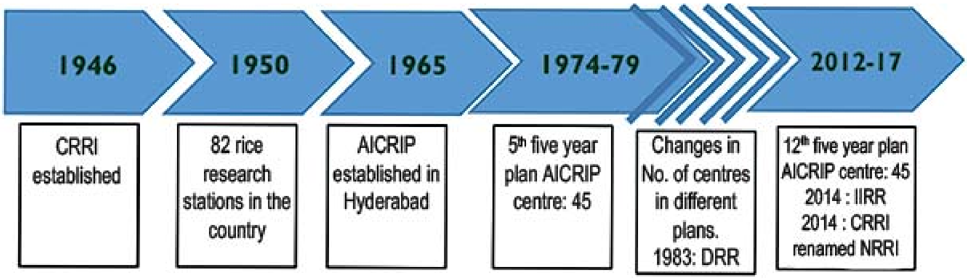

Fig. 2. Schematic diagram of genesis and evolution of AICRIP.

Universities (25%) or 50:50 basis with State Departments of Agriculture (50%). In August 1975, AICRIP at Hyderabad was elevated to the status of Directorate of Rice Research (DRR), headed by Project Director (PD), wherein lead research targeting mainly the irrigated ecosystem was included. During VI plan period (1980-85), 8 more sub-centres and 8 subject related special centres were sanctioned raising the total to 61. In the VII plan period (1985-86 to 1989-90), the number of centres, however, was reduced to 50 (18 main and 32 sub centres). During the VIII plan (1992-97), there were 51 approved centres of which 6 centres were withdrawn and the Karnal centre was merged with Kaul during the IX plan period (1997-2002). The total number of centres during X plan (2002-2007) was increased to 46 with the approval of Kanpur and Nagina centres. It further increased to 47 during XI plan (2007-2012) with addition of Navsari in southern Gujarat in western India. During the XII plan (2012-2017), two centres viz., Karimganj and Sabour were withdrawn. Currently there are 45 funded centres under AICRIP (Fig. 2). In addition, there are more than 100 voluntary centres, where trials are conducted on voluntary basis in each discipline (Ravindrababu et al., 2016).

2.2. Locations of AICRIP test centres

At present there are 7 AICRIP zones in the country (Fig. 3). Locations of the AICRIP zones and test centres in different states of the country are presented in Table 2.

Table 1. Changes in number of test centres of AICRIP over time.

Year	No. of test centres	Remarks
1965	22	Rockefeller Foundation and USAID supported
1974-79 (V Plan)	45	
1980-85 (VI Plan)	53	8 subject related centres included
1985-90 (VII Plan)	50	
1992-97 (VIII Plan)	51	
1997-02 (IX Plan)	44	6 centres withdrawn, Karnal merged with Kaul
2002-07 (X plan)	46	Kanpur and Nagina included
2007-12 (XI Plan)	47	Navsari included
2012-17 (XII Plan)	45	Karimganj and Sabour withdrawn

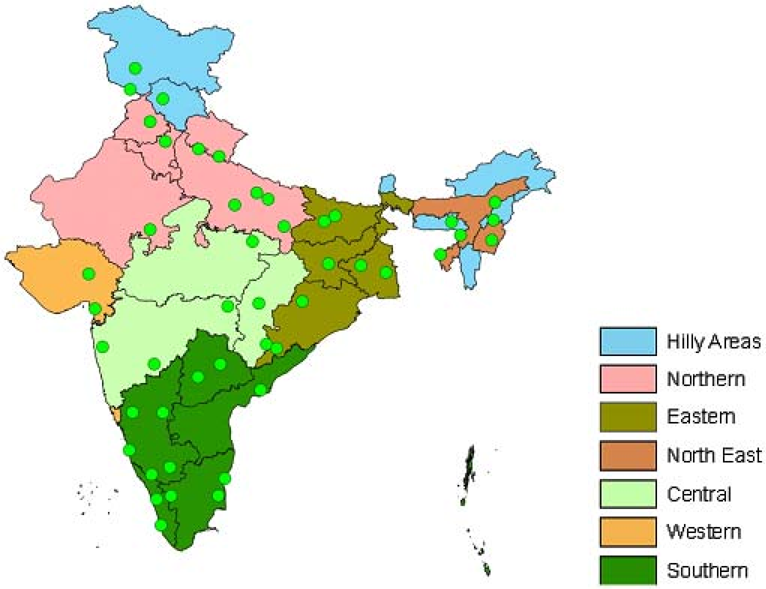

Fig. 3. Location of AICRIP zones and test centres.

Table 2. AICRIP zones and number of test centres in different states of the country.

Zones	State	No. of AICRIP test centres
I- Hilly	Jammu & Kashmir	2
	Himachal Pradesh	1
	Sub Total	**3**
II- Northern	New Delhi	
	Uttarkhand	1
	Punjab	1
	Haryana	1
	Uttar Pradesh	5
	Rajasthan	1
	Sub Total	**9**
III- Eastern	Odisha	2
	Bihar	2
	Jharkhand	1
	West Bengal	2
	Sub Total	**7**
IV- North East	Assam	1
	Manipur	1
	Nagaland	1
	Meghalaya	1
	Tripura	1
	Sub Total	**5**
V- Central	Madhya Pradesh	1
	Chhattisgarh	2
	Maharashtra	3
	Sub Total	**6**
VI- Western	Gujarat	2
	Sub Total	**2**
VII- Southern	Tamil Nadu	2
	Andhra Pradesh	1
	Telangana	2
	Karnataka	5
	Kerala	2
	Pucucherry	1
	Sub Total	**13**
Total		**45**

2.3. Area, production and productivity of rice in different AICRIP zones

For reorienting the AICRIP setup, one needs to understand the trends in area, production and productivity of rice in different zones (Table 3) for adjusting the number of centres to meet future demands. The next step is to analyse the rationale of distribution of centres in different zones vis-a-vis area, production and productivity of rice. The number and distribution of centres needs to be based on the relative ranking that a particular zone occupies in terms of area, production and productivity.

Based on the area under rice crop, the Eastern Zone occupies the first position followed by Northern zone and Central Zone (Table 4). Eastern Zone again occupies the first position followed by Northern Zone and South Zone based on rice production. Productivity wise, however, Northern Zone is in the first position, followed by South Zone and North East Zone. Ranking the zones based on the average ranking of area, production and productivity; Northern zone occupies the first position followed by Eastern and South Zone. South Zone ranks 4th based on rice area but occupies 2nd position on the basis of production and productivity (Table 4).

3. Reorientation of AICRIP

To capture the changes in area, production and productivity of rice and address the current and emerging challenges rice farming is going to face, there is a need to reorient the AICRIP. The specific reasons for reorientation are listed below.

- Improving the scientific basis for varietal testing and release for diverse regions
- Addressing the existing and emerging complex challenges in rice production
- Improving the efficiency of AICRIP
- Optimizing the use of resources
- Sharing the responsibilities by various ICAR Institutes
- Releasing a few but effective varieties
- Capturing natural resource management issues

Total rice area of the country is about 44 Mha and currently the funded AICRIP centres are 45 (Fig. 3). This means roughly each centre caters to the rice research needs of about 1 Mha area. Estimated number of centres required for catering to a cumulative area of 1.00, 0.75, 0.50 and 0.25 Mha are 45, 60, 91 and 181, respectively (Fig. 4). Similarly, assuming that the zones that have higher production should be supported by more number of AICRIP centres, estimated number of test centres required are 164, 82, 55, 41 for 1, 2, 3 and 4 Mt production, respectively. However, due to resource limitation establishment of more number of test centres is not feasible. Therefore, AICRIP should be reoriented using the following steps.

- Relocating the AICRIP test centres based on agro-climatic zones, area, production and productivity of rice.
- Testing and releasing production and protection technologies in the line of varieties.
- Improving the efficiency of the AICRIP system.

3.1. Relocation of test centres

Three approaches were followed for relocation of AICRIP test centres.

3.1.1. Approach 1: Relocation of test centres in AICRIP zones

In this approach the number of test centres in an AICRIP zone is based on normalized score of area, production and productivity of rice as mentioned in Table 5 using the

Table 3. Area, production and productivity of rice in different zones of AICRIP.

Zone	State	Area (Mha)	Production (Mt)	Productivity (t ha^{-1})
I. Hilly	Jammu & Kashmir	0.28	0.86	3.03
	Himachal Pradesh	0.07	0.22	3.14
	Nagaland	0.21	0.51	2.44
	Mizoram	0.04	0.09	2.25
	Meghalaya	0.11	0.30	2.74
	Arunachal Pradesh	0.13	0.33	2.52
	Sikkim	0.01	0.03	3.00
	Zone total	**0.85**	**2.34**	**2.74**
II. Northern	New Delhi	0.01	0.03	3.00
	Uttarkhand	0.26	0.95	3.62
	Punjab	2.90	17.38	6.00
	Haryana	1.39	6.68	4.82
	Uttar Pradesh	5.99	20.63	3.44
	Rajasthan	0.20	0.68	3.43
	Zone total	**10.74**	**46.34**	**4.31**
III. Eastern	Odisha	3.85	12.49	3.24
	Bihar	3.34	12.36	3.70
	Jharkhand	1.71	5.76	3.36
	West Bengal	5.50	22.95	4.18
	Zone total	**14.41**	**53.56**	**3.72**
IV. North East	Assam	2.47	7.09	2.87
	Manipur	0.24	0.65	2.71
	Tripura	0.28	1.22	4.41
	Zone total	**2.99**	**8.96**	**3.00**
V. Central	Madhya Pradesh	2.29	6.34	2.77
	Chhattisgarh	3.83	12.07	3.15
	Maharashtra	1.54	4.66	3.04
	Zone total	**7.65**	**23.08**	**3.01**
VI. Western	Gujarat	0.84	2.90	3.46
	Goa	0.04	0.17	4.25
	Zone total	**0.88**	**3.06**	**3.49**
VII. Southern	Tamil Nadu	1.44	3.55	2.46
	Andhra Pradesh	2.11	11.18	5.31
	Telangana	1.68	7.76	4.61
	Karnataka	1.03	3.91	3.78
	Kerala	0.17	0.66	3.88
	Andaman&Nicobar	0.00	0.02	?
	Puducherry	0.02	0.08	4.83
	Zone total	**6.46**	**27.15**	**4.21**
Total		**44.0**	**164.5**	**3.74**

Table 4. Ranks of different zones of AICRIP based on area, production and productivity of rice.

Zones	Ranks based on		
	Area	Production	Productivity
Zone 1: Hilly	6	6	4
Zone II: Northern	2	2	1
Zone III: Eastern	1	1	6
Zone IV: North East	5	5	3
Zone V: Central	3	4	7
Zone VI: Western	7	7	5
Zone VII: Southern	4	3	2

Table 5. Criteria for allotting test centres based on normalised score of area, production and productivity of rice in seven AICRIP zones.

Score	No. of AICRIP centres
<0.1	2
0.1-0.3	4
0.3-0.5	6
0.5-0.7	9
>0.7	11

following equation (Eq. 1). The value in Eq. 1 may be of production, productivity or area.

Normalised score = (Value - minimum value)/(Maximum value - minimum value)
Eq. 1

The AICRIP centres allotted based on normalised scores of (1) rice production and (2) equal weightage to productivity and area in each zone is presented in Table 6.

3.1.2. Approach 2: Relocation of test centres in agro-climatic zones

The Food and Agriculture Organization (FAO) of the United Nations defined an agro-climatic zone (ACZ) as a land unit delineated in terms of major climate and growing period, which is climatically suitable for certain range of crops and cultivars. Planning Commission of India, in its meeting held on July 20, 1987 identified 15 ACZs in the country based on similarity in soil type, climate (temperature and rainfall) and captive water resources (Table 7) with the objective to integrate the state and national plans to enable policy

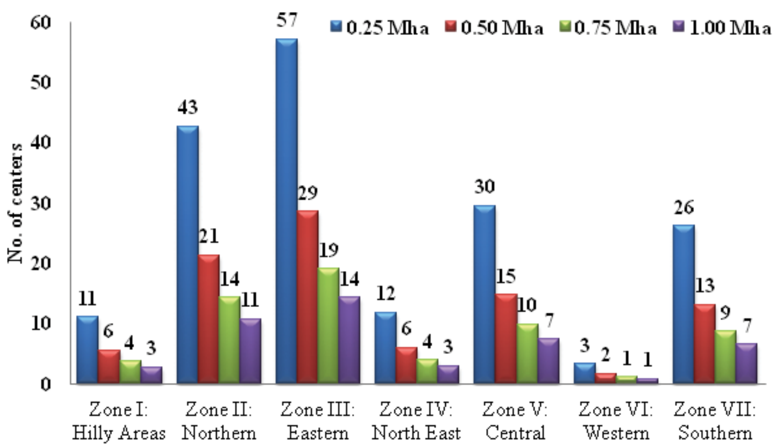

Fig. 4. Number of centres in different AICRIP zones based on area of rice.

Table 6. Number of proposed test centres in various AICRIP zones based on normalised score of area, production and productivity of rice.

AICRIP Zone	Normalised production	No of proposed centres	50:50:: Area: Productivity	No. of proposed centres	No. of existing centres
1.Hilly	0.0	2	0.3	6	3
2.Northern	0.9	11	0.9	11	9
3.Eastern	1.0	11	0.6	9	7
4.North East	0.2	4	0.3	6	5
5.Central	0.4	6	0.2	4	6
6.Western	0.0	2	0.2	4	2
7.Southern	0.7	11	0.7	11	13
Total		**47**		**51**	**45**

Table 7. Agro-climatic zones in India.

Agro-climatic zone	States
1.Western Himalayan	Himachal Pradesh; J & K; Uttranchal
2.Eastern Himalayan	Arunachal Pradesh; Assam; Manipur; Meghalaya; Mizoram: Nagaland; Sikkim; Tripura & three districts of West Bengal.
3.Lower Gangetic Plains	15 districts of West Bengal
4.Middle Gangetic Plains	23 districts of Uttar Pradesh & Bihar State
5.Upper Gangetic Plains	40 districts of Uttar Pradesh
6.Trans-Gangetic Plains	Delhi; Haryana; Punjab; Chandigarh UT & two districts of Rajasthan
7.Eastern Plateau & Hills	Chhattisgarh; Jharkhand; three districts of Madhya Pradesh; four districts of Maharashtra; 15 districts of Orissa & one district of West Bengal
8.Central Plateau & Hills	30 districts of Madhya Pradesh; 20 districts of Rajasthan & 7 districts of Uttar Pradesh
9.Western Plateau & Hills	15 districts of Madhya Pradesh; 25 districts of Maharashtra and one district of Rajasthan.
10.Southern Plateau & Hills	14 districts of Andhra Pradesh; 21 districts of Karnataka and 13 districts of Tamilnadu
11.East Coat Plains & Hills	9 districts of Andhra Pradesh; 15 districts of Orissa; 15 districts of Tamilnadu and 4 districts of Pondicherry
12.West Coast Plains & Ghats	Goa; Kerala; 6 districts each of Karnataka & Maharashtra and two districts of Tamilnadu.
13.Gujarat Plains & Hills	Gujarat; D & N Haveli and Daman & Diu
14.Western Dry	9 districts of Rajasthan
15.The Islands	Andamans & Nicobar Islands and Lakshdweep

development based on techno-agro-climatic considerations. Specific objectives of the delineating the ACZs are to manage regional resources to meet the food, fiber, fodder and fuel requirement without adversely affecting natural resources and environment; and form the basis for agricultural planning. In the agro-climatic zonal planning, further sub-zonation was done based on agro-ecological parameters.

Fig. 5 depicts the locations of AICRIP test centres in different agro-climatic zones in the country. Agro-climatic zone-wise area, production and productivity of rice are shown in Fig. 6, 7 and 8. Table 8 shows the area, production and productivity of rice in different ACZs. Ranking of different ACZs based on area of rice showed that Eastern Plateau zone occupies first position followed by Middle Gangetic Plains, East Coast Plains and Hill Zone (Table 9). Based on production, however, the Trans-Gangetic Plains zone ranks first followed by East Coast Plains and Lower Gangetic Plains. On productivity basis, the Islands Zone comes first, followed by Trans-Gangetic Plains and Southern Plateau. Ranking of zones based on the average ranking of area, production and productivity showed that the Trans-Gangetic Plains comes first followed by East Coast Plains and Lower Gangetic Plains. East Coast Plains zone stands 3rd in area, 2nd in production and 3rd in overall ranking.

Rice area, production and productivity for 15 ACZs were normalised from 0-1 and then AICRIP centres were allotted based on criteria mentioned in Table 10. For normalisation of scores Eq. 1 was used.

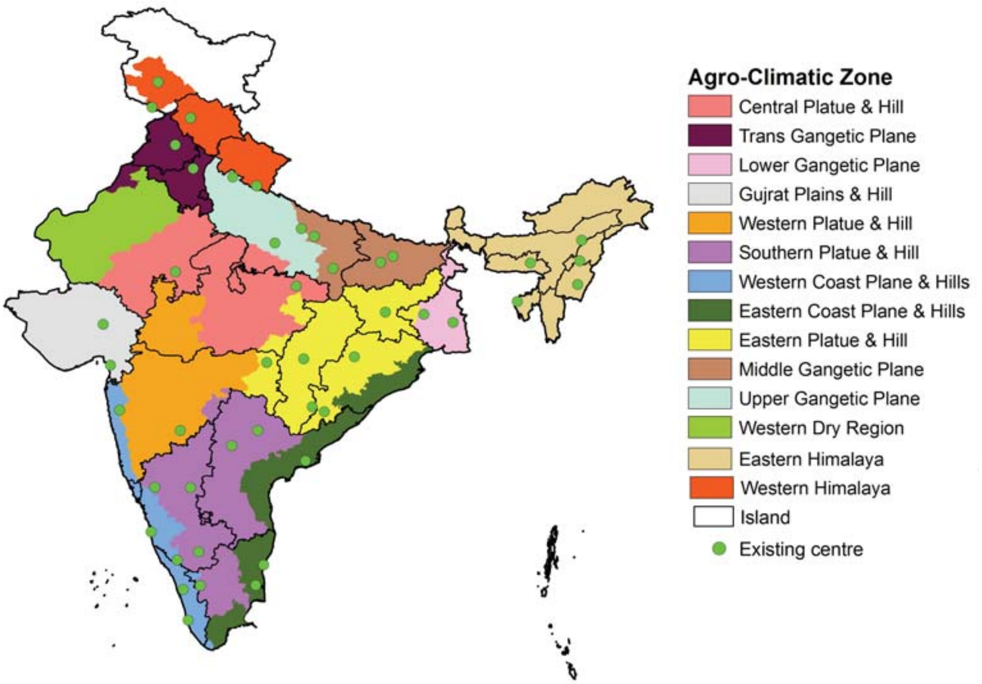

Fig. 5. Existing locations of AICRIP test centres in different agro-climatic zones of India.

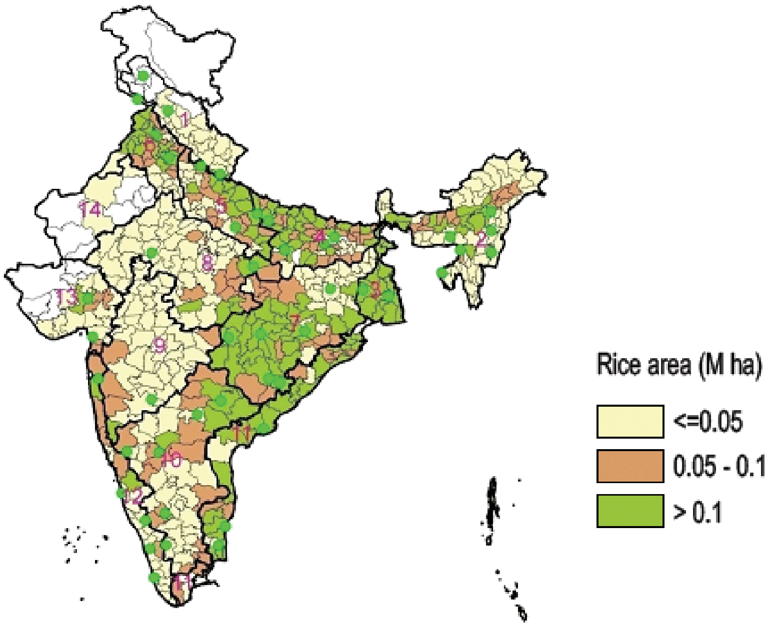

Fig. 6. District-wise rice area in different agro-climatic zones of India.

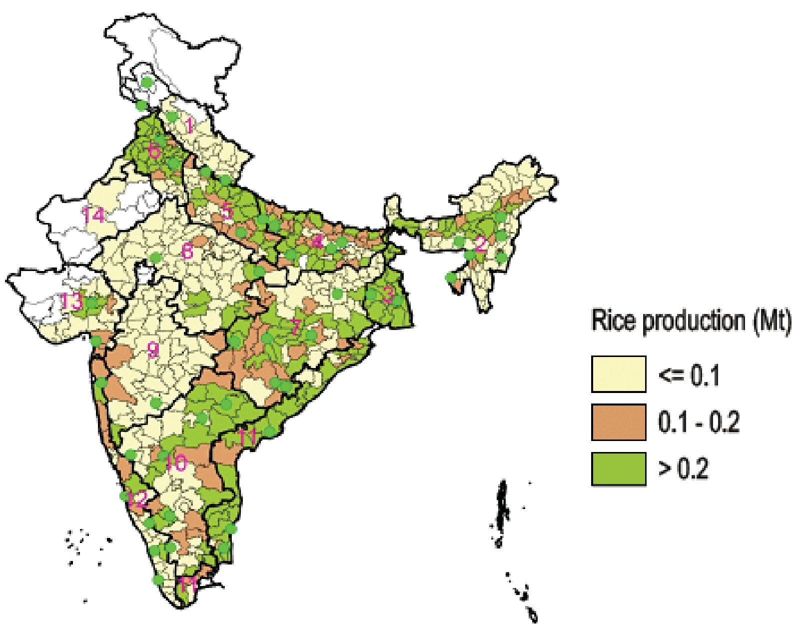

Fig. 7. District-wise rice production in different agro-climatic zones of India.

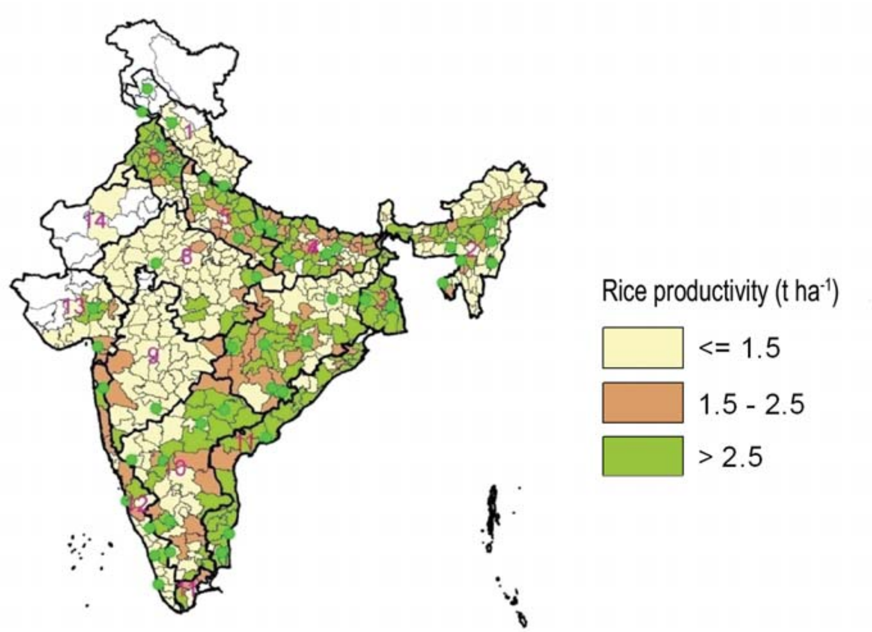

Fig. 8. District-wise rice productivity in different agro-climatic zones of India.

Table 8. Area, production and productivity of rice in different agro-climatic zones of India.

Agro-climatic Zones	Area (Mha)	Production (Mt)	Productivity (t ha^{-1})	No. of AICRIP centres
1.Western Himalayan	0.69	1.68	2.43	4
2.Eastern Himalayan	3.98	13.16	3.31	5
3.Lower Gangetic Plains	4.73	21.14	4.47	2
4.Middle Gangetic Plains	5.94	17.97	3.03	5
5.Upper Gangetic Plains	3.19	11.12	3.48	2
6.Trans-Gangetic Plains	4.27	23.81	5.57	2
7.Eastern Plateau & Hills	8.03	16.04	2.00	6
8.Central Plateau & Hills	1.70	4.34	2.55	1
9.Western Plateau & Hills	0.51	1.23	2.41	1
10.Southern Plateau & Hills	2.41	11.30	4.69	6
11.East Coat Plains & Hills	5.31	23.46	4.42	3
12.West Coast Plains & Ghats	0.98	3.86	3.93	5
13.Gujarat Plains & Hills	0.72	2.30	3.19	2
14.Western Dry	0.03	0.14	4.67	0
15.The Islands	0.01	0.03	3.00	0
Total No. of Centres				**45**

Table 9. Ranks of different agro-climatic zones of India based on area, production and productivity of rice.

Agro-climatic zone	Rank based on			
	Area	Production	Productivity	Average
1.Western Himalayan	12	12	12	12.0
2.Eastern Himalayan	6	6	8	6.7
3.Lower Gangetic Plains	4	3	4	3.7
4.Middle Gangetic Plains	2	4	9	5.0
5.Upper Gangetic Plains	7	8	7	7.3
6.Trans-Gangetic Plains	5	1	2	2.7
7.Eastern Plateau & Hills	1	5	14	6.7
8.Central Plateau & Hills	9	9	12	10.0
9.Western Plateau & Hills	13	13	15	13.7
10.Southern Plateau & Hills	8	7	3	6.0
11.East Coat Plains & Hills	3	2	5	3.3
12.West Coast Plains & Ghats	10	10	6	8.7
13.Gujarat Plains & Hills	11	11	11	11.0
14.Western Dry	14	14	10	12.7
15.The Islands	15	15	1	10.3

Table 10. Criteria for allotting AICRIP centres based on normalised score of rice area, production and productivity of agro-climatic zones.

Score	No. of AICRIP centres
<0.1	1
0.1-0.3	2
0.3-0.5	3
0.5-0.7	4
>0.7	5

The AICRIP test centres were allotted based on normalised score of rice production and equal weightage to rice area and productivity in each ACZ (Table 11).

3.1.3. Approach 3: Relocation of test centres in agro-climatic zones based on multi-criteria biophysical assessment

To capture the different dimensions of rice research and development, the AICRIP test centres may be relocated in the ACZs based on multi-criteria biophysical assessment using the following steps.

- Step 1: Identifying the parameters and criteria for relocation by expert opinion.
- Step 2: Assigning weightage to each parameter (total 100).
- Step 3: Assigning score for each parameter (0-9).
- Step 4: Calculating the weighted score for each of the existing AICRIP centres.
- Step 5: Proposing the relocation of centres in different ACZs based on normalised score.

Seven parameters (Table 12) were devised based on discussion with the rice experts. The criteria used to assign scores to parameters in each ACZ are briefly discussed below.

(1) Area and production of rice in the ACZ: Area under rice as well as productivity for each ACZ was used to assign this score.

Table 11. AICRIP centres based on normalised score of area, production and productivity of rice.

Agro-climatic zone	50:50:: area: productivity	Proposed No. of centres	Normalised production	Proposed No. of centres	Existing No. of test centres
1.Western Himalayan	0.1	2	0.1	1	4
2.Eastern Himalayan	0.5	3	0.6	4	5
3.Lower Gangetic Plains	0.6	4	0.9	5	2
4.Middle Gangetic Plains	0.6	4	0.8	5	4
5.Upper Gangetic Plains	0.4	3	0.5	3	3
6.Trans- Gangetic Plains	0.7	5	1.0	5	2
7.Eastern Plateau & Hills	0.5	4	0.7	4	6
8.Central Plateau & Hills	0.3	2	0.2	2	2
9.Western Plateau & Hills	0.0	1	0.1	1	1
10.Southern Plateau & Hills	0.5	4	0.5	3	6
11.East Coast Plains & Hills	0.7	4	1.0	5	3
12.West Coast Plains & Ghats	0.4	3	0.2	2	5
13.Gujarat Plains & Hills	0.2	2	0.1	2	2
14.Western Dry	0.2	2	0.0	1	0
15.The Islands	0.5	4	0.0	1	0
Total		**47**		**44**	**45**

Table 12. Selected parameters and their weightage.

Criteria	Weightage
1.Area and production of rice in the ACZ	24
2.Representativeness of the ACZs	19
3.Stresses in the ACZ	16
4.Rainfed/irrigated area in the ACZ	14
5.Physiography in the ACZ	11
6.Number of rice seasons	9
7.Land suitability for rice	7
Total	**100**

Table 13. Scoring based on area and productivity of rice in a state.

S.No.	Area (Mha)	Criteria Productivity (t ha^{-1})	Score
1.	>3	< 2	9
2.	>3	2-3	8
3.	>3	> 3	7
4.	1.5-3	< 2	6
5.	1.5-3	2-3	5
6.	1.5-3	> 3	4
7.	<1.5	< 2	3
8.	<1.5	2-3	2
9.	<1.5	> 3	1

Area under rice was categorized into 3 groups viz. <1.5, 1.5-3.0 and >3.0 Mha. Similarly, productivity was grouped as <2, 2-3 and >3.0 t ha^{-1}. Finally, scores for different combinations of area/productivity has been assigned as given in Table 13.

(2) Representativeness of the ACZs: Scores were assigned based on number of AICRIP test centres already existing in a particular ACZ (Table 14).

(3) Stresses in the ACZ: Scores were assigned based on number of abiotic stresses (drought, submergence, salinity and temperature) prevalent in the ACZ. The ACZ having higher number of stresses was assigned higher score (Table 15).

(4) Rainfed/irrigated area in the ACZ: If the ACZ has rainfed area >70%, then a full score of 9 was assigned considering more challenges in terms of varietal trials, insect-pest management and stress management. If rainfed area covers 30-70%, a score of 7 and rainfed area <30% score 5 was assigned (Table 16).

(5) Physiography in the ACZ: A score of 9 was assigned if the areas in ACZ occupies mostly hilly and difficult terrain whereas with mostly plain area was assigned a score of 5 (Table 17).

(6) Number of rice seasons: If rice is cultivated during both *kharif* and *rabi* seasons, full score 9 otherwise a score 5 was assigned (Table 18).

(7) Land suitability for rice: Based on soil characteristics (highly pervious soil is not suitable) and rainfall (<600 mm is not suitable), score was assigned using the criteria given in Table 19.

3.1.4. Final score

The final score for a particular ACZ was obtained by multiplying the weight of the parameter and adding scores for all the parameters. The sum of score was divided by

Table 14. Scoring based on number of existing test centres in each ACZ.

Number of centres	Score
1	9
2	4
3	2
4	1
5	0

Table 15. Scoring based on number of abiotic stresses prevalent in the ACZ.

No. of stresses	Score
4	9
3	7
2	5
1	3

Table 16. Scoring based on area under rainfed area in the ACZ.

Rainfed area (%)	Score
30-70	9
>70	7
<30	5

Table 17. Scoring based on physiography of the ACZ.

Criteria	Score
Hilly and difficult terrain	9
Plain area	5

Table 18. Scoring based on number of rice seasons.

No. of rice crops grown in a year	Score
2	9
1	5

Table 19. Scoring based on land suitability for rice cultivation.

Land suitability for rice cultivation	Score
Not suitable	1
Moderately suitable	5
Suitable	9

100 to get the weighted score for each ACZ. This weighted score was normalised based on equation 1 and centres were allotted based on criteria mentioned in Table 10. The existing and proposed numbers of AICRIP test centres in different ACZs based on multi-criteria are presented in Table 20.

3.2. Testing and release of production and protection technologies

Similar to release of varieties, crop production and protection technologies should also be tested in multi-locations and released through AICRIP. The parameters to be monitored for testing of crop production and protection technologies are mentioned in Table 21 and 22, respectively. General proforma for collecting basic data about the experiment and broad guidelines for testing crop production and protection technologies are mentioned in Annexure I.

3.3. Improving efficiency of the AICRIP system

To improve the efficiency of the AICRIP system the monitoring process should be improved and the guidelines of various activities be updated. Complete package of practices should be provided alongwith the release of a variety. Natural resource management, production and protection technologies should also be tested and released in line with release of varieties. There should be close collaboration with the state governments for consistency in the process of central variety release committee (CVRC) and state variety release committee (SVRC). Training and capacity building of cooperators should be conducted regularly as new cooperators join the process. The AICRIP-MIS system should be used for monitoring and reporting.

Table 20. Existing and proposed number of AICRIP test centres in different ACZ based on multi-criteria analysis.

Agro-climatic zone	No. of existing centres	No. of proposed centres
1.Western Himalayan	4	2
2.Eastern Himalayan	5	4
3.Lower Gangetic Plains	2	5
4.Middle Gangetic plains	4	5
5.Upper Gangetic plains	3	4
6.Trans- gangetic Plains	2	3
7.Eastern Plateau & Hills	6	5
8.Central Plateau & Hills	2	3
9.Western Plateau & Hills	1	3
10.Southern Plateau & Hills	6	2
11.East Coast Plains & Hills	3	5
12.West Coast Plains & Ghats	5	1
13.Gujarat Plains & Hills	2	2
14.Western Dry	0	1
15.The Islands	0	1
Total	45	46

Table 21. Parameters to monitor for testing and release of crop production technologies.

Crop Production Technology	Parameters to be monitored
1. Fertilizer tool/Diagnostic tool for fertilizer application/ Mobile app. for fertilizer application	1.Agro-climatic zone 2. Amount of fertilizer for whole crop duration 3.No. of split doses of fertilizer to be recommended 4.Principal behind the technology and its site-specificity 5.Leaf area Index of crop at regular interval (active tillering, maximum tillering, panicle initiation/harvesting) 6.Crop biomass at regular interval (active tillering, maximum tillering, panicle initiation/harvesting) 7.Grain and straw yields 8. Soil fertility status (major and micronutrients) 9.Operating cost 10.Cost of technology, Benefit cost ratio
2. Microbial formulations	1.Agro-climatic zone 2.Amount and doses to be recommended 3.Leaf area Index of crop at regular interval (active tillering, maximum tillering, panicle initiation/harvesting) 4.Crop biomass at regular interval (active tillering, maximum tillering, panicle initiation/harvesting) 5.Grain and straw yields 6.No. of tillers/hill; No. of panicles/m^2, Plant height 7.Pest and disease score 8.Soil fertility status (major and micronutrients) 9.Operating cost 10.Cost of technology, Benefit cost ratio
3. Farm machinery	1.Agro-climatic zone 2.Field capacity 3.Fuel efficiency 4.Manpower requirement 5.Operating speed 6.Weeding capacity/Sowing field capacity 7.Field efficiency 8.Grain and straw yields 9.Operating Cost 10.Cost of technology, Benefit cost ratio

Table 22. Parameters to monitor for testing and release of crop protection technologies.

Crop Protection Technology	Parameters to be monitored
1.Light trap/Insect trap/ pheromone trap	1. Agro-climatic zone 2.No. of insect pests trapped (YSB, BPH, LF, GLH, etc.) 3.No. of predators trapped 4.No. of parasitoids trapped 5.Infestation (%) in solar light trap installed rice field (1 trap/ha) 6.Infestation (%) in control plot 7.Operating cost 8.Cost of technology 9.Grain and straw yields 10.Benefit cost ratio
2.Location specific IPM technology	1.Agro-climatic zone 2.Disease pest incidence and severity under IPM 3.Disease pest incidence and severity under farmer's practice 4.Grain and straw yields 5.Operating cost 6.Cost of technology 7.Benefit cost ratio
3. Microbial formulations (ex. Trichoderma)	1.Agro-climatic zone 2.Crop biomass at maximum tillering and at harvest 3.Seedling vigor index 4.No. of tillers/hill at maximum tillering stage 5.Disease incidence and severity with formulation 6.Disease incidence and severity in control 7.No. of panicles m^{-2} 8.1000 grain weight 9.Grain and straw yields 10.Benefit cost ratio

4. Conclusions

The AICRIP has contributed immensely in testing and releasing varieties for different agro-climatic zones. The AICRIP became a role model not only for national institutes, but also for International rice research communities such as International Rice Research Institute (IRRI), the Philippines. The IRRI has used this model to initiate the IRTP (with India as a major partner) in 1975, which was later renamed as the International Network for Genetic Evaluation of Rice (INGER) and this program has facilitated easy and free exchange of genetic material among global rice researchers. However, there is a need to reorient AICRIP to address the emerging challenges and making it more effective. The re-orientation may come from structural and functional adjustments. The structural adjustments may be achieved by way of optimizing the number and distribution of AICRIP centres to cater to the location specificity whereas the functional adjustments may be achieved by sharing of workload of AICRIP between the IIRR, NRRI and other ICAR Institutes to improve the performance and effectiveness of processes involved in AICRIP. The following steps should be taken for reorientation of the AICRIP.

- Relocation of test centres in different ACZs based on multi-criteria biophysical assessment as discussed in section 3.1.3.
- Improving the monitoring process.
- Updating the guidelines of various activities.
- Providing a complete package of practices alongwith the release of a variety.
- Testing and releasing production and protection technologies in line of testing and release of varieties.
- Sharing the responsibilities by various ICAR Institutes.
- Broad-basing the monitoring team involving ICAR/SAUs.
- Collaborating with the state governments for consistency in the process of central variety release committee (CVRC) and state variety release committee (SVRC).
- Regular training and capacity building of cooperators.
- Use of AICRIP-MIS for monitoring and reporting.

References

Pathak H, Samal P and Shahid M (2018) Revitalizing Rice-Systems for Enhancing Productivity, Profitability and Climate Resilience. In Pathak H et al. (Eds.) Rice Research for Enhancing Productivity, Profitability and Climate Resilience, ICAR-National Rice Research Institute, Cuttack, Odisha, p 1-17.

Ravindra Babu V, Ch Padmavathi, CN Neeraja, D Krishnaveni, LV Subba Rao, P Raghuveer Rao, GSV Prasad, Gururaj Katti, T Ram, D Subrahmanyam, RM Kumar, AS Hari Prasad, K Surekha, MS Prasad and U Chaitanya (2016) 50 Years of AICRIP: Way Forward. Technical Bulletin No. 92/2016. ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-500 030, Telangana State, India, 292 pp.

Singh Panjab (2006) Final Report of the Working Group on Agro-Climatic Zonal Planning Including Agriculture Development in North-Eastern India for XI Five Year Plan.

Annexure I

Proforma for collecting basic data on trials on crop production and protection technologies.	
1.Agro-climatic zone	:
2.Trial No.	:
3.Name of the trial	:
4.Objective	:
5.Total No. of locations	:
6.Layout plan	:
7.No. of replications	:
8.Fertilizer dose and schedule	:
9.Plant protection measures	:
10.Plot size	:
11.Plant to plant spacing	:
12.Total No. of entries	:
13.General data to be collected :	i) Grain yield (kg/plot) ii) Panicle No. m^{-2} iii) Days to 50% flowering iv) Plant height (cm) v) Spikelet's/panicle (No.) vi) Grains/panicle (No.) vii) Sterility percentage viii) Test weight (g) ix) Notes on pests, diseases and lodging x) Grain quality characteristics xi) Rainfall during the crop growth xii) Number of rainy days xiii) Maximum and minimum temperatures

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