

Strategic ideas for balancing national food security

and doubling farmers income

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Of the 141 million ha of net cultivated area in India, rice occupies the maximum i.e., about 44 million ha (30%). In eastern India, about 60% of the cultivated area is rice. Therefore, doubling of farmers' income by 2022, calls for special emphasis on the rice farmers. However, doubling of income from rice farming is more challenging than that of any other commodity-farming. Farmers' income can be improved when productivity goes up, cost of production comes down, risk is reduced, post-harvest loss is minimized and commodities produced get a remunerative price. Additional income should flow from allied activities of agriculture too. The strategy will have to integrate all these avenues in a meaningful manner, by building on supplementary and complementary relations. In this context, the options available for increasing farmers' income in rice-based systems are discussed here.

Key words: Doubling income, Farmer, Food, Rice, Security

THE eighth volume of the Report of the Committee on Doubling Farmers' Income, Government of India, examined productivity led production, with perspective that farmers must be able to benefit from technologies and practices that allow them to create value in a more optimal manner. Production enhancement, as a result of productivity gains, optimizes on resources deployed, minimizes environmental stresses and also reduces per unit cost of production.

Productivity improvement among

crops comes from changed cultivation practices, i.e., selection of appropriate varieties/ hybrids, applying optimal inputs for soil and plant health, input use efficiency, suitable staggering of sowing and harvest and enhancing the cropping

intensity on land. To achieve this, a wide variety of technology, information, tools and scientific practices are required.

The gross cropped area along with the proportion of major crops across the states is given in Table 1. With



Table 1. System productivity and gross return of different rice-based cropping system

Cropping system	REY (tonne/ha)	Gross return (₹/ha)
Rice-rice	7.8	45,124
Rice-wheat	8.4	48,882
Rice-maize	10.2	59,110
Rice-pulse	8.5	49,152
Rice-oilseed	7.0	40,472



IIRR can coordinate with IIRI in stress tolerant rices DRR Dhan 42



22.1% of gross-cropped area, rice crop stands apart compared to any other crop. This showed that any attempt to double the farmers' income can not ignore rice farmers of the country. Even though there are arguments for diversifying the substantial area under rice to other commercial crops, the following two statements unequivocally substantiate the sustained efforts to promote rice farming in the country.

(i) Growth in population and increasing purchasing power will drive an increase in demand for food in India. No doubt that the relative demand for high value commodities like vegetables, fruits, milk, fish, meat and egg will increase in forthcoming years. According to the projections of the Population Foundation of India, India's population will be 1,412 million by the end of 2022.

It is estimated that the consumption demand for rice will be about 115 million tonne by 2022. Besides, India's current export of 4 million tonne of basmati rice and 6 million tonne of non-basmati rice can also be expected to rise.

(ii) At the current rate of population growth (1.98%) Indian population is expected to touch 1.63 billion by 2050. Of these, about 52% will be the urban population. Considering three divergent scenarios of economic growth under 'Business as Usual'; 'Maintain Momentum' or 'Upside Scenario', GDP growth rate may vary from 5.43, 6.0 to 8.0%, respectively. Per caput demand for food was estimated to be about 140 kg cereal/year or about 384 g/ day. Based on the assumption that about 60% of the cereal requirement will be fulfilled by rice, the requirement of rice can be estimated to be 230 g/day

or 84 kg/year/person.

Therefore, the rice requirement for an expected population of 162 million by 2050 would be about 136 million tonne for consumption purpose alone.

Rice technologies in doubling farmers' income: avenues

Doubling of income levels of rice farmers could be achieved with five pronged technology oriented strategy.

- (i) Increasing incomes by improving productivity
- (ii) Reduced cost of cultivation with Resource Use Efficiency
- (iii) Increased cropping Intensity – Farming system approach
- (iv) Supply and value chain management – better markets
- (v) Digital strategies to drive science led rice farming

Increasing incomes by improving productivity

Providing farmers with a cafeteria of varietal options will lead to enhanced productivity and improved income levels. Identifying the mutant lines and popularizing the varieties within a couple of years can boost the productivity, thereby profitability among the farmers. With varietal profiling and better targeting of existing varieties and hybrids, a v e r a g e productivity in all the districts could be improved to 20 to 30%. That will get translated into increase in income to that level.

This Institute will help states in effectively reducing the losses due to biotic stresses. Varieties that are in pipeline with multiple pest / disease-resistance will improve the opportunity costs for rice farmers.

The alternate varietal choice will go a long way in targeting such varieties. Farmers are cultivating varieties of rice like ADT 37 and ADT 43 for their short duration and ready marketability (due to demand for parboiled rice in Tamil Nadu etc) in some districts like Chittoor, in Andhra Pradesh. Thus demand based rice varietal selection and cultivation by farmers will improve income from rice cultivation.

With these efforts, it is expected that the average productivity could be increased from 3.3 tonne/ha to 5 tonne/ha. Such efforts will eventually lead to enhanced net income to the tune of 70% across the farming community. The seed production with PPP mode and targeting will hold key in achieving this.

For example 'Improved Samba Mahsuri' can be cultivated in areas with assured irrigation, where fine grained rice varieties are preferred and widely cultivated. It possesses three major bacterial blight resistance



In case DRR Dhan 44, it was proven with H2H trials.



PHB71 hybrid under aerobic system-water saving of 40% - Ravichedu, Mahaboobnagar Dist. Telangana

genes Xa21, xa13 and xa5 and exhibited high level of resistance to bacterial blight across the country in multi-location trials of All India Coordinated Rice Improvement Project. Adoption of first medium slender hybrid 'DRRH3' which is similar to Samba Mahsuri with 25 to 30% higher yield is likely to increase the income levels.

The taste and preferences are changing and the research community has to take this aspect in to consideration and design their crop improvement programme tailoring to the expectations of the endusers'. Though yield is an important aspect, nutrition and quality are gaining importance with respect to health conscious population. Besides, these speciality rice will fetch premium price thereby contributing to the income rise.

The hybrid rice technology is playing a pivotal role in increasing the rice production and productivity in India and is one of the components of 'National Food Security Mission' which was launched in 2007 with an aim to enhance the national annual rice production. With good management, yield advantage of 1.0 to 1.5 tonne/ha can be obtained by cultivation of hybrids

than the high-yielding varieties under the same set of growing conditions. So far, 97 hybrids are released for commercial cultivation in the country. Hybrid rice seed production is economically lucrative and this institute has perfected the technology over the years and many progressive seed growers recorded more than three tonnes of hybrid seed yields/ha.

Reduced cost of cultivation with resource use efficiency

Reducing the crop production costs-input costs, input saving technologies, bio-pesticides, soil health monitoring will be focus on these technologies. The varieties and hybrids suitable to aerobic cultivation, direct seeded conditions will have direct bearing on improving the productivity with limited resources.

The varietal choice can be widened by the Indian Institute of Rice Research for Telugu farmers with optimum resource use technologies. For example Leaf Colour Chart developed by IIRR may reduce the fertilizer use to the tune of 20 to 30%. A series of such modules developed by IIRR can help farmers in reducing the cost of cultivation and sustaining the abiotic stresses.

Most of the yield gap studies revealed that more than the varietal / hybrid technologies – the individual gaps in adoption of different production components (water, land, pest, harvest management) were responsible for reduced farm productivity. ICAR can help in identifying such factors and micro-target with its cafeteria of technologies.

Focused efforts to develop and release stress tolerant elite varieties (such as BLB-resistant Improved Samba Mahsuri) can reduce the cost of cultivation to the tune of ` 2,000/ha. In case of DRR Dhan 44, it was proven with H2H trials and field-line demonstrations that there is a possibility to increase the farmers' profitability by reducing the cost of cultivation. An ideal hybrid for Andhra Pradesh (medium slender grain type) with suitable duration will improve the productivity rapidly. Biofortified rice (DRR Dhan 45) may improve the profitability by increasing the market price of each quintal of rice sold.

IIRR can coordinate with IRRI in development and popularizing the stress tolerant rices (DRR dhan 42, Swarna sub-1, Samba Sub-1 etc.). With these efforts, it is expected that



DRR Dhan44 under aerobic system- 54% water saving – Nandaram, Vikarabad Dist. Telangana



Broadcasting Aerobic Rice – Machilipatnam Guntur District, Sprinkler System, Ananthapur District, Andhra Pradesh.

the average cost of cultivation across major agro-climatic zones can get reduced to 20 to 30%. Such efforts will eventually lead to enhanced net income to the tune of 20% across the farming community.

Better nutrient use efficiency varieties specifically for nitrogen (N) and phosphorus (P). Breeding for tolerance to low soil 'P' and use efficiency of the nutrient is the correct approach to ameliorate the problem.

Utilizing the Pup 1 introgression lines of Improved Samba Mashuri, IR 64 and MTU 1010 can definitely reduce the use of phosphatic fertilizers and thereby a significant reduction in input costs.

The IIRR has developed several high-yielding varieties that are suitable for cultivation under different abiotic stress conditions DRR Dhan 47 – variety with heat tolerance, DRR Dhan 42 and 44 – drought tolerant and high-yielding, Jarava, a salinity tolerant variety released.

Varieties with multiple resistances for major pests and pathogens and the important genes related to important rice pests/pathogens:

- (i) Rice Blast: Pi 2, Pi 54, Pi 9
- (ii) Brown Plant Hopper: Bph 3, Bph 17, Bph 20, Bph 21
- (iii) Gall Midge: Gm 4, Gm 8

A row seeder (also known as drum seeder) sows the per-germinated paddy seeds in the rows at a spacing of 20 cm in puddled soil. It is likely to benefit farmers by saving in the cost of cultivation to the tune of 35% by using drum seeder.

Rice consumes about 3,000 to 5,000 liters of water to produce 1 kg of grain. Per caput/year water resources of the country is continuously declining from 5,176 m³ in 1951 to 4,732 m³ in 1955, 2,200 m³ in 1991, 1,869 m³ in 2001 and 1,703.6 m³ in 2007. Hence, water saving technologies in rice is the need of the hour.

The customized LCC developed at IIRR, Hyderabad on the basis of spectral evaluation of leaves of hundreds of varieties under different N levels can be used for real time N management by using the N application schedules (20 to 30 kg N/ha depending on the crop stage). There will be a saving of 25 to 30 kg N for the crop in a growing season.

AWD is also called 'intermittent irrigation' or 'controlled irrigation'. Alternate flooding compared with the traditional continuous flooding system, AWD using lowland rice cultivars can reduce water input by 15 to 30% without yield loss

By correcting the existing gaps in sound fertilizer management technologies available, there is an ample scope to enhance use efficiencies of major fertilizer nutrients by at least 25% that can make a saving of almost ` 2,000/ farmer/ha.

Identification of soil related problems (soil physical, fertility, chemical and biological health problems) and amelioration through proper amendments will increase the production and productivity. By rejuvenating such soils, these also can

be brought under cultivation.

Research efforts made at IIRR revealed that utility of aromatic varieties of rice in trapping the larvae of key pest, yellow stem borer which can cause losses between 25 and 80% to rice yields. Planting of one row of Pusa Basmati-1 as trap crop, preferably in east– west direction, for every 2.5 to 3 m of main rice crop, can effectively manage the pest without resorting to harmful chemical use resulting in significant reduction in pesticide use costs. At the same time, yield from the trap crop would be of additional income value as aromatic rice fetches premium price in retail markets. The cost: benefit ratio is always favourable and fetches a return of ` 1.5 for every rupee invested.

Increased cropping Intensity : farming system approach

Bridging the existing yield gaps using high-yielding cultivars could be done with varieties like Sampada and Dhanrasi. Besides, short duration, moderately resistant to major pest/pathogens, aerobic rice varieties with high yield (>5-6 tonne/ha) will be very useful especially in input constrained conditions. Aerobic rice developed by IIRR - DRR Dhan 41 released for cultivation under aerobic ecology. Diversifying the farming practices – farming system approach based (horticulture, silviculture, fisheries, animal husbandry and poultry). Especially Rice-Pulse systems in place of Rice-fallow system will be more profitable. Rice-

Indicators	Short-/Medium-term goals 2022	Pathways	Requirements
Adoption of new varieties and increase in per hectare or per acre productivity	• With choice, Premium we may achieve ₹ 12,000/ per hectare	Increased incomes by Resource Use Efficiency	1. Supply of good quality seed, other inputs – release of loans on time
Micro economic indicators – net benefit cost ratio, partial budgeting	• Reduced cost of cultivation with use of resource will lead to ₹ 3,000 per ha	Careful planning and targeting the best suited rice varieties and hybrids with available varietal choice across the ecosystems (1188 varieties)	2. Popularization of Soil health cards and land use pattern
Reduced cost of cultivation, reduction in cost of inputs, water, nutrients, labour etc.,	• Value chain and market access may enhance the profitability to the tune of ₹ 6,000 - 12,000 per ha	Breeding and popularising bio-fortified and other premium rice varieties	3. Promotion of value-added products
Climate resilience, opportunity cost, losses avoided due to climate resilient technologies	• Climate Smart Rice Farming and new opportunities will bring a value proposition of ₹ 3,000 per ha	Supporting seed systems – for quality seed production and distribution	4. Promotion of Cooperative-systems in villages for providing services to farmers in procurement of quality inputs
Relative easiness in accessing advisories, inputs and other services – reduction in costs incurred till now	Varietal colonies for different regions / ecologies	Optimal Mechanization with custom hiring (Uberization)	5. Seed to seed problem to be solved in holistic manner & post harvest marketing
Farmers' share of benefits accrued from value addition in rice value chain	Developing and promoting location specific Good Agricultural Practices	Crop Suitability mapping	6. Design specific interventions to increase farmers' income
Increase in farm gate prices due to market interventions such as eNAM	MOAFW to undertake a rigorous campaign on 3 GAINS (yield/quality/ profit) campaign of AICRIP Increasing productivity levels by 1 ton per ha– bridging the yield gaps across ecologies	Soil enrichment / amelioration, Potash mobilizing & Phosphorus, Zinc & Potash solubilising bacteria, Nano technology – fertilizer MOAFW to undertake a campaign for 3 REDUCTIONS (seed, fertilizer and pesticide) campaign of AICRIP Intense efforts to cut down cost of cultivation by Rs. 3000 per hectare (30% income increase)	7. Basic Infrastructural facilities like seed godowns, cold storage etc.



Aromatic rice as a trap crop for stem borer management in rice

Pulse also helps in rejuvenation of soil health by addition of nitrogen to the soil.

Rice-based crop rotations evaluated at 13 locations across India revealed that rice-maize rotation produced the highest rice equivalent yield (10.2 tonne/ha) and gross monetary returns (₹ 59,110/ha).

A trial conducted at 18 locations confirmed that rice yield (5.22 tonne/ha) under 100% neem coated urea was 7% higher than 100% prilled urea (4.88 tonne/ha). So we can expect an increase in productivity of 7% (0.2 tonne/ha) over present rice productivity (2.97 tonne/ha) under irrigated condition due to adoption of NCU.

Digital strategies to drive science led rice farming

Intense efforts to bring faster, cheaper access to knowledge and inputs (30% easiness in access) are required for improving the livelihoods of rice farmers. This facilitates timely decisions and faster adoption of emerging rice technologies. This will improve markets access and market intelligence through e NAM.

Supply and value chain management - better markets

Another important area that can be successfully utilized in doubling

the farmers' income is 'Value Addition'. Bio-fortification programme initiated in rice for iron (Fe) and zinc (Zn) was successful in developing nutritionally enriched varieties. Ex. DRR Dhan 45, DRR Dhan 48 and DRR Dhan 49 – high zinc rice varieties (~24 ppm).

Crop diversification through inclusion of high value crops in the system will increase the farm income. Value-adding opportunities for farm residues such as utilization of rice straw for the production of mushrooms, and for providing bioenergy services should be promoted.

Encouraging rural entrepreneurship by establishing small-scale house hold entrepreneurship and providing skill development to locally produce at the village levels, the organics like compost, vermicompost, biofertilizers required for crop production will certainly provide additional income to the farmers.

Integration of crop and livestock farming will provide manure that improves soil-health and thereby soil productivity which in turn improves farmers' income.

Value-added products and services in rice sector will enhance the net incomes of not only farmers, but also several stakeholder communities. IIRR can leverage the strengths from

across the country in adding value to the rice (e.g. sticky rice use in textile dye industry, our products like health care products, pain relieving balms may benefit to those farmers where such industry will be built in near future). *Poha* making to puffed rice industry can influence the profitability of farmers in the nearby villages.

One of the means to increase farmers income is the efficient utilization of whole biomass/ by-products of crop, thereby generating additional employment opportunities. Rice produces huge amount of by products which are under utilized and underexploited and mostly considered as waste products although they are potential source of many valuable components. Rice bran, for example, is a potential source of edible high quality oil known as Rice bran oil (RBO), protein, cholesterol-lowering waxes, anti-tumour compounds, and various antioxidants which have various skin beneficial properties. India has potential to produce 1.47 million tonne of rice bran oil but the actual production RBO in 2013–14 was 0.93 million tonne only which was just 63.26% of the potential. Hence, there is vast scope to utilize rice bran oil and other byproducts in making novel rice-based products which will enhance the profitability of the rice farmers and will also generate rural employment.

Macro-level food security with AICRIP

The success of the coordinated maize improvement pilot project initiated by ICAR in 1957 led to the institutional innovation of India's NARES.

This subsequently led to the initiation of AICRIP in 1965, and to many other crop and research areas of agriculture. To date approximately 90 All India Coordinated Research Projects (AICRPs) were initiated by ICAR, linking ICAR institutions and state agricultural universities, and covering all major crops, livestock, dairy, fisheries, and natural resources. The AICRIP was launched in 1965. The system was designed to bring all rice researchers and rice research centers from across India under one



DRR Dhan 45: India's first high Zinc and high yielding rice variety

umbrella. The aims of the project were to collectively plan for rice breeding priorities, generate breeding material accordingly, coordinate the evaluation of the material generated, and decide rationally what and where to recommend it for commercial planting. Conceptually, the underlying strategy of rapid identification of test entries for a given situation is based on the scientific principle of multilocation evaluation for a few seasons. This helps to generate the same kind of data for understanding genotype $\times$ environment interactions as did the earlier practice of limited location testing for many seasons or years for precisely identifying varieties with general and specific adaptability.

The AICRIP system organizes the inter-disciplinary and inter-institutional three-tier multilocation testing of elite breeding lines and improves management practices for all rice ecosystems. Over the years, AICRIP became an institutionalized research and development network linking more than 100 research centers of both state agricultural universities and ICAR institutions. There are now more than 500 scientists working for AICRIP in 45-funded centers and more than 100

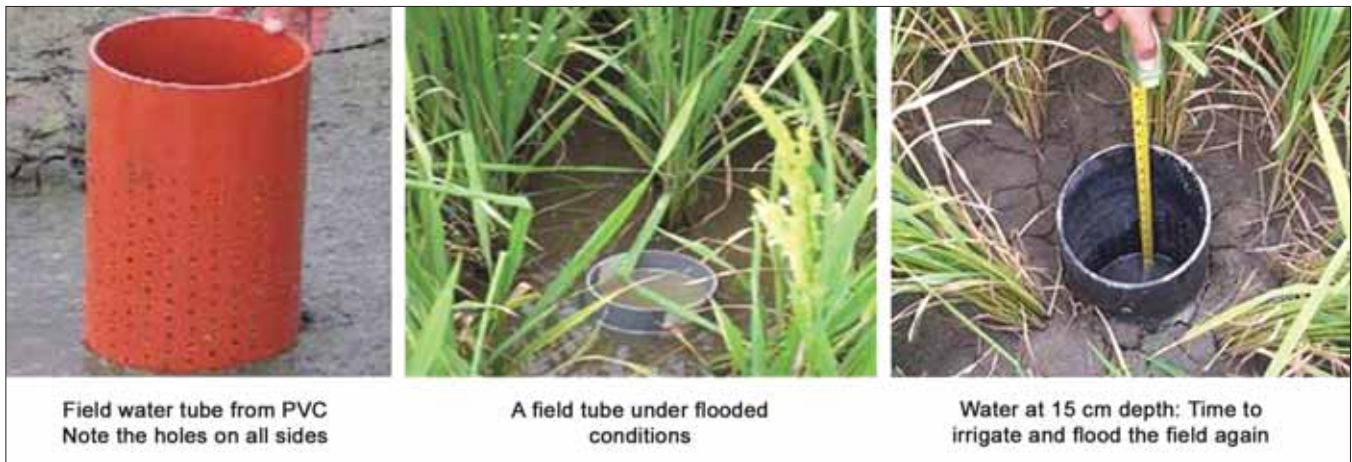
voluntary centers that plan, conduct, and monitor all rice research activities. This network facilitates the free movement of information, breeding material, and modern rice cultivars across the states, and promotes multilocation testing of improved germplasm through multi-institutional and multidisciplinary approaches. It also collaborates with the International Rice Research Institute for the collection, evaluation, and use of improved germplasm. The Indian NARES has a close partnership with international agricultural research centers through the AICRPs. The AICRP was used as a model for several countries, such as Zimbabwe, Bangladesh, the Philippines, and Kenya, to initiate similar coordinated multilocation research networks.

The AICRIP also became a model for IRRI to start the International Rice Testing Programme. This programme 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 rice varieties (IR8, IR20, IR36, IR64, IR70, and IR72) with high yield, multiple pest resistance, and better

grain quality reached India through International Rice Testing Programme nurseries, as have hundreds of valuable germplasm accessions that continue to add strength to the country's breeding research. It was the extensive adoption of high-yielding varieties (developed within India and introduced from IRRI) that brought about stability and incremental growth in rice production and productivity even in years of erratic monsoons.

Another role for which AICRIP is responsible is the conceptualization, formulation, and coordination of research networks on problems of national importance that warrant immediate, focused, aggressive, and product-oriented research involving all relevant institutions and scientists. Two success stories worth mentioning are the development of high-yielding basmati rice and hybrid rice technology.

Interstate movement of high-yielding varieties is another innovation process that evolved because of the AICRIP system. If a cultivar (in AICRIP trials) is found suitable in only one state, the concerned state agricultural university would approve its release as a high-yielding variety for that state. An elite or improved cultivar that is developed and identified in a state or institution may also be released by other states, if it is found suitable through a coordinated variety testing mechanism. This institutionalized network, which has a built-in transparent mechanism for the free sharing of improved germplasm among scientists and institutions, is the most powerful means to facilitate the movement of high-yielding varieties from one state or institution to another. Another means by which high-yielding varieties can move from one state to another is through on-farm or frontline demonstration programmes being conducted by the AICRIP network. All potential high-yielding varieties (mostly released ones) are identified from various states and their seeds are distributed to all targeted states for frontline demonstrations in farmers' fields (irrespective of where these high-



yielding varieties were released or developed). This is done in consultation with the state's Department of Agriculture. Participating states are allowed to promote any high-yielding varieties, if they were found to be suitable in farmers' fields through frontline demonstrations.

In the forth coming years, rice production systems are likely to face major challenges in view of production constraints. Besides the declining pace of productivity, there are limited possibilities for arable land expansion due to rapid urbanization and industrialization. Other expected concomitant developments include scarcity of labour for agriculture as well as issues of environmental and human health concerns. Global climate change impact in frequent droughts, cyclones, floods, enhanced temperature and CO₂ is another serious development needing urgent attention. Crop diversification due to rapid shrinking of water resources, deteriorating soil health, abiotic and biotic stresses as well as escalation of input costs will also be major threats to rice economy.

In view of these mounting challenges as well as needs on one hand and rapid advances in scientific research and developments on the other, the way forward should include development of roadmap for substantial revamping of AICRIP setup to meet the future demands. Transformation from routine field evaluation centers to highly efficient technology developing centers of excellence is the need of hour. Scientific developments need to be

rapidly converted into adoptable technologies and validated under diverse rice ecologies.

Thrust areas for coordinated rice research

Pre-breeding for broadening the genetic base to enhance yield, quality and stress tolerance in rice: Broadening of genetic base by including wild rice and other related species for exploiting the gene pool reservoir can help in overcoming limited genetic variability in the cultivated germplasm pool. This will also aid in incorporation of other desirable traits related to yield, quality and stress tolerance. It is now possible to track the variability present in the primary and secondary gene pool of rice and gainfully use them in breeding programmes by adopting novel breeding strategies and modern biotechnological tools. Exploiting hybrid vigour through precision breeding of parental lines to enhance their genetic diversity for better levels of heterosis can address the varietal needs of diverse ecosystems.

Soil and plant health management under changing climate: Understanding soil-health impacts in relation to climate change is possible using controlled environment and long- term research experiments to assess soil-health indicators affected by climate change such as aggregate stability, SOM, carbon (C) and nitrogen (N) cycling, microbial biomass and activity, and microbial fauna and flora diversity.

Adopting resource conservation technologies: The natural resources are under immense pressure owing to population growth and intensive

agriculture. Improved tillage and crop establishment practices, especially for rice, show real potential for sustainably improving the productivity and profitability of rice-based cropping systems. Reduced and zero tillage can improve yields, raise input-use efficiency, reduce the intensity of machinery use and lower reduction costs. Fine tuning of efficient agronomic practices (DSR, SRI, Aerobic, AWD, micro-irrigation) for scientific management of available water resources will be one of the critical components of adaptation to climate change in near future.

Incorporation of abiotic and biotic stress tolerance: The frequent occurrence of abiotic stresses such as drought and submergence was identified as the key to the low productivity of rainfed ecosystems. Similarly, biotic constraints also cause potential losses to rice production. Conventional breeding strengthened by molecular tools such as marker aided selection and gene pyramiding with the help of molecular markers appears to be the most promising approach for evolving a broad spectrum and durable resistance mechanism to the majority of the stresses.

Enhanced resource use efficiency: Development and standardization of efficient package of soil, nutrient, water and crop management practices keeping in view the nutrient dynamics, losses, crop responses to input and resource use, and land preparation, and pest/disease/weed dynamics will be the major objective of optimizing of resource and enhancing productivity. Precision

Our Actions are our Future.



farmers: The varieties/hybrids and technologies developed as a part of research and multilocation testing are validated for their suitability to various socio-economic and field conditions through field-line demonstrators. Therefore, 'Farmers FIRST approach' can be taken up as a novel and more aggressive approach for dissemination of technologies under All India Co-ordinated Research on Insect and Pest. Linking technology dissemination and information and communication technologies through model portals such as the existing Rice Knowledge Management Portal can expedite the transfer of technology to all classes of farmers across rice ecosystems. Some of the other activities planned for validation and transfer of technologies for years to come include strengthening seed chain supply, breeder seed production, capacity building and HRD programmes, impact and constraint analysis of adopted rice production technologies and appropriate follow up action.

RESEARCH AND DEVELOPMENT

Doubling of farmers' income by 2022 is quite challenging but it is needed and is attainable. Three pronged strategy focused on (i) Development initiatives (ii) Technology, and (iii) Policy reforms in agriculture is needed to double the farmers' income. Our research is directed to find out technological solutions to many of

agriculture management practices can significantly reduce the amount of nutrient and other crop inputs used while boosting yields. Crop diversification farming systems approach involving pulses, vegetables and oilseeds can also be suitably exploited for higher productivity, resource use efficiency and sustainability.

Selective mechanization to reduce human drudgery, value addition and post-harvest processing: Farm mechanization in rice aids in the timeliness of operations, reduces the human drudgery in farm operations and improves the productivity. Timely and selective mechanization also plays a key role in value addition through post-harvest processing.

Integrated pest management: The modern versatile tool of biotechnology has enough potential to develop multiple pest resistant cultivars in rapid time through

understanding of molecular basis of tritrophic interactions among host, insect-pest and natural enemies. Diagnostic tools and Decision support systems utilizing Geographical information system maps along with weather data will be helpful for pest risk analysis and forecasting of major pests. In the last few years, newer environment friendly chemicals with novel modes of action and effectiveness at low doses have fitted well into rice integrated pest management (IPM) programmes. Use of bio-pesticides and other novel bio-molecules can be advocated as environment friendly components of IPM, while precise delivery systems through deployment of nano-pesticides or nano-encapsulated pesticides and development of herbicide tolerant varieties are the other potential options in ecologically sound IPM.

Dissemination of technology for



Hybrid rice seed Production



DRR Dhan 49

the challenges. Modern rice varieties, hybrids and technologies could help not only to address these challenges but also double the current incomes of farmers within next few years.

The average income of an agricultural household in India between July 2012 and June 2013 was as low as ` 6,426, as against its average monthly consumption expenditure of ` 6,223. As many as 22.50% of the farmers live below official poverty line and most of them perhaps are engaged in rice farming. It is estimated that for doubling the farmers' income major contributor is better price realization (35% contribution), followed by reduction in yield gaps (25%), productivity gain (20%) and value addition (20%).

Indian Institute of Rice Research would continue to contribute to this mission with technological breakthroughs for shifting the production frontiers and raising efficiency in use of inputs. Evidence is growing about scope of targeting the existing varieties, precision farming to raise production and income of farmers. Similarly modern machineries such as laser leveller, precision seeder and planter, direct seeded rice, zero tillage etc., will help realize highly efficient farming. Further new models of farming system for different socio-economic and bio-physical settings combining

all available technologies into a package that has income focus will help. This would require combining technology for production, harvest, post-harvest value addition etc.

There is a need to undertake a comprehensive strategy involving activities such as promoting suitable varieties for improving the Seed Replacement Ratio, promoting mechanization for almost all operations through subsidized implements, promoting balanced use of nutrients, use of soil moisture residue for cultivating pulses where second *rabi* crop is not feasible, providing assured price to farmers to overcome the low farm gate rates and to provide assured / remunerative prices to overcome fluctuating market rates and insulating farmers against damage to crops due to adverse climatic conditions etc.

Increasing the productivity can be achieved by efficient use of inputs. The varieties released by IIRR recently are efficient in input use and also thrive well in biotic/abiotic stresses. The management techniques developed and standardized are aimed at better natural resources management.

The Institute will provide varietal choice across the ecosystems through its AICRIP system as well. Breeding bio-fortified and other premium rice varieties and supporting seed systems for quality seed production and

distribution will help realizing the mission of DFI. Further, a national campaign for 3 GAINS (yield/quality/profit) could be taken up using the AICRIP network. With the varietal choice provided in this bulletin itself, increasing productivity levels by 1 tonne/ha thereby bridging the yield gaps across ecologies could be realized. With DRRH 3, yield may be increased by 25% and further the seed production benefits would lead to 50 to 100% increased income.

SUMMARY

The Indian Institute of Rice Research can also support seed systems of various states by providing better options of quality seed production and distribution. Reduced cost of cultivation with resource use efficiency will bring down cost of cultivation. Labour saving technologies such as mechanization, direct-seeded rice etc are standardized by IIRR. Low cost precision farming practices in farmers' fields and Optimal Mechanization with custom hiring models could be evolved in due course.

Increased cropping Intensity and Farming system approach can help poor farmers to increase per acre income.

The IIRR can also facilitate digital strategies to drive science led farming in both these states. Intense efforts to bring faster, cheaper access to knowledge and inputs could be tried on pilot basis for benefitting rice farmers. There is a scope to intensify research on value-addition like the case of millets value added products. About one-third of the increase in farmers' income is easily attainable through better price realization, efficient post-harvest management, competitive value chains and adoption of allied activities.

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Greenhouse in Vietnam awarded by the WGBC

The Green One UN House (GOUNH) in Vietnam was awarded the Leadership in Sustainable Design and Performance Award in the Institutional Category at the World Green Building Council's (WorldGBC) biennial Asia Pacific Leadership in Green Building.

(Courtesy, FAO)