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Fostering Rice-Based Model Villages in India: Accomplishment & Impediments

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Abstract

ICAR-National Rice Research Institute (NRRI), Cuttack, India had taken up two tiny villages namely Gurujanga & Guali in Odisha state for developing as model villages and dissemination of improved rice production technologies. Adoption of few land mark rice varieties developed by ICAR-NRRI, Cuttack resulted huge yield advantage over varieties grown earlier. Non-farm income and labour force participation rate were key factors together with other improved traits for adoption of varieties and technologies. However, un-matching convergence, recurrent drought, low liquidity due to lack of financial inclusions, etc. were major impediments for reaping the benefits of technology transfer through model village programmes.

Keywords

Convergence, Drought, Impact of technology, Model village, Rice varieties

Introduction

About 70% of population in India lives in rural areas [1] and though number is expected to fall in the coming years, more than half of our population still would live there even during 2050. Several initiatives have been taken up by Government through different rural development schemes, but except few, most of them met with inadequate accomplishment, which might be due to lack of a holistic focus on the village as a unit. The "Model Village" concept could remove this flaw and it can address resources deficit, with adequate focus on the special needs of every village and its' people. Moreover, the interest of village youth has to be revitalised and retained in farming for livelihoods as well as to meet food and nutritional security of the nation. Further, most of the farming jobs are being carried out by womenfolk, but their access to assets, capital, and technology are limited. Thus, development of model village has to be customized by incorporating all these to tackle the farm problems effectively and improve the livelihood of villagers to benefit people at local as well as national level. The traditional concept of development meant only economic growth of the nation and its citizens. However, the modern views on development portrays it as a system-wide manifestation of the way that people, firms, technologies and institutions interact with each other within the economic, social and political system. Development is a characteristic of the system and sustained improvements in individual well-being are a yardstick by which it is judged [2]. Development is a complex phenomenon comprising many dimensions: Social, political, economic, administrative and cultural [3]. There is a need to merge the efforts from different sectors and schemes for entrepreneurship development among women and youth and preparing them for all-round development, which is possible by identifying appropriate indicators [4]. In this juncture, a rain fed cluster comprising two small villages, viz. Gurujanga & Guali at Tangi-Chowdhar block of Cuttack district, Odisha were identified using a set of indicator and developed by ICAR-National Rice Research Institute (NRRI), Cuttack for development of appropriate methodologies and approaches through dissemination of production technologies in the form of method as well as result demonstrations, training, etc. since 2011-12. Efforts has also been made for convergence of different departments and schemes to promote profitable enterprises to equip the marginal households, women and youth to cope with the vagaries of weather and natural perils. Stakeholder consultation meeting was organised at various stages of development and simultaneous monitoring and appraisal of planned actions were tak-

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Table 1: Tools and techniques for assessing the accomplishments and impediments.

Sl. No.	Objective	Tools/ techniques
1	Estimation of net returns from different enterprise combination introduced in the model villages.	Budgeting technique
2	Ascertaining the influencing factors for choice of crops and improved rice varieties.	Probit analysis
3	Ranking of important traits influencing adoption of ICAR-NRRI rice varieties.	Garrett ranking technique
4	Identification of drought situation as well as coping strategies.	Calculation of standard precipitation index (SPI) from monthly rainfall data (2009-18); identification of coping strategies and ranking.
5	Assessment of credit demand and availability situation.	Estimation of credit demand; credit access.
6	Understand the perception of beneficiaries on convergence of activities by various organizations.	Recording of observation on 10-point scale and averaging; Mann-Whitney 'U' test to show the un-anonymity between beneficiary and non-beneficiary groups.

en up. This particular article contributes by evaluating the impact of model village development (in terms of achievements as well as obstructions) for small-holder farmers in rain fed region through technology dissemination, including both critical inputs as well as better farming practices.

Methodology

Data

The villages were taken up for development during 2011-12 and supports being provided since then till 2015-16 through distribution of inputs like improved varieties of seeds released by ICAR-NRRI, Cuttack, vegetable seeds, fertilizers, pesticides/insecticides, etc. or training and exposure to better production practices. Focus group discussions were made during different phases and personal interview was conducted using semi-structured checklist/interview schedule for assessing the impact of various interventions made. The collected data were compiled, categorized and analysed to measure the achievements made and obstacles experienced during different phases of model village development. The objective-wise tools and techniques used for compilation and analysis of data are presented in Table 1.

Econometric framework

Probit model: To describe the responsiveness of farmers for adoption of ICAR-NRRI varieties and/or diversification of crops based on weather/water availability, utility maximization theory [5] was used. A farmer shifts his choice from local varieties to improved varieties or from monocrops to diversified crops, only if utility realized from the latter is larger. Hence, a farmer i makes a choice to accept the above proposition, if utility related with the decision (v_{1i}) is greater than the utility associated with the decision not to adopt (v_{0i}). These two different alternatives and respective utilities can be quantified [6] as: $Y_i^* = (v_{1i} - v_{0i})$, and the econometric description of the model is expressed by: $Y_i = 1$, with the condition of $Y^*_i > 0$ and $Y_i = 0$, $Y^*_i \leq 0$, where $Y_i = 1$ for adopters, and $Y_i = 0$ for non-adopters. The utility function can be estimated as: $Y^*_i = X'\beta_i + u_i$, where u_i is normally distributed error term and measures the random effect of this relationship. As utility is random, the i^{th} household will choose if $u_{i1} > u_{i0}$. So, in case of farmer i, the likelihood of choice can be expressed as: $P^* = P(u_{i1} > u_{i0})$, hence, $P^* = P(\beta_1 X_1 + u_{i1}) > (\beta_0 X_i + u_{i0})$, where, P* is the probability of choosing ICAR-NRRI rice varieties or diversification of crops.

The independent variables which were considered to be influencing the binary dependent variable were: Education of head of household, number of earning members in the family, extension contact, non-farm income and total family income.

Garrett ranking technique: Important traits of ICAR-NRRI varieties were listed with the help of Breeders who develops them and finalized based on the discussion with key informants (representatives of the model villages who were well informed about physical and demographic characteristics of the village) and the respondents. During survey, respondents were asked to rank the traits which they think influence them to choose ICAR-NRRI varieties as per their observations and perceptions. The Garett's ranking technique [7] was employed to rank the traits using the formula: $Gi = \frac{100(Rij - 0.50)}{Nj}$, where, G_i = Percentage position of i^{th} trait, R_{ij} = Rank accorded for i^{th} trait by j^{th} respondent, and N_j = Total number of traits ranked. By using Garett's table, scores for the individual trait was calculated from their percentage position [7] and final rank of the traits were determined.

Standard precipitation index (SPI): Using monthly rainfall data for 10 years (2009-2018), Standardized Precipitation Index (SPI) [8,9] was calculated to detect and characterize meteorological drought. The SPI indicator, measures precipitation anomalies at a given location, based on a comparison of observed total precipitation divergence from its distribution's average. Time series data on rainfall fits well with gamma distribution, hence, used by many authors [10,11], while calculating SPI. However, in the present study, SPI was obtained from the monthly rainfall by calculating the z-score (standard normal variate), which is similar to SPI assuming zero mean and unitary standard deviation. Here, z-score for rainfall time series, X_i (X_1, X_2, ...,X_n),was calculated as: $zi = (xi - \overline{X}) / Sx$

Table 2: Demographic/ financial profile of the model villages (2017-18).

Location	Geographical area (ha)	No. of households (numbers)	Family size	Labour force (%)	Land holding (ha)	Annual income ('000 INR)	Bank A/c holder (%)
Gurujanga (Village-I)	132	62	10.08	23.89	1.39	66.50	61.54
Guali (Village-II)	55	67	8.24	29.23	1.30	61.08	35.29
Total/Overall	187	129	9.03	26.86	1.34	63.43	46.67

where, $\overline{X}$ is arithmetic average and S_x is the standard deviation of monthly rainfall series.

Results and Discussion

Profile of model villages

Gurujanga and Guali are two small villages, located about 25 km away from the Cuttack city. They fall under Salagaon Gram panchayat (basic village governing institute in Indian villages) and Tangi-Chowdhar block of Cuttack district, Odisha state. The total geographical area of the villages is 132 ha and 55 ha, respectively. Annual rainfall ranged between 90 and 120 cm; most of which received during June to October. As per 2011 Census, Gurujanga and Guali had adult population of 349 and 343 persons, respectively (Table 2).

Brief descriptions of interventions & achievements

For improving livelihood of the marginal and small households, two major initiatives were taken up, viz., i) Substitution of rice varieties in different ecologies, and ii) Diversification of crop choices, besides targeting holistic development of the villages through other farm related measures. Supports being provided since 2011-12 and continued till the year 2015-16. The year-wise interventions made are discussed in following sub-sections.

The year 2011-12: A field demonstration of rice variety Sahabhagidhan was taken up, which is suitable for upland area in which 3.3 t ha^{-1} yield was observed. The variety provided a great relief to the farmers as there were no suitable varieties for upland ecosystem earlier. This variety was appreciated for its yield potential, better grain quality and resistance to pest and diseases. Demonstration was also made with the hybrid rice variety Rajalaxmi for popularization and to get the reactions of villagers about hybrid rice varieties. It is reported that farmers harvested the yield of 5.9 t ha^{-1}, about 50% over and above the existing popular variety Swarna. To identify appropriate replacement to Swarna, demonstrations were also made using few other varieties developed by ICAR-NRRI, Cuttack like Pooja, Satyakrishna and Swarna sub-1, which had yield advantage of 44%, 17% and 17%, respectively over the variety Swarna cultivated at adjacent plots.

The year 2012-13: About 15 result demonstrations (to show superiority of practices, varieties, technologies), 3 method demonstrations (to show the technique of doing things or carrying out new practices) including trainings and meetings were conducted to make the farmers aware about improved rice production technologies and the rice varieties demonstrated covered about 40% of the *kharif* rice area. The farmers articulated their wish for mechanization of operations, especially line transplanting by power operated transplanter and harvesting by reaper. However, high cost of power transplanter and reaper was the greatest obstacle in adoption of the technology. In addition to the support through inputs/training in rice production technologies, farmers and farm women were given advisory services to grow vegetables for commercial purposes and kitchen gardening. A group of women took up vegetable farming during *rabi* season in an area of 300 m^2, which generated a net income of INR 3649 (Indian Rupee). The group approach had generated lot of awareness and interest among the women folk and they decided to imitate this practise in other sites of the cluster. A stakeholder's meeting was held during February, 2013 by involving scientists, officials from state government departments, farmers and farm women of the cluster for developing an all-inclusive approach and mechanism of convergence for holistic development.

The year 2013-14: During 2013-14, two distinct approaches were taken up, viz. i) Ensuring participation of the disadvantaged sections of the society as well as women farmers, and ii) Crop diversification through post-rice vegetable cultivation using available water. Improved varieties from ICAR-NRRI, Cuttack covered 72 ha during *kharif* season, accounting about 63% of the total rice area of the village. Unfortunately, the rice crop was damaged intensively by a cyclonic storm 'Phailin' and heavy rain after wards. An effort was made during this year to create awareness among the farmers about hybrid vegetable cultivation and developing linkages with credible vegetable seed dealer for getting quality seeds. An assessment was also made during this year to estimate the returns from different cropping sequences followed by the farmers at small field with assured irrigation and the results indicated that rice-onion crop sequence, introduced during that year only, was more remunerative (with gross return to costs ratio of 1.80 and net returns of INR 227, 400 ha^{-1} yr^{-1} when extrapolated) than any other type of vegetables followed by rice cultivation.

The year 2014-15: During this year, varietal demonstration was taken up with ten newly released rice varieties of ICAR-NRRI, Cuttack in 2 ha of land and Front-Line Demonstration (FLD) (conducted by researchers on the farmers' field) was organized on 10 ha area to popularize hybrid rice cultivation. The varietal replacement initiatives yielded amazing outcome in terms of coverage of rice varieties from ICAR-NRRI, Cuttack, which further raised to 101 ha out of 161 ha available rice area in the cluster. Anticipating the threats from stray cattle and wild buffaloes during *rabi* season, farmers

Table 3: Ranking of important traits influencing adoption of ICAR-NRRI varieties.

Traits	Per cent position	Garrett score	Final rank
Higher yield	9.29	75	I
Drought tolerance	13.21	71	II
Low pest/disease	43.21	52	V
Better grain quality	36.43	56	IV
Higher return	23.57	64	III

Table 4: Socioeconomic factors responsible for adoption/continuation of ICAR-NRRI rice varieties/ practices and diversification[¥].

Particulars	Coefficients	Standard errors
Constant	-9.491	5.453
Education	0.516	0.432
Number of earners in family	0.482[*]	0.254
Extension contact	4.302	2.993
Non-farm income	0.001[*]	0.000
Total income	0.000	0.000
Observations	40	
Log-likelihood	-3.909	
pseudo R-square	0.855	

[*]indicates the significance level of 10%; [¥]Support was given during earlier years and crops/varieties continued or expanded during subsequent years.

remained reluctant to grow green gram. Hence, vegetable crops like okra, ridge gourd, bitter gourd, pumpkin and cowpea were demonstrated under rice-vegetable cropping system, mostly in the back-yard rice fields. Emphasis was also laid towards improving livestock production and actions were initiated under convergence mode with the involvement of Krishi Vigyan Kendra (KVK), Cuttack (a subsidiary of ICAR-NRRI, Cuttack) and Department of Animal Husbandry officials. Interventions like deworming, vaccination, treatment of sick animals, demonstration on duckery (ducklings were provided to the beneficiaries) and health management in goats through protein supplementation were done.

The year 2015-16: During 2015-16, two numbers of result demonstrations and 34 numbers of minikit (providing seed and other critical inputs) trial were conducted besides holding method demonstrations in vegetable farming and livestock production. However, rice grown under rain fed situation was affected due to terminal drought and farmer's income was affected. Short duration rice variety like CR Dhan-202 produced a maximum harvest of 3.5 t ha^{-1} followed by CR Dhan-204 (3.4t ha^{-1}) and Hazaridhan (3.2 t ha^{-1}).

Adoption of NRRI varieties/technologies

Various improved technologies and better agriculture practices hold potential for enhancing agricultural productivity and dipping poverty level in developing nations like India. The embracing of such technologies by small-holder farmers has remained slow but steady [12]. As reported by the key farmer during a focus-group discussion that earlier they were growing only local non-descriptive rice varieties (e.g. Saruchina, Kalamalata, Mathura, etc.) with very meagre yield (between 1.5 t ha^{-1} and 2.5 t ha^{-1}). The upgraded varieties namely; Sahabhagidhan, Swarna sub-1, Pooja, Ketekijoha, Varshadhan and Naveen were accepted by them and realized greater yield (4.0 to 5.0 t ha^{-1}). Important traits of the introduced rice varieties were listed during focus-group discussion and the respondents were asked (while survey conducted a few days later) to rank the factors which might influence them to adopt the variety. Finally, the ranks were converted to scores and final rank was calculated using the Garett's ranking technique [7]. The results showed that higher yield and drought tolerance were the major attributes of ICAR-NRRI rice varieties which influenced them to adopt it (Table 3).

To capture the influence of socioeconomic factors which might influences adoption/continuation of ICAR-NRRI varieties/production practices and shifting of crop choices/diversification based on weather and water availability, a probit model was fitted and estimated. Adoption of improved varieties and their continuance was measured using binary choice, viz. yes or no (1 = yes and 0 = no). The results indicated that the probability of adoption/continuation and diversification decision were influenced significantly by the numbers of earning members in the family and non-farm income of the households. This is due to the fact that earning members can support the diversified agricultural activities for crops/variety choice, which is labour intensive and non-farm income of the households is very important means to small farm households for buying of seeds and other critical inputs in time (Table 4).

Drought & coping strategies

Drought adversely affects the biophysical, environmental and socioeconomic sectors and results into food and nutritional insecurity, poverty, decaying of human capital and reduction in the economic assets [13]. Hence, to assess drought situation at the model village during the year 2015-16 and coping strategies adopted by the marginal and small households, a survey was conducted. Considering monthly rainfall data for 10 years' period (2009-18), standard precipitation index (SPI) calculated for the block where the village is located and the Cuttack district (average of all block within the district). The results indicated that there were droughts during 2012 and 2015 at the block, where the cluster is located, whereas, Cuttack district as a whole experiencing persistent drought only since 2016, barring the particular block (Figure 1). Though moderate intensity of drought was experienced during 2015, monthly SPI was found to be negative for more than three-fourths of number of months (Figure 2) and ex-

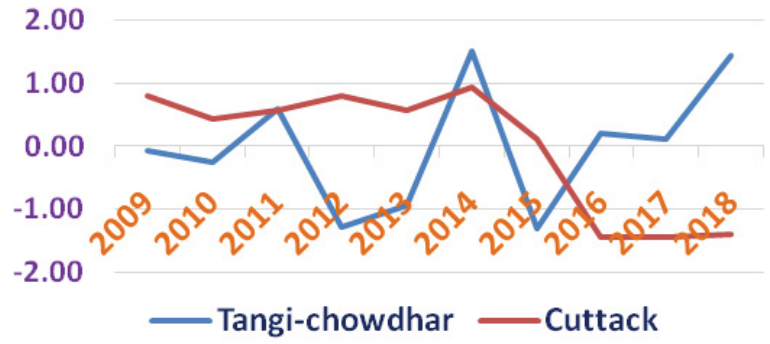

Figure 1: Standardized precipitation index based on 10 years (2009-2018) rainfall.

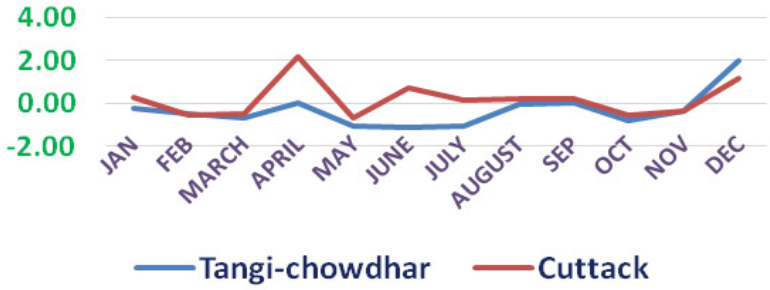

Figure 2: Standardized precipitation index for monthly rainfall during 2015 based on 10 years (2009-2018) rainfall.

Table 5: Coping strategies adopted during drought situations.

Sl. No.	Coping strategies	Embraced by (% of respondents)
1.	Arranging critical irrigation	14
2.	Borrowing	36
3.	Maintaining buffer of grains and fodder	7
4.	Sale of livestock/other asset	21
5.	Lowering consumption	43
6.	Resort to wage labour	50
7.	Postponement of social activities	14

cept April, September and December, all other months were deficient in rainfall.

On average, 40% reduction of rice productivity was reported, however, it was indicated that the extent of losses was low compared to the similar kind of drought situations few years back, which attributed to the adoption of drought resistant varieties of ICAR-NRRI, Cuttack. Loss owing from reduction of crop productivity was higher compared to loss in milk and productivity from small animals (sheep/goat and poultry). Drought generally results into poor access to basic inputs for production such as seed, fertilizer, implements, electricity and bullock power, etc., but none of the respondents have reported insufficient supply of above inputs or higher rates. However, due to poor accessibility of formal credit institutions, farmers have borrowed from non-formal sources, such as money lenders, traders, etc. at an exorbitant rate of interest which aggravates the burden of debts that led to other socioeconomic fall-out like poor nutritional status and low standard of living.

In dryland areas people are having their own strategies to cope with the drought situation. Various coping mechanisms adopted by the farmers at both the villages (as emerged from the survey done during 2016-17) indicated that small and marginal farmers adopts mainly three types of coping strategies like: postponement of farming activities and resort to wage labour, lowering consumption expenditure (foods, clothing, education, etc.) and borrowing (mainly from non-formal sources) (Table 5). Other practices they followed were arranging critical irrigation, sale of livestock and other household assets, postponement of social activities like marriages, etc.

Financial inclusion of small-holder rice farmer

Enhanced provision of rural credit accelerates agricultural production; however, access to financial services by small-holders is restricted due to information gap [14] and/or policy related constraints/deficiencies [15]. The failure to properly identify the credit needs of small-scale farmers also blamed for low demands of credit as well as capital inadequacy for adoption of even cost-effective/cheaper technologies [16]. Accordingly, a survey was conducted aiming assessment of needs as well as accessibility of credits to small scale rice farmers and comparison of credit delivery mechanisms among different categories of financial institutions. It was observed that access to information on institutional credit

Table 6: Perception of farmers on convergence of activities.

Organization	Average score (on 10-point scale)		
	Beneficiaries	Non-beneficiaries	Cumulative
1. ICAR-NRRI, Cuttack/ KVK, Cuttack	8.20	7.40	7.80 (I)
2. Agriculture department	2.60	2.60	2.60 (VI)
3. Horticulture department	4.30	2.40	3.35 (V)
4. Animal husbandry department	4.80	5.60	5.20 (III)
5. Minor irrigation department	1.90	3.00	2.45 (VII)
6. Forest department	0.20	0.20	0.20 (VIII)
7. Bank/cooperative society	4.20	3.60	3.90 (IV)
8. Block office/village panchayat	5.50	5.60	5.55 (II)

services were very low (57%), as banks and other financial institution (FIs) merely conducted any advertising or awareness programmes in the area and even 53% of respondents did not have an operational bank account. The immediate demand for credit estimated to be INR 47350 and the respondents prefer cooperative societies as better institutions over banks due to easiness of loan application and prompt delivery.

Convergence of schemes and institutions

During the process of model village development, efforts being made to bring together various government departments and developmental agencies through convergence mode. An enquiry was made to know the perception of respondents comprising non-beneficiaries (those who didn't received input support from ICAR-NRRI, Cuttack/KVK, Cuttack during preceding two years of survey) as well as beneficiaries (those who received input support) on the issue of efforts/activities made by various organizations at the village. They were asked to assess subjectively and assign score on a scale of 10 and the analysis indicates that after ICAR-NRRI, Cuttack, Block Office/Panchayat, Animal Husbandry and Horticulture department responded mostly to their needs and concern and least involvement of few departments were observed (Table 6). They further clarified that one water harvesting structure was due for renovation which has not been constructed (though assured for it). Similarly, no concrete measures have been taken up for control of wild buffaloes' menace particularly during *rabi* season. The scores were subjected to Mann-Whitney 'U' test [17] to show un-anonymity among beneficiary and non-beneficiary groups and no significant difference in scores were observed.

Conclusions

Dissemination and adoption of agricultural technologies for small-holders that too among rice-cultivating resource-poor farmers at rainfed regions depends upon careful planning and the use of suitable extension approaches. It also depends on the well-timed formation of partnerships among organization of similar agenda- including key farmers as well as officials from related departments, researchers and others. When interests of above unite appropriately so that they can focus their resources and efforts, alteration in agrarian situations towards better livelihoods achieved. This study explored that non-farm income and labour force participation rate were important factors among various socioeconomic characteristics in addition to the quality characters like better yield prospective, resistance to insects/pest/disease and better grain quality for acceptance of improved rice varieties as well as choices crops/enterprises by the farmers. During drought or other crisis, farmers used to adopt mainly three types of coping strategies like: Resort to wage labour, lowering consumption and borrowing (mainly from non-formal sources). Hence, concerted efforts are needed to enhance the institutional credit flow to farm through public awareness campaign, opening of bank accounts and simplification as well as promptness of credit delivery mechanism. Analysis of beneficiary's perception about standing of different organizations revealed un-matching contributions/efforts which calls for whole-hearted association of all stakeholders during planning as well as at every stages of interventions/activities for upbringing social & economic development of rural masses at model villages.

Declaration of Interest

None.

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