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Incremental returns from rice cultivation through gender sensitive approaches - a vivid illustration

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ABSTRACT

In addition to several household chores, women in rural areas remain involved very actively in farming activities. On getting similar access to productive resources as men, women can boost overall agricultural output as well as income significantly. A group of farm women from 'Sankilo' village of Cuttack district, Odisha have been provided with half-an acre land with the power to decide all farm operations and ICAR-NRRI, Cuttack provided technical support for five years' period. It is being observed that returns from rice cultivation increased considerably and 'technology' in terms of demonstrations mostly contributed the difference in yield and returns over pre-project situations. Household income of family of individual women was also assessed and observed that education, family size and irrigated land holding determine the variations in income. The study advocated for appropriate policies to extend access of farm resources and impart proper education as well as capacity building of the women for enhancing the knowledge and adoptive capacity for the technologies to boost the yield and income.

Key words: *Decomposition analysis, demonstration, gender, household income, rice*

INTRODUCTION

Agriculture in India directed by family custom, social relationships and gender roles. Women in farm sector, whether through traditional ways or industrial, for sustenance or as farm labourer, represents a significant chunk in total workforce. Apart from their regular domestic activities, women in rural areas engaged intensively in crop production. They are in general responsible for most of agricultural work in the homestead. Agricultural activities in the homestead, starting with seed selection to harvesting and storing of grains are largely managed by women. It is familiar that women alone or jointly with men, involved in almost all phases of farm production (Rothschild and Mahmud, 1989). Bala (2010) stated that women workers engaged and participate in most of the activities of farm but there is difference in wages inspite of doing similar kind or amount of work as male labour. Farid et al. (2009) conversed main role of women at farm and off-farm particularly in post-harvest operations, livestock and poultry rearing and homestead gardening. It is observed that women contribute about 43% of the farm labour and in some countries in Africa, this can often go to as high as 60% (FAO, 2011). The intensive participation of women has been recorded in the areas like land preparation (10-15%), seed selection for sowing operations (5-15%), nursery preparation (10-20%), transplanting (89-93%), irrigation of crops (10-15%), fertilizer management (2-10%), harvesting of the crop (70-89%), transportation of harvested crop (29-38%), threshing (37-42%) and storage of grains (70-83%) (Paris et al., 2006). In rainfed areas, male earners of the family migrate for short duration (seasonal) or long duration and women in migrant families have shown substantial capability and decision making power in farm operations (Paris et al., 2006). In Odisha situation, women participate in almost all the activities of rice

cultivation starting from sowing and transplanting operations to weeding, gap filling, harvesting, threshing, drying, storing and parboiling (Sadangi et al., 2004). Apart from agricultural production i.e. crop production, rural women play a vital and crucial role in different allied activities like post-harvest operation, livestock rearing, horticulture, agro-forestry, fisheries, etc.

Though women constitute about half of the total agricultural labour force, their access to household and farm resources as well as decision making power is limited. Predominantly, women in rice-based farming system undertake hard work, but they own or share very limited resources and benefits in comparison to other agricultural systems. Therefore, needs of the women, while undertake research and technologies developed should be addressed properly in terms of gender-based planning, implementation, monitoring as well as impact assessment. Though women contribute enormously to rice farming, they remain invisible and do not receive the benefits from farming, which are due to them. Studies indicated that in rainfed situation, women have a smaller access to farm assets and other facilities like agricultural inputs (e.g. seeds, fertilisers, plant protection chemicals), marketing facilities, extension services, etc. in comparison to men (Ajadi et al., 2015). Also, women do not possess land titles, which make them ineligible to access institutional credit for agriculture (Meinzen-Dick et al., 2019). Furthermore, women member of small and marginal households does have specific needs and priorities, which are not given due attention by the community and development agencies. Studies shows that if women had provided with the similar access to assets and inputs as men, it would boost yield by 30%, overall agricultural output can be raised by about 4% and hunger can be reduced by about 17% (FAO, 2011). Contribution of women in agriculture will be recognized only when they will gain knowledge and skill as well as get access to newer information for using in farming activities. Socio economic progress can be made only by connecting the information flow and skill amongst women (Dhaka et al., 2012).

The rural women have responsibility to feed the family, take care of the children and elders, arrange fuel and feed and care for animals. So, strategies need to be developed and implemented how rice technologies can better address the practical needs of women. In 21st century, women aspire for economic independence and influence the community by taking leadership positions. Women may need new pursuits, entrepreneurial skills and business endeavours, which can provide them higher economic returns. Therefore, rice researchers should have focussed approaches and methodologies to develop women friendly technologies (Sadangi and Mondal, 2019). They should be provided with autonomy besides higher social status and facilities through appropriate policies and programme. In this respect, the state's journey towards gender sensitive land governance took a new shape after 2000, when it started formulating progressive policies or amending the existing policies *viz*., 40% reservation for women in distribution of ceiling surplus land (2002), launch of Vasundhara scheme (2005), gender sensitive R & R policy (2006), etc. Through these initiatives, Government of Odisha ensured that women became land-owners and were considered equally important in the families (Choudhury et al., 2017). With cumulative effects of all efforts, number of operational holdings owned by women increased from 3.29% during 2010-11 to 4.07% during 2015-16. During the same period, extent of area operated by them changed from 3.05 to 3.66% (Government of Odisha, 2013 and Government of India, 2019). So, it is very pertinent to examine the capacity of women to control over resources and assess the impact in terms of incremental returns from rice cultivation at the end of the intervention period.

MATERIALS AND METHOD

Sample and data

To address the inequalities in access to resources between men and women and to design gender sensitive approaches in technology development and transfer, a village namely Sankilo (Nischintacoili block, Cuttack district of Odisha state) was adopted by ICAR-National Rice Research Institute, Cuttack during the year 2012-13. At the beginning 30 farm-women were chosen and a benchmark survey was conducted with regard to their involvement in rice farming, access to agricultural assets and inputs, extent of control over the outputs and benefits from rice cultivation. All the 30 farm-women have been provided with half-an acre land with the power to decide all the farm operations under the technical guidance of ICAR-NRRI, Cuttack. Interventions were taken up since 2012-13 upto 2016-17 in terms of demonstrations,

training, workshops and field days. An extended group of forty women farmers including earlier targeted thirty women were formally registered in the name of 'Ananya Mahila Bikash Samiti' aiming their all-round development. All the forty women farmers constitute the sample for the current study. An interview schedule has been prepared containing questions related to demographic features, on their profile, their involvement in farming activities (both in physical and managerial activities), access to farm assets and inputs, returns from rice cultivation, gender relations, etc. and it was pre-tested. Data was collected through primary survey of individual women farmer using one-to-one interview approach.

Analytical tools and techniques

Input-output analysis and sources of household income

Yield and returns from rice cultivation collected at the end of the project activities (2016-17) has been compared with the crop data collected before initiation of interventions (pre-project situations). Further, the sources of income of the beneficiary household viz. crop cultivation, livestock, labour wages and non-farm sector was assessed and analysed.

Decomposition analysis

It is observed that per hectare (ha) returns from rice cultivation was higher during post-project situation (2016-17) in comparison to pre-project period (2011-12) after compensating price changes (price during 2016-17 used to valuate input and output). This differences may be attributed to the effect of demonstration over the years apart from differentials in quantity of inputs used. If we call the interventions made through this project as a 'technology' and segregate the effect of inputs, we can get the estimates of contribution of 'technology' in terms of various interventions made through the project using decomposition analysis technique developed by Bisaliah (1977). To accomplish the decomposition analysis, Cobb-Douglas production function has been used as below:

$$Y_i = A_i L_i^{ai} S_i^{bi} F_i^{ci} M_i^{di} C_i^{ei} \varepsilon^{ui} \quad \ldots\ldots(1)$$

Where,

Y_i = Gross returns from rice cultivation, in rupees/ha

L_i = Human labour input, in rupees/ha

S_i = Value of seed, in rupees/ha

F_i = Value of fertilizer & manures, in rupees/ ha

M_i = Value of machine use, in rupees/ha

C_i = Miscellaneous capital expenses, in rupees/ ha

A_i = Scale parameter (constant term)

u_i = Random term with finite variance and zero mean

a_i, b_i, c_i, d_i, e_i = Output elasticities associated with human labour, seed, fertilizer, machine use & capital expenses, respectively.

By using the model (equation 1), the production function for pre-project period and for the year 2016-17 were specified as below:

$$Y_1 = A_1 L_1^{a1} S_1^{b1} F_1^{c1} M_1^{d1} C_1^{e1} \varepsilon^{u1} \ldots\ldots(2)$$

$$Y_2 = A_2 L_2^{a2} S_2^{b2} F_2^{c2} M_2^{d2} C_2^{e2} \varepsilon^{u2} \quad \ldots\ldots(3)$$

Variables and parameters as defined in equation (1) are similar in equation (2) and equation (3).

Following Bisaliah (1977), the composite decomposition from the above production functions was formulated as following.

$$\log [Y_2/Y_1] = \log [A_2/A_1] + [(a_2-a_1) \log L_1 + (b_2- b_1) \log S_1 + (c_2-c_1) \log F_1 + (d_2-d_1) \log M_1 + (e_2-e_1) \log C_1] + [a_2 \log(L_2/L_1) + b_2 \log(S_2/S_1) + c_2 \log(F_2/F_1) + d_2 \log(M_2/M_1) + e_2 \log(C_2/C_1)] + (u_2-u_1) \ldots\ldots\ldots(4)$$

The equation (4) describes the natural logarithm of the ratio of gross return during post-project period (2016-17) to the gross returns during pre-project period, which is approximately a measure of percent change in returns with the interventions. On the right hand side, the first expression closed by brackets is a measure of percent change in return due to shifting of scale parameter (A) of the production function, which is attributed to the neutral part of technology effect. The second expression closed by brackets, the sum of the arithmetic changes in output elasticities each weighted by the logarithm of the inputs used, is a measure of change in return due to shifting in slope parameters (output elasticities) of the production function (non-neutral part of technology effect). The third term closed by brackets refers to the gap, which can be attributed

to differences in the input use weighed by the slope coefficients of the production function with respect to the year 2016-17 (post-project period).

Regression analysis

A linear production function was fitted and estimated to identify the factors which might have influence the household income from all sources for the family of the adopted women farmers.

The function was fitted as below:

R = f (EDU, FSIZE, IRRIG, SAU, PARTICIP)

Where,

R = Total household income from all sources (rupees in thousand per year)

EDU = Education level of the women farmer (number of years of schooling)

FSIZE = Available number of working persons in the family

IRRIG = Irrigated land in ha

SAU = Standard Animal Unit (Patel and Kumbhare, 1980)

PARTICIP= Participation of the women farmer in number of demonstrations since beginning of the project.

RESULTS AND DISCUSSION

Brief descriptions of interventions & achievements

The year 2012-13: The Sankilo village of Cuttack district, Odisha state was selected for empowering the women through provision of access to farm resources. A preliminary meeting and sensitization programme was organized and a bench mark survey was conducted to know the demographic and socioeconomic characteristics, involvement of women in crop cultivation practices, access to agricultural assets and inputs, returns from rice cultivation, gender dynamics, etc. In respect to extent of involvement in major decision-making process in agricultural activities, it was observed that most of the women were involved in activities like selection of varieties, irrigation and sale of output, but rarely consulted in plant protection measures, fertilizer application and buying of farm equipment and inputs. During focus-group discussion, farmers stated that they were growing mostly local non-descriptive rice varieties (*e.g*., Saruchina, Kalamalata, Mathura, etc.) in rainfed land with very meagre yield (1.5 to 2.5 t ha^{-1}) before initiation of the programme. In limited areas, where irrigation was available, few high yielding varieties like Pooja, Sarala, etc. were cultivated with yield upto 4.0 t ha^{-1}.

The year 2013-14: Demonstrations of seven rice varieties conducted with the participation of 30 farm-women using the technologies like mat-type nursery, treatment of seeds, transplanting in lines, balanced fertilizer application and need-based pesticide application. All the varieties yielded higher than the control variety and control plots of similar varieties with incremental yield of about 10-20%. One awareness training on integrated pest management (IPM) and two number of training-cum-demonstration on mushroom cultivation using paddy-straw were conducted for the benefit of women as well as other farmers.

The year 2014-15: Six rice varieties developed by ICAR-NRRI, Cuttack namely, Shatabdi, Naveen, CR Dhan 303, CR Dhan 304, Pooja and Ketekijoha (aromatic) were demonstrated by thirty adopted farm-women in half-an-acre area each. In addition to varieties, demonstration of methods like treatment of seeds, raising seedlings in mat-type nursery, transplanting in lines, balanced use of fertilizers, need based plant protection measures; using of manual rice transplanters, drum seeder, finger weeder, etc. were also conducted. During this year, ten more women joined the group and all of them formally registered in the name of 'Ananya Mahila Bikash Samiti' for their all-round development through other income generating activities. During *rabi* season, vegetable crops, *viz*., capsicum, broccoli, red cabbage, China cabbage, carrot, potato, cherry tomato, cauliflower, garlic, pumpkin, coriander and amaranthus were demonstrated and critical inputs including seeds were distributed.

The year 2015-16: Demonstrations of seven rice varieties, *viz*., Naveen, Swarna *sub-1*, CR Dhan-303, CR Dhan-304, CR-1018 and Durga were conducted by all the forty adopted farm-women in half-an-acre area. Like previous years, methods like treatment of seeds, mat-type nursery, transplanting in lines, balanced use of fertilizers, need based plant

protection measures; using of manual rice transplanter, power operated transplanter, finger weeder, etc. were demonstrated. A value-chain of rice has been initiated for the benefit of 'Ananya Mahila Bikash Samiti' through cultivation of high value aromatic rice variety 'Geetanjali'.

The year 2016-17: Five rice varieties viz; Sachala, CR Dhan-310, CR Dhan-303, CR Dhan-304 and Maudamani were demonstrated in the ½ acre plot with the participation of all the forty farm-women. All of them adopted 'seed treatment with Carbendazim', 'line transplanting' and 'application of recommended dose of fertilizers' and perceived these technologies as very beneficial. Bio-fertilizers like Azotobactor liquid and Mycorrhiza were distributed to the farm-women for vegetable farming for additional income to the family.

Returns from rice cultivation

Before inception of the project, the beneficiary farm-women were cultivating many local varieties with less yield along with few improved rice varieties. However, after initiation of the project, they have been cultivating only improved rice varieties. Table 1 presents the growth in yield (average of all the varieties) as well as operational expenses over the pre-project period (2011-12). It indicates that average yield increased by 42% during the period. Though, operational expenses per unit area increased by 18%, gross returns and net returns over operational expenses increased by 41% and 76%, respectively.

To estimate the contribution of technology and associated inputs in differences of returns from per ha rice cultivation between the two periods, decomposition analysis was used. As described, per ha gross returns was higher during 2016-17 compared to the period before inception of the project. This differences may be attributed to the effect of demonstration over the years apart from the quantity of inputs used. If we call the interventions made through this project as a 'technology' and segregate the effect of inputs, we can get the estimates of contribution of 'technology' in terms of various interventions made through the project. Following decomposition analysis technique developed by Bisaliah (1977), segregation of factors which caused the differences in returns showed that the 'technology' effect contributed primarily and accounted for 27% difference (Table 2). This implies that even without changing the level of resource use, the returns could have been increased by about 27%, if all of them participated in the demonstration and other activities of the project thereof.

Table 2. Decomposition of difference in gross returns between the two periods.

	Sources of difference in gross returns	Per cent contribution
A.	Technical change	
I.	Neutral technological difference	381.44
II.	Non-neutral technological difference	-354.23
	Difference due to technical change	27.21
B.	Difference due to change in input use level	
1.	Physical inputs	7.83
2.	Labour input	3.17
	Difference due to input use efficiency	11.00
C.	Total estimated difference in gross returns	38.21
D.	Total observed difference in gross returns	40.11

Differences in the input use contributed for the gap to the extent of 11%, which indicate that gross returns could be increased by 11% even without any interventions, if the level of input use by them enhanced to the same level as during post project period. There was a minor divergence between the observed and the estimated differences in gross returns between the two periods, which may be due to the random error term and the missing variables (Kiresur and Ichangi, 2011; Mondal et al., 2014, 2015).

Table 1. Input-output analysis of rice cultivation (per ha) during pre-project period & post-project period.

Particulars	Pre-project (2011-12)	Post-project (2016-17)	Mean difference*	t-Stat
Yield (q/ha)	35.50	50.38	14.88 (42%)	3.95
Operational expenses (Rs. in thousand/ha)	25.58	30.28	4.70 (18%)	9.85
Gross returns (Rs. in thousand/ha)	42.27	59.59	17.32 (41%)	8.71
Net returns (Rs. in thousand/ha)	16.70	29.31	12.61 (76%)	6.22

*Mean differences were significant at 1% level.

Table 3. Sources of household income at the end of project (2016-17).

Sources	Mean income (rupees in thousand per year)	Proportion (%)	Standard deviation	Minimum (rupees in thousand per year)	Maximum (rupees in thousand per year)
Crops and horticulture	24.85	58.57	36.18	4.58	198.41
Livestock	6.41	15.11	7.10	1.00	10.07
Wage labour	5.17	12.18	2.52	1.98	9.77
Non-farm income	5.97	14.14	5.09	1.59	35.77
Total	42.39	100			

Household income and its' determinants

An analysis was done to assess the sources of income of the household during the year 2016-17, *viz*., crop cultivation, livestock, labour wages and non-farm sector and the result is presented in Table 3. It is observed that crop cultivation including horticultural crops and vegetables contributed about 59% of the household income followed by livestock (15%), non-farm sources (14%) and labour wages (12%). During a focus-group discussion, it was indicated that the acquired knowledge, skill and demonstrated technologies have been used and adopted for cultivation of rice as well as other crops and enterprises. Cultivation of vegetable and pulses increased and other livelihood opportunities like livestock rearing have also been strengthened, which also influenced to increase annual income of the households. Further, to understand the dispersion in income, a regression analysis was done to find the factors that might cause the variations. The results indicated that level of education, family size and extent of irrigated land influenced significantly towards accrual of income from crops and other enterprises (Table 4). The variable like participation of the women farmers, though found positive coefficient but not significant. This might be due to the fact that almost all the women farmer participated in most of the demonstration activities, hence, there is insignificant variations in determining household income.

Table 4. Determinants of household income at the end of project (2016-17).

Variables	Coefficients	Standard error	t Stat	P-value
Age	-0.10	0.59	-0.16	0.193
Education	2.87*	1.47	1.95	0.059
Family size	7.95**	2.45	3.25	0.003
Irrigated land	26.74**	5.56	4.81	0.000
Standard animal unit	-2.15	2.70	-0.80	0.430
Participation status	5.81	11.49	0.51	0.616
Intercept	-37.94	28.56	-1. 23	0.19
Multiple R	0.75			
R^2	0.56			
Observations	40			

*10% level of significance; **1% level of significance

CONCLUSIONS

Selected farm-women have been provided with land titles by their male-counterparts and power to decide all farm operations in half an acre land and ICAR-NRRI, Cuttack provided technological backstopping for five years' period. At the end of five years, they have been assessed in terms of increment in yield and returns from rice cultivation. It is being observed that change in return was almost double to four-fold of changes in operational expenses from rice cultivation. The decomposition analysis amply shows that 'technology' in terms of varietal and other demonstrations contributed mostly in differences of gross/net returns over pre-project situation. The results advocated for similar kind of interventions by developmental departments in terms of providing access to land other productive resources along with the demonstrations of newer technologies for boosting farm income. Household income from all the sources were analysed and regressed over socioeconomic characteristics of the farm households and it is indicated that education, family size and irrigated land holding influences the variation in total income of the households. So, education and capacity building of the women as well as household heads can enhance the knowledge and adoptive capacity for the technologies for boosting the yield and income.

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