

## Technology Dissemination Approaches for Bridging Rice Yield Gaps on Small Farms

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### ABSTRACT

*The small and marginal holdings at the national level constitute about 85% of the total number of operational holdings in 2011. The importance of rice cultivation on these small farms warrants systematic assessment of yield gaps and production constraints. Hence, a study was undertaken to measure the yield gap in small scale rice farming and to identify the factors that contribute to the gap. Guntur and Nalgonda districts of Andhra Pradesh were selected and the data were collected from 120 small holder rice farmers during Kharif 2012. The Index of yield gap was found to be 17.4%. Garrett's ranking technique revealed that lack of remunerative price, shortage of labour during peak operation periods, non-availability of fertilizers in time and incidence of pests and diseases were the major constraints in rice production. If the production constraints experienced by farmers in this region are addressed, productivity can be increased. The paper discusses various issues related to the yield gaps in small scale rice farming and strategies to address such gaps. Several extension approaches like Mobile application approach to provide price information, Volunteer farmer trainers for fertilizer, pest and disease management, farmer to farmer exchange and farmer's field schools are discussed for translating research yields to yields on small farms.*

**Key words:** Rice yield gaps; Extension approaches; Small farms;

India is the land of small and marginal farmers with an average land holding size of 1.16 ha. The small and marginal holdings at the national level, taken together (<2 ha) constitute 84.97% and the operated area under small and marginal holdings was 44.31 % in 2010-11 (Agril. Census 2011). In case of Andhra Pradesh, the number of the small and marginal holdings constitutes 86 % to the total number of the operated holdings and 55 % of the total operated area in 2010-11.

Rice, the staple food crop of India is grown on an area of 44 mha with production of 104.32 mt with yield levels still remaining low at around 2.37 t/ha of rice and 3.5 t/ha of paddy in comparison with world average paddy productivity of 4.4 t/ha. Andhra Pradesh is one of the leading producers of rice and it is often called the 'Rice bowl of India'. Rice is grown by almost all of the small and marginal holder farmers in Andhra Pradesh.

Several studies have shown the existence of yield difference between the potential, the best practices and actual yields in different rice growing areas representing

various agro-ecologies. The yield gaps were observed between 2 to 5.0 tons/hectare between average and climatic yield potential and 1.2 to 2.6 tons/hectare between average and best farmers' yields in South East Asia (Laborte, 2012). Yield analysis further reveals that 30 to 40 per cent of the potential yield is yet to be tapped with available rice production technologies. (Swathi et al 2006). In the irrigated rice ecology in south zone, the yield gap ranged from 15.6 percent in Tamil Nadu to 49.8 percent in Kerala (Siddiq et al 2000).

*Agrarian structure and rice production scenario in Andhra Pradesh :* In Andhra Pradesh, between 1956-57 to 2010-11, the share of small and marginal farmers has grown from 58 to 86 per cent and the share of the area under them has increased from 18 to 54 per cent. The area under the medium farmers has declined from 44 per cent to 41 per cent and the share of the number of the land holdings has gone down from 33 to 13 per cent. The share of the holdings of the big farmers has

declined from 9 per cent in 1956-57 to less than one percent with a 4 per cent share of the area under them in 2010-11. These results clearly indicate that the agrarian structure of Andhra Pradesh is dominated by small and marginal farmers.

During the year 2011-12, in Andhra Pradesh rice was grown on an area of 4.1 million hectares out of the 43.97 million hectares with a share of 9.32 per cent to the total rice area at national level. The contribution of the state to the total rice production was 12.35 per cent with 12.89 million tons. The average yield of the state was 3.14 tons per hectare which was well above the national average of 2.37 tons per hectare

In view of the above challenges and opportunities, the present study was taken up to know the extent of yield gaps and constraints in rice production among the small holder rice farmers of Andhra Pradesh, with the following objectives:

- i. To analyze the magnitude of yield gaps in rice on small farms
- ii. To elicit the constraints in realizing the potential yield of rice
- iii. To suggest various extension approaches to bridge the yield gaps on small farms

## METHODOLOGY

In the first stage, Guntur and Nalgonda districts of Andhra Pradesh were purposively selected for the present study as they represent two different agro-climatic zones *viz.*, Krishna and Southern Telangana zone respectively. In the second stage, Cherukupally mandal of Guntur district and Devarakonda mandal of Nalgonda district were selected because of the conduct of FLDs on rice production technologies in these mandals (by KVK Vinayashram of Cherukupally mandal of Guntur district and ARDS-NGO of Devarakonda mandal of Nalgonda district). Sixty small holder rice farmers with less than 2 ha of land holding were selected purposively from each of these two mandals. Thus the total sample size was 120 small holder rice farmers. A well-structured interview schedule was constructed and data were collected from the respondents through personal interview method, and the data pertains to *Kharif* 2012. The data on research station yield and frontline demonstration yield were collected from the offices of the KVK Vinayashram of Cherukupally mandal of Guntur district and ARDS-

NGO of Devarakonda mandal of Nalgonda district. Various indices of yield gaps were worked out using the following formulae:

$$\text{Yield gap I (\%)} = \frac{Y_p - Y_d}{Y_p} \times 100$$

$$\text{Yield gap II (\%)} = \frac{Y_d - Y_a}{Y_d} \times 100$$

$$\text{Index of Yield gap} = \frac{Y_p - Y_a}{V} \times 100$$

$$\text{Index of Realized Potential Yield} = \frac{Y_a}{V} \times 100$$

$$\text{Index of Realized Potential Farm Yield} = \frac{Y_a}{Y_d} \times 100$$

$$\text{Total Yield Gap} = \text{Potential yield} - \text{Actual yield}$$

Where,

$Y_p$  = Potential Yield/Experimental station yield

$Y_d$  = Potential Farm Yield/Front line demonstration yield

$Y_a$  = Actual Yield realized by the sample farmers

*Garrett's ranking technique:* The Garrett's ranking technique was employed to study the constraints of the farmers regarding the cultivation of rice. The percent position of each rank was found out by the formula:

$$\text{Per cent position} = \frac{100 (R_{ij} - 0.5)}{N_j}$$

Where,

$R_{ij}$  = Rank given for the  $i^{\text{th}}$  item by the  $j^{\text{th}}$  individual,

$N_j$  = Number of items ranked by the  $j^{\text{th}}$  individual.

The percent position of each rank was converted into scores using Garrett's table. For each constraint, scores of individual respondents were added together and were divided by total number of respondents for whom scores were added. Thus mean score for each constraint was ranked by arranging them in descending order.

## RESULTS AND DISCUSSION

*Assessment of yield gap :* The average potential yield realized at research station was 5.13 t/ha, the average yield obtained in the demonstration plots was 4.76 t/ha, whereas the average yield realized by the sample farmers was 4.27 t/ha (Fig 1). Yield gap I which is the difference between the potential yield and the potential farm yield is 7.2 % (Fig 2). Yield gap II which is the difference between the potential farm yield and actual yield realized by the sample farmers is 10.2 per cent. The Index of yield gap was found to be 17.4 per cent. The index of realized potential yield which is a measure of the extent to which the yield obtained at research

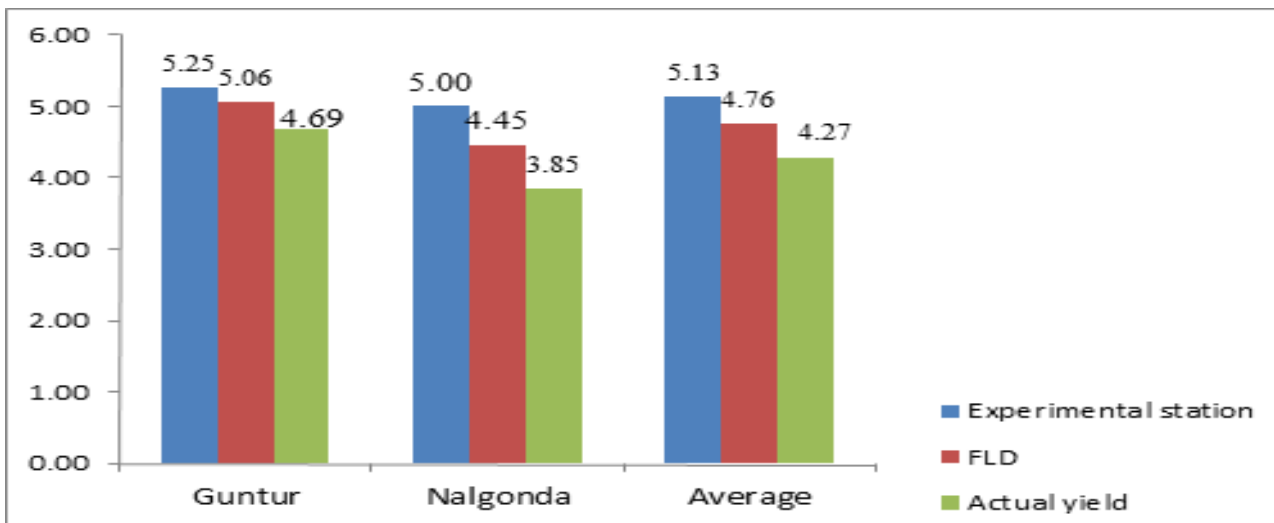


Fig: 1 Yields at different levels (t/ha)

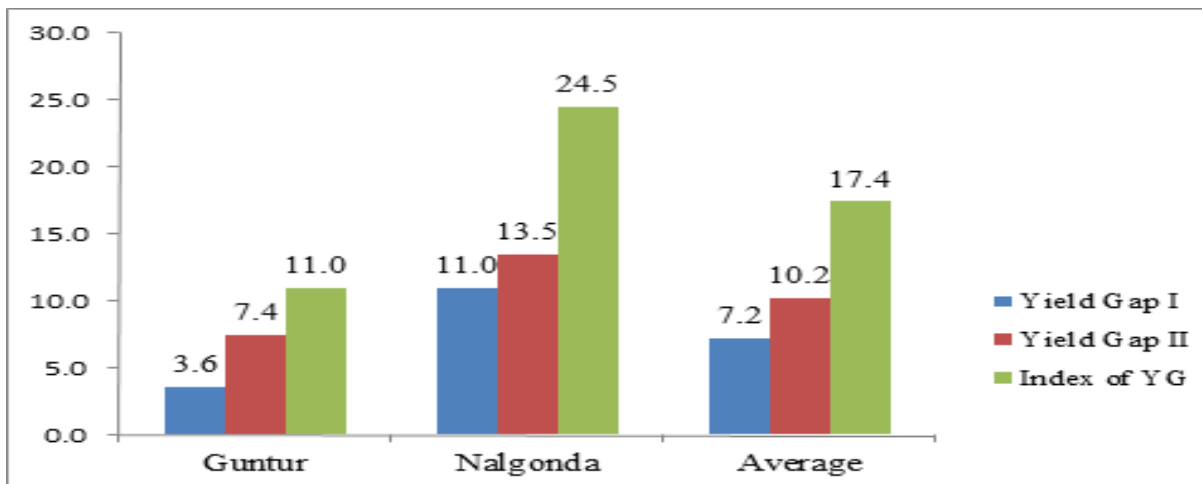


Fig: 2 Yield gaps in rice in the sample districts

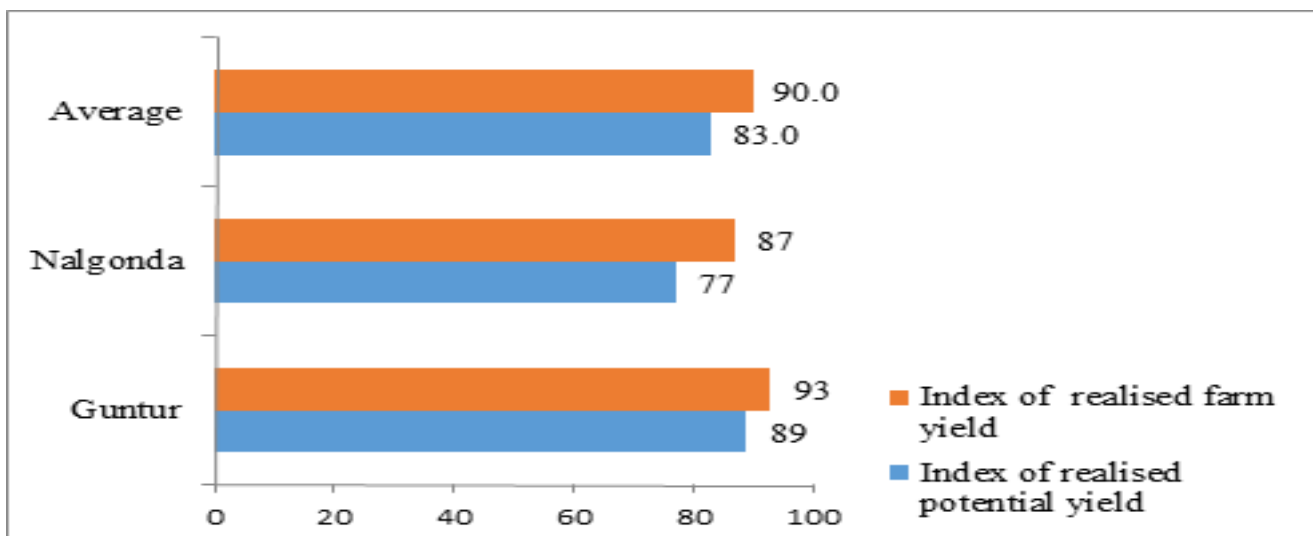


Fig: 3 Indices of yield gaps in the sample districts

**Table 1. Constraints in rice production in Guntur district**

Constraint category	Constraints (%)	Score	Rank
<i>Institutional</i>			
Release of canal water	20.62	66	III
Timely availability of fertilizers	10.12	75	I
Lack of remunerative price	13.82	72	II
<i>Technical</i>			
Late transplanting	78.46	35	IX
Imbalanced use of fertilizers	68.41	41	VII
Ineffective weed control	76.2	36	X
Pests and disease incidence	41.2	54	V
<i>Mechanization</i>			
Machinery and equipments	69.66	40	VIII
<i>Socio-economic</i>			
Problem of tenancy	63.64	43	VI
Labor shortage	27.24	62	IV

**Table 2. Constraints in rice production in Nalgonda district**

Constraint category	Constraints (%)	Score	Rank
<i>Institutional</i>			
Lack of remunerative price	16.4	69	II
Timely availability of fertilizers	20.2	66	IV
<i>Technical</i>			
Late transplanting	66.4	42	IX
Imbalanced use of fertilizers	22.5	65	V
Ineffective weed control	72.9	38	X
Pests and disease incidence	18.8	67	III
<i>Soil related problems</i>			
Salt affected soils	28.6	61	VI
<i>Mechanization</i>			
Machinery and equipments	48.4	50	VII
<i>Socio-economic</i>			
Problem of tenancy	56.8	47	VIII
Labor shortage	14.6	71	I

station has been realized on the farmer's field was 83 per cent. The index of realized potential farm yield which is a measure of the extent to which the yield obtained at demonstration plots has been realized on the farmers' field was 90 per cent (Fig 3). These results indicate that still there is an untapped yield of 17.4 per cent which can be realized on the farmers' field with the existing technologies.

*Constraints in realizing the potential yields:* The farmers were asked to rank the constraints in rice

production. The relative importance of the perception of the farmers regarding the major constraints in realizing the potential were prioritized by using Garrett's ranking technique.

The results revealed that non-availability of fertilizers in time, lack of remunerative price, non-release of canal water, shortage of labor during peak operation periods, and pests and disease incidence were the major constraints in Guntur district with a Garret's score of 75,72,66,62 and 54 respectively (Table 1). The problems of tenancy, ineffective use of fertilizers, lack and requisite machinery and equipment, late transplanting and ineffective weed control were the other constraints in rice cultivation, as opined by the sample farmers in the study area. In case of Nalgonda district, labour shortage, lack of remunerative price, incidence of pests and diseases, non-availability of fertilizers in time, and imbalanced use of fertilizers leading to yield losses were the major constraints as opined by the sample farmers with a Garret's score of 71,69,67,66 and 65 respectively (Table 2). Labour shortage was found to be more critically felt during harvesting than transplanting and weeding as the sample farmers felt that these operations could be staggered to some extent but harvesting could not be postponed and has to be carried out on time due to the fear of rainfall during the harvesting period and loss of yield and therefore labour was hired at higher charges during this period.

*Technology dissemination approaches:* New extension approaches are needed to help farmers to access information, adopt technologies and build their capacities to solve problems. There is an increasing emphasis on alternative and innovative extension approaches as the public sector extension services are facing decline in both budget and staff. Some of the following extension approaches that are participatory and farmer-centred can be effectively used for dissemination of improved technologies to reduce yield gaps in rice.

*Volunteer farmer trainers (VFT) :* Is a form of farmer-to-farmer extension where VFTs host demonstration plots and share information on improved agricultural practices within their community? VFTs are trained by extension staff and they in turn train other farmers. It is highly effective because VFTs have an in-depth knowledge of local conditions, culture, and practices, and are known by the other farmers. They live in the

community, speak the same language, use expressions that suit their environment, and instill confidence in their fellow farmers.

*Community based seed production* : Seed plays an important role in the efforts to improve the productivity and reduce yield gaps because farmers are concerned about a lack of seed at planting time. Farmers are informally involved in recycling grain as seed and both Public and Non-Governmental Organizations (NGOs) can play an important role in community based seed production activities with the active participation of farmers to improve the timely availability and supply of quality seeds.

*Informal farmer-to-farmer exchange* : It is important to give due recognition to the informal sector as a low-cost source of seed, and to use it as a vehicle for providing resource-poor farmers with improved seed of improved varieties at affordable prices as over 90 percent of smallholder farmers' requirements are met through these channels.

*Seed production through co-operatives and farmer Producer Organizations* : Organizing farmers into cooperatives, small enterprises, or growers' associations can be stimulated when local seed production is successful. Commercial specialization is difficult, however, when special expertise or resources do not produce significantly better-performing seed for which a better price can be obtained. This is the case for many self-pollinating crops that are relatively easy to store, with no important disease or storage problems.

*Seed kits* : The distribution of large numbers of relatively small samples of seed from improved varieties, with information on the seeds and with fertilizer, can be used as a way to introduce new varieties and quality seed into local seed systems, assuming further diffusion via farmer-to-farmer exchanges.

*Community seed banks* : Seed banks can support the storage of seed reserves, at the same time, contributing to improved production and selection practices, and communal storage. Community seed banks could potentially improve access to seeds for the poorest farmers and be an entry point for the development of farmers' organizations and capacity building. Seed banks can also be organized to serve as local germplasm collections to improve farmers' access to genetic diversity. Organization of community seed banks may, however, be complicated.

*Seed fairs and diversity competitions*: Local seed fairs have become important activities to stimulate local exchange of seeds and raise awareness among farmers of the relevance of crop genetic diversity. They are important occasions for farmers to find seed of varieties that have been lost or need replacement. Activities that directly support farmers usually have a strong local focus and make use of participatory methodologies. These activities all contribute to the strengthening of the local system of plant genetic resource management.

*Seed Village Concept* : The gap between requirement of quality seeds for the state and their supply rate is large. The supply of seeds by the public sector organizations and private agencies is insufficient to bridge the gap. The gap may be reduced by involving the end users i.e farmers in the production of quality seeds. A group of farmers or villages will be identified under "*Seed Village*" concept to produce a particular crop/variety. Villages with a potential of producing seeds will be identified around the research stations for easier and quality multiplication of varieties of different crops.

*Farmer Field School (FFS)* : The Farmer Field School (FFS) approach is a widely practiced participatory model that integrates farmers into the technology transfer process. FFS was first developed in Indonesia as a method to train farmers in controlling the brown plant hopper, which was ravaging Java's rice paddies. The key to the success of the FFS approach is that it gives farmers the opportunity to not only observe the effects of new technologies on smallholder plots, but also to discover the problems and solutions themselves. In so doing, participants gain skills in training techniques and deepen their understanding of the technical material as well.

*Voice Information Delivery Services* : This is a telephone-based information delivery service that provides advice on farming methods and market access to improve the lives of rural farming communities. Answers to many of these problems may well be on the internet – but with connectivity, literacy and language barriers, this is way beyond the reach of the vast majority of farmers. The solution is comprised of a unified messaging platform incorporating Interactive Voice Response (IVR) functionality, integrated with a Customer Relationship Management application to support integrated call handling and management of a very large audio database.

*Radio: Dial-UP (agricultural information on*

*demand) and regular radio broadcasts* : This includes regular radio broadcasts that provide market prices or other agricultural information and dial-up radio that feature a series of short segment audio programs that provide small-scale farmers telephone access to relevant information through an automated voice system. This radio system is an information hub featuring a regularly updated, diverse menu of pre-recorded agricultural content.

*Extension services based on mobile phone and database monitoring* : This is a media channel that allows anyone anywhere to affordably share market information via mobiles or through the internet. By tracking activities and profiles, the service becomes a crucial profiling and business monitoring tool, as well as an advertising medium. By focussing on profiling, this service can minimize risk in transactions, offer some brokerage services, and provide a revenue stream by permitting advertising and data mining. To date, most licensees have been donor projects.

*E-learning for basic skills, agricultural education and Video-based approaches* : E-learning courses are a potential medium for the provision of information and learning material for agricultural skills. The specific video-based approach has several important advantages to traditional forms of agricultural content, which are typically not in the local language, are intended for a literate audience, use expert terminology, lack grassroots level practicalities, and remain inaccessible in a sea of scattered media.

*Using Mobiles in Agriculture*: The use of mobile phones in agriculture has already witnessed failure as well as success. Mobile agricultural applications, may

(1) educate and raise awareness, (2) distribute price information, (3) collect data, and (4) track pests and diseases. They can promote improved livelihoods through networking and informing previously unconnected portions of the population. Mobile phones can serve as an important tool for early warning systems to mitigate agricultural risks and safeguard agricultural incomes. Mobile phones also help in the commercialization of farm products.

## CONCLUSION

The results revealed a considerable yield gap of 17.4 per cent in the study area, implying that, if the production constraints experienced by the farmers in this region are addressed, productivity can be increased to the tune of 17.4 per cent. Lack of remunerative price, shortage of labour during peak operation periods, non-availability of fertilizers in time and incidence of pests and diseases were the major constraints in realizing the potential yield in rice in the study area. Owing to a rise in wage costs, the cost of cultivation has gone up and the farmers felt that there is a need to increase the minimum support price to make small scale rice farming remunerative. Adoption of selective mechanization of farm activities can be considered as a strategy to overcome the problem of labour shortage. Timely extension services on pest and disease management will help in reducing the yield losses. Institutional support in the form of provision of credit facilities to procure and use the recommended level of inputs may be considered to enable the farmers to bridge the productivity gaps and thereby realize the potential yield and sustain small scale rice production.

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