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and all others interested

On Critical Policy Issues in India's Agricultural Economy

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Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Madhya Pradesh

H. O. Sharma, Deepak Rathi, Pradeep Kumar Patidar

Introduction

- Improving crop yields is essential to meet the increasing demand for food driven by the increasing population and income growth in the 21st century. Increasing agricultural productivity or yield is critical to economic growth and development. It can be achieved by using improved agricultural technologies and applying efficient management techniques. Since, the adoption of techniques differs for every farmer, focus should be on high yielding management practices (Yang et al., 2008)[1], and minimizing yield gaps in major crops by using optimal management practices which may lead to an improvement in production, while offering both environmental benefits and economic value.

- Bundelkhand is a mountain range in central India divided between the states of Uttar Pradesh (U.P.) and Madhya Pradesh (M.P.) with the larger portion in Madhya Pradesh. Bundelkhand comprises of 14 districts: Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakoot (in U.P.), and Datia, Tikamgarh, Niwari, Chhatarpur, Panna, Sagar and Damoh (in M.P.). Bundelkhand is a rocky area and has a high percentage of barren and uncultivable land. The soil form is the mixture of black and red-yellow which is not considered very fertile. Rainfall is sparse and the agricultural production is low. Bundelkhand has lost its forest cover to a large extent. So, dependency on forest as a means of livelihood is reducing day by day.

- It seems that the farmers are not able to adopt the recommended package of practices for cultivation of crops due to several socio-economic, technological constraints, etc., resulting into low farm income, high poverty levels which is the main cause of farmers' dissatisfaction.

- The present study was undertaken in all the districts in Bundelkhand region of Madhya Pradesh to analyze the yield gap of major crops grown by the cultivators across sizes of holdings and factors affecting the productivity of these crops. The collection of data and analysis related to interviews was conducted using Computer-Assisted Personal Interviewing (CAPI).

- All the major crops having more than 10 percent share in gross cropped area were selected. Therefore, wheat (27.64%), soybean (16.30%) and gram (14.04%) were considered. Yield gap between the average yield of major crops in the district and average yield of that particular crop was studied. Districts with a higher and a lower yield gap had been selected for each crop. Panna (-43.96%) and Tikamgarh (-19.79%) districts were selected for soybean, while Panna (-43.88%) and Datia (-4.78%) districts were selected for wheat and Chhatarpur (-23.05%) and Damoh (-4.04%) districts were selected for gram for this study.

- A block in each district was further selected on the basis of the highest area under the crop. A list of all the villages in each selected block was prepared and three villages having maximum area under cultivation of the crop were selected for the study. A list of all the cultivators growing the selected crop was further prepared and

1 Yang, Woonho & Peng, Shaobing & Laza, M. R. & Visperas, Romeo & Dionisio-Sese, Maribel (2008). Yield Gap Analysis between Dry and Wet Season Rice Crop Grown under High-Yielding Management Conditions. Agronomy Journal- AGRON. 100. 10.2134/agronj2007.0356.

classified into small (area<2 ha), medium (2-5ha) and large (>5ha) categories and 10 farmers in each category were selected randomly. A total of 180 farmers-30 each from districts with high and low yield gap were selected for all the crops in the study.

Findings

- Maximum yield gap between the potential and average farm yield (yield gap III) was found in cultivation of gram (43.59%) followed by soybean (38.87%) and wheat (29.86%). The yield gap II (highest farm yield-average farm yield) was found to be more than yield gap I (potential farm yield-highest farm yield) in cultivation of wheat, gram and soybean (see Table 1). It is understood that the Recommended Package of Practices (RPP) for cultivation had reached the field but farmers could not adopt these technologies due to unavailability of desired variety of seeds, high cost of inputs, lack of knowledge about the dose of fertilizers as per soil test recommendation, the method of seed treatment. Table 1 given below shows the yield gap analysis for various crops.

Table 1: Yield Gap Analysis (quintals/acre)

Particulars	Wheat	Gram	Soybean
Potential Yield (A)	23	8	10
Average Yield (B)	16.13	4.51	6.11
Highest Yield (C)	20.31	6.5	8.86
Yield gap-I (A-C)	2.69	1.5	1.14
	(11.68)	(18.79)	(11.43)
Yield gap-II (C-B)	4.18	1.98	2.74
	(20.29)	(30.49)	(30.85)
Yield gap-III (A-B)	6.87	3.49	3.89
	(29.86)	(43.59)	(38.87)

Source: *Survey*. ***Note:*** *Figures in parenthesis shows percentage difference*

- Low germination of soybean seed (70%) was reported as the major constraint in the study area. The respondents also reported the unavailability of capital, electricity and labor during the peak cultivation season.
- A multiple regression model was run to find out determinants for yield of major crops and was found to be a good fit as it explained more than 80 percent contribution of known independent variables. The crop response in terms of productivity with respect to independent variables like use of High Yielding Varieties (HYVs), improved method of sowing, seed replacement (purchase seed), consumption of fertilizers as per soil test recommendation, proper seed rate, increased consumption of Di-Ammonium Phosphate (DAP) fertilizer was found to be positive while age (in years) was found to be negative.

Table 2: Determinants of Yield of Major Crops (Regression Coefficients b1 to b12)

Particulars	Coefficients		
	Wheat	Gram	Soybean
"a" value	621.68 (0.1235)	251 (0.0003)	122.24 (0.9440)
Education (X1)	-0.0541 (0.6057)	37.2378 (0.0401)	11.0281 (0.0652)
Age in years (X2)	-0.0181 (0.2831)	-1.6908 (0.2684)	-1.2299 (0.1439)
Source of Seed (X3) (Purchase-1, Self-0)	1.0517* (0.0213)	49.2581 (0.1990)	103.7147 (0.0839)
Soil Test (X4) (Yes-1, No-0)	1.5739** (0.0001)	42.1450 (0.3040)	53.5092 (0.5784)
Seed Rate (kg) (X5)	0.0262** (0.0000)	31.1188** (0.0051)	3.8736* (0.0353)
Seed Treatment (X6) (Yes-1, No-0)	-0.2309 (0.5528)	106.4320* (0.0252)	29.8112 (0.5238)
Use of HYV's Seed (X7) (HYVs-1, Local-0)	0.3258 (0.4659)	154.4361** (0.0031)	81.8860* (0.0226)
Urea (kg) (X8)	0.0274* (0.0498)	35.4693** (0.0015)	-0.5941 (0.9087)
DAP (kg) (X9)	0.0469 (0.1014)	2.3281 (0.4938)	5.7391** (0.0094)
Area under Irrigation (X10)	0.1172 (0.0955)	63.8487* (0.0274)	51.0759** (0.0036)

Particulars	Coefficients		
	Wheat	Gram	Soybean
Size of Holding (X11)	-0.1079* (0.0309)	1.5688 (0.2583)	-32.4088** (0.0077)
Method of Sowing (X12) (Line sowing=1 & Broadcasting=0)	-	-	203.5692 (0.0647)
Estimates	116.34	117.63	73.61
R^2 (Coefficient of Multiple Determinates)	0.855	0.839	0.839

Note: ** & ** significant at 5 (P<0.05) & 1 (P<0.01) percent, respectively. Figures in parenthesis show P-value.*

- In the table 2 given above, X1 through X12 are the Independent Variables. The regression coefficients b1 through b12 can be studied for wheat, gram and soybean.
- The response of wheat in term of productivity with respect to soil test based application of fertilizer and use of proper seed rate was found to be positive and highly significant, use of purchased seed and consumption of urea were found to be positive and significant while size of holding was found to be negative and significant.
- In case of gram, independents variables like use of HYVs seed, seed treatment, area under irrigation, increase of a kg of urea and proper seed rate would be able to enhance yield of gram to 154, 106, 63, 35 and 31 kg per acre respectively.
- In case of soybean, use of HYVs seed, proper seed rate, increased area under irrigation and one kg increase in DAP per acre would be able to enhance yield of soybean to 81.88, 3.87, 51.07 and 5.74 kg per acre respectively, while increase in one-acre size of holding would be able to decrease yield of soybean with 32.41 kg per acre.

Conclusion and Recommendations

- It was found during the course of investigation that majority of sample respondents did not adopt need based Integrated Farming System (IFS) efficiently, efforts could be made to introduce it. At least one seed producer company, custom hiring center could be established in every gram panchayat/development block of Bundelkhand Region of Madhya Pradesh.
- It was observed that the 'Toll Free number' of the Kisan Call Centre (1800-180-1551) had not yet become the main source of information dissemination to the farmers in the area under study. Hence, strategies could be made to ease access to the farmers so that they could solve their problems related to crop and animal husbandry.
- Need based training programmes on RPP for cultivation of crops must be organized in the nearest Krishi Vigyan Kendra (KVK) for the field staff of the Department of Farmers Welfare and Agriculture Development, Madhya Pradesh followed by producers before the start of the season. The training must be designed for the field staff and producers in such a way that it directly aids the crop productivity.
- Technology adoption in agriculture is a long drawn process, which involves developing appropriate need-based technology, testing the new technology, taking it from lab-to-land, and optimum application of it for obtaining the desired benefit. The new technology needs to be integrated within the existing system and policies for wider acceptability. Technology demonstrations could be shown in villages to popularize RPP for cultivation of crops. If there is an incidence of insects or disease, a field day could be organized for all the farmers of the village to help them to learn through observation.

- Since majority of farmers reported that unavailability of desired variety of seed was a major constraint in the cultivation of crops, an online portal on seed distribution could be created by the government to show the variety and class-wise availability of seeds with the facility of online purchase/booking.
- Digital technology requires the use of computers, internet, mobile technology, application tools, etc. It may not be easy for majority of farmers with their current level of education, exposure and remoteness to use it properly and appropriately. To certain extent, capacity building on the principle of demonstration could be adopted to motivate farmers to accept technological change in agriculture.
- There is also a need of Public Private Partnership (PPP) for knowledge management and procurement of produce at reasonable prices which works as a catalytic agent for increasing adoption of crop production technologies leading to breaking yield barriers in crop production.

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Market Imperfections and Farm Profitability in Gujarat

S. S. Kalamkar and Kalpana Kapadia

Introduction

- Profitability is an important economic motivator for the farmers to take up sustainable agricultural practices. As farming in India is characterized by small and fragmented land holdings, disguised unemployment, uncertainties and high dependence on monsoon rains, profitability in farming still needs to be worked upon. The economic viability depends on input costs, institutional framework and different government policies.
- Agrarian distress is not only limited to rain fed areas but also spread to progressive states like Punjab and Kerala where the new generation of farm households is distantly interested in farming. Agriculture needs to be made more profitable, attractive and enterprising so that the rural to urban migration could be reduced and farmers take pride in their profession, which can only happen if bottlenecks are removed.
- Understanding of agricultural input and output market is essential for improving agricultural productivity and growth because farmers cannot be motivated to increase yield if they are unable to sell their produce. If this occurs, it defeats the objective of intensifying agricultural production as the majority of the population derives its livelihood from agriculture.
- Recent efforts to improve farmers' income have been focused on raising Minimum Support Prices (MSPs). Historical evidences show that MSP does not directly translate into higher income for farmers due to a deficient and ineffective implementation framework. Additionally, high MSPs result in market distortions and render Indian exports uncompetitive in world markets. Realizing the need to pay special attention to the plight of the farmers, union government changed the name of Ministry of Agriculture to Ministry of Agriculture and Farmers' Welfare in 2015.
- One of the important ways to achieve the government's goal of doubling farmers' income by the year 2022 could be by reducing agrarian

distress and bringing income parity through better price realization for their harvest. This can be achieved through upgrading traditional agricultural produce market to electronic markets. The current policy focused on doubling farmers' income can also achieve its desired objectives by redesigning the existing market system in the country.

- Many studies have highlighted the grim situation of unstable income from agriculture while there are lesser studies focusing on the market imperfections and farm profitability in Gujarat. The present study was undertaken to fill this literature gap and focus on policy formulation towards doubling of farmers' income. The study is based on both, the secondary and primary level data. The secondary data were compiled from different publications and related websites. The primary data were collected from the selected 800 households from eight agro-climatic zones of Gujarat.

Findings

- The field survey results revealed that out of the total quantity produced, 85 percent produce was sold and around 15 percent was reported unsold or kept at home. Across land holding groups, it was observed that the lower the land holding size, the more the share of total produce retained which may be due to less marketable surplus available. Majority of the produce gets sold during the first attempt itself (96.5 %) to local private trader and then in the nearby *mandi*. This might be an indication of distress sale of produce by this vulnerable section of farming community. More than 98 percent of the selected households reported unsatisfied sale of crops due to receipt of lower rate than market, delayed payments, deductions for loans borrowed and faulty weighing and grading system.
- As crop cultivation is shifting from subsistence to commercialized farming, use of off-farm inputs from the market have increased. While less than 10 percent of households used farm saved seed, the input dealer and the local private trader were the two important sources for the purchase of seed. The labor was provided by family members mostly.
- More than 85 percent of the selected households reported that the price paid for the seed input was high and unreasonable. The prices paid for off-farm inputs such as fertilizers, plant protection, diesel was reported to be high while in case of manure, it was reported reasonable. The labor rate was reported at a very high level. Overall, the inputs were categorized under high to very high category.
- In case of animal produce, more than 86 percent of the total milk produce was sold in the village itself of which more than half of the total produce was sold to the local traders and more than one third of total produce was directly sold to households in the village in the first disposal itself. The remaining produce was sold during the second disposal to the same agencies. The highest share of households of marginal group reported the sale of milk to co-operative and government agencies during first disposal. Majority of produce disposal was done mainly during the first attempt. Major reasons for the dissatisfactions over the sale of animal produce reported by households were the realization of lower price than the market and deductions towards loan borrowed. Collusion of private buyers and less availability of other buyers are the major reasons for the unreasonable prices.
- More than half of the households had taken loans. It was surprising to note that all the farmers from very large farm holding group had borrowed money and the lowest ratio was

reported in case of marginal landholder group. It showed how incidence of loan increases with the land holding size. The major sources of borrowing money were formal agencies such as government bank and cooperative society. On an average, Rs.191885 amount was borrowed to meet capital expenditure and day to day working expenditure in farm business. About two thirds of total households had repaid the loans. The reasons cited for non-repayments were that payments would be made after harvesting, or delayed due to medical expenses, lesser income than expectation and the expectation of a loan waiver.

- Information provided by newspaper/radio/ television were followed by the nearby progressive farmer and gram sevak as well as extension officer of the respective area were the sources of information for households in the study. Higher the land size, more the access to sources of technical advice. The advice given by the Krishi Vigyan Kendra and private commercial agents was adopted on a cent percent basis, while adoption of advice given by veterinary department was not taken seriously. The major reasons for non-adoption of technical advice received were mostly application of technical advice or lack of financial resources to adhere the advice given. Majority of households reported that the advice was useful.

- Hardly 38 percent of selected farmer households were aware about the MSP. Out of those, majority of them were not aware about the procurement agencies for the crop. Across the land groups, hardly one fourth of the marginal famers were aware about the MSP while more than half of the large farmers were aware about the same. Very few households had reported the sale of produce to agencies nominated by the government. Sale of produce was highest in case of the very large farmers group due to their approach and marketable surplus available with them. The crops sold at MSP to stipulated agency were groundnut, rapeseed, mustard, and cotton and the rate received by them was equal to or higher than MSP.

- None of the farmers reported receipt of deficiency payment under Bhavantar Bhugtan Yojana (BBY) or Pradhan Mantri Annadata Aay SanraksHan Abhiyan (PM-AASHA) which indicates a poor coverage under these schemes. Under the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme, around 78 percent of the selected farmers had received assistance which took almost 5-6 months to realize the same in their account.

- More than half of the selected households had reported crop loss. It was cent percent in case of large farmer group strangely. The major cause of crop loss was inadequate rainfall/drought like situation. About 86 percent of households had not received the claim amount, while 9.2 percent received delayed payment and the remaining received the amount in time. Hardly 14 percent of claims were settled by insurance company.

- About 99 percent of households reported that income generated from farming was not adequate. The major reasons were the problem of pest/diseases, nuisance of animals, insufficient irrigation, non-remunerative prices and labor shortage. Small size of holdings makes farming uneconomical for marginal farmers.

- The economic risks faced by the households were lack of finance/capital, access to inputs, sharp fluctuations in input and output prices, lack of demand/inability to sell agricultural products, lack of demand/inability to sell non-agri products and seasonal unemployment. Households had adopted coping strategies such as borrowing money from friends/relatives,

working as a wage laborer in the village, borrowing money from bank, moneylenders, reducing household consumption expenditure, deferring social & family obligations and petty business/shops.

Conclusion and Recommendations

- Efficient physical market infrastructure is critical in enhancing production, marketed surplus and higher returns to farmers. The development of quality physical infrastructure could help in reducing transactional costs and improving market efficiency. Improved roads and creation of market hubs closer to producers would reduce transportation costs and post-harvest losses, which in turn leads to higher prices for outputs.
- Farmers sell almost the entire produce immediately after the harvest as they need credit for cultivation of the next crop. This leads to serious constraints in handling and storage of produce for procurement agencies, particularly for rice and wheat. Access to institutional credit and proper storage facilities at the village level can play an important role in marketable surplus and reduce distress sale.
- Most of the times, off-farm inputs are purchased from the market or are borrowed. There is a need to ensure timely availability of quality seed and fertilizer, among other inputs, at reasonable price, particularly by the concerned state department of agriculture. Apart from that, financial inclusion needs to be focused upon since many households take loan to meet their capital/working expenditure.
- Market information and extension services play a significant role in increasing productivity and market participation of small farmers. There is a need to strengthen information dissemination channels so that farmers can make an informed decision. It was also noticed that there is a need to create awareness about MSP, crop insurance as well.
- Since farmers can receive higher prices under competitive markets, there is a need to create more competitive market structure by liberalizing agricultural markets so that farmers could choose the agency to whom they wished to sell. Small and marginal farmers are forced to sell their produce just after harvest at lower prices. Sometimes farmers may want to sell it later when prices are higher but feel constrained by, among other things, lack of storage facilities and access to credit. Therefore, a competitive market combined with storage facilities can ensure better prices to small farmers by allowing them to have greater flexibility in the timing and location of their sales.

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Assessing the Status of Feed and Fodder in Haryana: Findings from Field Survey

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Introduction

- India is the largest producer of milk in the world with 187.7 Million Tons (MT) worth of production in 2018-19 (National Dairy Development Board), nearly double from that in the year 2004-05. The per capita availability

2 The authors are grateful to Prof. P. K. Joshi, Honorary Director, Agricultural Economics Research Centre (AERC), Delhi and Prof. C. S. C. Sekhar, Agricultural Economics Research Unit(AERU), Institute of Economic Growth and former Honorary Director AERC, Delhi for their guidance and valuable suggestions in preparing this policy brief.

(394 grams/day) in same year also doubled compared to 1995-96. The livestock population in the country witnessed 5.3 percent increase in the year 2019 as compared to 2012 (Livestock Census, 2019). Due to the observed trend and emerging demand of milk, the present availability of feed and fodder seems to be lagging behind and the existing shortage may get widened to fulfil the fodder given the expected increase in livestock population.

- Various studies estimated the shortage of feed and fodder in the country, i.e., Niti Aayog (2018), Landes et. al. (2017) and World Bank (2011) estimated the shortages in range of green fodder (28 to 35%), dry fodder (10 to 11%) and concentrates (33 to 35%). Dikshit and Birthal (2010) estimated that by 2020 India would require a total 526 MT of dry matter, 855 MT of green fodder, and 56 MT of concentrate feed.

- Many reasons are highlighted for this shortfall such as limited availability of area under fodder crops, limited availability of good varieties of fodder crops, lack of quality seeds, poor quality of dry fodder, limited post-harvest management technological upgradation, poor management of grazing and pasture lands and inadequate research, extension and manpower support (Ministry of Agriculture, 2011) to name a few.

- Haryana constitutes nearly eight percent of country's land area under fodder crops (LUS database, MoA, 2015-16). The state also contributes nearly 1.3 percent livestock population (Livestock census, 2019) but witnessed -20 percent decline in livestock population during 2012-19.

- In this study, an attempt was made to assess the supply of feed and fodder from various available land resources and the requirement of feed and fodder for livestock in Haryana using field survey data. The growth patterns of major livestock population in Haryana were analyzed. The study also assessed the problems and constraints faced by livestock rearing farmers. The livestock considered here are buffalo, cattle (crossbreed and indigenous), sheep and goat.

Findings

- The combined area under fodder crops was about 29 percent of net operated area in the three study districts of Haryana. The entire net operated area available with the farmers was irrigated and canals and bore-wells are the major sources of irrigation. While only limited village land was available for grazing, there wasn't any land available for agro-forestry in the selected districts. There was a high proportion of area under fodder crops in kharif season as compared to the rabi season. The by-products of wheat, paddy and mustard were used as sources of dry fodder.

- The production of green fodder was estimated through the total potential production per unit hectare from the land classified under different categories, i.e., 'respective land use in any particular category' multiplied with 'green fodder productivity in that land category'. Hence, the availability of 'green fodder' grown on 'crop land area' and 'permanent pastures and other grazing lands' was estimated at 5.14 and 0.07 tons/year/animal, respectively.

- The availability of dry fodder and concentrates produced in the form of crop residues, oil cakes, grains, bran and chunnies was calculated by directly using the previously worked out standard conversion factor values of the 'harvest indices' and 'extraction rates'. The availability of 'dry fodder' estimated from such sources was 2.72 tons/year/animal.

- The availability of green fodder from 'land area' on per animal basis was calculated using only 'buffalo' and 'cattle' population. While the availability of green fodder from 'Pasture and other grazing land' on per animal basis was calculated using only 'goat' and 'sheep' population. This was done because the 'buffalo' and 'cattle' rearing farmers feed the green fodder to such animals at home and the 'goat' and 'sheep' rearing farmers take animals for grazing most often.
- The demand was calculated directly by multiplying the 'number of animals' in any specific category with the 'per day consumption' of different types of fodders fed to the livestock. The yearly demand was calculated using the assumption based on the field experience by considering a tentative requirement of 'dry fodder' for four months and that of 'green fodder and concentrate' for eight months.
- The requirement of 'green fodder' was estimated about 11.16 tons/year/ animal, whereas, the dry 'fodder and concentrate' requirement on combined basis was estimated at 7.19 tons/year/animal. This was the total requirement generated on combined basis from each category of livestock. A shortage of 'green fodder' by nearly 26.6 percent was observed in the selected districts. The deficit of 'dry fodder and concentrate' was estimated at nearly 35.3 percent on combined basis.
- The cost of the feed and fodder fed to the livestock on per day basis was comparatively high for buffaloes and crossbreed cattle as compared to the indigenous cattle. Also, the feeding cost increases as the age of the livestock increases. Based on the life stages of livestock, the cost of green fodder varies from Rs.45 to Rs.95 per day per animal for buffaloes and cattle. Male laborers are usually hired to take care of livestock. The expenditure on veterinary is reported highest for buffalo rearing.
- Few farmers receive up to Rs.24000 to Rs.30000 per acre (or Rs.3000 to Rs.3750 per kanal) as a return from the fodder crop. This was observed as a profitable income source, as it offered better return compared to other food crops, but the farmers have limited land resources to compromise land under food crops. Whereas, the share of cost incurred in growing 'fodder crops', was observed just above one-third of the cost of growing all other crops altogether.
- The direct selling of fodder is not a common practice among the farmers. Also, multiple cuttings are made on the same standing fodder crop to get green fodder from time to time for feeding purposes. Hence, many of the farmers were not aware about the exact or comparable returns from the fodder crops.

Farmers' perception

- 'Limited land holding' was the most common and major constraint faced by the households under study to allocate more area under fodder production. Inadequate irrigation, high cost of fodder cultivation, low returns, and lack of awareness of government's programmes on various subsidies were other important constraints that the farmers faced. The major reason for not adopting the post-harvest techniques was lack of awareness on production and post-harvest management.
- Most of the farmers were not receiving the benefits offered by the government, except about less than one-fourth of the farmers who received free treatment and medicines, vaccinations of livestock from the government. Very few farmers were benefited by the veterinary services, low cost insurance and free fodder seed distribution. Unawareness regarding such schemes is major reason for this.

Conclusion and Recommendations

- More emphasis needs to be put on extension of already existing High Yielding Varieties of fodder crops to reach the farmers.
- The cost of growing fodder crops is cheaper compared to that of other food crops, so farmers may be encouraged to put more efforts and inputs on fodder cultivation. Since farmers have limited financial resources, they may be provided with subsidized inputs such as good quality seeds and other related inputs.
- There is an urgent need to encourage farmers to adopt post-harvest techniques. Some initiatives may be launched to conduct training programmes on post-harvest management techniques thus exposing farmers to such initiatives relating to fodder cultivation so that the farmers can utilize these efficient practices in limited land resources to achieve better gains.

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Strategies to Bridge Yield Gap of Major Crops in Bundelkhand Region of Uttar Pradesh

G.C. Tripathi

Introduction

- The advancement in agricultural technology and cultivation practices has taken Indian agriculture to great stride by achieving record food grain production of 279.80 million tons in 2017-18 fiscal, against that of 50.82 million tons in 1951-52. It is, however, still lagging behind many developed countries like U.S.A., France, Brazil etc., in terms of productivity. In order to attain similar levels of productivity, it is critical to deliver a similar yield per acre/hectare. Studies to understand possible strategies for bridging the yield gap have become imperative to serve as a remedial measure in enhancing country's overall aggregate crop production to meet our increasing food demand.
- Assessing the yield gap in major food crops can help in understanding (i) yield variability, (ii) yield potential, and (iii) the input use efficiency

of major crops as a guideline to indicate appropriate pathways for improving agricultural efficiencies and farm income.

- Among three principal components of a crop, viz. Area, Production and Yield, the yield (productivity) i.e., production per unit area of land is a key component in agriculture. Land as an input factor is a scarce resource, therefore, to increase overall agricultural production, main emphasis has to be laid on the yield to minimize yield gap of major crops and boost regional/ national economy.

- Updating farmers' knowledge on the causes of yield gaps in crops and the corresponding measures to narrow them down through training, demonstration, field visits and monitoring by external agencies towards achieving higher yield is the need of the hour. The government needs to explore the scope of increasing production as well as productivity of crops by narrowing down the yield gap to ensure food security.

- The utility of yield gap study of a crop lies critically in its serving as a multifaceted solution on adoption of improved agricultural technology with proper management practices. It identifies various factors and constraints responsible for the yield gap such as respondents' lack of knowledge, method of seed treatment, proper doses of fertilizers, unavailability of desired varieties of seed, required input mixes, labor force, timely irrigation and high cost of inputs. These factors focus on the need to take due care to maintain soil neutrinos and their basic characteristics towards reducing yield gaps.

Findings

- In the survey conducted, inputs from 120 farmers/respondents with small, medium and large land-holdings were collected. The table 1 below shows that 55 percent of respondents were Soil Tested farmers, while only 34 percent had received Soil Health Cards (SHCs). Category-wise as well, Soil Tested farmers' percentage ranged from 53 to 58 percent, while that of farmers with SHCs varied from to 30 to 38 percent.

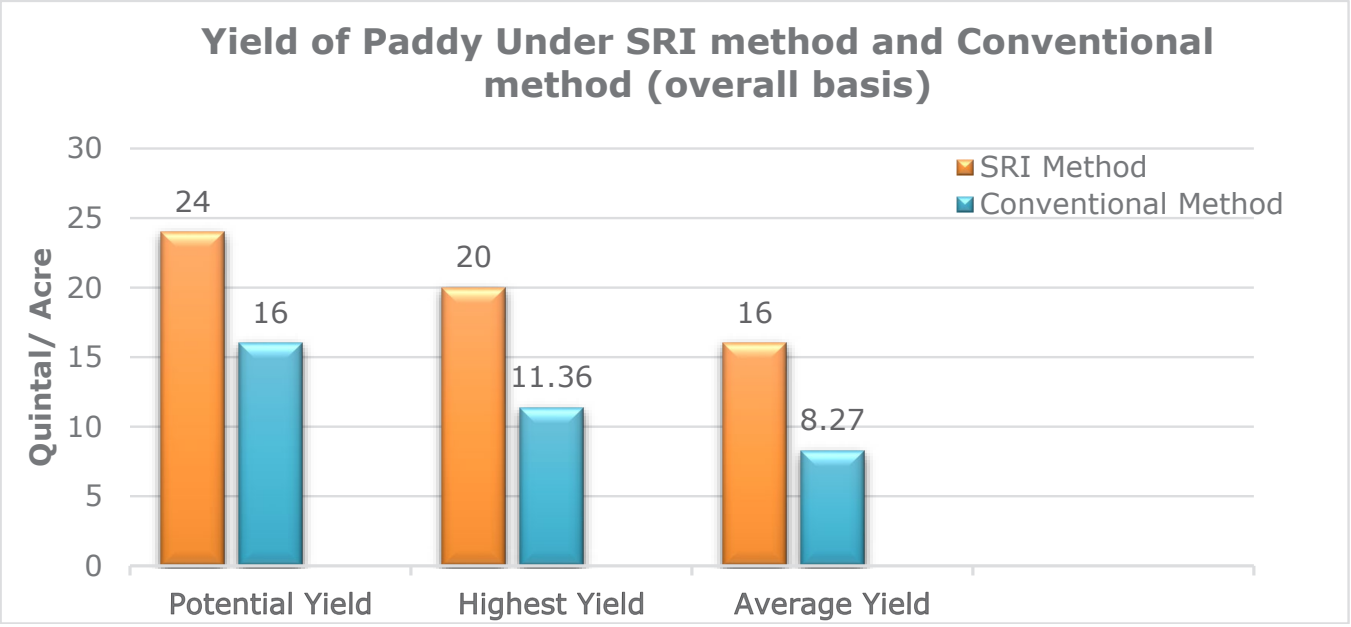
Table 1: Soil Testing and Soil Health Cards (SHCs): Status of the Respondents

Particulars	Small	Medium	Large	Total
No. of Respondents	40.00 (100.00)	40.00 (100.00)	40.00 (100.00)	120.00 (100.00)
No. of Soil Tested farmers	23.00 (58.00)	21.00 (53.00)	22.00 (55.00)	66.00 (55.00)
No. of farmers who received SHCs	15.00 (38.00)	12.00 (30.00)	14.00 (35.00)	41.00 (34.00)

Note: *Figures in parentheses show percentages.*

- Under System of Rice Intensification (SRI) method, the potential yield of paddy in Bundelkhand region of Uttar Pradesh has been recorded at 24 quintals per acre. Against this, the highest and the average recorded yields for the study sample have been 20 quintals per acre and 16 quintals per acre respectively. Under conventional method of paddy cultivation, against potential yield of 16 quintals per acre, the highest and average yields were recorded at 11.36 quintals per acre and 8.27 quintals per acre respectively. The comparative values of SRI and Conventional method of paddy cultivation are shown in figure 1 below.

Figure 1: Comparative Yield of Paddy Under SRI and Conventional methods



Source: *Survey*.

- The yield gap analysis for wheat crop shows that the potential yield, highest yield and average yield of wheat match with the respective paddy yields under SRI method, but they are relatively higher than those of paddy yields under conventional method.
- Among SRI and conventional methods, the main sources of information regarding paddy cultivations by farmers are from the agriculture department, progressive farmers and relatives/neighbors, while television/radio and newspapers as sources of information were mostly not found to be used by any category of paddy growers either under SRI or conventional method.
- The two major constraints for paddy growers under SRI method in adopting recommended packages were found to be the lack of suitable machinery and high cost of inputs. Other constraints in paddy cultivation were unavailability of desired variety of seeds, capital, lack of knowledge about the method of seed treatment and proper doses of fertilizers. Under conventional method of paddy cultivation, farmers faced similar hurdles. High cost of inputs was found to be a major constraint for wheat crop cultivation as well. Among other constraints, the unavailability of desired variety of seed was found to be a main constraint for paddy and wheat cultivation.
- The findings in respect of various constraints reveal that (a) high cost of inputs and unavailability of desired variety of seeds has been the main constraint for both paddy and wheat crops, (b) unavailability of labor at peak operational period has also been a serious concern for both the crops, and (c) lack of suitable machinery or unavailability of capital is a constraint faced by both the crops, but extensively in case of paddy.
- Variable/factor-wise analysis showed that among 12 independent variables (X1 through X12) selected for paddy (Table 2) and 11 for wheat (Table 3), nine variables had statistically significant effect on yield of paddy and six in case of wheat at ten, five and one percent level

of significance. Among these, the two variables significantly affecting the yield for both paddy and wheat crops were urea (X8) and DAP applications (X9) with positive coefficients.

Table 2: Factors Affecting Productivity of Paddy

Particulars	Coefficients	Standard Error	P-value
Education (X1)	7.6058	9.0856	0.4068N
Age (X2)	1.1152	1.7190	0.5197N
Source of Seed (X3)	135.2879	53.8269	0.0154**
Soil Test (X4)	81.4322	36.2644	0.0295**
Seed Rate (kg) (X5)	0.1279	0.9016	0.8878N
Seed Treatment(X6)	97.2556	47.4362	0.0459**
Varietal Improvement (X7)	154.2798	55.2940	0.0076***
Urea (kg) (X8)	1.7541	0.8949	0.0559*
DAP (kg) (X9)	2.4834	1.3782	0.0780*
Irrigated land (X10)	-16.9956	7.3105	0.0245**
Size of Holding (X11)	13.3519	4.2454	0.0029***
Method of Sowing (X12)	249.6084	92.6053	0.0097***
R^2(Coefficient of Multiple Determinates)	0.942		

Note: **, ** & *** significant at 10(P<0.10), 5(P<0.05) & 1(P<0.01) percent, respectively.*

Table 3: Factors Affecting Productivity of Wheat

Particulars	Coefficients	Standard Error	P-value
Education (X1)	3.9079	7.6797	0.6132N
Age (X2)	-2.9822	1.3885	0.0368**
Source of Seed (X3)	89.1319	22.2670	0.0002***
Soil Test (X4)	22.8821	19.4767	0.2459N
Seed Rate (kg) (X5)	-0.2949	0.1273	0.0249**
Seed Treatment(X6)	10.6329	18.8898	0.5761N
Varietal Improvement (X7)	14.6168	18.1652	0.4250N
Urea (kg) (X8)	1.7891	0.9796	0.0740*
DAP (kg) (X9)	4.0615	2.2745	0.0805*
Irrigated land (X10)	33.6030	8.7769	0.0004***
Size of Holding (X11)	10.0994	10.0779	0.3213N
R^2(Coefficient of Multiple Determinates)	0.862		

Note: **, ** & *** significant at 10(P<0.10), 5(P<0.05) & 1(P<0.01) percent, respectively.*

- The variables which had statistically significant and positive coefficients were X3 (source of seed), X4 (soil test), X6 (seed treatment), X7 (varietal improvement), X8 (urea application), X9 (DAP application), X11 (size of holding) and X12 (method of sowing) for paddy crop and X3 (source of seed), X8 and X9 (Urea and DAP applications) and X10 (irrigated land) for wheat crop. These recorded positive contribution(s) in increasing respective crop yields.

- Irrigated land (X10), the sole variable in case of paddy while age (X2) and seed rate (X5), two variables in case of wheat had negative and statistically significant coefficients at five percent level of significance showing their adverse contribution in yield of paddy and wheat.

- On an overall basis, all the selected variables-12 in case of paddy and 11 for wheat, when taken jointly explain 94.20 percent of total variations in yield for paddy and 86.20 percent for wheat. This is quite a satisfactory performance of selected variables in case of both the crops towards increasing crop productivity.

Conclusion and Recommendations

- The awareness level of the farmers of Bundelkhand region in Uttar Pradesh needs to be worked upon regarding the testing of soils and they should be encouraged to get Soil Health Cards (SHCs). The agencies entrusted with the responsibility of carrying out soil testing and distribution of SHCs could work in this direction.

- The importance of agriculture department, progressive farmers and relatives/neighbors in providing needful information to paddy growers of the region for enhancing aggregate production needs to be highlighted. For this, sources like television/radio, Kisan Call Centre (KCC), newspapers, etc., could become effective sources of information dissemination to farmers.
- Focus may be laid on (i) making available the required inputs and machineries to the concerned farmers to aid them through subsidies on recommended input mixes (packages) and their timely availability, and (ii) providing financial assistance, desired variety of seeds and Soil Health Cards(SHCs) as a remedial measure.
- All variables in the study which had a positive and insignificant coefficient like education, age and seed treatment in case of paddy and education, soil test, seed treatment, varietal improvement and size of holding in case of wheat, need due attention in their applications to underline their individual impacts in increasing the crop yield and narrowing down the existing yield gaps of wheat and paddy crops to the minimum.
- Apart from different schemes launched/ being launched by the government, various government/nodal agencies, extension workers, researchers, soil scientists/soil health workers could devise training programmes keeping in view the cultivators' literacy regarding appropriate cultivation practices. Training may be imparted through demonstrations and field trials for proper seed treatment, sources of seed, varietal improvements, Soil Health Cards (SHCs) in adopting cropping schemes and need based fertilizer (Urea/Diammonium phosphate (DAP)) applications. This could be done to increase crop yields and aggregate crop production of paddy and wheat in Bundelkhand region of Uttar Pradesh.
- For this study to have wider applicability, it could be continued for another two successive years for both the parts, i.e., Uttar Pradesh and Madhya Pradesh region of Bundelkhand agro climatic zone of India. The respondents for the successive studies may remain the same or new respondents may be selected.

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