

Assessing the Impact of Balanced Use of Inorganic Fertilizers in Rice-Wheat Cropping System: An Effective Strategy for Enhancing Income of Farmers in Bihar, India

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Abstract

The study was conducted in two different districts namely Madhubani and Sitamarhi of Bihar state during the two different agricultural year 2012-13 (base year) and 2014-15 (assessment year). A total of 58 farmers, 29 from each district have been selected for detailed survey. Rice and wheat is the major cropping pattern and playing critical role in the agrarian economy of the state. These crops are highly fertilizers consuming crops so that impact assessment of balanced fertilizer (NPK) use can be worked out. Primary data of use of fertilizer and their impact on yield and production of rice and wheat were collected by interviewing the farmers with the help of specially structured and pre-tested schedule. The extent of incremental income derived from the rice and wheat production in surveyed area in assessment year has been emerged as impact of balanced use of fertilizer in enhancing profitability of crops as well as income of farmers. Farmers were applied NPK fertilizers as 76, 45 and 28 kg/ha in Madhubani whereas, in Sitamarhi it was 82, 44 and 23 kg/ha in base year which is lower when compared to recommended doses. However, the application of NPK doses were about 84, 49 and 49 kg/ha and 82, 42 and 51 kg/ha in corresponding districts during assessment year. Similarly the NPK doses used in wheat in these districts were 87, 53 and 34 kg/ha and 93, 48 and 29 kg/ha in base year, which is also lower and imbalanced than the recommended doses. The NPK doses were applied 73, 40 and 48 kg/ha in Madhubani and 78, 43 and 52 kg/ha in Sitamarhi districts in the assessment year. The incremental income of Rs. 12633/- and Rs. 18174/- per household are realized from rice and wheat crop, respectively in the assessment year over base year. Farmer also perceived that quality of grain improved and quantity of produce increased after balanced use NPK especially reduced the doses of nitrogen and induced quantity of potassium fertilizers in the field. In same manner by use of balanced fertilizer, the incidences of disease and pest infestation reduced as more than 90% farmers reported in the surveyed area.

Therefore, appropriate technological interventions and policy option need to be design to encourage farmers for use of balanced inorganic fertilizers in crop production.

Keywords: Inorganic Fertilizers; Rice-Wheat Cropping System; Farmers

Introduction

Agriculture is the vital source of wealth in the Bihar State with about 79% of its population is engaged in agricultural pursuits. Bihar's productive contribution in food grain, fruit, vegetables, spices and flowers can increase manifold with improved methods and system management. Across the state soil texture is varies from sandy loam to heavy clay. Sitamarhi and Madhubani come under Agro-climatic zone I (Northern West). Crop production can be improved by adding plant nutrients. Soil fertility often does not support optimum growth and yield due to lack of or low doses of specific nutrients. Sixteen plant food nutrients are known to be essential for proper development of crop. Each one is equally important to the plant, and yet each is required in vastly different amounts. Carbon (C), hydrogen (H), and oxygen (O) which are derived from the air comprise more than 90 per cent of the fresh plant tissue. Macronutrients, needed in large amounts, derived from the soil are nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), and magnesium (Mg). Legumes are the

exception because they fix N from the air. The soil supply of NPK is often supplemented by fertilizers and manures. Micronutrients are needed, only in very small (micro) quantities. The capacity building of farmers/extension functionaries/rural youth is one of the important activities performed by central government sponsored schemes such as ATMA and KVK. In changing scenario, agriculture is being more knowledge intensive. For adopting improved production practices in agriculture, farmers are needed to update their knowledge and specific skills for performing the present agriculture [1-6].

Objective of the Study

The objective of this paper is to characterize the impact of using potash in crop production and their influence on profitability by enhancing production and reducing costs in rice-wheat cropping system of Bihar state.

Methodology

Survey design and data

The present study has been carried out on the basis of primary data collected from two different districts namely; Madhubani and Sitamarhi, Bihar for two different agricultural years 2012-13 as bench mark or base year and 2014-15 as assessment year on which estimate can be made for balanced use of NPK fertilizers in rice-wheat cropping system. From each district, 29 farmers have been selected so that a total sample of 58 farmers have been surveyed from six experimental (06) villages. Required data from sample farmers were collected through a pre-tested schedule and questionnaires by personal interview method. Descriptive statistics were employed to ascertain average, mean etc. Tabular analysis has been used to obtain the result pertaining to the cropping pattern, use of material and labor inputs and cost and returns of rice and wheat cultivation in target area.

Results and Discussion

The following table 1 shows the description of Madhubani and Sitamarhi district of Bihar. The three villages have been selected from each selected district. The total samples of farmers were 58. The farming experience of farmers of Madhubani district was 17 years while in Sitamarhi district was 26 years. Average rice/wheat areas per household were 1.9 and 1.8 ha in Madhubani and Sitamarhi district. About 90% income comes from farming occupation under surveyed area. Infrastructure facility like input market, electricity, road, drinking water and school etc were 100% in both districts.

In Madhubani district mostly area was covered by upland and midland whereas, in Sitamarhi district was found mostly lowland.

Cropping pattern

The following table 2 shows the cropping pattern on sample farms under study area. Cropping pattern in the districts is dominated by cereal followed by pulses, oilseed, potato etc. Rice and wheat are the major cereals and popular cropping pattern in Madhubani and Sitamarhi districts. These crops are major inorganic nutrient consuming crops in the study area. Rice occupies about 89 and 74% area to total cropped area in kharif season in Madhubani and Sitamarhi district, respectively across the years. Besides these, a minor area also covered under fodder crop (sorghum) in kharif season which ranges from 5-13% to total cropped area. Wheat is the major cereal crop in rabi season accounting for 89% and 73% to total cropped area in Madhubani and Sitamarhi district during both the periods with minor shifting in later district. However, berseem is taken as main fodder crop in rabi season in the earlier district.

Addition to it, mustard is main oilseed and lentil and chick pea and pulse crops grown on minor and variable area in both the districts. There is no crop cultivated in zaid season (summer) due to water scarcity and stray animals' problems. Thus the cropping intensity is below 200%.

Input used in rice and wheat production

The major input doses were calculated for rice and wheat crops on per ha basis. Rice crop covered around 110 and 111 ha area in base and assessment year, respectively. Wheat crop covered area 110 and 112 ha in base and assessment year, respectively. The doses of seed were 19.8 and 112.20 kgs of rice and wheat in base year, whereas in assessment year the doses of seed were 21.10 and 115.40, respectively in rice and wheat crop. The doses of NPK applied by sample growers in rice crop were 79, 44 and 25 kg/ha in base year, while in case of assessment year the doses of NPK were 83, 45 and 50 kg/ha. In case of wheat crop the application of NPK in base year of the study were 90, 50 and 32 kg/ha, whereas in assessment year NPK doses in wheat crop were 76, 41 and 50 kg/ha, respectively (Figure 1).

Particulars/descriptions	Madhubani	Sitamarhi	Numerals
Name of villages	Baudhar, Nakta and Bengra	Padari, Madanpur and Sundergama	06
Number of farmers	29	29	58
Average age of households head (years)	36	39	37
Average schooling of household head (years)	8	11	10
Experience in farming (years)	17	26	22
Average family size (no.)	4	4	4
Average cultivated area/household (ha.)	2.2	2.4	2.3
Average area under rice/household (ha.)	1.9	1.8	1.9
Average area under wheat/household (ha)	1.9	1.8	1.9
Occupation (%)			%
Farming	90	90	90
Government services	3	7	5
Private services	7	3	5
Infrastructure (%)			
Access to input market	100	100	100
Access to electricity	100	100	100
Pucca road (connected sub-road)	100	100	100
Drinking water supply	100	100	100
Access to school/colleges	100	100	100
Land type (%)			
Upland	14	-	7
Midland	77	1	39
Lowland	9	99	55
Irrigated area (%)	94	79	87
Area under rice (%)	89	74	81
Area under wheat (%)	89	73	81

Table 1: Description of surveyed villages in selected districts, Bihar.

Particulars/Districts/Years	2012-13				2014-15			
	Madhubani		Sitamarhi		Madhubani		Sitamarhi	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Kharif season								
Rice	57.27	89.24	52.92	73.67	57.27	89.24	54.00	75.19
Fodder	4.73	7.37	9.45	13.16	4.73	7.37	4.73	6.58
Fallow land	2.18	3.40	9.45	13.16	2.18	3.40	13.09	18.23
Total	64.18	100	71.82	100	64.18	100	71.82	100
Rabi season								
Wheat	57.09	88.95	52.55	73.16	57.45	89.52	54.18	75.44
Barseem	0.36	0.57	0.91	1.27	-	-	0.36	0.51
Mustard	0.73	1.13	4.91	6.84	1.09	1.70	0.91	1.27
Lentil	1.64	5.55	2.18	3.04	1.64	2.55	2.00	2.78
Chickpea	2.10	3.40	1.82	2.53	0.36	0.57	1.27	1.77
Fallow	2.18	3.40	9.45	13.16	0.64	5.67	13.09	18.23
Total	64.18	100	71.82	100	64.18	100	71.82	100
Zaid season								
Fallow land	64.18	100	71.82	100	64.18	100	71.82	100
Total	64.18	100	71.82	100	64.18	100	71.82	100
Gross Cropped Area (GCA)	124.00	-	124.74	-	125.54	-	117.46	-
Net Cultivated Area (NCA)	64.18	-	71.82	-	64.18	-	71.82	-
Cropping Intensity (%)	193.20	-	173.68	-	195.60	-	163.55	-

Table 2: Cropping pattern.

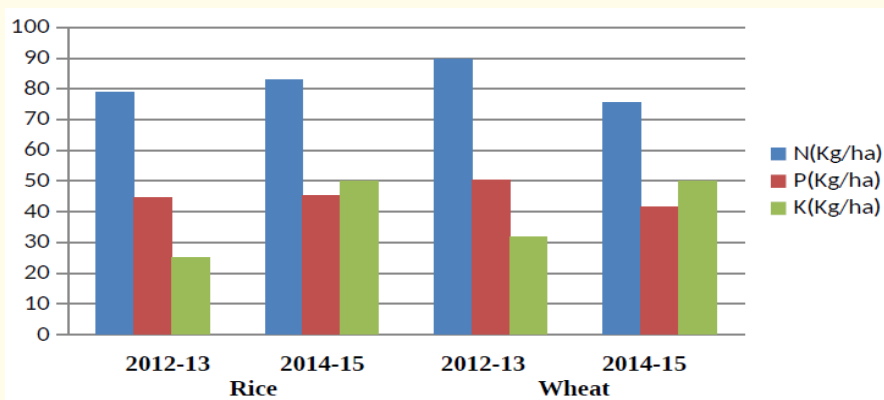


Figure 1: NPK used in rice and wheat cultivation.

Particulars	Units	Rice		Wheat	
		2012-13	2014-15	2012-13	2014-15
Yield	qtls/ha	41.89	46.82	32.01	38.27
Material cost					
Area	ha	110.19	111.27	109.64	111.63
Seed	Kg./ha	19.80	21.10	112.19	115.37
N	Kg./ha	78.98	82.92	89.71	75.57
P	Kg./ha	44.47	45.24	50.34	41.43
K	Kg./ha	25.17	49.91	31.66	49.97
Total NPK	Kg./ha	148.62	178.07	171.71	166.97
ZnSO4	Kg./ha	3.73	2.84	0	0
Herbicide	Lit/ha	1.11	1.36	1.70	1.59
Insecticide	Lit/ha	1.43	0.74	0	0
Labour use					
Land preparation including nursery establishment	Mandays/ha	4	4	3	3
Uprooting nursery and transplanting	Mandays/ha	42	36	4	3
Fertilizer application	Mandays/ha	2	3	3	3
Herbicide application	Mandays/ha	2	2	3	3
Weeding	Mandays/ha	36	32	0	0
Irrigation	Mandays/ha	3	3	2	2
Harvesting	Mandays/ha	3	3	3	2
Threshing	Mandays/ha	4	4	3	3
Winnowing, drying and cleaning	Mandays/ha	4	3	3	3
Transportation and storage	Mandays/ha	2	2	3	2
Total	Mandays/ha	102	92	27	24

Table 3: Input use in rice and wheat cultivation.

Sources of NPK nutrients- Urea, DAP and MOP

In case of rice, more labour used in transplanting and weeding operation, while in case of wheat the labour used were similar to all operations.

Cost and returns of rice and wheat production

The per hectare cost of cultivation of rice and wheat are Rs. 28900/- and Rs. 21612/- in base year and Rs. 32993/- and Rs. 24331/- in assessment period, respectively in surveyed villages. The material cost in rice and wheat cultivation were Rs. 7935 and Rs. 8659 in initial year and Rs. 9394/- and Rs. 9118/- respectively in assessment year. The labour cost were Rs. 8365/- in base year and Rs. 8652/- in assess-

ment year in rice cultivation. The Machine labour in rice cultivation per hectare were Rs. 12600/- and Rs. 14947/- in base and assessment year, respectively, whereas, it was in wheat crop Rs. 12953/- and Rs. 15213/- respectively in the reference periods. The gross value of produce of rice was Rs. 56285/- in base year and Rs. 65109/- in assessment year. However, in case of wheat the corresponding figure was Rs. 60222/- and Rs. 75687/- in base and assessment year, respectively (Figure 2).

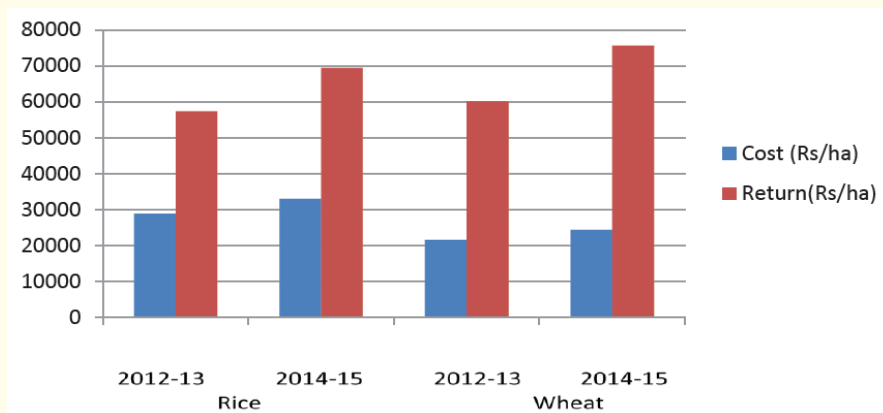


Figure 2: Cost and return of rice and wheat production.

Particulars	Rice		Wheat	
	2012-13	2014-15	2012-13	2014-15
1. Material cost	7935 (27)	9394 (28)	8659 (40)	9118 (37)
2. Labour cost	8365 (29)	8652 (26)	0 (0)	0 (0)
3. Machine charges	12600 (44)	14947 (45)	12953 (60)	15213 (63)
Total cost	28900 (100)	32993 (100)	21612 (100)	24331 (100)
Analysis of produce and returns				
Yield (qtl./ha)				
a. Main product	41.89	46.82	32.01	38.27
b. By-product	48.00	60.00	40.00	41.00
Average disposal rate of produce (Rs./qtl)				
a. Main-product	1254	1347.00	1400.00	1508.00
b. By-product	100	106.00	392.00	438.00
Value of main product (Rs)	52530	63088	44523	57717
Value of by-product (Rs.)	4789	6343	15699	17970
Gross value of produce (Rs.)	57319	69431	60222	75687
Returns	28419	36438	38610	51356
Cost (Rs./qtl.)	690	704.68	675.16	635.77
B:C Ratio	1.98	1.91	2.06	2.37

Table 4: Cost and returns analysis of rice and wheat cultivation. (Rs./ha)

The incremental income of Rs.12633/- and Rs. 18174/- per household were realized from rice and wheat production, respectively in the assessment year over the base year. The benefit cost ratio of rice production were 1.95 and 1.97 whereas, it was 2.79 in base year and 3.11 in assessment year of wheat production.

Ranking of responses for use of potash

Table 5 indicates the ranking wise responses for use of potash under surveyed area. The whole Bihar state data is showing that hoardings, radio publicity, field days and potash campaigns are considered to be most effective and strong communication tools to educate farmers for use of potash.

Particulars	Positive responses	% age of responses	Ranks of responses
Hoarding	51	88	I
Radio Publicity	50	86	II
Field Days	42	72	III
Potash Campaigns	40	69	IV
Demonstration plots	37	64	V
Wall Paintings	37	64	VI
SMS Mobile voice	35	60	VII
TV Publicity	30	52	VIII
Digital Media-www.potash4life.com	26	45	IX
Crop Seminars and Farmers Meeting	20	34	X
Agri Fairs	17	29	XI
Printed Publicity Material- Brochures	15	26	XII
Puppet Shows	0	0	XIII

Table 5: Ranking of beneficiary responses of potash use.

An overall basis about 88, 86, 72 and 69% sample farmers are used information from hoardings, radio publicity, field days and potash campaigns communication tools, respectively. Besides these, demonstration plots, wall painting, SMS mobile alerts are also important to give timely information regarding availability, doses and fertilization techniques to the farmers. TV Publicity, crop seminars and farmers conclave/gosthi, agri fair are also emerged out as a beneficial tool of communication in project sites, as many farm beneficiaries are getting necessary information from these.



Figure 3: Glimpses of organizing socioeconomic survey in the project villages.

Concluding Remark and Policy Recommendations

Assessing the impact of balanced use of inorganic fertilizers in rice- wheat cropping system revealed that the rice crop covered around 110.19 and 111.27 ha area in base and assessment year, respectively. Wheat crop covered area 109.64 and 111.63 ha in base and assessment year, respectively. The doses of NPK applied by sample farmers in rice were 78.98, 44.47 and 25.17 kg/ha in base year, while in case of assessment year the doses of NPK were 82.92, 45.24 and 49.91 kg/ha. However, in case of wheat the application of NPK in base year were 89.71, 50.34 and 31.66 kg/ha, whereas in assessment year it was 75.57, 41.43 and 49.97 kg/ha, respectively. Further result revealed

that farmers were used balanced doses of fertilizers by incorporation of potash in tier crops. Farmer also perceived that quality of grain improved and quantity of produce increased after balanced use of NPK especially reduced the doses of nitrogen and induced quantity of potassium fertilizers in wheat crop. The per hectare cost of cultivation of rice was Rs. 28900/- in base year and Rs. 32993/- in assessment year under surveyed area. In case of wheat, the total cost involved on per hectare basis was Rs. 21612/- and Rs. 24331/- in base and assessment year, respectively. The gross value of produce of rice crop were Rs. 56285/- and Rs. 65109/ha base and assessment year, respectively. Similarly, the corresponding figures of wheat production were Rs. 60222/- and Rs. 75687/ha, respectively. The incremental income of Rs.12633/- and Rs. 18174/- per household were realized from rice and wheat production, respectively in the assessment year over base year.

Conclusion

It can be concluded from the above discussion that the farm-level activities initiated under the “Potash For Life” (PFL) project has been crucial impact in enhancing yield of crops that ultimately transformed in increasing profitability of crops so the income of farmers by using balanced doses of fertilizers especially potassium nutrient. Therefore, it is essential for extension agencies to create awareness among the farming for balanced use of inorganic fertilizers in their crops so that they can be more benefited because of per unit cost reduction as well as induced production at a great extent. Soil health can also maintained by use of balanced fertilizers in the crops. Therefore, appropriate technological interventions and policy option need to be design to encourage farmers for use of balanced inorganic fertilizers in crop production. Policy interventions also required to ascertain timely supply of fertilizers through local/rural input supply centers on reasonable price to the farmers.

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Bibliography

1. Sekar I and Pal S. “Rice and Wheat Crop Productivity in the Indo-Gangetic Plains of India: Changing Pattern of Growth and Future Strategies”. *Indian Journal of Agricultural Economics* 67.2 (2012): 238-252.
2. Ghosh BN., *et al.* “Soil and Input Management Options for Increasing Nutrient Use Efficiency”. Springer India (2015): 17-27.
3. Khan H., *et al.* “Effect of Nitrogen and Phosphorus on Growth and Yield of Brassica juncea L”. *Pakistan Journal of Biological Sciences* 3.8 (2000): 1231-1233.
4. Ravichandran M and Sriramchandrasekharan MV. “Optimizing timing of potassium application in productivity enhancement of crops”. *Karnataka Journal of Agricultural Sciences* 24.1 (2011): 75-80.
5. Rehman OU., *et al.* “Effect of balanced fertilization on yield and phosphorus uptake in wheat-rice rotation”. *Journal of Agricultural Research* 44.2 (2006): 105-113.
6. Manzoor Z., *et al.* “Effect of split application of potash on yield and yield related traits of basmati rice”. *Journal of Animal and Plant Sciences* 18.4 (2008): 120-124.

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