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Assessing the impact of balanced use of inorganic fertilizer in enhancing yield, nutritional value of crops and stabilizing income of farmers' in Uttar Pradesh India

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Abstract

The inorganic fertilizers are major yield contributing factor and key input for the crops productivity. Since the introduction of HYV seeds of paddy, wheat and other crops, the consumption of fertilizers has been increasing year by year in the Uttar Pradesh a populous state of India. The target of nitrogenous fertilizer had been fixed at 33.11 lakh tonnes during 2014-15 of which 81.36% were available. Against this, there was huge shortage of phosphatic and potassic fertilizers in Uttar Pradesh during above cropping season.

Since this study is based on impact assessment and evaluation of potassium fertilizer uses in cereal, pulses, vegetables, sugarcane, orchard etc. on productivity and increasing farmers net income from cultivation of crops. Therefore, two different periods termed as 'base' and 'assessment' years: 2012-13 and 2014-15, respectively, have been considered. On the basis of bench mark, the impact of multi-dimensional effects of inorganic nutrients in general and potassium nutrient particularly on productivity and profitability of crops in experimental/surveyed villages can be assessed and quantified.

In this study, well designed and standard methodology has been followed for villages (experimental sites) and respondents (cooperator farmers) selection from the districts in which Potash for Life project activity is operated after its beginning. The study was conducted in four district and 04 blocks, one from each district selected in initial stage. Ten villages from all 04 blocks were randomly selected and from these villages 101 respondents were selected randomly for detailed survey of farming practices. The economic analysis performed for three major crops were rice, wheat and sugarcane. The study indicates that on-going 'Potash for Life' project has several implications in strengthening skill, education and knowledge of farmers in various aspects of crop management practices including nutrient management in rice, wheat and sugarcane crops. The project has multi-dimensional effect on productivity, production, cost and returns and restoration of soil health and environment are discuss in this paper.

Keywords: Potash, incremental income, extension strategies and enhancing yield

Introduction

Uttar Pradesh state is located in northern India. Abbreviated as UP, it is the most populous state in the Republic of India as well as the most populous country sub-division in the world. The densely populated state, located in the northern region of the Indian subcontinent has over 200 million inhabitants. It was created on 1 April 1937 as the United Provinces during British rule and was renamed Uttar Pradesh in 1950. The state is divided into 18 divisions and 75 districts with the capital being Lucknow. Nepal is an International boundary of the state. The state is bordered by Rajasthan to West, Haryana and Delhi to northwest, Uttarakhand to north, Bihar to east and Jharkhand to south east and Madhya Pradesh to south west.

Survey design and data collection

The study has been started with initiation of visit to Western Uttar Pradesh to conduct socioeconomic survey by implementing Focus Group Discussion (FGD) as a survey tool with project beneficiaries. A well structured socioeconomic survey schedule has been developed and pre-tested in the project villages of Muzaffarnagar district. After the finalization of survey schedule, visits of Bihar, Chhattisgarh, Maharashtra, Madhya Pradesh, West Bengal, Andhra

Pradesh and Uttar Pradesh (east & west) have been organized to conduct socioeconomic survey for data collection of various selected crops. In this study, well designed and standard methodology has been followed for villages (experimental sites) and respondents (cooperator farmers) selection from the districts in which PFL project activity is operated after its beginning.

Since this study is based on impact assessment and evaluation of potassium fertilizer uses in cereal, pulses, vegetables, sugarcane, orchard etc. crops productivity and profitability. Therefore, two different periods termed as 'base' and 'assessment' years: 2012-13 and 2014-15, respectively, have been considered. In impact assessment analysis term 'base year' indicates year 2012-13 (pre-inception of PFL project activity) which is considered as bench mark or baseline. On the basis of bench mark, the impact of PFL project considering multi-dimensional effects of inorganic nutrients in general and potassium nutrient particularly on productivity and profitability of crops in experimental villages can be assessed and quantified.

The attempt has been made to compare nutrient management,

productivity and profitability of crops between two distinct periods mentioned as above: base year (2012-13) during which use of inorganic fertilizer was either with minimum doses of potash or without potash, which was followed by the farmers as common practice, whereas in the assessment year (2014-15) the inorganic fertilizers use was essentially with potash in their fields and also it has become a part of input management practice now a days.

Three villages namely, Hanumanganj, Bhagwanpur, Turkaha from Khaddha block, three villages: Brijnathpur, Khesrari and Rajmalmadara from Siswa block, two villages: Dadari, Chakbandi from Sardhana block and three villages: Rohana kala, Rohana khurd from Charthawal block and Parai from Sadar block were selected from Kushinagar, Maharajganj, Meerut and Muzaffarnagar districts, respectively. From these selected villages, 101 cooperator farmers were identified for final interview on different aspects of agronomic management practices of crops under study (Table-1).

Table 1: Selection of districts, blocks, villages and cooperator farmers

Districts	Kushinagar			Maharajganj			Meerut		Muzaffarnagar			
Blocks	Khaddha			Siswa			Sardhana		Charthawal			Total
Villages	Hanumanganj	Bhagwanpur	Turkaha	Brijnathpur	Khesrari	Rajmalmadara	Dadari	Chakbandi	Rohana kalan	Rohana khurd	Parai	
Number of cooperator-farmers	10	10	10	10	10	5	9	7	10	10	10	101

Agriculture is the backbone of Indian economy, in spite of concerted efforts towards industrialization in last three decades. Agriculture contributes a high share of net domestic product by sectors in India. Now a day's farmers are adopting multi-cropping system rather than mono-cropping due to availability of irrigation, HYVs seed and inorganic fertilizers. The distributional pattern of crops in any region is an outcome of predominance of certain crop or combination of crops followed by the farmers.

1. Demographic features of selected farm households in surveyed area

The population of male adults was found to be 43, 48, 43 and 56% and that of female adult as 28, 31, 32 and 32% in Kushinagar, Maharajganj, Meerut and Muzaffarnagar districts, respectively. The average family size comprises of 5 members in Kushinagar but 4 members each in Maharajganj, Meerut and Muzaffarnagar districts. The average age of male and female adults on overall basis was 39 and 41 years, respectively. Whereas, the average age of male and female children were 11 and 13 years, respectively. Average age of household head ranged between 43-53 years in surveyed area and on overall basis it was found to be 49 years. The demographic data indicates that the young and active aged population is involved in the farming business. Average years of schooling of family head on overall basis was 9 years indicating lower education level which need to be improved for increasing awareness and technical knowledge among farmers. Average farming experience of household head calculated to be 25 years in Kushinagar 31 in Maharajganj, 32 in Meerut and 30 in Muzaffarnagar districts, which show high level of dependency and dedications of farmers in agricultural sectors (Table 2).

2. Employment pattern of farm households

Rice and wheat are staple food crops while sugarcane is considered major cash crop of Uttar Pradesh. Therefore, the major share of population involved in farming activity for their livelihood in the state. These crops are major nutrient consuming and planted on large area in the state due to climatic,

socioeconomic, physical and bio-physical factors. Live stocks and birds domestication are also common practice of farming community. The other crops are vegetables, pulses, oilseed and horticulture are planted on substantial area in the state.

Table 4 indicates the employment pattern of selected households in surveyed area. Farming is the major sector of employment of rural populations which accounted about 86% of households is dependent solely on agriculture. While 7% population is involved in govt. sector jobs and 6% of households are serving in private organizations/units and 1% engaged in business. The reason being engaged in private and government sectors is to sustain and improve income of family. It shows that the agriculture is the primary occupation of majority of the population in the state.

3. Acreage of different crops by seasons/Cropping pattern in target area

Table 3 indicates the cropping pattern followed by the cooperator-farmers in surveyed area in all four selected district during 2012-13 and 2014-15. Sugarcane is the major crop which occupied more than 53% area to total cropped area in *kharif* season. Rice is also an important *kharif* season crop after sugarcane which covered about 31.40 and 31.20% area to total cropped area followed by banana fruit crop but limited into Kushinagar and Maharajganj districts in eastern Uttar Pradesh. The other *kharif* crops are jowar, maize, moong and green fodder were grown in target area but have minor importance in terms of area. Poplar plantation was found on sample farms in Muzaffarnagar district only located in western Uttar Pradesh.

In case of *rabi* season, wheat is the major crops accounted more than 30% area to total cropped area. The other crops which have minor importance in area were green fodder (berseem & jai), mustard, pea, masoor and gram. Maize planted by the farmers of Kushinagar and Muzaffarnagar districts. Similarly, tomato was planted by the farmers of Kushinagar and onion crop in Maharajganj districts. Table also indicates that the diversified cropping pattern/systems are followed by the farmers in each season in surveyed area to support their livelihood and family requirements.

The major was left fallow in zaid season due to strong sunlight in summer and problem of stray animals. But few farmers of Meerut and Muzaffarnagar districts were planted cucumber crop

on very small area in zaid season. Poplar and banana are horticultural crops were planted by the farmers on their farms.

Table 2: Employment pattern of selected farm households.

Name of occupation	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall	
	No.	%	No.	%	No.	%	No.	%	No.	%
Farming activities	27	90	23	92	12	75	25	83	87	86
Government Services	2	7	1	4	3	19	1	3	7	7
Private Services	1	3	0	0	1	6	4	13	6	6
Business and professionalism	0	0	1	4	0	0	0	0	1	1
Total	30	100	25	100	16	100	30	100	101	100

4. Input use in sugarcane crop

Total material input used in sugarcane cultivation during base and assessment years in all the districts. Sugarcane crop solely covered around 14.80, 16.80 and 13.20 ha area in Kushinagar, Maharajganj and Meerut in both the periods, respectively. However, sugarcane is major crop of Muzaffarnagar district and it was cultivated on huge area of 70.53 ha on sample farms. The average seed rate (cane sets) ranges from 76.53 to 74.23 qtls/ha in Kushinagar, 81.15 to 80.29 in Maharajganj, 75.16 in Meerut and 75.31 to 75.72 in Muzaffarnagar districts.

The recommended dose of NPK for sugarcane cultivation is 120:60:40 kgs/ha which is in ratio of 3:1.5:1 and a total of 220 kg./ha nutrients is required. Half dose of N in the form of urea, full dose of P₂O₅ (phosphorus) and full dose of K₂O (MOP) were applied as basal during final land preparation as per recommendation. The rest half of N was top dressed in two equal split doses; one at shoot stage and another one before the beginning of monsoon rain with the objective of supplying nitrogen readily available form plant growth.

The NPK doses of fertilizers were applied during 2012-13 to be 167, 89 and 27 kg/ha which is in the ratio of 6.1:3:1 (283 kg/ha) in the Kushinagar which is not only higher but also unbalanced than the recommended dose. Likewise, in Maharajganj district, the ratio of NPK fertilizers was used in the ratio of 2.6:1.5:1 (287 kg/ha), which is also not up to the standard doses. Now use of fertilizers in Meerut district during base year was in the ratio of 11.4: 7.7:1 (303 kg/ha). The ratio of fertilizers applied in Muzaffarnagar was 13.3:9:1(303 kg/ha). The amount of fertilizers was found to be high and unbalanced in the surveyed area than the recommended (N high). In assessment year, the amount of N:P:K applied in the ratio of 2.6:1.5:1 (287 kg/ha), 2.8:1.8:1 (287), 1.8:1.4:1 (333) and 1.9:1.4:1 (335) in Kushinagar, Maharajganj, Meerut and Muzaffarnagar districts, respectively, which shows a reduction in doses of nitrogen and phosphorus and noticeable increase in the doses of potash over base year and ratio are also found near to the recommended dose. The use of total nutrients in the sugarcane crop has been changed considerably in assessment year. It is interesting to note from the analysis that use of potash increased by 222.50% in assessment year and the doses of nitrogen and phosphorus are being cut short significantly by 13.91 and 4.29%, respectively. However, total use of inorganic fertilizers increased on overall basis about 7.15% in assessment year. Result revealed that the farmers are using higher doses of potash after they have gained knowledge about significance of potash in the crop production.

Plant protection measures to control insects and diseases were also been used by the farmers in both the study periods in surveyed area and there is significant reduction in the chemicals-herbicides and insecticide by 15.40 and 18.90%, respectively, that ultimately leads to reduction in environmental hazards and cost of cultivation (Table-8).

Labor use in sugarcane cultivation

The activity-wise labor used in sugarcane cultivation in

surveyed area is given in table 9. The farming characteristic of the eastern part is pre-dominantly peasant type and in western parts of state is somehow commercialized. Different activities of sugarcane cultivation from land preparation to post-harvesting operation were mainly done by human labor except land preparation. The shares of family labor involvement in different activities are relatively higher in Kushinagar district but the proportion of hired labors was more in other three districts in surveyed area. The total labor days used in sugarcane cultivation in base and assessment years are almost similar in all the districts. The total labour use was higher 114 and 112/ha, in the Kushinagar district, and the corresponding figure for other three districts of Maharajganj, Meerut and Muzaffarnagar ranged between 99 to 101. The average share of family labor involvement in sugarcane cultivation was about 24% to total labour use in the target area.

5. Costs and return analysis of sugarcane cultivation

Table 4 represent costs and return analysis of sugarcane production in the surveyed area of selected districts where PFL project activities are intensively continued from 2013. Table indicates that the average cost of cultivation of sugarcane in surveyed areas were Rs.64116.00/- and Rs.80907.00/ha in base and assessment years, respectively (Table 5).

In nutrient management the cost of nitrogenous and phosphatic fertilizers was decreased by 9.80 and 2.20% in assessment year. However, potashic fertilizers tended to increase by 260.48% in reference period and this increment can further be helpful in enhancement of net income of farmers due to increased biomass production.

The net return increased in assessment year as owing to enhanced quantity of produce the cooperator farmers have been able to have more gross return due to increased in the production by 16.53%. On an average, about 65.97% net return hike have been gained by cooperator farmers in assessment year due to balance use of inorganic fertilizer especially potash and also coupled with price hike of cane by the Govt. Benefit cost ratio also improved in assessment year in the target area. The cost of plant protection measures also reduced in the later period due to use of balanced fertilizers means incidence of insect and diseases were minimal.

In labor cost planting, intercultural operation and harvesting happen to be most cost intensive operations which covered 3.78-3.51, 3.15-3.14 and 8.91-11.35% to total cost in both study periods on overall basis. In power operations mainly tractor is being used for land preparation that makes proportion of 11.77% and 11.61% in base and assessment period respectively, out of total cost of cultivation. The cost of cultivation is relatively increased in assessment year by 26.19% owing to increased material and labor cost according to price hikes in the market. However, fewer fluctuations have been recorded in cost involved in power operations across the years (Tale 6.)

Table 3: Acreage of different crops and their productivity in target area.

Districts/ Particulars	Kushinagar						Maharajganj						Meerut						Muzaffarnagar						Overall					
	2012-13			2014-15			2012-13			2014-15			2012-13			2014-15			2012-13			2014-15			2012-13			2014-15		
	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv	Area	%	Prdv
Kharif season																														
Rice	25.3	50.9	51.1	25.3	50.9	57.6	31.8	49.7	53.8	31.8	49.7	59.7	1.5	9.3	28.7	1.5	9.3	35.3	10.7	11.8	28.4	10.3	11.3	37.7	69.4	31.4	40.5	68.9	31.2	47.6
Green fodder	1.0	2.0	-	2.2	4.4	-	0.8	1.3	-	0.8	1.3	-	1.5	9.1	-	1.3	7.7	-	5.5	6.0	-	5.7	6.3	-	8.8	4.0	-	10.0	4.5	-
Poplar plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.4	-	0.3	0.4	-	0.3	0.2	-	0.3	0.2	-
Jowar	-	-	-	-	-	-	-	-	-	-	-	-	0.3	2.0	-	0.3	2.0	-	-	-	-	-	-	-	0.3	0.2	-	0.3	0.2	-
Maize	2.7	5.4	59.6	2.3	4.6	61.9	2.0	3.1	58.8	2.0	3.1	65.0	-	-	-	-	-	-	2.8	3.1	60.6	3.4	3.7	68.0	7.5	3.4	59.7	7.7	3.5	64.9
Moong	-	-	-	-	-	-	-	-	-	-	-	-	0.2	1.2	10.0	0.2	1.2	12.5	-	-	-	-	-	-	0.2	0.1	10.0	0.2	0.1	12.5
Fallow	0.2	0.4	-	0.2	0.4	-	0.2	0.3	-	0.2	0.3	-	-	-	-	-	-	-	0.1	0.1	-	-	-	-	0.5	0.2	-	0.4	0.2	-
Banana	4.5	9.1	-	3.7	7.4	-	8.2	12.8	-	8.2	12.8	-	-	-	-	-	-	-	-	-	-	-	-	-	12.7	5.7	-	11.9	5.4	-
Sugarcane	16.0	32.2	-	16.0	32.2	-	16.8	26.3	-	16.8	26.3	-	13.2	79.9	-	13.2	79.9	-	71.3	78.6	-	71.0	78.3	-	117.3	53.1	-	117.0	52.9	-
Total	49.7	100.0	-	49.7	100.0	-	64.0	100.0	-	64.0	100.0	-0	16.5	100.0	-	16.5	100.0	-	90.7	100.0	-	90.7	100.0	-	221.0	100.0	-	221.0	100.0	0.0
Rabi season																														
Wheat	22.5	45.3	35.2	22.9	46.1	41.6	31.6	49.4	35.8	31.6	49.4	39.9	0.9	5.2	38.3	0.9	5.6	42.3	11.1	12.3	41.7	11.1	12.3	45.0	66.1	29.9	37.8	66.6	30.1	42.2
Green fodder	0.8	1.6	-	-	-	-	-	-	-	0.8	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	0.4	-	0.8	0.4	-
Berseem	1.0	2.0	-	0.8	1.6	-	4.8	7.5	-	4.0	6.3	-	1.3	7.7	-	1.3	7.7	-	4.5	5.0	-	4.7	5.1	-	11.6	5.2	-	10.7	4.9	-
Poplar plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.4	-	0.3	0.2	-	0.3	0.2	-
Mustard	2.2	4.4	12.7	1.8	3.6	14.0	0.4	0.6	11.3	0.4	0.6	13.8	0.3	2.0	12.0	0.3	2.0	13.5	1.8	2.0	14.6	2.9	3.2	14.6	4.7	2.1	12.7	5.4	2.4	14.0
Maize	-	-	-	0.4	0.8	25.0	-	-	-	-	-	-	-	--	-	-	-	-	0.3	0.4	13.5	-	-	-	0.3	0.2	13.5	0.4	0.2	25.0
Tomato	0.4	0.8	425.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.2	425.0	-	-	-
Pea	0.4	0.8	17.5	1.2	2.4	21.3	1.2	1.9	16.3	1.2	1.9	18.4	0.3	1.6	18.8	0.3	1.6	24.4	0.3	0.4	48.0	0.3	0.4	60.0	2.2	1.0	25.1	3.0	1.4	31.0
Masoor	0.6	1.2	13.0	0.4	0.8	15.0	0.8	1.3	8.8	0.8	1.3	10.6	0.2	1.2	12.5	0.2	1.2	17.5	0.7	0.8	13.7	0.8	0.9	14.0	2.3	1.1	12.0	2.2	1.0	14.3
Onion	-	-	-	-	-	-	-	-	-	0.8	1.3	175.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	0.4	175.0
Gram	1.7	3.4	18.8	1.3	2.6	22.1	0.4	0.6	17.5	0.4	0.6	20.0	0.4	2.4	11.6	0.3	2.0	15.0	1.3	1.5	14.0	1.2	1.3	18.2	3.8	1.7	15.5	3.2	1.5	18.8
Banana	4.5	9.1	376.4	4.5	9.1	444.9	8.0	12.5	342.5	7.2	11.3	387.5	-	-	--	-	-	-	-	-	-	-	-	-	12.5	5.7	359.5	11.7	5.3	416.2
Sugarcane	15.6	31.4	391.2	16.4	33.0	480.8	16.8	26.3	391.5	16.8	26.3	447.1	13.2	79.9	672.3	13.2	79.9	789.8	70.2	77.4	661.2	69.4	76.5	778.2	115.8	52.4	529.1	115.8	52.4	624.0
Total	49.7	100.0	-	49.7	100.0	-	64.0	100.0	-	64.0	100.0	-	16.5	100.0	-	16.5	100.0	-	90.7	100.0	-	90.7	100.0	-	221.0	100.0	-	221.0	100.0	-
Zaid season																														
Poplar plants	-	--	-	-	-	--	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.4	-	0.3	0.4	-	0.3	0.2	-	0.3	0.2	-
Banana	4.1	8.2	-	4.1	8.2	-	9.0	14.1	-	8.2	12.8	-	-	-	-	-	-	-	19.7	21.7	-	19.7	21.7	-	32.8	14.8	-	32.0	14.5	-
Cucumber	-	-	-	-	-	-	-	-	-	-	-	-	0.6	3.6	131.3	0.6	3.6	153.8	0.1	0.1	150.0	0.1	0.1	225.0	0.7	0.3	140.6	0.7	0.3	189.4
Sugarcane	16.0	32.2	-	14.4	29.0	-	16.8	26.3	-	16.8	26.3	-	12.7	76.6	-	12.7	76.6	-	70.7	77.9	-	70.6	77.8	-	116.1	52.6	-	114.5	51.8	-
Fallow	29.6	59.6	-	30.0	60.4	-	38.2	59.7	-	39.0	60.9	-	3.3	19.8	-	3.3	19.8	-	-	-	-	-	-	-	71.1	32.2	-	72.3	32.7	-
Total	49.7	100.0	-	49.7	100.0	-	64.0	100.0	-	64.0	100.0	-	16.5	100.0	-	16.5	100.0	-	90.7	100.0	-	90.7	100.0	-	221.0	100.0	-	221.0	100.0	-

Sources: Farm survey 2015-16

Table 4: Material input used in sugarcane crop.

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall		% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	
Area (ha)	14.8	14.8	16.8	16.8	13.2	13.2	70.53	69.73	115.33	114.53	-0.69
Cane sets (qtl/ha)	76.53	74.23	81.15	80.29	75.16	75.16	75.31	75.72	77.04	76.35	-0.89
FYM (qtl/ha)	205.28	189.15	137.73	136.56	499.88	414.79	502.09	422.05	336.24	290.64	-13.56
NPK (kg/ha)											
N	167.00	145.00	163.00	144.00	172.00	145.00	173.00	148.00	169.00	145.50	-13.91
P	89.00	87.00	97.00	92.00	116.00	111.00	117.00	112.00	105.00	100.50	-4.29
K	27.00	55.00	27.00	51.00	15.00	77.00	13.00	75.00	20.00	64.50	222.50
Total	283.00	287.00	287.00	287.00	303.00	333.00	303.00	335.00	294.00	315.00	7.15
Zink (Kg)	7.69	6.20	10.78	9.21	11.14	9.99	12.33	11.62	10.48	9.25	-11.75
Herbicide(lit)	2.20	2.07	2.11	1.46	2.21	1.96	2.28	1.95	2.20	1.86	-15.43
Insecticide(lit)	1.36	1.15	1.34	1.10	0.94	0.75	0.94	0.73	1.15	0.93	-18.98

Sources: Farm survey 2015-16

Table 5: Labor input use in sugarcane cultivation (Mandays/ha)

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall		% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	
Area (ha)	14.8	14.8	16.8	16.8	13.2	13.2	70.53	69.73	115.33	114.53	-0.69
Land preparation											
Family	3.10	3.27	1.42	1.51	1.24	1.24	1.25	1.28	1.75	1.83	4.15
Hired	1.52	1.55	1.86	2.05	1.27	1.27	1.23	1.23	1.47	1.53	3.63
FYM application											
Family	4.37	4.37	1.90	1.90	1.24	1.24	1.27	1.29	2.20	2.20	0.23
Hired	2.03	2.03	2.88	2.88	1.83	1.83	1.84	1.86	2.14	2.15	0.20
Planting											
Family	6.52	6.52	2.70	2.70	1.30	1.30	1.28	1.30	2.95	2.96	0.17
Hired	17.57	17.07	21.17	19.69	9.22	9.22	14.75	9.79	15.68	13.94	-11.06
Fertilizer application											
Family	3.48	3.48	2.13	2.13	1.30	1.30	1.24	1.27	2.04	2.04	0.36
Hired	1.55	1.58	1.44	1.79	2.73	2.73	2.72	2.76	2.11	2.21	4.90
Intercultural operation											
Family	10.66	10.66	4.08	4.08	1.30	1.30	1.22	1.25	4.32	4.32	0.17
Hired	21.32	20.31	25.52	23.33	3.15	3.15	3.56	3.62	13.39	12.60	-5.88
Herbicide											
Family	3.23	2.52	1.77	1.77	1.30	1.30	1.21	1.23	1.88	1.71	-9.31
Hired	0.35	0.29	0.82	0.74	1.30	1.30	1.41	1.43	0.97	0.94	-3.18
Irrigation											
Family	8.07	8.07	3.59	3.59	1.30	1.30	1.27	1.28	3.56	3.56	0.10
Hired	0.76	0.76	1.53	1.53	1.90	1.90	2.02	2.02	1.55	1.55	-0.01
Insecticide											
Family	3.77	2.40	1.93	1.93	1.30	1.30	1.22	1.25	2.06	1.72	-16.29
Hired	0.90	0.84	1.56	1.42	1.90	1.90	1.93	2.03	1.57	1.55	-1.51
Harvesting											
Family	9.17	9.17	4.23	4.23	1.46	1.59	1.31	1.34	4.04	4.08	0.97
Hired	16.30	17.68	20.61	22.08	55.95	58.91	55.84	59.33	37.17	39.50	6.26
Total labor use											
Total family	52.37	50.46	23.75	23.84	11.74	11.87	11.27	11.49	24.80	24.42	-1.53
Total hired	62.30	62.11	77.39	75.51	79.25	82.21	85.30	84.07	76.05	75.97	-0.11
Total	115.00	113.00	101.00	99.00	91.00	94.00	97.00	96.00	101.00	100.00	-0.46

Table 6: Costs & return analysis of sugarcane cultivation on sample farm (Rs./ha)

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall				% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13		2014-15		
Area hact	14.8	14.8	16.8	16.8	13.2	13.2	70.53	69.73	115.33	%	114.53	%	
Yield (qtls./ha)	405.06	478.37	416.54	474.74	676.83	789.75	665.32	778.55	540.94		630.35		16.53
Material cost													
Seed	17783.7	20655.5	18894.8	22270.6	17287.6	20844.4	17320.2	21127.3	17821.57	27.80	21224.42	26.23	19.09
FYM	1026.4	1324.0	688.7	955.9	2499.4	2903.5	2510.4	2954.3	1681.22	2.62	2034.46	2.51	21.01
Urea	1725.0	1565.0	1629.7	1533.6	1657.6	1442.9	1653.6	1465.4	1666.46	2.60	1501.74	1.86	-9.88
DAP	4544.3	4523.8	4960.1	4784.4	5921.8	5768.8	5974.9	5856.3	5350.26	8.34	5233.33	6.47	-2.19
MOP	638.6	1461.1	623.1	1347.1	345.1	2053.7	296.7	1999.8	475.87	0.74	1715.44	2.12	260.48
Zink	230.7	217.0	323.4	322.3	334.1	349.5	370.0	406.6	314.55	0.49	323.85	0.40	2.96
Herbicide	604.2	628.0	591.8	458.3	655.9	686.9	663.3	681.9	628.78	0.98	613.78	0.76	-2.39
Insecticide	2375.4	2262.9	2380.1	2206.3	1718.1	1602.3	1689.3	1540.7	2040.72	3.18	1903.04	2.35	-6.75
Sub total	28928.2	32637.3	30091.6	33878.4	30419.4	35652.1	30478.4	36032.4	29979.4	46.76	34550.1	42.70	15.25

Cost involved In power operations													
Tractor	5791.7	6518.8	5895.6	6713.5	9200.0	12164.3	9290.1	12180.6	7544.34	11.77	9394.34	11.61	24.52
Bullock	1849.0	2572.4	1787.1	2382.8	1274.1	1592.6	1123.2	1540.2	1508.34	2.35	2022.00	2.50	34.05
Irrigation	10730.2	8971.2	8186.2	10445.3	6105.0	9010.3	6294.4	7979.3	7828.94	12.21	9101.53	11.25	16.26
Transportation	3240.5	5740.5	3332.3	5696.9	6768.3	11846.3	6653.2	11678.3	4998.58	7.80	8740.46	10.80	74.86
Sub total	21611.3	23803.0	19201.2	25238.5	23347.4	34613.5	23360.9	33378.4	21880.2	34.13	29258.3	36.16	33.72
Labor cost													
Land preparation	303.57	386.90	372.92	513.02	250.77	311.00	239.53	302.39	291.70	0.45	378.33	0.47	29.70
FYM Application	405.95	507.44	575.00	718.75	362.88	448.25	358.80	450.10	425.66	0.66	531.13	0.66	24.78
Planting	2635.42	3414.68	3175.78	3937.50	1447.38	1977.83	2436.13	2044.47	2423.67	3.78	2843.62	3.51	17.33
Fertilizer use	261.90	334.82	288.54	447.92	681.25	772.50	681.19	791.77	478.22	0.75	586.75	0.73	22.69
Intercultural operation	3197.92	4061.51	3828.13	4666.67	496.54	668.21	564.42	774.05	2021.75	3.15	2542.61	3.14	25.76
Herbicide use	69.44	71.92	163.54	184.90	325.83	371.88	353.00	410.81	227.96	0.36	259.88	0.32	14.00
Irrigation	152.78	190.97	305.21	381.51	379.33	474.17	403.72	504.47	310.26	0.48	387.78	0.48	24.99
Insecticide use	180.56	210.81	311.46	354.17	474.17	474.17	481.52	507.87	361.93	0.56	386.75	0.48	6.86
Harvesting	2444.94	3535.71	3092.19	4416.67	8670.25	14336.58	8655.86	14438.56	5715.81	8.91	9181.88	11.35	60.64
Sub total	9652.48	12714.78	12112.76	15621.09	13088.40	19834.58	14174.16	20224.49	12256.95	19.12	17098.74	21.13	39.50
Total cost	60192.0	69155.1	61405.6	74738.1	66855.2	90100.2	68013.5	89635.2	64116.6	100.00	80907.1	100.00	26.19
Gross value	91138.39	133944.44	93720.70	132927.08	152287.50	221130.00	149697.17	217994.03	121710.94	-	176498.89	-	-
Net Return	30946.39	64789.37	32315.14	58189.01	85432.26	131029.82	81683.65	128358.80	57594.36	-	95591.75	-	65.97
B:C Ratio	1.51	1.94	1.53	1.78	2.28	2.45	2.20	2.43	1.90	-	2.18	-	-

Sources: Farm survey 2015-16

6. Input use in rice production

Table 7 presents the total material input used in rice production in surveyed area during study years in the selected districts of eastern and western Uttar Pradesh. Rice crop solely covered around 24.50 ha area in Kushinagar, 31.80 ha in Maharajganj, 1.50 ha in Meerut and around 10.70 ha in Muzaffarnagar districts during 2012-2015. But during the assessment year acreage under rice slightly decreased which is about 1%. The average seed rate ranges from 56.55 to 59.10 kg/ha in Kushinagar and Maharajganj district that falls in eastern U.P. Whereas it was 37.26 to 40.80 kg/ha in Meerut and

Muzaffarnagar districts that lies in the western part of Uttar Pradesh. The variable seed rate depends on the land topography, quality of seed and types of varieties including rice establishment technique in different locations. The popular varieties of WUP were fine, aromatic and long slender grain which is basically belongs to basmati group of rice (PB 1, Pusa 1121, Pusa 1509 etc.) where as Swarna, Shamba Mahsuri, Saryu 52, hybrids etc. were found on farmers field in Eastern Uttar Pradesh. These varieties have variable characteristics from field conditions to post-harvest operation and quality that are satisfying farmers need and preferences.

Table 7: Material input use in rice cultivation.

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall		% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	
Area (ha)	24.5	24.5	31.8	31.8	1.5	1.5	10.7	10.1	68.6	68.0	-0.9
Seed (kg/ha)	37.0	35.00	38.00	37.00	37.50	40.80	37.26	40.20	37.44	38.25	2.16
NPK (kg/ha)											
N	112.0	102.0	132.0	121.0	158.0	124.0	152.0	122.0	138.5	117.2	-15.3
P	16.0	13.0	57.0	47.0	104.0	76.0	97.0	73.0	68.5	52.2	-23.7
K	26.0	47.0	25.0	50.0	25.0	25.0	15.0	16.0	22.7	34.5	51.6
Total	154.0	162.0	214.0	218.0	287.0	225.0	264.0	211.0	229.7	203.9	-11.23
Zink (Kg)	15.8	15.8	15.3	15.3	16.7	16.7	16.1	16.5	16.0	16.1	0.7
Herbicide (lit)	2.1	2.1	2.2	2.2	0.8	0.8	0.8	0.8	1.5	1.5	0.5
Insecticide (lit)	1.2	1.0	1.2	0.9	0.8	0.8	0.8	0.8	1.0	0.9	-14.0

The recommended dose of NPK is 150:60:60 kgs/ha in ratio of 2.5:1:1 and a total of (270 kg) nutrients per hectare is required for rice production. Half dose of N in the form of Urea, full dose of P_2O_5 (DAP) and full dose of K_2O (MOP) were applied as basal dose during final land preparation as per recommendation. The rest half of N was top dressed in two equal split doses; one at active tillering and another one at panicle initiation stage with the objective of supplying nitrogen in readily available form to growing plants. The NPK doses of fertilizers were applied during 2012-13 to be 112, 16 and 26 kg/ha, respectively, which is in the ratio of 7:1:1.6 (154 kg/ha) much deviating from recommended ratio and indicating unbalanced application of inorganic fertilizers practiced by the farmers in surveyed area of Kushinagar.

Likewise in Maharajganj district, the ratio of NPK fertilizers was used in the ratio of 5.2:2.2:1 (214 kg), which is also not up to the standard doses. The amount of fertilizers used in Meerut

which is in the ratio of 6.3:4.16:1 (287 kg/ha) and in Muzaffarnagar, the ratio is 10.1:6.4:1 (264 kg). The amount of nitrogenous fertilizer was found to be quite high in the surveyed area than the recommended dose. In assessment year, the amount of N:P:K being applied in all four districts were in the ratio of 7.8:1:3.6 (162 kg), 2.5:1:1.06 (329 kg), 4.9:3.04:1 (225 kg) and 7.6:4.5:1 (211 kg/ha) respectively, which shows a reduction in doses of nitrogen and phosphorus and noticeable rise in the doses of potash over the base year. The use of total nutrients in the rice crop has been changed considerably in assessment year. It is interesting to note from the analysis that use of potash increased by 51% in assessment year and the doses of nitrogen and phosphorus were being cut short significantly by 15.30% and 23.70%, respectively. Result revealed that the farmers were initiated using higher dose of potash after they have gained knowledge and significance of potash in the crop production from PFL project activity.

Plant protection measures which control insects and diseases have also been used by the farmers in both the study periods in surveyed area and there is significant reduction in these chemicals including insecticide which was reduced by 14% and use of herbicide increased by 0.50% (Table 7).

Labor input use in rice cultivation

The activity-wise labor used in rice production in surveyed area is given in table 12. The total labor days used in rice cultivation in the Kushinagar district was almost similar in both the periods (94 /ha) in surveyed area. The corresponding figure for Maharajganj district was also found to similar result that about 88 labor days per hectare. However, in Meerut district the total labor days was about 68 labor in both the periods. The total labor days for Muzaffarnagar were 64.70 and 68.30 in base and assessment years. It has been found that more labor used to complete all management practices from land preparation to harvesting in Kushinagar district as compare to other three districts.

In nutrient management the cost of nitrogenous and phosphatic fertilizers were decreased by 6.10 and 21.70% but potashic fertilizers tended to increase by 75% and this increment can further be helpful in enhancement of net income of farmers due to increased biomass production. Transplanting and weeding are

common practice in labor cost in sample area and happened to be most cost intensive activity as it covered 9.40-17.60 and 7.80-9.30% of total cost in both study periods on overall basis. In power operations mainly tractor was being used for land preparations and it covered about 1.70 and 1.80% of total cost of cultivation in base and assessment period of study on overall basis. The cost of cultivation relatively increased in assessment year by 18.10% owing to increase in material and labor cost according to price hikes in the market.

Table 8 represents analysis of costs and return of rice production in Kushinagar, Maharajganj, Meerut and Muzaffarnagar districts of Uttar Pradesh state where PFL project activities are continued from 2013. The total cost of cultivation of rice of surveyed area in both the periods: base and assessment years were Rs. 21955.80 and Rs. 27327.50 /ha, respectively. In material cost, seed accounted 3.70% and 3.50% of total cost due to its high quality and better resistance many stresses. The net income increased in assessment year owed to better quality of their produce, the co-operator farmers have been able to fetch attractive price in market. Income also increased due to incremental income from increased production. On an average, about 52% net return hike have been gained by co-operator farmers in assessment year over base year due to balance use of inorganic fertilizer especially potash (Table 9).

Table 8: Labor input use in rice cultivation.

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall		% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	
Area (ha)	24.5	24.5	31.8	31.8	1.5	1.5	10.7	10.1	68.6	68.0	-0.9
Land Preparation											
Family Labor	2.7	2.4	2.5	2.2	1.6	1.6	1.9	2.0	2.2	2.0	-5.4
Hired Labor	1.3	1.2	1.1	1.1	3.3	3.3	2.3	2.5	2.0	2.0	1.6
Transplanting											
Family Labor	6.2	6.0	5.3	5.0	3.2	3.2	4.0	4.7	4.6	4.7	1.4
Hired Labor	17.5	16.7	17.2	17.1	24.5	24.5	23.4	24.1	20.7	20.6	-0.1
Fertilizer use											
Family Labor	2.5	2.8	2.0	2.2	1.7	2.0	2.5	2.5	2.1	2.4	10.1
Hired Labor	0.3	0.3	0.4	0.4	1.4	1.4	1.1	1.3	0.8	0.8	4.8
Weeding											
Family Labor	8.0	8.0	6.3	6.3	3.3	3.3	3.5	3.5	5.3	5.3	0.2
Hired Labor	20.3	19.5	20.6	20.4	14.4	14.4	12.8	13.4	17.0	16.9	-0.6
Herbicide use											
Family Labor	2.1	1.8	1.8	1.8	1.7	1.7	1.8	1.8	1.8	1.8	-2.5
Hired Labor	0.2	0.2	0.3	0.3	2.0	2.0	1.0	1.2	0.9	0.9	3.5
Irrigation											
Family Labor	4.0	3.8	3.1	3.2	1.7	1.7	2.4	2.4	2.8	2.7	-0.9
Hired Labor	0.2	0.2	0.4	0.4	1.7	1.7	1.4	1.5	0.9	1.0	3.3
Pesticide use											
Family Labor	2.4	2.2	2.1	1.8	1.7	1.7	1.7	1.8	2.0	1.9	-5.3
Hired Labor	0.4	0.3	0.3	0.2	2.7	2.7	2.4	2.6	1.5	1.5	1.0
Harvesting											
Family Labor	6.8	7.4	5.7	5.8	1.7	1.7	1.9	2.0	4.0	4.2	4.6
Hired Labor	15.3	15.8	14.6	14.9	1.6	2.3	0.7	1.2	8.1	8.6	6.4
Threshing											
Family Labor	2.6	2.6	2.5	2.5	-	-	-	-	1.3	1.3	-
Hired Labor	1.5	2.1	1.5	2.1	-	-	-	-	0.7	1.1	42.8
Total labour use											
Total family	37.3	37.0	31.3	30.8	16.6	16.9	19.7	20.7	26.1	26.3	0.77
Total hired	57.0	56.3	56.4	56.9	51.6	52.3	45.1	47.8	52.6		
Total	94.2	93.4	87.7	87.9	67.9	68.9	64.7	68.3	78.6	79.6	1.3

Table 9: Costs & return analysis of rice cultivation.

Districts/ Particular	Kushinagar		Maharajanj		Meerut		Muzaffarnagar		Overall				% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	%	2014-15	%	
Area hact	24.5	24.5	31.8	31.8	1.5	1.5	10.7	10.1	68.6		68.0		-0.9
Yield (qtls./ha)	51.3	58.5	53.8	59.9	28.7	35.3	28.4	37.7	40.5		47.8		18.1
Material Cost													
Seed	449.92	616.0	418.0	518.0	1050.0	1141.5	931.2	1002.4	712.28	3.24	819.48	3.0	15.05
Urea	1373.8	1374.8	1429.0	1452.2	1535.4	1328.0	1492.9	1319.4	1457.8	6.6	1368.6	5.0	-6.1
DAP	819.2	691.3	2921.4	2461.0	5287.5	3967.2	4941.8	3820.3	3492.5	15.9	2735.0	10.0	-21.7
MOP	599.8	1258.0	572.3	1355.0	583.8	667.2	355.1	413.9	527.7	2.4	923.5	3.4	75.0
Zinc	442.8	474.4	427.8	458.3	466.2	499.5	449.8	496.2	446.6	2.0	482.1	1.8	7.9
Sub Total	3685.42	4414.55	5768.45	6244.55	8922.90	7603.4	8170.8	7052.3	6636.90	30.23	6328.68	23.21	-4.64
Plant Protection Cost													
Herbicide	630.0	630.0	697.0	697.0	231.3	231.3	227.1	236.1	446.3	2.0	448.6	1.6	0.5
Insecticide	2144.2	1742.1	2237.7	1704.6	1173.9	1296.8	1088.2	1209.4	1661.0	7.6	1488.2	5.5	-10.4
Sub Total	2774.2	2372.1	2934.7	2401.6	1405.2	1528.1	1315.2	1445.4	2107.3	9.6	1936.8	7.1	-8.1
Labor Cost													
Land Prepration	260.3	311.5	221.9	277.3	592.5	806.3	417.8	588.9	373.1	1.7	496.0	1.8	32.9
Transplanting	1745.4	2510.8	1721.8	2571.2	2452.5	5266.9	2342.1	5060.0	2065.5	9.4	3852.2	14.1	86.5
Fertilizer use	56.1	70.1	79.7	104.8	270.0	378.8	224.5	355.6	157.6	0.7	227.3	0.8	44.3
Weeding	2029.9	2928.5	2059.0	3057.3	1440.0	2160.0	1277.8	2005.4	1701.7	7.8	2537.8	9.3	49.1
Herbicide use	46.7	58.3	88.4	110.5	330.0	339.4	284.3	318.2	187.3	0.9	206.6	0.8	10.3
Irrigation	73.9	75.0	63.5	59.0	540.0	810.0	483.1	680.0	290.1	1.3	406.0	1.5	39.9
Pesticide use	1528.5	2369.8	1461.2	2240.6	157.5	483.8	74.4	253.7	805.4	3.7	1337.0	4.9	66.0
Harvesting	151.9	320.8	146.8	319.1	-	-	-	-	74.7	0.3	160.0	0.6	114.2
Threshing	46.7	58.3	133.3	166.7	120.0	-	122.7	173.9	105.7	0.5	99.7	0.4	-5.6
Sub Total	5939.3	8703.3	5975.6	8906.6	5902.5	10245.0	5226.8	9435.7	5761.0	26.2	9322.6	34.2	61.8
Cost Involved in Power Operations													
Tractor	5007.8	5886.7	5090.1	5817.7	2767.5	3874.5	2800.7	3873.5	3916.5	17.8	4863.1	17.8	24.2
Irrigation Tube well	444.4	587.5	125.0	175.0	1140.0	2070.0	1887.4	2428.4	899.2	4.1	1315.2	4.8	46.3
Combine	495.8	657.5	1151.9	1413.5	2520.0	3300.0	2466.0	3326.5	1658.4	7.6	2174.4	8.0	31.1
Threshing	2124.4	3030.6	1412.5	1765.6	-	-	-	-	884.2	4.0	1199.0	4.4	35.6
Sub Total	8072.5	10162.2	7779.5	9171.9	6427.5	9244.5	7154.1	9628.4	7358.4	33.5	9551.8	35.0	29.8
Total Cost	20471.4	25652.1	22458.3	26724.7	22658.1	28620.9	21866.9	27561.8	21863.7	100.0	27139.9	100.0	24.1
Value of M.P.*	53595.1	75001.5	59449.9	76735.4	50910.0	75037.5	57593.5	83916.0	55387.1	-	77672.6	-	40.2
Value of B.P.**	3329.9	5673.4	3545.1	5903.6	2535.0	4074.0	2317.1	4272.5	2931.8	-	4980.9	-	69.9
Gross income	56924.9	80675.0	62995.0	82639.1	53445.0	79111.5	59910.6	88188.5	58318.9	-	82653.5	-	41.7
Net return	36453.5	55022.9	40536.8	55914.4	30786.9	50490.6	38043.7	60626.7	36455.2	-	55513.6	-	52.2
B:C Ratio	2.8	3.1	2.8	3.1	2.4	2.8	2.7	3.2	2.7	-	3.0	-	-

(Rs./ha)

*Main product and **By product

Sources: Farm survey 2015-16

7. Input use in wheat cultivation

The recommended dose of NPK in wheat is 150:60:60 kg/ha in ratio of 2.5:1:1 and a total of 270 kg nutrients per hectare is recommended for wheat production. Half dose of N in the form of urea, full dose of P₂O₅ (DAP) and full dose of K₂O (MOP) were applied as basal during final land preparation. The rest half of N was top dressed in two equal split doses; one at active tillering and another one at panicle initiation stage with the objective of supplying nitrogen in readily available form to growing plants. The NPK doses of fertilizers were applied during 2012-13 to be 136, 75 and 19 kg/ha, respectively, which was in the ratio of 7.1:3.9:1 (230 kg/ha) not much deviating from recommended ratio and indicating little bit unbalanced use of inorganic fertilizers practiced by the farmers in Kushinagar. Likewise in Maharajanj district, the ratio of NPK fertilizers was used in the ratio of 4.7:2.7:1 (254 kg), which is also not up to the standard doses. The amount of fertilizers used in Meerut which was in the ratio of 49:32.3:1 (242 kg) and in Muzaffarnagar the amount in the ratio of 17.2:11.5:1 (268 kg). The amount of fertilizers was found to be high doses in the surveyed districts than recommended. In assessment year, the amount of N:P:K being applied in all four districts were in the ratio of 3.6:2:1 (213 kg/ha), 2.6:1.5:1 (243 kg), 4.6:3.2:1 (188

kg) and 3.4:2.1:1 (205 kg), respectively, which shows a reduction in doses of nitrogen and phosphorus and noticeable rise in the doses of potash over base year. The use of total nutrients in the wheat has been changed considerably in assessment year. It is interesting to note from the analysis that use of potash increased by 114% in assessment year and the doses of nitrogen and phosphorus has been reduced significantly by 23.20 and 23.70%, respectively, in 2014-15.

Table 10 revealed that the farmers are using higher doses of potash after they have gained knowledge and significance of potash in the crop production. Plant protection measures to control insects and diseases were also significantly reduced in surveyed area during study period (Table-14). The activity-wise labor used in wheat production in surveyed area is given in table 15. The total labor days used in wheat cultivation in the Kushinagar district was 43.70 and 44.5/ha in base and in assessment year, respectively. The corresponding figures for Maharajanj, and Muzaffarnagar were 37.20 and 36.60, 41.40 and 42.10/ha in base and assessment years. It has been found that higher labor used found to complete all practices from land preparation to harvesting, threshing etc in Kushinagar district as compare to other three districts. Table 11 presents the labour use by different operation in rice cultivation practices. Table

revealed that labour use in rice cultivation were almost similar with minor differences in both the years.

Analysis of costs and return of wheat cultivation in Kushinagar, Maharajganj, Meerut and Muzaffarnagar districts are presented in Table 12. The total cost of cultivation of wheat in surveyed area in both the periods: base and assessment years were Rs. 21393.50 and Rs. 24236.70 per ha, respectively. The material

cost involved in wheat cultivation such as costs of seed, fertilizer and plant protection chemicals which accounted 8.60, 25.60 and 2.00% to total cost of cultivation, respectively.

Similarly in nutrient management the cost of nitrogenous and phosphatic fertilizers was decreased by 17.00 and 21.80% but potashic fertilizers tended to increase by 232%.

Table 10: Material input use in wheat cultivation.

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall		
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	% Change
Area ha	23.3	23.3	31.6	31.6	0.9	0.9	11.1	11.0	66.9	66.8	-0.2
Seed (kg/ha)	100.8	106.1	95.7	103.1	93.8	103.3	92.4	105.2	95.7	104.4	9.1
NPK (kg/ha)											
N	136.0	117.0	142.0	124.0	147.0	98.0	155.0	106.0	145.0	111.2	-23.2
P	75.0	64.0	82.0	72.0	97.0	69.0	104.0	68.0	89.5	68.2	-23.7
K	19.0	32.0	30.0	47.0	3.0	21.0	9.0	31.0	15.2	32.7	114.7
Total	230.0	213.0	254.0	243.0	247.0	188.0	268.0	205.0	249.7	212.6	-15.06
Herbicide(lit)	1.7	1.7	1.9	1.5	1.3	1.3	1.4	1.3	1.6	1.5	-7.3

Table 11: Labor input use in wheat cultivation

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall		
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	% Change
Area (ha)	23.3	23.3	31.6	31.6	0.9	0.9	11.1	11.0	66.9	66.8	-0.2
Land Preparation											
Family	2.4	2.4	2.1	2.1	1.3	1.3	1.6	1.7	1.9	1.9	0.3
Hired	1.2	1.4	1.0	1.0	1.5	1.5	1.4	1.5	1.3	1.3	5.9
Sowing/panting											
Family	2.4	2.4	1.9	1.9	1.8	1.8	1.8	1.8	2.0	2.0	0.3
Hired	0.7	0.7	1.6	1.6	0.5	0.5	1.3	1.3	1.0	1.0	0.0
Fertilizer application											
Family	2.6	2.1	2.2	1.6	4.2	4.2	1.7	1.7	2.7	2.4	-10.6
Hired	0.5	0.5	1.4	1.4	0.3	0.3	0.2	0.2	0.6	0.6	0.0
Herbicide application											
Family	1.8	1.8	1.5	1.5	1.8	1.8	1.7	1.7	1.7	1.7	0.3
Hired	0.2	0.2	0.7	0.7	1.0	1.0	0.9	0.9	0.7	0.7	0.8
Irrigation											
Family	3.9	3.9	3.1	3.1	3.7	3.7	2.0	2.1	3.2	3.2	0.2
Hired	0.6	0.6	0.8	0.8	2.5	2.5	1.1	1.1	1.3	1.3	0.4
Harvesting											
Family	6.4	6.4	5.1	5.1	0.8	0.8	2.1	2.1	3.6	3.6	0.1
Hired	16.4	17.3	12.3	12.4	6.7	6.7	21.5	21.9	14.2	14.6	2.6
Threshing											
Family	2.7	2.7	1.6	1.6	2.8	2.8	1.4	1.5	2.1	2.2	0.6
Hired	1.8	2.0	1.9	1.9	2.3	2.3	2.6	2.7	2.2	2.2	2.0
Total labour use											
Family	22.2	21.7	17.5	16.9	16.4	16.4	12.3	12.6	17.2	17.0	-1.16
Hired	21.4	22.7	19.7	19.8	14.8	14.8	29.0	29.6	21.3	21.7	1.88
Total	43.7	44.5	37.2	36.6	31.3	31.3	41.4	42.1	38.4	38.7	0.52

Table 12: Costs & return analysis of wheat production.

Districts/ Particular	Kushinagar		Maharajganj		Meerut		Muzaffarnagar		Overall				% Change
Year	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	2014-15	2012-13	%	2014-15	%	
Area (hact.)	23.3	23.3	31.6	31.6	0.9	0.9	11.1	11.0	66.9	-	66.8	-	-0.2
Yield (qtls./ha)	35.2	41.6	35.8	39.9	38.3	42.3	41.7	45.0	37.8	-	42.2	-	11.79
Material Cost													
Seed	1578.9	1883.7	1765.5	2165.4	1470.5	2286.7	1428.1	2034.9	1560.8	7.3	2092.7	8.6	34.1
Urea	1394.6	1297.7	1431.6	1359.0	1430.0	1007.5	1499.6	1113.4	1438.9	6.7	1194.4	4.9	-17.0
DAP	3809.0	3316.7	4183.3	3758.1	4935.0	3600.0	5290.4	3570.0	4554.4	21.3	3561.2	14.7	-21.8
MOP	593.6	1165.8	573.4	1114.0	235.7	1893.3	331.8	1596.7	433.6	2.0	1442.5	6.0	232.6
Herbicide	504.3	586.7	577.0	535.0	329.2	415.0	359.8	410.3	442.6	2.1	486.8	2.0	10.0
Sub Total	7880.4	8250.6	8530.7	8931.6	8400.3	9202.5	8909.7	8725.2	8430.3	39.4	8777.5	36.2	4.1
Cost Involved in Power Operations													
Land Preparation	4261.8	4869.4	3945.4	4447.9	3820.0	2940.0	3874.6	4520.4	3975.5	18.6	4194.4	17.3	5.5
Irrigation	3797.1	4328.3	4021.5	4606.5	3066.7	3680.0	3062.6	3675.1	3487.0	16.3	4072.5	16.8	16.8
Harvesting	266.7	336.7	595.1	918.8	-	-	-	-	215.4	1.0	313.9	1.3	45.7

Threshing	1878.3	2265.6	1544.0	1772.9	1700.0	2275.0	1980.1	2398.9	1775.6	8.3	2178.1	9.0	22.7
Sub Total	10203.9	11800.0	10105.9	11746.1	8586.7	8895.0	8917.3	10594.4	9453.5	44.2	10758.9	44.4	13.8
Labor Cost													
Land Preparation	221.9	353.8	195.0	243.7	300.0	375.0	287.6	364.9	251.1	1.2	334.4	1.4	33.1
Sowing	188.6	235.8	169.1	211.4	366.7	458.3	377.9	483.0	275.6	1.3	347.1	1.4	26.0
Fertilizer use	112.8	141.0	130.4	163.0	200.0	200.0	67.1	89.3	127.6	0.6	148.3	0.6	16.3
Herbicide use	46.7	58.3	275.0	343.8	66.7	83.3	125.0	156.3	128.3	0.6	160.4	0.7	25.0
Irrigation	77.8	97.2	164.6	205.7	500.0	625.0	208.4	284.6	237.7	1.1	303.1	1.3	27.5
Harvesting	2638.3	3625.6	1869.2	2483.9	1000.0	1333.3	3111.7	4384.6	2154.8	10.1	2956.8	12.2	37.2
Threshing	199.0	297.3	188.4	282.6	466.7	583.3	484.6	637.4	334.7	1.6	450.1	1.9	34.5
Sub Total	3485.1	4809.0	2991.6	3933.9	2900.0	3658.3	4662.4	6400.1	3509.8	16.4	4700.3	19.4	33.9
Total Cost	21569.5	24859.6	21628.2	24611.7	19887.0	21755.9	22489.4	25719.7	21393.5	100.0	24236.7	100.0	13.3
Value of M.P.*	44816.7	63127.8	45029.0	60332.6	54400.0	67733.3	57923.6	70383.9	50542.3	-	65394.4	-	29.4
Value of B.P.**	4161.1	9620.8	4039.9	8946.2	4566.7	4800.0	4613.6	10772.9	4345.3	-	8535.0	-	96.4
Gross value	48977.8	72748.6	49068.9	69278.7	58966.7	72533.3	62537.1	81156.8	54887.6	-	73929.4	-	34.7
Net Return	27408.3	47889.0	27440.7	44667.1	39079.7	50777.5	40047.7	55437.1	33494.1	-	49692.7	-	48.4
B:C Ratio	2.3	2.9	2.3	2.8	3.0	3.3	2.8	3.2	-	-	-	-	-

(Rs./ha)

*Main product and **By product

In power operations mainly tractor is being used for land preparations and it covered about 18.60 and 17.30% cost to total cost of cultivation in base and assessment years on overall basis. The cost of cultivation relatively increased in assessment year by 11.79% owing to increase in material and labor cost according to price hikes in the market. The net income increased in assessment year owed to better quality of their produce, the co-operator farmers have been able to dispose on better prices in the market. On an average, about 52% net return increased in assessment year over the base year. Harvesting and threshing were common practice so that cost incurred in surveyed area to be most intensive and ranged between 10.10-12.20% and 1.60-1.90% of total cost in both base and assessment years, respectively on overall basis.

8. Responses of different extension strategies and communication techniques

Agronomists share their knowledge and experience in events like haats, field days, harvest festivals, farmers' conferences/conventions, crop seminars, kisan melas, agro exhibitions, dealer training programs, field demonstrations, soil testing, and meeting at agro service centers. Various activities were organized including mass media programs, radio jingles, road side hoardings, wall paintings, distribution of elaborately printed publicity literature like crop leaflets, hand bills; POP displays material such as posters, stickers, tin plates, glow signs, calendars and exhibition material. PFL project field staff has been rendering excellent agronomic services without any commercial consideration thereby, acting as the farmers' friend, philosopher and guide to make them adopt balanced

fertilizations by use of potash in their crops (Table 13).

Among all communication techniques/ strategies, demonstration plots were most effective tools in spreading and creating awareness for use of potash in projects sites. Demonstration plots influenced about 68% farmers' in all four districts for use of potash in their crops. Farmer's field days were also found helpful in generating awareness amongst beneficiaries to an extent of 63% in Kushinagar, 76% in Maharajganj, 56% in Meerut and 57% farmers in Muzaffarnagar where farmers updated of using techniques and availability of potash. Farmers are adopting recommended fertilizer schedule and other new methodologies by seeing their excellent results through ongoing demonstration of tools. Similarly SMS mobile alerts regarding optimum time of fertilizer application and availability of chemicals, printed publicity brochures to create awareness regarding correct methods of application of inputs and cultivation techniques and crop seminars and farmers meeting, wall paintings and radio publicity were also found to be very effective and helpful in creating awareness amongst the selected farmers in surveyed area (Table 14).

9. Perception of farmers on effect of potash in crop growth and development

The data has been collected regarding effect of potash on crops in different stress conditions have been presented in table 18. In response to a query whether farmers had notice any effect of frost on crops? About 95% farmers had denied having any adverse effect of frost on crops growth and development in study periods.

Table 13: Responses of different extension strategies and communication techniques.

Particulars	Kushinagar				Maharajganj				Meerut				Muzaffarnagar				overall				Ranking
	Yes	%	No	%	Yes	%	No	%	Yes	%	No	%	Yes	%	No	%	yes	%	No	%	
Demonstration plots	20	67	10	33	16	64	9	36	12	75	4	25	21	70	9	30	69	68	32	32	I
Field Days	19	63	11	37	19	76	6	24	9	56	7	44	17	57	13	43	64	63	37	37	II
Printed Publicity Material- Brochures	14	47	16	53	15	60	10	40	8	50	8	50	16	53	14	47	53	52	48	48	III
SMS Mobile voice	15	50	15	50	13	52	12	48	9	56	7	44	15	50	15	50	52	51	49	49	IV
TV Publicity	16	53	14	47	16	64	9	36	7	44	9	56	11	37	19	63	50	50	51	50	V
Digital Media-www.potash4life.com	17	57	13	43	10	40	15	60	6	38	9	56	16	53	14	47	49	49	51	50	VI
Crop Seminars and Farmers Meeting	14	47	16	53	14	56	11	44	5	31	11	69	16	53	14	47	49	49	52	51	VI
Radio Publicity	11	37	19	63	14	56	11	44	8	50	8	50	14	47	16	53	47	47	54	53	VII
Wall Paintings	16	53	14	47	9	36	16	64	7	44	9	56	13	43	17	57	45	45	56	55	VIII
Agri Fairs	15	50	15	50	10	40	15	60	4	25	12	75	13	43	17	57	42	42	59	58	IX
Potash Campaigns	13	43	17	57	11	44	14	56	5	31	11	69	12	40	18	60	41	41	60	59	X
Hoarding	9	30	21	70	9	36	16	64	7	44	9	56	12	40	18	60	37	37	64	63	XI

Sources: Farm survey 2015-16

Effect of frost can be minimized by use of potassic fertilizer. Similarly, 92% of farmers were thus in the opinion that there is very low effect of water stress on their crops, if they apply potash. Since farmers have started to use increased doses of potash in their crop which resulted to increase tolerance of water stress conditions as perceived by the cooperator-farmers in surveyed area. Approximately, 98% farmers accepted having improved tolerance to water logging during cropping period. In same manner severity of disease and insect-pest incidence also reduced as 92 and 100% farmers reported the response (Table 14). So, it can be concluded that potash is maintaining overall

performance of crop and ultimately helping to sustain crop and soil health and enhanced productivity.

Table 15 indicates the effect of potash on grain quality of rice and wheat in surveyed area of all four districts. During the interaction to beneficiary farmers it has been found that grain quality also improved up to great extent after using potash alongwith nitrogen and phosphorus. Almost all the cooperators were confirming that shining, size, weight of grains/tubers and total production tended to enhance during evaluation year after using balanced doses of potash in systematic manner with nitrogenous and phosphatic fertilizer in the crops.

Table 14: Perception of farmers on effect of potash in crop growth and development.

Particulars	Kushinagar				Maharajganj				Meerut				Muzaffarnagar				Overall			
	No	%	No	Ex %	No	%	No	Ex %	No	%	No	Ex %	No	%	No	Ex %	No	%	No	Ex %
Effect of frost	26	87	4	13	24	96	1	4	15	94	1	6	28	93	2	7	93	92	8	8
Water stress	30	100	-	-	25	100	-	-	14	88	2	13	29	97	1	3	98	97	3	3
Water logging	29	97	1	3	25	100	-	-	16	100	-	-	29	97	1	3	99	98	2	2
Severity of diseases	28	93	2	7	23	92	2	8	15	94	1	6	27	90	3	10	93	92	8	8
Incidence of insects	30	100	-	-	25	100	-	-	16	100	-	-	30	100	-	-	101	100	-	-

Sources: Farm survey 2015-16

Table 15: Perception of farmers on effect of potash on quality of grains in rice and wheat crop on sample farms.

Particulars	Kushinagar				Maharajganj				Meerut				Muzaffarnagar				Overall			
	No	%	No	Ex %	No	%	No	Ex %	No	%	No	Ex %	No	%	No	Ex %	No	%	No	Ex %
Shining of grain	27	90	3	10	22	88	3	12	15	94	1	6	27	90	3	10	91	90	10	10
Size of grain	30	100	-	-	25	100	-	-	16	100	-	-	30	100	-	-	101	100	-	-
Weight of grain	30	100	-	-	23	92	2	8	15	94	1	6	28	93	2	7	96	95	5	5
Total production	29	97	1	3	25	100	-	-	16	100	-	-	30	100	-	-	100	99	1	1

Nutritive contents of sugarcane, rice and wheat available for human health

Per 100 g, raw sugarcane contains about 58 calories (kcal), with about 13 grams of carbohydrates and a small amount of dietary fiber and minerals, but it is primarily composed of sugars. Nutritional values can vary slightly between sources and depend on whether the data refers to the whole stalk or the extracted juice.

The breakdown of nutritional value of 100 grams of sugarcane juice are: includes Energy: 58 calories (kcal), Carbohydrates: 13.11 grams, Sugars: 12.85 grams, and dietary fiber: 0.56. grams. Addition to it, small amounts of calcium, magnesium, and potassium minerals are also available, though specific quantities vary by source. The other contents such as fat-0grams, cholesterol-0mg and protein 0.29grams. Sugarcane is a good source of carbohydrates and sugars, providing a quick energy boost.

Whole wheat flour is rich in protein around 15-16% DV, fiber 10-13%, and minerals like magnesium, iron, potassium, phosphorus and manganese, along with B vitamins (thiamin, niacin and folate). However, refined wheat flour has fewer nutrients, primarily providing carbohydrates and some protein, with most of the fiber, vitamins, and minerals removed during processing. It has roughly 340-360 calories per 100gms serving, low in fat

The nutritional value of 100g of rice varies significantly between uncooked and cooked and between white and brown rice per 100g. White rice contains about 356-370 calories, 80g carbohydrates, 6.5-7g protein and around 0.6-0.7g fat in uncooked rice. While brown rice has 80g carbohydrates, 6.5-7g protein, and around 0.6-0.7g fat.

The white cooked rice per 100g significantly lower in calories, with about 130 kcal, 28g carbohydrates, 2.7g protein, and 0.3g fat. While the calories remain higher than cooked white rice

(around 218 kcal per cup), cooked brown rice has a good amount of fiber, providing around 3.5g of fiber per 100g. Cooking usually reduces the calorie, carbohydrate, and fat content of rice. Brown rice is a whole grain, retaining more fiber and some other minerals compared to white rice which has the bran and germ removed.

Concluding remarks and policy for implication

Salient features of the study conducted on rice, wheat and sugarcane crops in state of Uttar Pradesh are presented here under:

Findings of the study indicates that on-going 'Potash for Life' project has several implications in strengthening skill, education and knowledge of farmers in various aspects of crop management practices including nutrient management in rice, wheat and sugarcane crops. The project has multi-dimensional effect on productivity, production, cost and returns and restoration of soil health and environment. Broadly following points has been emerged from above findings.

- 'Potash For Life' project activities seem effective in creating awareness to the cooperator-farmers for crop production management practices by using various tools of extension and communication. Results of survey indicate that the production and net return of crops increased significantly by incorporating potash with nitrogenous and phosphatic fertilizers. Therefore, this intervention needs to be popularized among the farming community on larger area in the country. Agriculture extension department of state/central Govt/or NGOs should take lesson from the PFL project activity to popularize importance of use of potash among the farming community.
- Project activities have strengthened and enriched the knowledge and skill of farmers in study area for nutrient management in general and use of potash in particular in

different crops. The area of operation of PFL project activity should be expanded in more villages/district/states so that the under-privileged farmers could be benefited. Also there is need for continuation of project activity for longer period to develop confidence of perceived benefits of use of potash among the farming community.

- Develop skill of the cooperator farmers to reduce the effect of stresses by application of potash in the crop on larger scale. The designed extension strategies seem to be more effective in increasing production of crops and minimize yield losses due to several abiotic and biotic stresses by use of potash. The whole package of these extension approaches/strategies should strongly be followed and expanded in new areas where farmers could be benefited.
- Government should ensure the timely availability of potash in the market on reasonable price. For popularization of potash among the farming community, Govt. should increase the amount of subsidy on potash fertilizer to benefit farmers for time being.
- In the present days, input supplier centers become major source of information of agri-technologies in the rural area. Therefore, there is need to impart training and develop skill to shopkeepers effectively and efficiently so that they can disseminate information among the farmers successfully.
- Farmers are well exposed to apply inorganic fertilizers in required ratio and use micro-nutrient like zinc which ultimately enhances not only crop productivity, but also income at a great extent. Therefore, it can be concluded that 'Potash for Life' project or alike project activity should be continued to increase production and productivity of crops. Since land is limited and there is no scope to expand area under cultivation of crop, only option to increase production is through increasing productivity per unit land to feed growing population. In this backdrop, PFL project activity seems instrumental to arrive on this objective.
- The nutritional availability in all three crops is important for smooth life line of human health as analysis revealed.

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