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Original Research Article

Assessment of Variations in Yield Gap and Constraints analysis in the Sugarcane Production in Bihar

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A B S T R A C T

Sugarcane is well known as a higher employment and capital intensive crop and oriented towards agro-based industry. The actual yields obtained are considerable lower than those recorded in the demonstration plots and research stations/farms. Therefore, there is need to know the different yield gaps between farmer's fields and the demonstration plots. In the present study, an attempt has been made to analysis the yield gap and constraints faced in the adoption of sugarcane production by the farmers of Bihar. The study in based on primary data collected on personal interview with 136 farmers of the two districts of the state. The study has shown that the degree of yield gap was highest (97.30 kg/ha) on marginal farms and lowest (60.50 kg/ha) on large farms. The magnitude of total yield gap has shown to be 76.52 kg/ha, which comprise relatively higher size of yield gap-I (58.0 kg/ha) than yield gap – II (18.50 kg/ha) in the overall study area. However the excess use of chemical fertilizer by in anticipation of maximizing the yield but also decrease the soil fertility. The study has suggested that to bridge this gap the use of recommended levels of input in most essential. The most important constraints responsible for yield gaps in sugarcane cultivation is shortage of labour during crucial operations. It necessitates the urgency of mechanization in sugarcane if constraints are addressed and a proper package of practices are being followed.

Introduction

India ranks second in the world in sugarcane production with an average production of 302.40 million tones and it had share of 17.27% in world sugarcane production in 2014-15 [Ref.: United State Department of Agriculture (USDA, 2015)]. In sub tropical region Bihar is the second highest in terms of area and production about 2.98 lakh ha and 149 lakh tones (Ref.: Indian Sugar, 2015) respectively.

In Bihar the major sugarcane districts are West Champaran, Gopalganj, East Champaran, Sitamarhi, Siwan and Samatipur which contributes with a share of about 79.87% in production of the state's sugarcane crop.

Indian agricultural sector in recent years has experienced significant change from traditional to the modern methods of cultivation through conversion of

agricultural technology into production accomplishment. But, this change has been confined to certain states, certain type of farmers and selected crops only, which in turn have resulted inexistent of yield gaps. Presently, sugarcane yield in Bihar is quite low in comparison to other states. Even though large scale verification trails and demonstrations were conducted to test the feasibility and suitability of the new technologies before releasing the variety for adoption on farmer's fields. The farm yield realized on the farmers field are considerably lower than those recorded on the demonstration plots and research station farms. Several studies shows the existence of considerable untapped yield potential in various crops, (Gaddi *et al.*, 2002, Lakshmanans, Rama, Rao IVY, 2012 and Gavali, A.V. *et al.*, 2011) and attributed this gap to difference in input use level between the farmer's field and the demonstration plots. There is a need to take up in-depth analysis of yield gap. In the present study, it was planned to make analysis of yield gap and constraints in the adoption of sugarcane production technologies in Bihar.

Materials and Methods

The study was conducted on the basis of is based on the primary data collected from 136 sample farmers spread over in eight villages of four blocks from two leading districts viz. East Champaran and Gopalganj with respect to sugarcane area in Bihar. The farmers sample farmers were selected with the help of multistage random sampling technique with district, block and villages at different stages of selection.

The farmers sample were post-classified into marginal (<1ha), small (<2ha), medium and large (> 2ha) categories based on their land holdings. The data on various aspects of sugarcane production on farmer's fields, demonstration plots and research station plots were collected with the help of pre-tested schedules during the year 2012-13.

The methodology developed by the international rice research institute (IRRI) were used to study the yield gaps. According to IRRI, methodology, the total yield gap (TYG) in the difference between the potential yield (YP-yield realized on the research station) and the actual yield (AY-yield realized on sample farmer's field.

Yield gap-I (YG-I) = y_p-y_d.

Where,
y_p = Potential yield as obtained in the research station
y_d = Yield realized on the demonstration plots and
Yield gap –II = YG-II :Y_d-Y_a

Where,
y_d=yield realized on the demonstration plots
y_a = yield realized on sample farmers field

In addition to this various indices of yield gaps viz., index of yield gap (IYG = (y_p-y_a)%y_p), index as realized potential yield [IRPY = (y_a/y_p)] and index of realized potential farm yield [IRPFY = (y_a/y_d)] were also studied.

It may not possible for always the farmers to raise the crop productivity on their farms to the level of research station. However, it would be realistic aim at demonstration plot yield (potential farm yield) level. Hence, in this study more emphasis was given to yield gap – II.

Garrett's ranking technique

The opinions survey of farmers sample about the various constraints in the influencing the magnitude of yield gap were

collected. For identifying and quantifying the influence of these constraints' on yield gap. The garrets ranking technique were carried out the ranks given by each respondent were converted into percent position by using formula.

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

Where,
R_{ij} = rank given to i^{th} constraints by the j^{th} individual and
N_j = number of constraints ranked by the j^{th} individual

The estimated percent position were converted into scores using Garrett's table. The mean score values estimated for each factor were arranged in the descending order. The constraints with the higher mean value was considered as the most important one and the other followed in that order.

Results and Discussion

Yield gaps and Indices of yield gaps in sugarcane production

It could be observed from the data (table-1) that there was an existed a wide gap in the sugarcane productivity among the research station, the demonstration plots and the farmer's sample field.

The magnitude of total yield gap worked out to be 76.52 tonnes/ha which comprised relatively higher size of yield gaps – I (58.0 tonnes/ha) than yield gap–II (18.50 tonnes/ha) in the overall study area. Higher yield gap-II implied that greater amount of potential yield was left untapped on demonstration plots. This was attributed to the scientific environmental differences and party to the non-transferable component of technology like cultural practices. Hence, the technology developed on research station cannot be fully replicated on the demonstration plots. The results of the study are in confrontly with (Gaddi *et al.*) for cotton production.

Farm size-group wise analysis as the total yield gap over the districts showed the highest (97.30 tonnes/ha) magnitude recorded on the marginal farms of East Champaran district, which the lowest (60.50 tonnes/ha) magnitude was noticed on the large farms of East Champaran district. A similar tendency was noticed with respect to the magnitude of yield Gap-II.

The estimated index of yield gap worked out to be 51.32 per cent (table-2). Hence, there was an existed a tremendous scope to improve the sugarcane production in the study area.

The index of potential yield worked out to be 48.70 per cent in the overall category of farms sample. It may not be always possible for the farmers to adopt certain aspects of new technology developed in research station due to difference in the environmental factors and other constraints operating at the farm level. The farmers sample realized 79.37 per cent (index of realized potential farm yield) (Table-2). Thus, all the recommended packages and production technology used on the demonstration plots was adopted. The farmer sample could obtain 30% more sugarcane yield, farm size-group wise analysis showed that the large farmers obtained relatively better yield than their marginal counterparts. Sugarcane crop being more capital intensive, it demands costly inputs, hence due to better economic condition, large farmers have taken up timely application of chemical fertilizer and realized higher yield level.

Table.1 Sugarcane yield realized and the estimated yield gaps under different field situations

(tonnes/ha)

Sl No.	Particulars	Study district		
		East Champaran	Gopalganj	Over all
1	Potential yield (yp)	150	150	150
2	Potential farm yield (yd)	92	92	92
3	Actual yield (ya)			
	a. Marginal farms N*=20	52.70	70.50	61.62
	b. Small farms N*=20	71.20	74.00	72.61
	c. Large farms N*=20	89.50	83.00	86.26
	d. Over all N*=60	71.18	75.82	73.52
4	Yield gaps-I (yp -ya)	58.00 (38.68)	58.00 (38.68)	58.00 (38.68)
5	Yield gaps-II (yd-ya)			
	a. Marginal farms N*=20	39.30	21.50	30.41
	b. Small farms N*=20	20.80	15.00	19.42
	c. Large farms N*=20	2.50	9.00	5.75
	d. Over all N*=60	20.82 (22.63)	16.18 (18.63)	18.50 (20.10)
6	Total yield gap (yp-ya)			
	a. Marginal farms N*=20	97.30	79.50	88.40
	b. Small farms N*=20	78.80	76.00	77.40
	c. Large farms N*=20	60.50	67.00	63.75
	d. Over all N*=60	78.82 (82.54.)	74.18 (49.42)	76.52 (51.10)

(N* = Number of sample farmers)

Note : Figures within parentheses denote percentages under respective columns.

Table.2 Estimated index of yield gaps in sugarcane under different field situations

(Percent)

Sl No.	Particulars	East Champaran	Gopalganj	Over all
1	Index of yield gap			
	a. Marginal farms	64.86	53.00	58.93
	b. Small farms	52.53	50.66	51.60
	c. Large farm	40.33	44.66	42.50
	d. Over all	52.55	50.09	51.32
2	Index of realized potential yield			
	a. Marginal farms	35.13	47.00	41.07
	b. Small farms	47.47	49.33	48.50
	c. Large farm	59.67	55.33	57.60
	d. Over all	47.45	49.91	48.70
3	Index of realized potential farms yield			
	a. Marginal farms	57.28	76.63	66.96
	b. Small farms	77.36	80.43	78.92
	c. Large farm	97.28	50.33	73.81
	d. Over all	77.36	81.36	79.37

Table.3 Level of material input use in sugarcane in East Champaran District

(N* = Number of sample farmers)

Particular	Recommended dose	Marginal (N*=20)		Small (N*=20)		Large (N*=20)		Over all (N*=60)	
		Actual input use	Gap	Actual input use	Gap	Actual input use	Gap	Actual input use	Gap
Seed (kg/ha)	6000	5487	513 (8.55)	5891	109 (1.82)	6839	-710 (-11.83)	6070.15	-70.15 (-1.17)
Nitrogen (kg/ha)	150	105.99	44.01 (29.94)	127.26	22.74 (15.16)	235.89	-85.89 (-57.26)	179.04	-29.04 (-19.36)
Phosphorus (kg/ha)	85	94.76	-9.75 (-11.47)	103.00	-18.00 (-21.18)	145.00	-60.00 (-70.59)	114.19	-29.19 (-34.34)
Potassium (kg/ha)	60	70.22	-10.22 (-17.03)	67.87	- 7.87 (- 13.12)	105.06	-45.06 (-75.10)	79.26	-90.26 (-32.10)
Plant protection (Rs./ha)	6884	3032.81	3851.19 (55.94)	3531.65	3352.35 (48.70)	4898.76	1985.24 (28.84)	3819.62	3064.38 (44.51)
Irrigation (Rs./ha)	13760	5866.20	7893.80 (57.36)	6054.77	7705.23 (55.99)	6736.25	7023.75 (51.04)	6219.07	7540.93 (45.20)

Note :1.Figures in the parentheses indicate gap percentage.

2. Negative sign indicates excess use of inputs.

Table.4 Level of material input use in sugarcane in Gopalganj District

Particular	Recommended dose	Marginal (N*=20)		Small (N*=20)		Large (N*=20)		Over all (N*=60)	
		Actual input use	Gap	Actual input use	Gap	Actual input use	Gap	Actual input use	Gap
Seed (kg/ha)	6000	5621.00	379 (6.32)	5816.00	184 (3.07)	6794	-794 (-13.27)	6074	-74 (-1.23)
Nitrogen (kg/ha)	150	158.03	-58.03 -(38.69)	184.29	- 34.29 (- 22.86)	221.16	-71.16 (-47.44)	204.22	-54.22 (-36.15)
Phosphorus (kg/ha)	85	99.42	-14.42 (-16.96)	104.91	-19.91 (-23.42)	111.90	-26.90 (-31.65)	105.34	-20.34 (-23.93)
Potassium (kg/ha)	60	71.31	-11.31 (-18.83)	69.35	- 9.35 (-15.58)	82.22	-22.22 (-37.03)	74.25	-14.25 (-23.75)
Plant protection (Rs./ha)	6884	3689.27	3194.73 (46.41)	4710.21	2173.79 (31.58)	4822.54	2061.46 (29.94)	4400.35	2483.65 (36.08)
Irrigation (Rs./ha)	13760	6945.94	6814.06 (49.52)	7715.08	6044.92 (43.93)	6195.52	7564.48 (54.97)	6948.52	6811.48 (49.50)

Note : 1. Figures in the parentheses indicate gap percentage.
2. Negative sign indicates excess use of inputs.

Table.5 Opinions of sample farmers on problems influencing yield gap in sugarcane production

Sl No.	Problems	Mean scores	Garret ranking
1	Labour problems during peak crop season	81.50	I
2	Non-avaibility of fertilizer on time	81.04	II
3	Poor source of irrigation	77.03	III
4	Non-avaibility of seed in time	76.97	IV
5	Costly fertilizers and plant protection chemicals	76.78	V
6	Expensive improved technology	76.03	VI
7	Lale plantation of cane	75.22	VII
8	Low value of the product	72.93	VIII
9	High cost of borrowing	71.11	IX
10	Unfavourable climatic conditions and insufficient moisture	71.00	X

Gaps in recommended and actual use levels

Based on size of holding hectare gaps in the recommended and actual use level of inputs for sugarcane production is presented in table- 3 and 4. The use of inputs per hectare at the overall level were below than the recommendation. There was a large gap between the recommendation and actual use level of sugarcane seed, which must be the major region for high yield gap. In case of nutrients in Gopalganj district, potash observed to have high use gap compared to others. It has also observed that the use gap was less in nitrogen as farmers have developed tendency to use easily available and cheap straight fertilizers such as urea. The over use of the inputs win lead to less profitability by reducing yield.

Constraints responsible for yield gaps

Various constraints operating at the farm level may be partly responsible for this yield gap. Hence, the opinion of farmers sample on the difficulties in realizing potential farm yield was collected and it is presented in table – 4. Non availability of labour during planting, weeding and harvesting, season was a major problem. Thus, it was mainly due to higher labour wages and MNREGA was also responsible for scarcity of farm labour in the study area. Among these problems non-avaibility of fertilizer at time, poor source of irrigation with average score of 81.04 and 77.03, respectively. More than 50 per cent of the farmers sample were not aware of recommended spacing, schedule of application for chemical fertilizers, seed rate dose, and plant protection chemicals. Thus, it may be suggested that the extension services should create awareness among the farmers about new options and developmental efficient crop management skills.

Policy implication

The study has revealed that in sugarcane production there existed a yield gap-I was 38.68 per cent and 20.10 per cent was yield gap-II with overall study area. The district wise analysis has shown that the maximum total yield gap 82.54 per cent has been noted in East Champaran district followed by 49.42 per cent in Gopalganj district. Farm size group wise analysis of the total yield gap over the districts showed the highest (97.30 kg/ha) magnitude recorded on the marginal farms while the lowest (60.50 kg/ha) was on the large farms of East Champaran district. Keeping in view their poor economic condition, more attention needs to be given agricultural credit facilities will give economic support for procurement of inputs. Conducting training not only the professional experts but also farmers of the area whose yield is the highest also join in imparting knowledge will help in giving practical knowledge. The labour problem during peak crop season, non-avaibility of fertilizers, poor source of irrigation were the major constraints faced by the sugarcane growers.

Following policy implications have emerged from the study:

The major constraints in sugarcane cultivation is labour shortage, it necessary the urgency of mechanization in sugarcane.

Thus, study may be suggested that the bridge gap the use of recommended levels of inputs was most essential. The farmers should be motivated towards visit of progressive farmer's field, farmers training, seminars and to use recommended level of inputs, improved variety of seeds, provide farmers with appropriate technological package to bridge the yield gap and enhance the production and productivity of sugarcane in the study area.

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