ECONOMIC ANALYSIS OF PLANT GROWTH PROMOTER - PULSE MAGIC APPLICATION ON PIGEONPEA PRODUCTION IN KARNATAKA

ABSTRACT

Pigeonpea (*Cajanus cajan* (L) mill. sp.) is one of the major pulse crops of tropics and sub-tropics and owed with several unique characters. The study is conducted in Raichur district of Kalyan Karnataka region. Pulse magic is a combi product, released by University of Agricultural Sciences, Raichur as it contains major nutrients, micro nutrients and Plant Growth Regulators (PGRs) which helped the crop to achieve maximum yield potential. Total sample size of 120 respondents consisting of 60 users and 60 non- users of pulse magic. The total cost of cultivation of pigeonpea with pulse magic use was (₹ 23238) considerably higher than non-users (₹ 22344). The net return accrued was also highest in pulse magic users (₹ 16951.62) compared to non-users (₹ 11287.52). The returns per rupee of investment was found to be marginally higher in pulse magic (1.73) users compared to non-users (1.50). The per acre incremental gain yield was 19.52 per cent due to application of pulse magic in comparison with non adoption of pulse magic technology. The partial budgeting revealed higher net gain of ₹ 5667 per acre in pulse magic users compared to non-users of pulse magic on pigeonpea production. The results of probit model indicated that age, education, variety and extension contact were statistically influencing in adoption of pulse magic technology.

Keywords: Pigeonpea, Pulse magic, cost of cultivation, partial budgeting, Probit model.

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L) mill.*sp*.) is one of the major pulse crops of tropics and sub-tropics and owed with several unique characters. It ranks second important pulse crop next to bengalgram. It finds an important place in farming systems adopted by small holding peasants in large number of developing countries. Pigeonpea is considered to be origin of peninsular India.

India accounts for about 90 per cent of world output with an area of 4.53 million hectares and production of 4.25 million tons of pigeonpea. Karnataka is the single largest producer of pigeonpea in the country, accounting for over 28.94 per cent of total production. Maharashtra, Uttar Pradesh and Madya Pradesh contributed about 27.94 per cent, 7.18 per cent, and 7.06 per cent, respectively. In Karnataka, pigeonpea is grown in an area of 1545 thousand ha with production of 1126.31thousand tones and productivity of 0.73 tones/ha. Major pigeonpea growing districts in Karnataka are Kalaburagi, Vijayapur, Raichur Bidar, Yadgiri and Bagalkot.

Pulses are popularly known as "poor man's meat" and "rich man's vegetable" (Singh and Singh, 1992). Pulses are excellent sources of proteins (25-40 per cent), carbohydrates (50-60 per cent), fats, minerals and vitamins. In addition, they also contain enzyme inhibitors, lectins, phytates, oxalates, polyphenols, saponins and phytosterols. Pulses contain two to three times more protein than cereals ranging approximately between 20 to 40 per cent (Arora, 1989). The current productivity of pulse crops including pigeonpea is not sufficient enough to meet the growing domestic demand. Hence, there is a need for enhancement of the productivity of pigeonpea by adopting advanced production practices. Among all the yield-limiting factors, fertility management is imperative to ensure better crop production on exhausted soils as nutrients play a vital role in enhancing yield of pulses. In addition to the genetic makeup, the physiological factor *viz*., insufficient portioning of assimilates, poor pod setting due to the flower abscission, and lack of nutrients during critical stages of crop growth, coupled with several diseases are the reasons for the poor yield.

The use of intensive non sustainable practices increases the economic, health, social, and environmental costs to agriculture. Thus, in recent years, global agriculture has faced new challenges related to the development of sustainable alternatives for satisfying high food demand. In this context, currently microbial inoculants are gaining importance, which are eco-friendly and sustainable bio-products containing live microorganisms that, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or plant tissues for promoting growth by increasing the supply or availability of primary nutrients to the host plant or controlling the colonization of phytopathogens (Villarreal-Delgado *et al.*, 2018; de los Santos-Villalobos *et al*., 2018). The global interest in this type of bio products is recognized since their international market has been valued at over US $ 1.72 billion in 2014, which is expected to reach US $ 4.17 billion by 2023, with an annual growth rate of 9.9% (Timmusk *et al.*, 2017).

Among several strategies to increase the productivity of pigeonpea, foliar application of nutrients may serve as one of the important strategy. As foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation, and regulating the uptake of nutrients by plants. Again application of nutrients through the foliar spray at appropriate stages of growth becomes important for their utilization and better performance of the crop. Looking into the importance of foliar nutrition in enhancing crop productivity of various field crops, Krishi Vigyan Kendra (KVK) Kalburgi, University of Agricultural Sciences Raichur, Karnataka state has developed a product 'Pulse Magic' in the year 2014 and which contains a mixture of nitrogen, phosphorus, micronutrients and Plant Growth Regulator (PGR). Supplying this nutrient at the reproductive stage of the crop will help to reduce the flower drop and get a higher yield, foliar spray was carried out during 50 percent flowering stage of the crop and 15 days after first spray.

Keeping in view of the above background, and having the importance of pigeonpea production in the state and Kalyan Karnataka in particular on attempt is made to study pulse magic technology contribution towards pigeonpea productivity and its economic impact on pigeonpea producers and economy. Hence, the present study has been taken up with the following specific objectives.

1. To analyse the comparative economics of pigeonpea production with and without application of pulse magic.

2. To estimate the economic contribution of pulse magic in pigeonpea economy.

METHODOLOGY

The study was conducted in the Kalyan Karnataka region, the Raichur district was purposively selected as it has highest area and number of farmer user of pulse magic. The stratified random sampling procedure was adopted for selection of sample taluks and villages based on the highest users of pulse magic on pigeonpea crop. In the first stage two taluks *viz*., Raichur and Manvi were selected out of seven taluks in the Raichur district. In the second stage, three villages were selected from each taluk, and in the third stage from each village 10 users and 10 non-users of pulse magic was selected. Thus, a total of 60 users and 60 non-users of pulse magic were selected randomly for study.

Analytical tools used

Based on the nature and extent of availability of data, descriptive statistics and the following analytical techniques were used.

Partial budgeting technique: Impact of pulse magic on pigeonpea production is evaluated using the partial budgeting approach. The technique considers the additional costs involved under the pulse magic use and incremental returns realized by pulse magic use on pigeonpea production. The difference indicates the profitability due to use of pulse magic on pigeonpea production.

Probit model: It is a statistical probability model where the dependent variable is binary in nature (Liao, 1994). The probit estimate is based on the cumulative normal probability distribution. It reveals the crucial factors that affected their adoption about the pulse magic users. The dependent variable, Y_i, that is 1 for pulse magic users, and 0 for pulse magic non users. The outcomes of '*Y*' are mutually exclusive and exhaustive. The dependent variable, *Yi*, depends on m observable variables, X_m where m = 1, … ….M (Aldrich and Nelson, 1984). While the values of 0 and 1 were observed for the dependent variable in the probit model, there was a latent, unobserved, continuous variable, *y*.

$$Y_i^* = \sum_{m=1}^{M} \beta_m x_m + \varepsilon$$

$$\varepsilon \text{ is } IN(0, \sigma^2).$$

The dummy variable, *Y*, was observed and was determined by Y^* as follows:

$$Y_i = \begin{cases} 1 \text{ if } Y^* > 0 \\ 0 \text{ otherwise} \end{cases}.$$

The point of interest relates to the probability that Y equals one. From the above equations, we find that:

$$\text{Prob }(Y_i = 1) = \text{Prob}\left(\sum_{m}^{m} = \beta_m\, x_m + \varepsilon > 0\right)$$

$$= \text{Prob}(\, \varepsilon > -\sum_{m}^{m} =_1 \beta_m\, x_m)$$

$$1 - \Phi\,(- \sum_{m}^{m} =_1 \beta_m\, x_m$$

Where Φ represents the cumulative distribution function of ε (Liao 1994). The probit model estimates assume that the data was collected from a random sample of size N with a sample observation denoted by N. The observations of Y must therefore, be statistically independent of each other to rule out any serial correlation. It was also assumed that the independent variables are random variables (Morgan *et al*. 2004).

The maximum likelihood estimation (MLE) technique was used to estimate the parameters. The MLE focused on choosing the parameter estimates that gave the highest probability or likelihood of obtaining the observed sample Y. The main principle of MLE was to choose an estimate of β, the set of M numbers that would maximize the likelihood of having observed Y (Aldrich and Nelson,1984).

The study also estimated the marginal effects of different variables for better interpretation of the factors associated with pulse magic users. The marginal effects account for a partial change in the probability and are associated with continuous explanatory variables x_m on the probability $Prob\ (Y_i = 1 \mid X)$, holding other variables constant. These can be derived as follows:

$$\frac{\partial y_i}{\partial x_{im}} = \emptyset(x'_m\beta)\beta_m,$$

Where $\emptyset$ represents the probability density function of a standard normal variable. The marginal effects of dummy variables should not be estimated, as these are estimated for continuous explanatory variables. Discrete changes in the predicted probabilities constitute an alternative to the marginal effect when evaluating the effect of a dummy variable. This effect can be derived from the following:

$$\nabla = \emptyset\,(\bar{x\beta}, d = 1) - \emptyset\,(\bar{x\beta}, d = 0).$$

The marginal effects provide an explanation for how both continuous and dummy explanatory variables shift the probability of frequency of the factors responsible for pulse magic users.

Empirical model specification

Where Yi is a dichotomous choice model, which is equal to one, if farmer use the pulse magic on pigeonpea, 0 otherwise. The probit model is specified as:

$$Y_i = f\,(X_1, X_2, X_3, X_4, X_5, X_6, X_7) + U$$

X_1 = Age of the farmers in years.

X_2 = Level of education of farmers in years

X_3= Farm experience in years

X_4= Landholding in acres

X_5= Family type (1 for nuclear, 0 for joint family)

X_6= Variety (1 for improved variety (TS-3R and GRG-811), 0 for local variety)

X_7= Contact with extension agencies (1 for yes, 0 for no)

U = Error term.

RESULTS AND DISCUSSION

The costs and returns of pulse magic user and non user, assessment of net gain and net loss of pulse magic technology and its impact on pigeonpea production and factors influencing the adoption of pulse magic technology were assessed and presented in the following paragraphs.

Cost and returns of pigeonpea among users and non users of pulse magic

The details of the per acre cost of cultivation as well as the gross and net returns of pigeonpea with users and non users of pulse magic are presented in the Table 1. It is evident from the table that the total cost of cultivation of pigeonpea under pulse magic user was higher (₹ 23239.36) compared to non users (₹ 22344). Even though, the cost of cultivation per hectare in pulse magic users was considerably higher, the gross return and net returns were significantly higher in users of pulse magic. There was slightly difference in input use pattern between the two categories of farmers. In pulse magic users, human labour (₹ 5216.67) was higher due to application cost of pulse magic compared to non users of pulse magic (₹ 4947). The total variable cost was higher in pulse magic users (₹ 17523.07) compared to non users (₹ 16687). Hence, the interest on working capital works out to be higher in the case pulse magic users (₹ 1222.47) as compared to pulse magic non users (₹ 1150). Similarly, the total fixed cost was found to be marginally higher (₹ 5716.29) in pulse magic users as against pulse magic non users (₹ 5656). All the operations were similar between users and non users of pulse magic expect the cost of pulse magic. Similar results were obtained by Pavan *et al*. (2008) in pigeonpea cultivation by IPM and non-IPM farmers, where labour constituted major share in the cost of cultivation. The above results were also inline with the Priyanka *et al*. (2013) and Kumar and Kumar (2017) they conducted study on comparative analysis of transplanted and dibbled method of redgram cultivation in Bidar district of Karnataka and cost and return of pigeonpea in Kalaburagi district.

Assessment of net gain or net loss in adoption of pulse magic user over non user

To access the net gain or net loss due to the adoption of pulse magic as a plant growth promoter over the pulse magic non users, the partial budgeting approach was carried out and the results were found that The inputs were allocated between both credit and debit side, on debit side addition in the cost due to the cost of pulse magic ₹ 390 per acre and application cost of pulse magic ₹ 500 per acre which was summed up ₹ 890 per acre. However, on the credit side, reduced cost was nil and, on debit side decrease in return was nil. Increase in return due to the adoption of pulse magic technology was about ₹ 6557 per acre (Table 3). Thus, there was a net gain of rupees 5667 per acre due to the adoption of pulse magic on pigeonpea production in the study area. The results were comparable with Aditya *et al* (2010) they reported in their study farmers who adopted dibbling method technique in pigeonpea cultivation derived on additional net income (₹ 10170 per acre).

Economic impact of pulse magic use in pigeonpea production

The average yield of pigeonpea with pulse magic users was found to be high 5.99 Qtl compared to pulse magic non users 5.02 Qtl (Table 2). The per acre increment in the yield was 19.52 per cent due to adoption of pulse magic in comparison with non adoption of pulse magic technology. The total cost of cultivation of user of pulse magic was high (₹ 23238.36) compared to non-users of pulse magic (₹ 22344). The seed weight per plant is governed by yield components like number of pods per plant, number of seeds per pod and hundred seeds per weigh. Foliage applied macro and micronutrients at critical stages of the crop were effectively absorbed and translocated to the developing pods, producing a greater number of pods and better filling in soybean (Jayabal *et al*. 1999). Increase in the total cost was ₹ 894.36 (3.38%) due to the cost of pulse magic and its application cost on the pigeonpea crop in the study area. The gross return was high in pulse magic users (₹ 40189.98) as compared to non-users of pulse magic (₹ 33413). There was 20.28 per cent (₹ 6776.86) increment in the gross return due to application of pulse magic. The net return was high in case of pulse magic users (₹ 16951.62) compared to pulse magic non user (₹ 11287.52). There was a positive impact of ₹ 5664.10 and increment in the net returns due to the adoption pulse magic technology on pigeonpea production in the study area. The findings of the study were comparable with the Teggelli *et al* (2016) who conducted study on pulse magic application on yield and economics of transplanted pigeonpea.

Estimation of factors influences for adoption of pulse magic technology

Probit model was used to determine the factors that were influencing the probability of adoption of pulse magic technology by sample farmers. The results of the probit regression are presented in the Table. 4. The results of probit regression analysis indicated that the variables of age, education, variety and extension contact showed significant and had Exp (B) values more than unity. And the variables of farming experience, landholding and family type were found to be positive and non-significant. Age had Exp (B) value of 1.255 which meant, if age is increased by a unit, there will be 1.255 times increase in farmers decision for adoption of pulse magic technology. Education had Exp (B) value of 1.164 which meant, if education is increased by a unit, there will be 1.164 times increase in farmers decision for adoption of pulse magic technology. Increase in a landholding by one unit would increase 1.234 times for adoption. The farmers used the improved variety of pigeonpea there will be 1.052 times more in the adoption of pulse magic technology, and contact with extension agencies mainly KVKs had a positive effect on farmers for adoption of pulse magic technology. The relative odds value was 1.526, which meant, a unit increase in contact with extension agencies will make the farmer 1.526 times likely to adoption of technology. Therefore, the result confirmed that age, education, variety and extension contact of the farmers would have positive and significant impact on pulse magic technology. The above results were in line with Donkoh *et al* (2019) and Kota *et al* (2020) where age, education farm size and contact extension agencies significantly influenced on adoption of improved agricultural technologies on rice farmers and adoption of intercropping technologies on cotton farmers, respectively.

To summarize the model, Cox and Snell R square was 0.55 and Nagelkerke R square was 0.76. and -2 Log likelihood was 79.421. And chi-square value was 6.85 and it was significant at 5 per cent level, which meant the model was a good fit. The final classification of table showed that the hit ratio or the predicted percentage means the probit model predicts 86.7 per cent of the cases correctly.

CONCLUSION

The net returns and yield per acre was also higher in users than non-users of pulse magic. The returns per rupee of investment was found to be marginally greater in pulse magic users compared to non users.

POLICY IMPLICATIONS

- The study revealed that the cultivation of pigeonpea with application of pulse magic was profitable. Hence, production and marketing of pulse magic has to be promoted in larger area.
- The study suggested that the production of pulse magic could be increased by granting licences to private agencies and transfer of technology with the public-private mode to realize the full economic potential of a technology.
- Pulse magic increases productivity of pigeonpea and to make it affordable to the farming community, Government should consider subsidy for promotion of pulse magic in larger area.
- The majority of technologies released by the State Agricultural Universities (SAU’s) are adopted by a few farmers. In order to reach the technologies to all the category of farmers, there is need to form farmers producers’ organizations and through them

conduct more extension activities for effective transfer of technologies on collective basis.

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Table 1 Cost and returns of pigeonpea among users and non users of pulse magic

(Per acre)

Sl. No.	Particulars	Pulse Magic Users			Pulse Magic non-Users		
		Qty	Value (`)	%	Qty	Value (`)	%
A	**Variable cost**						
1	Seeds cost (kg)	4.72	360	1.6	4.7	360	1.61
2	Farm yard manure (Cart load)	1.04	1203.33	5.2	1.1	1183	5.3
3	Fertilizers (kg)	98.12	1510	6.5	96.9	1463	6.55
4	Plant Protection Chemicals (Litre)	1.4	1226.67	5.3	1.6	1225	5.48
5	Pulse Magic (Kg)	2	390	1.7			
7	Human labour (Man days)	19.64	5216.67	22	18.73	4947	22.14
8	Bullock labour (Pair days)	1.3	2433.33	10	1.3	2433	10.89
9	Machine labour (Hrs.)	4.95	3435	15	4.95	3400	15.22
10	Marketing cost (Rs.)		525.6	2.3		525	2.35
11	Interest on working capital @ 7.5%		1222.47	5.3		1150	5.15
	Sub total		**17523.07**	**75**		**16687**	**74.69**
B	**Fixed cost**						
1	Depreciation (Rs.)		524.3	2.3		543	2.43
2	Land revenue (Rs.)		70	0.3		70	0.31
3	land rent (Rs.)		4650	20		4577	20.48
4	Interest on fixed capital @9%		471.99	2		467	2.09
	Sub total		**5716.29**	**25**		**5656**	**25.31**
C	**Total cost of cultivation (A+B)**		**23239.36**	**100**		**22344**	**100**

Table 2 Economic impact of pulse magic use in pigeonpea production in the study area

(Per acre)

Sl. No	**Particulars**	**Pulse Magic user**	**Pulse Magic non user**	**Impact**	**%**
1	Total cost of cultivation (₹)	23238.36	22344.00	+ 894.36	4.00
2	Yield (Qty)	6.00	5.02	+0.98	19.52
3	Price (₹ /Qtl)	6698.33	6656.00	+42.33	0.64
4	Gross return (₹)	40189.98	33413.12	+6776.86	20.28
5	Net return over total cost (₹)	16951.62	11287.52	+5664.10	50.18
6	Returns per rupee of expenditure	1.73	1.50	+0.23	15.65
7	Cost of production (per Qtl)	3873.06	4451.00	-577.94	-12.98

Table 3 Assessment of Net gain or loss in adoption of pulse magic technology

(Per acre)

Pulse magic user over pulse magic non user				
Sl. No.	**Debit**		**Credit**	
	A. Added cost		C. Reduced cost	NIL
1	Cost of Pulse Magic (2kg)	390		-
2	Application cost of pulse magic	500		-
	Sub total	890	Sub total	
	B. Reduced returns	NIL	D. Added returns	
3		-	Main product (Qtl)	0.98
4		-	Price (₹ /Qtl)	6,691
5		-	Sub total	6,557
	Total (A+B)	890	Total (C+D)	6,557
Net gain / loss = [(C+D) - (A+B)] = ₹ 5667				

Table 4 Estimation of probit regression model for adoption of pulse magic technology

Variables	Description	B	S.E.	Wald	P-value	Exp(B)
Constant		0.785	2.1	1.025	0.994	2.314
Age	Age (Years)	0.368	0.238	2.875	0.002	1.255
Education	Education (Years)	0.152	0.085	3.214	0.043	1.164
Farming experience	Farming experience (Years)	0.074	0.238	1.479	0.994	3.95
Land holding	Land holding (acre)	0.181	0.116	2.433	0.119	1.234
Family type	Family type (1 for Nuclear, 0 for Joint family)	0.039	0.068	0.692	0.993	1.589
Variety	Variety (1 for Improved variety, 0 for local variety)	0.178	0.104	2.158	0.001	1.052
Extenstion contact	Extension contacts (1 for yes. 0 for No)	0.98	0.017	7.851	0.002	1.526
-2 Log likelihood		79.421				
Cox & Snell R Square		0.559				
Nagelkerke R Square		0.765				
Chi-square		6.85				
sig.		0.001				
Hit ratio		86.7				