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Factors Determining Supply of Pulses in India

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Abstract

Objective: Pulses are the primary source of protein for the vegetarians. However, there is wide gap between demand and supply of pulses in the country. Hence, it is important to determine the factors responsible for mismatch in demand and supply of pulses in the country.
Methods: Four important pulses grown in the country were considered for the study. Total sample size constitutes 120 comprising of 30 farmers each from redgram, bengalgram, greengram and blackgram cultivars. The principal component and multiple linear regression analysis were employed to assess the response of pulses production to a given change in selected inputs.
Findings: The study revealed that out of the 20 variables considered for the study, 8 variables were found influencing on pulses production, particularly area under crop, selection of variety, usage of fertilizers, seeds, incidence of pest and disease, prevailing market price and rainfall during flowering. The co-efficient of area, fertilizers, seeds and use of improved varieties were influenced significantly on production of pulses. Whereas, incidence of pests and diseases have negatively influenced on pulses production and were fail to exert any significant influence on decline in pulses production.
Application: In order to optimize the usage of critical inputs, agricultural scientist and line department should educate the farmers on scientific cultivation of pulses including the use of weedicides, improved tools for planting and harvesting, IPM, etc. Further, production constraints need to be addressed on priority basis in pulses growing area to increase pulse production and to minimise the import of pulses to meet out future demand and also attaining food security.

Key words: Co-efficient, disease, inputs, principle component analysis, pests, Pulses.

1. Introduction

Pulses have been cultivated since time immemorial in rainfed conditions characterized by poor soil fertility and moisture stress environments. These are the seeds of leguminous plants and belong to the Fabaceae family. Pulses are also an excellent feed and fodder for livestock. Endowed with the unique ability of biological nitrogen fixation, carbon sequestration, soil amelioration, low water requirement and capacity to withstand harsh climate, pulses have remained an integral component of sustainable crop production system, especially in the dry areas. They also offer good scope for crop diversification (grow profitably in relatively low-input management conditions) and intensification (short growing period).They thus play an important role in ushering sustainable agriculture [1].

Pulses are the primary source of protein for the poor and the vegetarians. The split grains of these pulses are called dal and are excellent source of high quality protein, essential amino and fatty acids, fibers, minerals and vitamins. The water requirement of pulses is about one-fifth of the requirement of cereals thus it saves water.

The major producers of pulses in the country are Madhya Pradesh(24%), Uttar Pradesh(16%), Maharashtra(14%), Andhra Pradesh(10%) followed by Karnataka(7%) and Rajasthan(6%), which together share about 77 per cent of total pulse production while remaining 23 per cent is contributed by other states of the country. Contribution of pulses in the national food basket has reduced from 17 per cent to 7 per cent [2].

The irony is that India is the largest producer and importer of pulses in the world. Annual import of pulses has increased from 0.50 million tonnes to 1.80 million tonnes during last five years. For many pulses, large shares of import, including desi bengalgram, redgram, mungbeans, and kidneybean, comes from Myanmar. Canada and Australia are major suppliers of drypeas and kabuli chickpeas to the Indian market, each supplying about one-third of India's pea imports. Most kabuli chickpeas come from Mexico, Australia, Canada, Turkey and Iran. Nepal and Syria account for the largest shares of Indian lentil imports. Depending on the domestic shortfall in pulses production, India’s net imports of pulses have ranged from one million tonnes to three million tonnes, while exports are one-tenth of the volume of imports [3,4].

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Karnataka is one of the important pulses growing state in the country. Pulses are grown in an area of 28.66 lakh ha with the production of 10.61 lakh tonnes during 2014-15. Major pulses grown in the state are redgram, bengalgram, greengram and blackgram. These four pulses accounted 87.93 per cent of total pulse area and 80.75 per cent of state total pulse production during 2014-15 [5].

No doubt the production shortage is due to technological fatigues, the crop is highly sensitive to wide range of pests (plant diseases, insects and weeds) at various stage of crop growth as well as storage conditions. In general, the pulse production is not keeping pace with the domestic requirements and is a matter of concern. Further, farmers and other stake holders are in the opinion that minimum support price (MSP) announced by GOI is not encouraging farmers to increase area under pulse cultivation [6].

Keeping aforesaid issues in view, an attempt is made to study the extent of indiscriminate use of inputs, cost of cultivation, MSP and also identification and assessment of factors determining supply of pulses.

2. Material and Methods

2.1 Sampling area

North-Eastern Karnataka is purposively studied because it is one of the important pulses growing area in Karnataka state. Based on the highest area under total pulses, redgram, bengalgram, greengram, and blackgram were chosen which together accounted 84.48 percent of area and 80.75 percent of state total pulses production. Hence these four crops were selected for the study and are the major source of income for pulse growing farmers.

2.2. Primary data

For evaluating the objectives designed for the study, primary data was collected from the two districts. From two districts two each pulses are selected.

2.3 Sampling Size

Multistage random sampling technique was adopted in designing sampling frame for the study. In the first stage, two districts namely Gulbarga and Bidar were selected based on the highest area under selected pulses in the State. Similarly, in the second stage, two taluks were selected based on potentiality and highest area under each crop, in the third stage, 30 pulses growing farmers for each selected crops from selected taluks of the district were chosen at random in view of spread out of pulse growers in different villages. Thus, total sample size constitutes 120 sample respondents for the study.

2.4 Analytical Tools

Principal component analysis technique was employed to ascertain the major factors influencing supply of pulses in the study area. Factor analysis was used in data reduction by identifying a small number of factors, which explain most of the variance observed in a much larger number of variables. In this study, principal component analysis was used because it has some advantages than other techniques. In principal component analysis, a set of original variables is transformed into a new set of uncorrelated variables called principal components. The new variables are linear functions of the original variables. The objective is to find out only a few components, which account for most of the variation in the original set of data. The principal component (Pi) is determined as follows.

$$P_i = a_{1j}Z_1 + a_{2j}Z_2 + a_{3j} Z_3 + \ldots\ldots + a_{nj}Z_n$$

Where,

P_i = 1 to n, are new uncorrelated components,

a_{ij} = i = 1 to n, and j = 1 to n, the Z coefficients are factor loadings,

Z_i = 1 to n, are observed variables as standardized by dividing (X-X) by its standard deviation (σx).

Each component makes a maximum contribution in descending order to the sum of the variance of the variables. Normally, the first principal component contributes a maximum to their total variance; the second principal component contributes to the residual variance and so on. The sum of the variance of all the principal components is equal to the sum of the variance of the original variables. Sum of square of factor loadings ($a^2_{1j} + a^2_{2j} + a^2_{3j} + \ldots\ldots + a^2_{nj}$) is called variance explained by factor (j). This is also known as Eigen value (λ). The percentage contribution of Pi in the total variance of original variables (Xi) is given by,

$$P_i = \lambda/n \times 100 \quad (n = \text{number of variables})$$

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The principal component analysis was carried out to identify important variables. The package provided output such as correlation matrix, initial factor matrix and rotated factor matrix. Initial factor matrix generally fails to be meaningfully interpretable. Therefore, rotated factor matrix was used for identification of factors. Varimax rotation (an orthogonal method), the most common rotation method was used for rotation. This method tries to produce factors that are as simple as possible by maximizing the variance of the loadings across the items within factors. For the selection of factors eigen values more than one are taken into account. Identification of and naming of any factor would be a subjective conclusion. Generally, the heavy loaded key variables would be considered as basis for identification and naming of dimension. In order to assign some meaning to factor solution a minimum level of significance for factor loading was 0.5 was taken. Higher the value of factor loading of the variable on a particular factor, greater would be the association with that factor. In pulse production, 20 variables were considered as major factors influencing supply of pulses in the study area. These variables were identified after careful investigation of the earlier studies and consultation with the scientists of Pulses Research Station, Gulbarga. The selected variables are given Table 1.

Table 1. Particulars of variables selected for the study

Sl.No.	Label	Particulars
1	P1	Rainfall during sowing/pre-sowing rainfall(mm)
2	P2	RH during flowering (%)
3	P3	Rainfall during pod formation (mm)
4	P4	Rainfall during flowering(mm)
5	P5	Growth regulators(ml)
6	P6	Micro Nutrients (kg.)
7	P7	Farm Yard Manure (t.)
8	P8	Pest incidence (%)
9	P9	Disease incidence (%)
10	P10	Vermicompost (q.)
11	P11	Weedicide (ml)
12	P12	Availability of Labour (Shortage, Normal)
13	P13	Quantity of Labour used (Mandays)
14	P14	Bullock Labour (Pairs)
15	P15	Machines Labour (Hrs.)
16	P16	Seeds (kg.)
17	P17	Fertilizers (q.)
18	P18	Varieties used (HYV, Local)
19	P19	Area under crop(Acres)
20	P20	Market price (High, Low)

Multiple Regression Analysis was employed to ascertain the response of production to a given change in selected variables as indicated by principal component analysis, following multiple linear regression equation was employed.

$Y = a+b_1X_1+b_2 X_2+b_3 X_3+b_4 X_4+b_5 X_5+b_6 X_6+b_7D_1+b_8D_2+U_i$ …… (2.1)

Where,

Y = Output
a = Intercept
bi's = Regression coefficients of i^{th} input
X_1 = Area (acres)
X_2 = Fertilizers (Kg.)
X_3 = Seeds (Kg.)
X_4 = Pest incidence (%)
X_5 = Disease incidence(%)
X_6 = Rainfall during sowing (mm)
D_1 = Variety used (Dummy variable with value one for improved variety and zero for local)
D_2 = Market price(Dummy variable with value one for higher price and zero for lower price)
U_i = Error term

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The regression co-efficients were tested for their significance using 't' test at choosen level of significance while the function as a whole was tested using the 'F' test.

$$t = \frac{X_i}{SE(X_i)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2.2)$$

Where,

X_i = Regression co-efficient of i^{th} input

$SE(X_i)$ = Standard error of i^{th} input

$$F = \frac{R^2/P}{(1-R^2)/(n-1-P)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

Where,

R^2 = Co-efficient of multiple determination (unadjusted)

P = Number of parameters in the sample

n = Number of observations in the sample

To test the goodness of fit of the estimated function, the adjusted co-efficient of multiple determination ($\bar{R}^2$) was calculated using the formula.

$$\bar{R}^2 = \frac{\text{Regression sum of squares (RSS)}}{\text{Total sum of squares (TSS)}}$$

$$\bar{R}^2 = \frac{[1-(1-R^2)]}{[(n-1)/(n-P)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2.4)$$

Variables in the equation 2.4 are same as defined in equation 2.3

3. Results and Discussion

3.1 Factors influencing production of pulses: The results of principal component analysis revealed that out of 20 variables selected for principal component analysis, 8 variables were found influenced on the production of pulses (table-2). The most important variables influenced on production of pulses were adequate and timely rainfall during pre-sowing period, area under crop, use of improved variety, fertilizers, seeds, incidence of pest and disease and market price. However, pre-sowing rainfall, area under crop, use of improved varieties, seeds, fertilizers and increase in market price were positively influenced on production while incidence of pests and diseases were negatively influenced on pulses production.

The regression analysis provides useful information on extent of influence of resource on the production of pulses in general and redgram, bengalgram, greengram and blackgram in particular (table-3). In case of redgram, fertilizers, adequate and timely pre-sowing rainfall and use of improved varieties were influenced significantly on redgram production. However, area under crop and market price have not influenced significantly. In case of bengalgram area under crop and pre-sowing rainfall were positive and significantly influenced on production. Whereas, increase in incidence pests and diseases resulted significant decline in production because severe incidence of insect pests and diseases namely Pod borer, Pod fly, SMD and Wilt were observed during study and also expressed by farmers during opinion survey.

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Table 2. Principal component and factor loading of variables influencing pulses production

Sl No.	Variables	Label	Factor loading
A	**Component-I**		
	1. Area under crop	P19	0.95872
	2. Varieties used	P18	0.95600
	3. Fertilizers	P17	0.94125
	4. Seeds	P16	0.94041
	5. Pest incidence	P8	0.92383
	6. Market price	P20	0.88831
	7. Rainfall during Pod formation	P3	0.78601
	8. RH during Flowering	P2	0.61537
	Variance explained		**90.07**
B	**Component-II**		
	9. Disease incidence	P9	0.82738
	10.Rainfall during sowing	P1	0.82570
	11.Rainfall during flowering	P4	0.78829
	12.Bullock Labour	P14	0.5611
	Variance explained		**7.23**
C	**Component-III**		
	13.Quantity of Labour used	P13	0.79435
	14.Availability of labour	P12	0.72769
	Variance explained		**2.24**
D	**Component-IV**		
	15.Growth regulators (Planofix)	P5	0.79248
	16.Farm Yard Manure	P7	-0.6926
	Variance explained		**0.36**
E	***Component-V***		
	17.Weedicide	P11	0.79921
	18.Vermicompost	P10	0.63102
	19.Micro Nutrients	P6	0.24797
	20.Machine labour	P15	0.0000
	Variance explained		**0.10**
	Cumulative variance explained		**100.00**

Table 3. Regression coefficient estimates in pulses production (Per Farm)

Sl. No.	Explanatory variables	Parameters	Redgram	Bengalgram	Greengram	Blackgram	Pooled
1	Intercept	a	57.405 (64.675)	-43.019 (18.414)	-6.984 (18.366)	4.895 (24.823)	3.133 (5.827)
2	Area(Acres)	X1	0.388 (2.706)	3.317*** (0.531)	2.991**(1.201)	0.343 (0.472)	2.969*** (0.392)
3	Fertilizer(q.)	X2	10.349***(2.869)	0.100 (0.375)	-1.273* (0.699)	-0.71 (1.181)	1.267*** (0.365)
4	Seeds(kg.)	X3	-0.003 (0.323)	0.153 (0.136)	0.375* (0.195)	0.605***(0.094)	0.267***(0.083)
5	Pest incidence (%)	X4	-0.749 (6.157)	-0.858* (0.502)	-1.574 (1.323)	-0.021 (0.249)	-0.072 (0.091)
6	Disease incidence (%)	X5	-0.389 (0.765)	-0.139** (0.062)	-0.908**(0.452)	-5.265* (2.474)	-0.368 (0.272)
7	Rainfall during sowing(mm)	X6	0.707* (0.611)	2.710* (1.492)	0.16 (0.164)	0.073 (0.094)	0.019 (0.03)
8	Variety used	D1	2.508**(3.896)	1.595 (1.784)	0.419 (2.05)	0.677 (1.584)	0.278** (1.451)
9	Market price	D2	1.899 (5.784)	2.459 (2.491)	1.292 (1.735)	1.837 (1.342)	1.072 (1.525)
10.	Coefficient of determination	R^2	0.972	0.988	0.981	0.846	0.955
11.	Adjusted R^2	$\bar{R}^2$	0.961	0.984	0.974	0.788	0.952
12.	F value	F	90.522	222.873	136.341	14.457	294.192
13.	No. of observation	N	30	30	30	30	120

Note : Figures in parentheses indicate standard errors of respective regression coefficients
*** Significant at 1 per cent level, ** Significant at 5 per cent level, * Significant at 10 per cent level

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Among the independent variable included in the model regression co-efficient of area (2.991) and seeds (0.375) were influencing positively and are highly significant at five and ten per cent probability level implying for every one per cent increase in area under crop and seeds would increase production of greengram by 2.99 and 0.37 per cent. Whereas, elasticity co-efficient of fertilizers, incidence of pests and disease were negative implying for every one per cent increase in these variables resulted decline in production by 1.27, 1.57 and 0.91 per cent respectively. In case of blackgram production, seed was the only input variable significantly influencing on production positively, whereas, incidence of pest was influencing negatively and all other inputs included in the model where fail to exert any significant influence on production of blackgram.

In case of total pulses, **t**he high R^2 value indicated that the variables included in the regression model were capable of explaining nearly 96.00 per cent variation in the pulses production. The regression co-efficient of area, fertilizers, seeds and use of improved varieties were influenced significantly on production of pulses. Whereas, incidence of pests and diseases have negatively influenced on pulses production and were fail to exert any significant influence on decline in pulses production even though both the variables with negative co-efficient. The findings of the study are in line with [7] and [8]. This may be due to better management practices with optimum use of land and high cost inputs like seeds and fertilizers as reflected by positive and significant regression co-efficient. From the foregoing results it is clear that most of the variables were positive in all the selected pulses except diseases and pests. Therefore, in order to increase the production and optimize the external use of input, there is immediate need to educate the farmers on scientific cultivation of pulses including the use of weedicide, bio-fertilizers, improved tools for planting and harvesting, integrated pest management, etc.

4. Conclusion

The PCA analysis revealed that 8 variables were found influenced on the production of pulses. The most important variables influenced on production of pulses were adequate and timely rainfall during pre-sowing period, area under crop, use of improved variety, fertilizers, seeds, incidence of pest and disease and market price. The regression co-efficient of area, fertilizers, seeds and use of improved varieties were influenced significantly on production of pulses. Whereas, incidence of pests and diseases have negatively influenced on pulses production and were fail to exert any significant influence on decline in pulses production. In order to optimize the use of inputs, need to educate the farmers on scientific cultivation of pulses including the use of weedicides, improved tools for planting and harvesting, IPM, etc. Further, production constraints need to be addressed on priority basis in pulses growing area to increase production to meet out future demand and also attaining food security**.**

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