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Resource Use Efficiency in Bottle Gourd for the Contract vis-à-vis Non-Contract Farms in the Jaipur District of Rajasthan

Arjun Singh Rajput*, Latika Sharma*, M. K. Jangid*, R.C. Sharma**
*Department of Agricultural Economics and Management,
Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan
**Department of Agricultural Economics, SKNAU, Jobner, Jaipur

Abstract

The present investigation was undertaken with a view to analyze the resource use efficiency of bottle gourd under contract vis-à-vis non-contract farming in the Jaipur district of Rajasthan. In this regard a contracting firm, Rajasthan Olive Cultivation Ltd. was selected. Three villages were selected for the study from which 30 contract and 20 non-contract farmers were selected randomly. Primary data were collected for the agricultural year 2015-16. The conventional budgeting technique and multiple regression functions were used to analyze the data. The net income per hectare from bottle gourd cultivation was 31.69 per cent higher on contract farms as compared to the non-contract farms. The regression results revealed that out of six explanatory variables, only five variables namely; human labour, machine labour, seed, irrigation and fertilizer were significantly influencing gross return of contract and non-contract farms.

Key words: *Contract farming, Resource use efficiency, Bottle gourd*

JEL Classification: *C83, Q10, Q19, Q12*

Introduction

The studies related to contract farming revealed that the farmers favored contract farming because it provided better prices of the commodities, reliable incomes, and generated employment opportunities to the farmers. India is the second largest producer of vegetables contributing 14 per cent of world's vegetable production. With an area of 8.5 million hectares under vegetables, the average productivity of vegetables in India was 17.3 tonnes per hectare in 2010-11. An area, production and productivity of vegetables in Rajasthan were 1.4 million hectare, 10.719 tonnes and 6.3 tonnes per hectare, during the year 2010-2011, respectively (Vegetable Statistics – IVRI (2010-2011). Rajasthan Olive Cultivation Ltd. entered in the production and marketing of vegetables like cabbage, cauliflower, strawberry, olive, tomato, squash green/yellow, chilli, watermelon, bottle gourd, cucumber, etc. under contract farming in the state during the year 2007 under the Company Act, 1956. The company was constituted in collaboration with the Government of Rajasthan through Rajasthan State Agriculture Marketing Board, Plastro Plasson Industries (India) Limited (now Finolex Plasson Industries (India) Limited), Pune & Indolive Limited of Israel having equal partnership. In Rajasthan contract farming is done mainly in Jaipur, Jodhpur, Sikar, Ajmer, Ganganager, Kota, Bharatpur, Hanumangar, Alwar, Jhalawar and Udaipur districts. In Jaipur district watermelon, bottle gourd, cucumber, etc. are the major growing cucurbits under contract basis. In Jaipur district Bassi, Jhotwara and Shahpura are the major blocks for the production of bottle gourd with an area and production of 125 hectare (360 qt/ha), 65 hectare (350 qt/ha) and 50 hectare (350 qt/ha), respectively. Productivity of vegetables can be increased through adoption of improved technology (Obare and Kariuki, 2003). Seeds, manures, plant protection measures,

Corresponding Author e-mail: latika4@gmail.com

fertilizers, irrigation, human labour and machine power are the most important crucial inputs for increasing the production of vegetables. Judicious use of resources coupled with proper technology plays an important role in stepping up vegetable production. It is generally noticed that the farmers are not using recommended level of crop production technology. This results in a gap between the potential and actual yield. As such there is a need to evaluate the resource use efficiency on contract farms vis-a-vis non-contract farms in the state.

Data Sources and Methodology

In Jaipur district contract farming in case of cucurbits was prevalent only in three tehsils namely Bassi, Jhotwara and Shahpura. Among these three tehsils, Bassi tehsil ranks no. one in area and production of bottle gourd. Therefore, bassi tehsil was selected purposively as study area. Multi stage stratified random sampling technique was used for drawing a sample for the present study. A list of 26 villages having contract farming in bottle gourd was obtained from the tehsil headquarter. Three villages namely Dhindon, Damodarpura and Kacholiya from the selected tehsil were selected randomly. Of the total 127 bottle gourd growers 57 were contract farmers and 70 were non-contract farmers, 50 farmers were selected randomly for the study of which, 30 were contract and 20 were non-contract farmers. The contracting firm ROCL Ltd. was also selected for the study.

Resource use efficiency

Regressions using the Ordinary Least Squares method were used to study the factors responsible for gross returns with the farmers. The model and explanatory variables selected and discussed were as under:

Selection of the variables

Gross return is affected by a large number of factors depending upon the climatic conditions and socio-economic situation of and prices of the crop. However, all the factors cannot be taken into account due to a variety of reasons like non-availability of desired data, multicollinearity among the explanatory variables, problems in their quantification, etc. To get rid of such problems only a few but most probable variables are taken into account. In the present investigation, based on the theoretical *a* priori reasons, the following variables were selected to study the resource use efficiency: (a) human labour, (b) machine labour, (c) seeds, (d) irrigation, (e) fertilizers, (f) plant protection expenditures.

Specification of the regression model for the study

The factors affecting gross return of bottle gourd crop on the contract and non-contract farms in the study area were identified by regressing gross returns on the following explanatory variables (all measured in ₹/ha):

Functional relationship

$$Y = f(X_1, X_2, X_3, \ldots\ldots, X_6)$$

Where,

Y = Gross income

X_1 = Human labour

X_2 = Machine labour

X_3 = Seed

X_4 = Irrigation

X_5 =Fertilizers

X_6 = Plant protection expenditures

Both linear and log-linear (Cobb-Douglas) forms of the multiple regression function as shown below were fitted to the data.

(i) Multiple linear functional forms

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots\ldots + b_6 X_6 + U$$

(ii) Multiple log-linear (Cobb-Douglas) functional form

$$Y = a\ X_1^{b1}\ X_2^{b2}\ X_3^{b3} \ldots\ldots\ X_6^{b6} U$$

which on log transformation takes the following form:

$$\text{Log } Y = \text{Log } a + b_1 \text{ Log } X_1 + b_2 \text{ Log } X_2 + \ldots\ldots + b_7 \text{ Log } X_6 + U$$

Based on the magnitude of R^2 (coefficient of determination) and significance of the estimated regression coefficients multiple log-linear (Cobb-Douglas) relationship was chosen for further study.

The resource use efficiency could be judged based on the MVP (marginal value productivities), which indicates the increase in the gross return from the use of an additional unit of a given input while keeping the level of other inputs constant. The marginal value productivity of the i^{th} input was measured by using the following formula:

$$MVP = b_i \frac{\overline{Y}}{\overline{X}_i}$$

bi = Regression coefficient of i^{th} factor

$\overline{Y}$ = Geometric mean of gross returns (₹)

$\overline{X}i$ = Geometric mean of i^{th} input (₹)

Testing the significance of regression coefficients

The reliability of the regression coefficients (b_i) was tested through the student's 't' test of the form:

$$t = \frac{b_i - \hat{b}_i}{SE(\hat{b}_i)}$$

Where;

i = 0,1,2,3 ---- K-1 (K – being the total number of parameters estimated)

t = The variable which follows the 't' distribution with (n-k) degrees of freedom at chosen level of significance

$\hat{b}_i$ = Estimate of the regression parameter (b_i);

SE ($\hat{b}_i$) = Standard error of the estimate (b_i)

To test the presence of multicollinearity (high degree of correlation among the explanatory variables), simple correlation matrices as well as variance inflation factor (VIF) were worked out. For testing multicollinearity on the basis of correlation coefficients Klein's (1962) observation was taken in to consideration that the effect of multicollinearity was tolerable if the correlation between any pair of independent variables (r_{ij}) included in the model did not exceed in magnitude to the multiple correlation coefficient (R), that is, $|r_{ij}| < |R|$. Where r_{ij} is the simple correlation coefficient between ith and jth variables (Kutner, 2004).

For understanding the working out procedure for VIF consider the following linear model with k independent variables:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_jX_j + \ldots\ldots\ldots\ldots + b_kX_k + e$$

The standard error of the estimate of b_j is $\sigma (X'X)^{-1}_{j+1,\ j+1}$,

where X is regression design matrix – a matrix such that $X_{i,j+1}$ is the value of the j^{th} covariate for the i^{th} case or observation, and $X_{i,1}$ equals 1 for all *i*. It turns out that this variance can be equivalently expressed as

$$Var\ (\hat{b}_j) = \frac{\sigma^2}{(n-1)\ \mathrm{var}(\hat{X}_i)} \cdot \frac{1}{1-R_j^2}$$

Where,

R_j^2 is the multiple R^2 for the regression of X_j on the other covariates (a regression that does not involve the response variable Y). This identity separates the influences of several distinct factors on the variance of the coefficient estimate:

σ^2: Scatter in the data around the regression surface

n: Sample size,

Var ($\hat{X}_j$): Variability in the covariates

The remaining term, $1/(1-R_j^2)$ is the VIF.

The term autocorrelation is defined as "correlation between members of series of observations ordered in time (as in time series data) or space (as in cross sectional data. Symbolically, E (UiUj) = 0 i ≠ j. Violation of this assumption leads to the problem of autocorrelation. The remedial measures are needed depending upon the nature of interdependence among the disturbances U_i (William and Kendall, 1971). In the present investigation Durbin-Watson test (1951) was used to test the autocorrelation between the residuals. For testing autocorrelation Durbin – Watson 'd' statistic was calculated as follows:

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

Where;

H_O = Null hypothesis

H_A = Alternative hypothesis

= Autocorrelation coefficient

d = Durbin – Watson statistic

d_L = Lower limit for the critical value

du = Upper limit for the critical value

The elasticity of gross return for log-linear (Cobb-Douglas) relationship was computed as under;

$$E(x_i) = \hat{b}_i \frac{\bar{X}_i}{\bar{Y}_i}$$

Where;

$\hat{b}_i$ = Partial regression coefficient of the independent variable,

$\bar{X}_i$ = Geometric mean of the i^{th} explanatory variable, and

$\bar{Y}_i$ = Geometric mean of dependent variable.

Results and Discussion

An attempt was made to study and compare the efficiency of existing factor combinations on contract and non-contract farms and to suggest changes in these combinations in the optimal direction. This section is further sub-divided into following sub-heads.

Production function analysis for contract farms

The regression results for contract farms revealed that five explanatory variables namely; human labour (X_1), machine labour (X_2), seed (X_3), irrigation (X_4), and fertilizer (X_5) significantly affected the gross return (Table 1).

The results of VIF indicated that there was no multicollinearity problem among these variables. The estimated value of Durbin –Watson 'd' statistic (1.692) lay within the bounds of du < 1.692 < 4 –du, *i.e.,* 1.670 < 1.692 < 2.330 indicating no autocorrelation (positive or negative) among the estimated residuals at 1 per cent

Table 1. Estimated Cobb-Douglas production function for contract farmers

Number of contract farmers (N) = 30

Explanatory variable	Regression coefficient	Standard error	VIF	Elasticity coefficient
Intercept (a)	2.783	0.493	-	-
Human labour (X_1)	- 0.341***	0.065	2.071	- 0.341
Machine labour (X_2)	0.356***	0.049	5.062	0.356
Seed (X_3)	0.125**	0.050	2.803	0.125
Irrigation (X_4)	0.509***	0.164	7.115	0.509
Fertilizer (X_5)	-0.115**	0.049	5.939	-0.115
Coefficient of multiple correlation (R)			-	0.947
Coefficient of determination (R^2)			-	0.897
Adjusted coefficient of determination (R^2)			-	0.893
d statistics			-	1.692
F value			-	135.87
Returns to scale			-	0.53

*** *Significant at 1 per cent level of significance*
** *Significant at 5 per cent level of significance*

level of significance .The regression coefficients for human labour (-0.341), machine labour (0.356), seed (0.125), irrigation (0.509) and fertilizer (-0.115) had significant influence on the amount of gross return. The results indicated that the effect of human labour was significantly negative at 1 per cent level of significance and that of fertilizer at 5 per cent level of significance. Machine labour and irrigation positively and significantly affected the gross return at 1 per cent level of significance. The effect of seed was also significantly positive but at 5 per cent level of significance.

The coefficient of multiple determination (R^2) was 0.897 indicating that 89.70 per cent of variation in gross return was explained by the explanatory variables included in the model. The observed F-value (135.87) for R was higher than the tabulated F value indicating regression to be significant.

The elasticity coefficients of gross return with respect to all the selected explanatory variables were estimated to be – 0.341, 0.356, 0.125, 0.509 and -0.115 for human labour, machine labour, seed, irrigation and fertilizer, respectively. This indicated that 1 per cent increase in human labour and fertilizer decreased the gross return by 0.341 per cent and 0.115 per cent. Likewise 1 per cent increase in the expenditure of machine labour, seed and irrigation increased the gross return by 0.356, 0.125 and 0.509 per cent, respectively. This was taken to mean that the gross return was inelastic to change in human labour, machine labour, seed, irrigation and fertilizer. The sum of elasticity coefficients, *i.e.,* returns to scale of production on overall contract farms was 0.53 implying decreasing returns to scale.

Production function analysis for non-contract farms

The regression results for non-contract farms revealed that only five explanatory variables namely; human labour, machine labour, seed, irrigation, and fertilizer significantly affected the gross return (Table 2).

The results of VIF indicated that there was no multicollinearity problem among these variables. The estimated 'd' statistic was indicating no autocorrelation (positive or negative) among the estimated residuals.

The regression coefficients for human labour (-0.262) and fertilizer (-0.129) were significantly negative at one per cent level of significance. For seed (0.324) and irrigation (0.406) these were significantly positive at one per cent and for machine labour (0.166) at five per cent level of significance. The coefficient of multiple determinations (R^2) was 0.913 indicating that 91.30 per cent of variation in gross return was explained by the explanatory variables included in the model. The observed F-value was higher than the tabulated F value indicating regression to be significant.

The elasticity coefficients for gross return with respect to human labour, machine labour, seed, irrigation and fertilizer were estimated to be –0.262, 0.166, 0.324, 0.406 and -0.129 respectively. This indicated that one per cent increase in human labour and fertilizer decreased the gross return by 0.262 per cent and 0.129 per cent. Likewise one per cent increase

Table 2. Estimated Cobb-Douglas production function for non-contract farmers

Number of contract farmers (N) = 20

Explanatory variable	Regression coefficient	Standard error	VIF	Elasticity coefficient
Intercept (a)	2.872	0.362	-	-
Human labour (X_1)	-0.262***	0.049	1.847	-0.262
Machine labour (X_2)	0.166**	0.062	9.538	0.166
Seed (X_3)	0.324***	0.036	6.591	0.324
Irrigation (X_4)	0.406***	0.131	8.195	0.406
Fertilizer (X_5)	-0.129***	0.028	4.924	-0.129
Co-efficient of determination (R^2)		-	0.913	
F value		-	232.18	
Returns to scale		-	0.51	

*** *Significant at 1 per cent level of significance*
** *Significant at 5 per cent level of significance*

in expenditure on machine labour, seed and irrigation increased the gross return by 0.166, 0.324 and 0.406 per cent, respectively. This was taken to mean that the gross return was relatively inelastic to change in human labour, machine labour, seed, irrigation and fertilizer. The sum of elasticity coefficients, *i.e.,* returns to scale of production was 0.51 on overall farms implying decreasing returns to scale.

Out of seven explanatory variables, only five variables namely; human labour, machine labour, seed , irrigation and fertilizer were significant factors influencing gross return of contract and non-contract farmers. At aggregate level human labour and fertilizer had significantly negative and machine labour, seed and irrigation had significantly positive effect on the quantum on gross return of the contract as well as non-contract farms. These results were in confirmation with that reported by Dileep *et al.* (2002), Kale (2005), Tripathi *et al.* (2005), Singh *et al.* (2006) and Nimoh *et al.* (2012).

A look into factor-wise influence revealed that human labour and fertilizer negatively and significantly influenced the gross return on contract and non-contract farms. Machine labour, seed and irrigation had significantly positive effect on the gross return on contract farms and non-contract farms.

Marginal value productivity, factor costs and economic efficiency

The regression coefficient (here is also referred as elasticity coefficient of production) of an explanatory variable indicates the percent change in gross farm output associated with one per cent change in factor input. In order to enable comparison of the absolute output response per unit of factor input, it is necessary to compute the marginal value productivity of each factor input, holding all other independent variables constant at their respective geometric mean level. An input factor is considered to be most efficient if its marginal value product is just sufficient to offset its cost. Equality of marginal value product to factor cost is the basic condition that must be satisfied to obtain efficient resource use. The ratio of marginal returns to acquisition costs *i.e.,* economic efficiency for all variables were calculated by dividing the marginal value productivities by the marginal factor costs. The marginal factor cost (MFC) was assumed to be constant, *i.e.,* ₹ 1 for each input.

Marginal value productivities (MVPs) of different inputs on contract farms and non-contract farms

Marginal value productivities of different inputs on contract farms and non-contract farms are depicted in Table 3. The table indicates that marginal value productivity of human labour was ₹ -2.75 on contract and ₹-1.83 on non-contract farms. On both farms, the MVP was estimated to be negative because the MVP of human labour on contract and non-contract farms was observed to be non-significant, indicates over utilization of human labour as such farms. The MVP for this factor was estimated to be ₹-2.70 on contract and ₹ -1.80 on non-contract farms when time element was taken in to consideration. The (gross) marginal value productivity of machine labour, seed and irrigation were ₹ 5.38, ₹4.16 and ₹3.98 on contract and ₹2.25, ₹ 9.02 and ₹ 2.74 on non-contract farms - the net being ₹5.29, ₹ 4.09 and ₹ 3.93 on contract and ₹ 2.21, ₹ 8.88 and ₹ 2.69 on non-contract farms, respectively. Among all the variable factors the MVP of machine labour on contract and seed on non-contract farms was noted to be the highest. The MVP of fertilizer per rupee investment was ₹ -3.12 on contract and ₹ -3.87 on non-contract farms, respectively. The MVP on contract and non-contract was negative because of its being not significant on both farms. This implied that it was over utilized.

Variable expenses were considered to be flow variables because they were invested throughout the season and investment was recovered generally at the end of the season. Therefore, the average period of operating expenses during which funds were tied up in a crop was three months. Taking 7 per cent interest rate per annum on short term loans, the interest charge on variable expenses investment was 1.75 (3.5/2) per cent. After deducting this 1.75 per cent interest cost, values of marginal value productivity in parentheses were obtained.

From the above discussion, it may be concluded that the marginal value productivities of different factor inputs on contract and non-contract farms were positively influenced but human labour and fertilizer

Table 3. Marginal value productivities (MVPs) of different factor inputs on contract farms

Category of farm/ Variables	Contract farms	Non-contract farms
Human labour (X_1)	-2.75(-2.70)	-1.83(1.80)
Machine labour (X_2)	5.38(5.29)	2.25(2.21)
Seeds (X_3)	4.16(4.09)	9.02(8.88)
Irrigation (X_4)	3.98(3.93)	2.74(2.69)
Fertilizer (X_5)	-3.12(-3.07)	-3.87(-3.80)
Plant protection (X_6)	-	-

were negatively influenced.

Conclusion and Policy Implications

Out of six explanatory variables, five variables namely; human labour, machine labour, seed, irrigation and fertilizer were significant factors influencing gross return of contract and non-contract farmers. Though, their effect was not the same across the categories of contract and non-contract farms. On contract and non-contract farms, machine labour, seed and irrigation had positive influence on the gross return. This indicates that machine labour, seed and irrigation led to increase in gross return on both farms in the study area. At aggregate level human labour and fertilizer had significantly negative effect on the quantum on gross return of the contract as well as non-contract farms.

A look into factor-wise influence revealed that human labour and fertilizer negatively and significantly influenced the gross return on contract and non-contract farms also.

On contract and non-contract farms the MVPs of different factor inputs human labour and fertilizer had negative influence. It was taken to mean that all factors were underutilized except human labour and fertilizer on both the categories of farms. Human labour and fertilizer were over utilized on both the categories of farms.

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