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ANALYSIS OF OFF-SEASON CUCUMBER PRODUCTION EFFICIENCY IN PUNJAB: A DEA APPROACH

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ABSTRACT

The current research was designed to estimate technical, allocative and economic efficiency and determinants of inefficiency in the cultivation of off-season cucumber in Punjab, Pakistan. Simple random sampling was selected for the collection of primary data from 70 off-season cucumber growers in 2014. Data Envelopment Analysis Procedure revealed that average value of technical efficiency was higher (87.4%) followed by allocative (42.0%) and economic efficiency (37.2%). It shows the potential of 12.6% reduction in the level of input use and 58.0% reduction in total cost for obtaining same output level with same technology. The lowest value of technical (60.7%), allocative (13.7%) and economic (9.9%) efficiency was also calculated. Medium farmer shows high value of technical (96.7%) and economic (46.5%) efficiency while allocative (49.0%) efficiency was higher in case of small farmer. Inefficiency determinants shows that the education, experience in off-season cucumber production and number of meetings with extension staff had significant and negative effect on inefficiency score. The effect of family size, off-season cucumber area and distance of vegetable market from vegetable farm was significant and positive on inefficiency score. Government should take steps for the improvement in education, technical knowledge, meetings with extension staff and quality of inputs. Government should provide subsidy to small farmers in the purchase of tunnel material.

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1 Introduction

Government promoted new technologies for the improvement in agriculture sector. The share of agriculture sector was 19.8% in gross domestic product with the involvement of 42.3 % labor force (Government of Pakistan, 2016a). There is a strong association exists between agriculture and various climate factors like precipitation, temperature, floods which ultimately influence on the economy of a country. Increase in the production as well as yield of agricultural crops is a need of time for successful achievement of food security (Government of Pakistan, 2015; Government of Pakistan, 2016a).

Vegetables are considered as an essential part of agriculture because these are a source of livelihood and foreign exchange. These are useful for health, maintenance of nutrition level and resistance against diseases (Ogunniyi & Oladejo, 2011; Ibrahim & Omotesho, 2013). There exists 120% expansion in the production of vegetables on the globe (Bozoglu & Ceyhan, 2007). Major problems faced by developing countries were unemployment, poverty and malnutrition. The sector of vegetables can tackle these problems in short period of time. Their short growing period was also helpful in the cultivation of many crops in a particular season (Akter et al., 2011).

The value of vegetables and fruits export was 47895.6 million rupees in 2010-11 but the amount becomes 66531.3 million rupees in 2015-16 (Government of Pakistan, 2016b). Per capita recommended use of vegetables was 73 kg on annual basis but per capita annual vegetable consumption was 27.4 kg less in Pakistan (Shaheen et al., 2011).

Cucumber (*Cucumis sativus* L.) is a popular vegetable of Cucurbitaceae family having 118 genera and 825 species (Khan et al., 2015; Maurya et al., 2015). It is growing in western Asia since last 3,000 years but India is marked as their homeland (Maurya et al., 2015). Its local name is Khira and is an essential ingredient of salad. It is real versatile vegetable because of variety in their use from salad to pickles as well as from digestive aids to beauty products. It was found useful against human constipation and improvement in digestion (Maurya et al., 2015). It is used as a cooling food in summer (Maurya et al., 2015). A fresh cucumber provides vitamin C, niacin, iron, calcium, thiamine, fibers and phosphorus (Khan et al., 2015; Sanjeev et al., 2015). More than 50% production of cucumber comes from Asia. Turkey, Iran, Uzbekistan, Japan and Iraq were considered as leading cucumber producing countries in Asia (Khan et al., 2015).

In Pakistan, the cultivation area under cucumber and gherkins was 3,528 ha in 2013 while it was 3,499 ha in 2012. Total production of cucumber and gherkins was 50,164 tonnes in 2013 while it was 49,947 tonnes in 2012 (FAO, 2016). Yield of cucumber and gherkins was 14,218.8 kg ha⁻¹ in 2013 while it was 14,274.6 kg ha⁻¹ in 2012. So, the area and total production showed 0.83% and 0.43% increase, respectively.

However, there is 0.39% decrease in per hectare yield (FAO, 2016).

In Punjab, the cultivation area under cucumber was 1,795 hectares in 2012-13 while it was 1,742 hectares in 2011-12. Total production of cucumber was 40,439 tonnes in 2012-13 while it was 38,952 tonnes in 2011-12. Punjab contributes 80.96% in the total production of cucumber in 2012-13 while its area under cucumber cultivation was 51.30% of total area under cucumber cultivation in Pakistan in 2012-13. It shows that the average yield was higher in Punjab as compared to other provinces (Government of Pakistan, 2014).

Off-season vegetable production was useful for the reduction in high prices at start and end of vegetable season. Temperature and moisture level were under the control of farmers in off-season or tunnel farming (Government of Pakistan, 2013). Extension in the season and yield of a particular vegetable is observed in case of off-season cultivation (Iqbal et al., 2009).

The yield difference was observed in case of different farmers due to difference in the use of inputs. It indicates the existence of inefficiency in input usage (Khan & Ghafar, 2013). Production function, mathematical programming and frontier function techniques were used for the measurement of technical efficiency of agricultural farms (Bozoglu & Ceyhan, 2007). Therefore, it is required to uplift the living standard of vegetable farmers by improving their technical efficiency (Ibrahim & Omotesho, 2013).

Alboghady & Shata (2014) explored the technical efficiency in the production of cucumber under greenhouses, plastic tunnels and open field system. Results confirmed the difference in efficiency among various cultivation systems. They pointed out toward the improvement of efficiency and productivity. Education, extension services and agricultural knowledge were found beneficial for the improvement of efficiency.

Similarly, Shrestha et al. (2014) demonstrated the efficiency in the production of vegetables in Nepal. Average technical efficiency was 0.77 and pointed out 23% expansion in the production of vegetables. They recommended improvement in land, seed quality, pesticide and fertilizer availability, labour skills, women participation, extensions services and credit availability.

The current research was designed for the estimation of production efficiency in off-season cucumber production and checked the opportunity of input reduction keeping output level as constant or opportunity of obtaining more output keeping the input use level constant. The study also designed to give policy implications in the light of results. The production efficiency of off-season cucumber production was further decomposed into technical, allocative and economic

efficiency with the help of Data Envelopment Analysis Procedure.

2 Material and Methods

2.1 Data and study area

The present study used a comprehensive questionnaire for primary data collection from off-season cucumber growers in Toba Tek Singh and Faisalabad districts of Punjab, Pakistan in 2014. Simple random technique was adapted to interview off-season cucumber growers about socio-economic variables like education, size of family, off-season cucumber growing experience, contacts with extension agents, distance of vegetable market. They were also asked about the prices and quantity of inputs and output. A sample size of 60 respondents was suitable for the purpose of decision in the presence of large population as mentioned by Poate & Daplyn (1993), cited in Mari (2009). Therefore, the current study used a sample size of 70 off-season cucumber growers. Farmers were divided according to farm size in three groups which are small, medium and large. According to Hassan et al. (2005), a farmer having less than 12.5 acres was considered as small farmer; a farmer with greater than 12.5 acres and less than 25 acres was considered as medium; and a farmer having greater than 25 acres was considered as large. Software like Microsoft Excel, SPSS-15, DEAP-2.1 and EvIEWS 7 were used for empirical analysis.

2.2 Efficiency Background

A comparison between existing and maximum productivity of a firm is called as efficiency (Farrell, 1957). Maximum productivity of a firm was determined by using production frontier. Production frontier was developed by using two different techniques such as stochastic frontier analysis (SFA) and data envelopment analysis (DEA). The technique of linear programming was used in DEA model. The increasing difference among actual data and frontier explored the presence of increasing inefficiency of a firm (Javed, 2009). Coelli et al. (1998) mentioned both output and input oriented nature of DEA model but a farmer has more control on inputs. Therefore, input oriented DEA model was used in this study.

According to Javed (2009), technical efficiency is the achievement of maximum output by utilizing given input resources on the basis of production model. DEA model based on constant as well as variable return to scale was used for the estimation of technical efficiency. According to Coelli et al. (1998), constant returns to scale DEA model was feasible when all firms were working at an optimal scale otherwise it gives technical efficiency confounded by scale efficiency. Banker et al. (1984) incorporated convexity constraint in proposed variable returns to scale DEA model. DEA model based on constant and variable return to scale were used in this study.

2.2.1 Empirical Models

Present study calculated total technical and pure technical efficiency by using DEA model based on constant and variable return to scale, respectively. Total revenue (Y) was considered as output variable in the calculation of efficiency scores. Land (X1), tractor (X2), seed (X3), fertilizer (X4), pesticide (X5), irrigation (X6), labour (X7), polythene sheet (X8) and mulch sheet (X9) were used as input variables in the analysis.

(a) DEA Model for technical efficiency estimation

Input oriented constant return to scale DEA model was applied for technical efficiency estimation as mentioned by Javed (2009) like:

$$\min_{\theta, \lambda} \theta,$$

subject to:

$$-y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

Where:

Y represents the output matrix for N off-season cucumber farmers.

θ represents the total technical efficiency.

λ represents $N \times 1$ constants.

X represents input matrix for N off-season cucumber farmers.

y_i represents the total revenue (Rs.)

x_i represents the vector of inputs $x_{1i}, x_{2i}, \dots, x_{9i}$

X_{1i} represents the area under off-seasonal cucumber (acres)

X_{2i} represents the total tractor used (hours) in farm operations

X_{3i} represents the total quantity of seed (kg)

x_{4i} represents weight of NPK (kg)

x_{5i} represents the chemical applications (No.)

X_{6i} represents the total irrigation (hours)

X_{7i} represents the total labour man days required for all farm operations

x_{8i} represents the polythene sheet weight (kg)

x_{9i} represents the mulch sheet weight (kg)

(b) DEA Model for Pure Technical Efficiency Estimation

An input oriented variable return to scale DEA model was used by Coelli et al. (1998), cited in Javed (2009) for pure technical efficiency estimation. It is expressed as:

$$\min_{\theta, \lambda} \theta,$$

subject to

$$-y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$N1' \lambda = 1$$

$$\lambda \geq 0$$

Where:

θ represents the pure technical efficiency for i th off-season cucumber farmer.

$N1'/\lambda = 1$ represents a convexity constraint to ensure that an inefficient farmer was benchmarked against same size farmers.

(c) Scale Efficiency Estimation

Scale efficiency was obtained by dividing total technical efficiency with pure technical efficiency and expressed as:

$$SE = TE_{CRS}/TE_{VRS}$$

The firm was scale efficient or working at constant return to scale when it shows a value of 1. A firm whose value of scale efficiency was less than 1 represents scale inefficiency. A firm's working either at increasing or decreasing return to scale causes scale inefficiency.

(d) Economic Efficiency Estimation

Cost minimization DEA model is considered as first step for the estimation of economic efficiency and it is simply a ratio between minimum to observed cost as mentioned by (Javed, 2009). Cost minimization DEA model was expressed as:

$$\min_{\lambda, x_i^E} w_i x_i^E$$

subject to

$$-y_i + Y\lambda \geq 0$$

$$x_i^E - X\lambda \geq 0$$

$$N1'/\lambda = 1$$

$$\lambda \geq 0$$

Where:

w_i represents input price vector $w_{1i}, w_{2i}, \dots, w_{9i}$

x_i^E represents the vector of cost minimizing input quantities

N represents the total off-season cucumber farmers

w_{1i} represents land rent in Rs.

w_{2i} represents total money spent on tractor use in Rs.

w_{3i} represents total cost of seed in Rs.

w_{4i} represents total cost of NPK in Rs.

w_{5i} represents total cost of pesticide in Rs.

w_{6i} represents total cost of irrigation in Rs.

w_{7i} represents total cost of labour in Rs.

w_{8i} represents total cost of polythene sheet in Rs.

w_{9i} represents total cost of mulch sheet in Rs.

Economic efficiency is simply a ratio between minimum cost and observed cost.

Economic Efficiency = minimum cost/observed cost

$$EE = w_i x_i^E / w_i x_i$$

(e) Estimation of Allocative Efficiency

Allocative efficiency is obtained by dividing economic efficiency with technical efficiency.

$$AE = EE/TE$$

$$\text{Allocative Efficiency} = \text{Economic Efficiency} / \text{Technical Efficiency}$$

(f) Tobit Regression Model

Efficiency improvement studies also explored the causes of efficiency variations between different farmers (Ibrahim & Omotesho, 2013). The score of inefficiency for each farmer was obtained by subtracting their efficiency score from 1. The technical, allocative, and economic inefficiency score were separately regressed on selected variables. The range of efficiency score by using DEA model was from 0 to 1. It shows that the dependent variable in the model was not normally distributed. Biasness in results becomes a hurdle for the use of ordinary least square technique (Javed, 2009). So, the current study used Tobit regression model proposed by Tobin (1958).

Socio-economic and farm related variables were education of farmer, family size, contact with extension agents, off-season cucumber growing experience and area, and distance of vegetable market. Tobit regression model used by Javed (2009) for the determinants of inefficiency was expressed as:

$$E_i = E_i^* = \beta_0 + \beta_1 Z_{1i} + \beta_2 Z_{2i} + \beta_3 Z_{3i} + \beta_4 Z_{4i} + \beta_5 Z_{5i} + \beta_6 Z_{6i} + \mu_i$$

If $E^* > 0$

$$E = 0 \quad \text{if} \quad \text{If } E^* \leq 0$$

Where

i represents i th farmer in the sample

E_i represents the technical, allocative, and economic inefficiency

E_i^* represents the latent variable.

Z_{1i} represents the education (years)

Z_{2i} represents the total family size (no.)

Z_{3i} represents the off-season cucumber experience (years)

Z_{4i} represents the contact with extension agents (no.)

Z_{5i} represents the area under off-season cucumber (acres)

Z_{6i} represents the vegetable market distance (km) from i th farm

β 's represents unknown parameters.

μ_i represents the error term.

3 Results

3.1 Summary statistics

Table 1 reveals the summary statistics of socio-economic variables. Average age of off-season cucumber growers was 40.81 years with minimum (15 years) and maximum (80 years). Mean value of education was 9 years. Average family size was 9.17 members with minimum (6) and maximum (24).

Table 1 Summary statistics of socio-economic variables.

Variables	Unit	Mean	Maximum	Minimum	Standard Deviation
Age	Year	40.81	80	15	13.80
Education	Year	9.00	18	0	4.97
Size of family	No.	9.17	24	4	3.31
Off-season cucumber experience	Year	6.85	20	1	4.52
Contact with extension agent	No.	4.54	10	1	1.44
Off-season cucumber area	Acre	4.61	40	0.5	5.79
Vegetable market distance	Km	74.64	105	15	27.79

Off-season cucumber growers had 6.85 years experience about this activity while some farmers were new entrants in this business. Extension services are also important for this business and off-season cucumber growers had 4.54 contacts with extension staff. On average, the cultivation area under cucumber in off-season was 4.61 acres. On average, the distance of vegetable market from cucumber farm was 74.64 km.

Table 2 shows the summary statistics of variables incorporated in DEA model. It shows the mean value of a particular variable as well as their range. There exists variation in the use of input level because it depends on financial power of farmers and small farmers used fewer resources due to financial constraints. Credit availability was an alternative option but many farmers considered high interest as a hurdle to avail this opportunity. On average, per acre total output of off-season cucumber was 124.12 tonnes with minimum (26.78 tonnes) and maximum (220 tonnes). The wide range of output supported the concept

of production inefficiency among the farmers. Per acre average revenue was Rs. 1,328,569.64 or Rs. 1.329 million (USD 12733.06). Total variable cost was Rs. 555,531.05 and total cost was Rs. 671,935.96 calculated on per acre basis. On average, tunnel material cost was Rs. 61,205.14 in this activity. Tunnel material cost do not includes the cost of long life tunnel material. The cost of long life tunnel material was a part of fixed cost in the form of depreciation. A farmer paid Rs. 29,270.83 in the form of land rent calculated for seven months in off-season cucumber production. Tractor cost was Rs. 14,391.07 on average. On average, a farmer allocated Rs. 55,653.93 as seed cost. Average expenditure on fertilizer was Rs. 100,559.64. Chemical cost in off-season cucumber production was Rs. 38,607.14 per acre. Cultivation of cucumber is a water intensive activity and a farmer spends Rs. 15,528.82 on irrigation. Labor was used in various farm practices. On average, the share of labour in total variable cost was Rs. 102,711.07 with minimum (Rs. 32,000.00) and maximum (Rs. 198,750.00).

Table 2 Summary statistics of variables used in DEA model.

Variables	Unit	Mean	Minimum	Maximum	Standard Deviation
Yield	Kg/acre	124123.21	26775.00	220000.00	31955.61
Revenue	Rs./acre	1328569.64	630000.00	2200000.00	294432.92
Variable cost ¹	Rs./acre	555531.05	183205.00	825570.00	123328.34
Total cost ²	Rs./acre	671935.96	242988.05	975329.37	147565.27
Tunnel material cost ³	Rs.	61205.14	18140.00	103950.00	19594.85
Land rent	Rs./acre	29270.83	17500.00	40833.33	6073.16
Tractor use cost	Rs./acre	14391.07	7250.00	25500.00	3077.37
Seed cost	Rs./acre	55653.93	25000.00	162000.00	17799.66
NPK cost	Rs./acre	100559.64	13800.00	251375.00	45270.00
Chemical cost	Rs./acre	38607.14	5000.00	65000.00	11880.72
Irrigation cost	Rs./acre	15528.82	4180.00	68000.00	9485.92
Labor cost	Rs./acre	102711.07	32000.00	198750.00	26314.77

On per acre basis -

¹Variable cost consists of tunnel preparation cost, land preparation cost, seed cost, pesticide cost, irrigation cost, fertilization cost, picking cost and marketing cost; ²Fixed cost includes depreciation, interest on initial investment, interest on variable cost, administration charges, rent of land and water charges by Govt. (abyana); ³Tunnel material cost includes cost of string, nut bolt, polythene sheet, mulch sheet, labour charges

Table 3 Frequency distribution of efficiencies.

Efficiency range	Technical efficiency		Allocative efficiency		Economic efficiency	
	N	%	N	%	N	%
0.01-0.30	0	0	33	47.15	35	50
0.31-0.40	0	0	4	5.71	8	11.43
0.41-0.50	0	0	11	15.71	8	11.43
0.51-0.60	0	0	4	5.71	8	11.43
0.61-0.70	5	7.14	9	12.86	5	7.14
0.71-0.80	21	30	5	7.14	2	2.86
0.81-0.90	14	20	3	4.29	3	4.29
0.91-1.00	30	42.86	1	1.43	1	1.43
Total	70	100	70	100	70	100
Mean	0.874		0.420		0.372	
Maximum	1		1		1	
Minimum	0.607		0.137		0.099	

3.2 Efficiency score estimation

Table 3 reveals that the mean total technical efficiency in the production of off-season cucumber was 87.4% with minimum (60.7%) and maximum (100%). It depicts the possibility of 12.6% reduction in inputs for working at technical efficient level while output and technology remains unchanged. Results showed that 42.86% off-season cucumber growers had more than 90% value of technical efficiency and 57.14% remaining falls between 60% and 90%. Average value of allocative efficiency was 42% with lowest (13.7%) and highest (100%). It depicts the possibility of 58.0% reduction in total cost for an allocatively efficient farmer keeping the level of output and technology constant. Score of allocative efficiency was more than 70% for only 12.86% farmers. Average pure technical efficiency was 96.4% with lowest (78.3%) and highest (100%). It is more due to the absence of production scale. Average scale efficiency was 90.4% with lowest (62.7%) and highest (100%). Economic efficiency was 37.2% on average with minimum (9.9%) and maximum (100%).

Table 4 explores the impact of farm size efficiency scores. All production efficiency scores were found for small, medium and large off-season cucumber farmers. The mean of total technical efficiency was 96.7% for medium farmers followed by large (95.0%) and small (92.1%) farmers. The average allocative efficiency was higher for small farmers (49.0%) followed by medium (48.0%) and large (43.1%) farmers. Economic efficiency was more for medium farmers and it was 46.5% on

average while its value was 45.7% and 40.8% for small and large farmers, respectively. Small farmers were more in Pakistan and their prosperity was also important for the uplift of Pakistani society (Adil et al., 2004).

3.3 Inefficiency determinants

3.3.1 Education

Education was included to test the hypothesis that a farmer with more schooling is more efficient in off-season cucumber production. The results revealed a negative and significant education coefficient for economic and allocative inefficiency. Therefore, it confirmed the hypothesis and showed a decrease in allocative and economic inefficiency with increase in education.

3.3.2 Family Size

Family size was included to test the hypothesis that a farmer with increasing size of family had high value of inefficiency score. There exists a significant and positive coefficient for the size of family in off-season cucumber production for all production inefficiencies. So, it confirmed the direct relationship of inefficiency score with family size. Generally a farmer spends more financial resource in case of large family and has fewer resources to invest in a business that involve new technology. Off-season cucumber cultivation is profitable but requires higher initial investment.

Table 4 Estimation of production efficiencies with respect to farm size.

Farm Size	Efficiency estimates				
	TE _(CRS)	TE _(VRS)	SE	AE	EE
Small	0.921	0.995	0.925	0.490	0.457
Medium	0.967	0.994	0.972	0.480	0.465
Large	0.950	0.982	0.968	0.431	0.408

Table 5 Determinants of inefficiency.

Variables	Unit	Technical inefficiency		Allocative inefficiency		Economic inefficiency	
		β	Sig.	β	Sig.	β	Sig.
Education	year	0.007	0.381	-0.009	0.015	-0.007	0.002
Size of family	no.	0.081	0.000	0.094	0.000	0.072	0.000
Off-season cucumber experience	year	-0.050	0.001	-0.022	0.000	-0.002	0.522
Extension agent contacts	no.	-0.171	0.000	-0.008	0.074	-0.014	0.000
Off-season cucumber area	acre	0.037	0.019	0.022	0.000	0.001	0.854
Vegetable market distance	km	0.010	0.000	-0.001	0.163	0.000	0.129

3.3.3 Off-season cucumber experience

Experience in off-season cucumber cultivation was included to test the hypothesis that the inefficiency decreases with increase in experience. The coefficient of experience was significant and negative for technical as well as allocative inefficiency. It revealed that the decrease in the level of inefficiency was associated with the increase in the value of off-season cucumber growing experience.

3.3.4 Contact with extension agent

Extension services are important for a new technique and it was included to test the hypothesis that there is a negative impact on production inefficiency in the presence of extension services. The coefficient of contacts with extension agents was significant and negative for all kind of production inefficiency. It showed that the value of inefficiency decreases when a farmers increases the contact with extension staff.

3.3.5 Off-season cucumber area

The coefficient of off-season cucumber area was positive and significant for allocative and technical inefficiency. It showed an increase in the value of inefficiency due to more area under control. Generally small farmers were recognized as more efficient because they utilize the scarce resources more efficiently.

3.3.6 Distance of vegetable market

Distance between vegetable market and vegetable farm was included to test the hypothesis that a distant farm had more value of inefficiency. The coefficient of distance from vegetable market was significant and positive for technical inefficiency. A distant vegetable farm bears more labour cost and transportation cost.

4 Discussion and Conclusions

The present research explored the technical, allocative and economic efficiency in cucumber production in off-season with the help of primary data collected from 70 respondents in Punjab, Pakistan. Data Envelopment Analysis showed a higher mean value for technical efficiency (87.4%) followed by allocative (42.0%) and economic (37.2%) efficiency. It

explored the possibility of 12.6% reduction in inputs and 58.0% reduction in production cost for a technical and allocative efficient farmer while output and technology remains unchanged. The mean value of technical efficiency was 77% in cucumber production as found by Shrestha et al. (2014). Tobit regression was applied to explore the sources of technical, allocative and economic inefficiency. Results showed that the education, experience of cucumber cultivation in off-season, contacts with extension agents had significant and negative effect on production inefficiency. The negative effect of education on inefficiency was also explored by Bozoglu & Ceyhan (2007); Ogunniyi & Oladejo (2011); Shaheen et al. (2011); Khan (2012); Adenuga et al. (2013); Khan & Ali (2013) and Shrestha et al. (2014). The effect of family size on production inefficiency was matched with Bozoglu & Ceyhan (2007).

The impact of extension service was in line with the findings of Bozoglu & Ceyhan (2007), Khan (2012), Khan & Ali (2013) and Shrestha et al. (2014). The impact of family size, area under off-season cucumber and vegetable market distance was significant and positive on the score of technical, allocative and economic inefficiency. Result confirmed a significant potential for the improvement of technical, allocative and economic efficiency in off-season cucumber production.

Government should improve the technical education of farmers for the decrease in inefficiency score. Extension department should improve their contact with farmers and create awareness about this profitable business. Government should control the prices of various inputs like fertilizers, hybrid seed, electricity and chemicals. Government should also improve the quality of inputs like seed, sprays and fertilizers. High Initial investment on tunnel material is a problem for small farmers. Government should provide subsidy to small farmers in the construction of tunnel structure.

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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