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Production and Marketing Analysis of *Knol-khol* under Sub-Tropical Conditions of Jammu Region: A case study

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ABSTRACT

The numbers of small farms are increasing over time mainly due to division and subdivision and sale and resale of farms. These small farms are inefficient for growing crops such as wheat, cotton, sugarcane and rice, since a lot of money resource is prerequisite for growing these crops. With such circumstances, crops that are short duration and fetch high returns are suitable for such farms. Such crops are vegetables that not only give high returns but they are also a cheap source of essential nutrients. The present study has analysed the cost and return analysis as well as technical efficiency of *knol-khol* producing farms of Jammu region of Jammu and Kashmir state. Three districts Jammu, Udhampur and Samba are selected for the said study. DEA (Data Envelopment Analysis) have been used for the estimating the technical efficiency. Farmers in the study area used purchased as well as home produced inputs. The costs of home produced inputs were calculated in monetary terms on the basis of opportunity cost principle i.e., the market price. The cost of cultivation is found to be ₹ 7796.65 /acre (overall) with ₹ 7743.27/acre for Bhalwal block and ₹ 7850.02/acre for Marh block for Jammu district, in Samba district, the overall average was ₹ 6855.57/acre with ₹ 6416.38/acre for Vijaypur block and ₹ 7294.76 for Samba block and it was ₹ 7999.68/acre (overall average), ₹ 8166.21/acre (Udhampur block) and ₹ 7833.15/acre (Chenani block) in Udhampur district. The gross returns were ₹ 25250.00/acre, ₹ 31500.00/acre, ₹ 27720.00/acre, ₹ 34560.00/acre, ₹ 27000.00/acre and ₹ 36300.00/acre for Bhalwal, Marh, Vijaypur, Samba, Udhampur and Chenani blocks whereas the overall average for Jammu, Samba and Udhampur districts were ₹ 28325.00/acre, ₹ 31050.00/acre and ₹ 31500.00/acre, respectively.

Keywords: Subdivision, small farms, Jammu and Kashmir, cultivation

India is the second largest producer of vegetables in the world (ranks next to China) and accounts for about 15% of the world's production of vegetables. During 2012-13, production level of vegetables was over 162186.6'000 MT with the total area around 9205.2 000 hectares and the productivity of 17.6 MT/ha (Anoymous, 2013). Vegetables are typically grown in India in field conditions, the concept is opposed to the cultivation of vegetables in green houses as practiced in developed countries for high yields. During 2011-12, India exported vegetables and fruits worth ₹ 4801.29 crores. The major destinations for Indian vegetables and fruits are Bangladesh, UAE, Pakistan, Malaysia, Sri Lanka, UK, Saudi Arabia and Nepal (NHB, 2011).

Knol-khol is a European vegetable, very popular in Jammu & Kashmir in India. It is a greenish white colored big and round vegetable, somewhat similar to cabbage, although it does not have leaves covering. There are long light green colored extrusions, which come out as its shoots. It belongs to the *brassica* family, which also contains the cabbage and brussels sprouts. It is one of those few vegetables which originated in Europe. Kohlrabi (or *Brassica oleracea*) is a perennial plant as it is

grown all throughout the year. It has a very cool and succulent stem, which can be consumed. Average yield of *Knol-khol* varieties is 200q/ha. It is rich in the antioxidant, so helps fight cancer. It also contains good amounts of vitamins C, E and carotene, is considered good sources of dietary fiber, contains sulphoraphanes and other isothiocyanates, which are believed to stimulate the production of protective enzymes in the body. Aqueous extract of *Knol-Khol* is reported to have anti-diabetic activity.

Agriculture has been the mainstay of J&K state economy. More than 70% of our population depend upon agriculture for their livelihood. Even though the contribution of agriculture to GSDP is only 19.96 % (as per advance estimates for 2013-14). Nevertheless, the importance of agriculture can't be underestimated for years to come. It has been a way of life and a tradition. It has forward and backward linkages with other activities particularly the agro based activities. As per the latest census out of 100main workers 27½ % are engaged in the agricultural activities. The State is endowed with large natural resources and tremendous potential for growth in the agro-horti-forestry. Horticulture is emerging as a fast growing sector of the economy which has a great potential for further development. Almost 45 percent of economic return in agriculture sector account for horticulture produce. Around 6 lakh households with 30 lakh people are involved in horticulture trade directly or indirectly. Diverse agro-climatic conditions, varied soil etc. have endowed with promising horticulture and value added products that can be marketed within the country and abroad. Fruits like apple, cherry, walnut, plum, pear, mango, ber, citrus etc. are grown here.

Though vegetables were not previously grown on a larger area but now it covers an area of 63.1 '000 ha i.e., 0.69 % of area of India under vegetable cultivation, 1395.5 '000 MT of production or 0.86% of national production and the productivity of 22.1 MT/ha which is more than the national level of 17.6 MT/ha (Anonymous, 2013). Kashmir region is famous for apple and walnut, while as Jammu region is famous for certain specialities and local cultivars like Bhadarwah/Marwah Rajmash, Rongi, RS Pura Basmati, Kishtwar Kesar, Kala Zeera, Desi Mash, Desi Kheera, Garlic, Knol-Khol and a variety of other traditional productions. These vegetables have a definite market advantage and provide assured better returns to the farmers. The Jammu, Samba and Udhampur district of the state has become famous for the production of quality knol-khol. Also, being short-duration crop, 3-4 crops of knol-khol can be taken by the farmers to augment their income. In this backdrop, the present study was conducted to investigate the economics of cultivating knol-khol Jammu division with the following objectives:

1. To work out the technical efficiency of *knol-khol* crop.
2. To study its marketing channels, cost and price spread.
3. To identify the constraints in its production and marketing.

MATERIALS AND METHODS

The present study was carried out in Jammu region of Jammu & Kashmir state. The primary data were collected by survey method using well designed and pre-tested schedules. Collection of data was done by the personal interview method. In this study multi-stage sampling was adopted with districts (Jammu, Samba and Udhampur) selected purposively on the basis of highest area under vegetable production at the first stage,then blocks (Bhalwal and Marh blocks from Jammu district, Vijaypur and Samba blocks from Samba district, Udhampur and Chenani Blocks from Udhampur district) again purposively on the basis of highest area under vegetable production at the second stage and the ultimate units i.e., growers were selected randomly from each block so as to constitute sample units of 40 growers from each district with the total of 120 farmers/growers. To achieve the stipulated objectives, the required information was collected on farm implements, machinery, farm inputs and crop yields etc. so that to work out cost and returns, technical efficiency, resource use efficiency, marketing behaviour. To work out the cost of knolkhol production, various cost concepts of CACP were used.

Technical Efficiency

Modern efficiency measurement begins with Farell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency which could account for multiple

inputs. Farell (1957) proposed Technical Efficiency (TE) as the ability of a firm to produce existing level of output with the minimum inputs (input-oriented), or to produce maximal output from a given set of inputs (output-oriented). Thus, TE of the any firm is their ability to transform multiple resources into multiple outputs and if a firm fails to do so then it will operate below the frontier and is said to be technically inefficient. The two principal methods of studying comparative efficiency are parametric and non-parametric methods. Stochastic frontier analysis (SFA) is a parametric method which determines comparative efficiency levels by hypothesising a functional form and DEA is a non-parametric method which employs mathematical programming (linear programming model) (Coelli *et al.* 1998).

In present study DEA, originally proposed by Charnes, Cooper and Rhodes (CCR) in the year 1978 and 1979, has been used to analyse the performance of the decision making units (DMUs),which are farmers in our case, having the multiple input and output mixes. Compared to other methods like traditional, SFA, free disposal hull, etc., DEA shows several advantages.

Firstly, it handles multiple inputs and outputs in a non-complex way. Second, it does not require any initial assumption about a specific functional form linking inputs and outputs like stochastic frontier analysis. There are several issues that need to be resolved whenever DEA is to be carried out. Firstly, the choice and number of DMUs should be taken into consideration. The relation between number of DMUs and the number of input and outputs is governed by some rule of thumb. The two thumb rules are: (a) the number of DMUs is expected to be larger than the product of number of inputs and outputs in order to discriminate effectively between efficient and inefficient DMUs (b) the sample size of the data should be at least two or three times larger than the sum of number of inputs and outputs.

Secondly, the choice of number of inputs and outputs and with respect to this there is no specific rule or procedure for selection of inputs and outputs. The study should normally start with an exhaustive list of number of inputs and outputs that are considered to be relevant for the study. But different screening procedures can be carried out for reducing the numbers that are reasonable to conduct the study (Coelli *et al.* 1998; Ramunathan, 2003; etc.).

Thirdly, is the choice of DEA model, various model are classified according to whether they are input-oriented or output-oriented to conduct the study as when the inputs are inflexible and not under control, output-based model would be appropriate and on the contrary when the inputs are under control of management, the input-based formulations are appropriate for details. In present study an input oriented measure have been applied opposing to the output oriented method as the later maximises the level of output from the given level of inputs and the former seeks to minimise the usage of inputs given a fixed level of output. Under DEA, the constant returns to scale (CRS) model proposed by Charnes *et al.* (1978) can be used to evaluate the efficiency of vegetable growers. The output and input oriented measures are equivalent measures of TE when CRS exists (Fare and Lovell, 1978). The CRS-DEA model states that increase in the inputs will result the same proportionate increase in the output but if farmers do not operate at optimum scale then using CRS for such vegetable growers will provide TE score affected by SE. Thus, the use of variable returns to scale (VRS) can then be applied to devoid these SE effects. To overcome the limitations of CCR DEA model, Banker *et al.* (1984) developed a model to calculate the VRS TE score. VRS implies that an increase in inputs may results in either more or less proportionate increase in the output. The VRS model uses the dual of CRS model with an extra constraint of convexity, i.e., λ. Hence, following model can be formulated:

$$\text{Minimise } z_0 = \theta - \varepsilon\sum_{r=1}^{r=s} s_r^+ - \varepsilon\sum_{i=1}^{i=m} s_i^-$$

$$\sum_{j=1}^{j=n} \lambda_j y_{rj} - s_r^+ = y_{r0} \quad \text{for } r = 1\ldots\ldots, s$$

$$\theta x_{i0} - \sum_{j=1}^{j=n} \lambda_j x_{ij} - s_i^- = 0 \text{ for } i = 1\ldots\ldots, m$$

$$\sum_{j=1}^{j=n} \lambda_j \geq 1 \text{ for } j = 1\ldots\ldots, n$$

$$s_r^+ \text{ for } r = 1,\ldots\ldots\ldots, s$$

$$s_i^- \text{ for } i = 1,\ldots\ldots\ldots, m$$

where, x_{ij} is amount of i^{th} input required by j^{th} DMU; y_{rj} is amount of r^{th} output produced by the

j^{th} DMU; ε is small positive integer; λ_j is a weight of i^{th} DMU; S_r^+ is a slack variable of r^{th} output; S_i^- is a slack variable for i^{th} input; θ obtained will be the efficiency score of i^{th} farmer. The CRS TE scores can be decomposed into pure TE and SE. The SE score can thus be measure by conducting both CRS and VRS-DEA. The SE can be roughly measured as the ratio of TE_{CRS} to TE_{VRS}. The DEA model in this study is calculated under CRS and VRS conditions. Thus, in the present study to calculate the level of TE and other indicators of the vegetable growers in Jammu region of J&K state VRS-DEA model has been applied.

Output variable (O) includes gross returns (₹/acre) from knolkhol production in the present case and expenses incurred in ₹/acre on land preparation, nursery/ seedlings, irrigation, fertilizers, farm yard manure, plant protection, hired human labour and family labour as inputs (I). The models were solved using the DEAP version 2.1 taking an input orientation to obtain the efficiency levels.

Analysis of marketing

Marketing part is analysed with the help of formulae as used by Kachrooand Bhat (2012).

(a) Marketing margins, costs and loss

1. Net Farmer's Price

$$NP_F = GP_F - \{C_F + (L_F \times GP_F)\} \text{ or}$$

$$NP_F = \{GP_F\} - \{C_F\} - \{L_F \times GP_F\}$$

Where,

NP_F is net price received by the farmers (₹/Kg)

GP_F is gross price received by the farmers or whole sale price to farmers (₹/Kg)

C_F is the cost incurred by the farmers during marketing (₹/Kg)

L_F is physical loss in produce from harvest till it reaches assembly market (per Kg)

(b) Marketing Margins

Intermediaries = Gross price – Price paid – Cost of marketing during wholesaling– Loss in value

Margin (sale price) (cost price)

Net marketing margin of the wholesaler is given mathematically by,

$$MM_w = GP_w - GP_F - C_w - (L_w \times GP_w) \text{ or}$$

$$MM_w = \{GP_w - GP_F\} - \{C_w\} - \{L_w \times GP_w\}$$

Where,

MM_w is net margin of the wholesaler (₹/kg),

GP_w is wholesaler's gross price to retailers or purchase price of retailer (₹/Kg)

C_w is cost incurred by the wholesalers during marketing (₹/Kg),

L_w is physical loss in the produce at the wholesale level (per kg)

Total margin of the wholesaler

$$MM_w = MM_{w1} + \ldots\ldots\ldots + MM_{wi} + \ldots\ldots\ldots + MM_{wn}$$

Where,

MM_{wi} is the marketing margin of the i-th wholesaler.

Net marketing margin of retailer

$$MM_R = GP_R - GP_W - C_R - (L_R \times GP_R) \text{ or}$$

$$MM_R = \{GP_R - GP_W\} - \{C_R\} - \{L_R \times GP_R\}$$

Where,

MM_R is net margin of the retailer (₹/Kg),

GP_R is price at the retail market or purchase price of the consumers (₹/Kg)

L_R is physical loss in the produce at the retail level (per kg),

C_R is the cost incurred by the retailers during marketing (₹/Kg).

Total marketing margin of the market intermediaries (MM)

$$MM = MM_W + MM_R$$

Total marketing cost (MC)

$$MC = C_F + C_W + C_R$$

Total Marketing Loss (ML)

$$ML = \{L_F \times GP_F\} + \{L_W \times GP_W\} + \{L_R \times GP_R\}$$

Marketing efficiency (ME)

$$ME = \frac{NP_F}{MM + MC + ML}$$

Where,

NP_F is net price received by the farmers (₹/Kg),

MM is the marketing margin,

MC is marketing cost,

ML is marketing loss.

RESULTS AND DISCUSSION

Cost structure of *Knol-khol* in various districts of Jammu division

For financial analysis of different enterprises, it is necessary to workout costs of various inputs, which needs to be deducted from the value of inputs. Farmers in the study area used purchased as well as home produced inputs. The costs of home produced inputs were calculated in monetary terms on the basis of opportunity cost principle i.e., the market price. The cost of cultivation of knol-khol is presented in Table 1. The cost involved in the land preparation for knol-khol on an average worked out to be ₹ 565.00 in Jammu district which was lowest as compared to Udhampur district (₹ 592.50) and Samba district (₹ 611.50) as is clear from the table. The block level per acre land preparation cost worked out to be ₹ 580.00, 550.00, 605.00, 617.50, 597.00 and 592.50 for Bhalwal, Marh, Vijaypur, Samba, Udhampur and Chennani blocks, respectively. The table further makes it clear that as far as nursery/ seedlings were concerned, again Jammu district had lowest amount of money involved (₹ 2475.00) in which Bhalwal block incurred ₹ 2450.00 and Marh block incurred ₹ 2500.00 amount. With regard to Samba district, the overall average came out to be ₹ 2562.50 wherein its two blocks of Vijaypur and Samba incurred an amount of ₹ 2525.00 and 2600.00, respectively. Udhampur district had the money involvement of ₹ 2890.00 and ₹ 2787.00, respectively with an overall average of ₹ 2838.50 for nursery/seedlings. The perusal of data makes it clear further that as far as irrigation was concerned Jammu district had the lowest overall average of ₹ 157.50 followed by Udhampur district with ₹ 163.50 and then by Samba district with ₹ 181.00. The data further makes it clear that overall average

Table 1: Cost and return structure of Knol-khol in various district of Jammu division (₹/acre)

Particulars	Jammu			Samba			Udhampur		
	Bhalwal	Marh	Overall Avg.	Vijaypur	Samba	Overall Avg.	Udhampur	Chennani	Overall Avg.
Land Preparation	580.00	550.00	565.00	605.00	617.50	611.25	597.00	588.00	592.50
Nursery/ Seedlings	2450.00	2500.00	2475.00	2525.00	2600.00	2562.50	2890.00	2787.00	2838.50
Irrigation	150.00	165.00	157.50	185.00	177.00	181.00	167.00	160.00	163.50
Fertilizers	901.50	891.50	896.50	735.50	855.50	795.50	950.00	810.00	880.00
FYM	900.00	1100.00	1000.00	775.00	825.00	800.00	700.00	900.00	800.00
Plant Protection	1185.00	1240.00	1212.50	1024.00	1109.00	1066.50	906.67	1040.00	973.34
Hired Human Labour	1285.00	1115.00	1200.00	1300.00	1100.00	1200.00	1675.00	1325.00	1500.00
Land Revenue + Depreciation on buildings equipments etc.	180.00	175.10	177.55	199.00	206.00	202.50	162.25	109.00	135.63
Total	**7631.50**	**7736.60**	**7684.05**	**6324.50**	**7190.00**	**6757.25**	**8047.92**	**7719.00**	**7883.46**
Interest on working capital @6% p.a	111.77	113.42	112.60	91.88	104.76	98.32	118.29	114.15	116.22
Total Cost A1	**7743.27**	**7850.02**	**7796.65**	**6416.38**	**7294.76**	**6855.57**	**8166.21**	**7833.15**	**7999.68**
Cost A2	7743.27	7850.02	7796.65	6416.38	7294.76	6855.57	8166.21	7833.15	7999.68
Interest on amount of owned capital invested	345.45	329.00	337.23	287.95	225.50	256.73	249.45	206.50	227.98
Cost B1	8088.72	8179.02	8133.87	6704.33	7520.26	7112.30	8415.66	8039.65	8227.66
Rental value of owned land	2500.00	3000.00	2750.00	2450.00	2475.00	2462.50	2890.00	2705.00	2797.50
Cost B2	10588.72	11179.02	10883.87	9154.33	9995.26	9574.80	11305.66	10744.65	11025.16
Family labour	2500.00	2300.00	2400.00	2330.00	2470.00	2400.00	2075.00	2425.00	2250.00
Cost C1	10588.72	10479.02	10533.87	9034.33	9990.26	9512.30	10490.66	10464.65	10477.66
Cost C2	13088.72	13479.02	13283.87	11484.33	12465.26	11974.80	13380.66	13169.65	13275.16
	1308.87	1347.90	1328.39	1148.43	1246.53	1197.48	1338.07	1316.97	1327.52
Cost D	**14397.59**	**14826.92**	**14612.26**	**12632.76**	**13711.79**	**13172.28**	**14718.73**	**14486.62**	**14602.68**

cost involved for fertilizers was lowest in case of Samba district (₹ 795.50) followed by Udhampur district (₹ 880.00/acre) and then by Jammu district (₹ 896.50/acre). The blockwise cost incurred for fertilizers was ₹ 901.50/acre, ₹ 891.50/acre, ₹ 735.50/acre, ₹ 855.50/acre, ₹ 950.00/acre and ₹ 810.00/acre for Bhalwal, Marh, Vijaypur, Samba, Udhampur and Chenani blocks, respectively. With regard to FYM, Jammu district had the overall average cost of ₹ 1000/acre and ₹ 800.00/acre each for Samba and Udhampur districts. The table further makes it clear that the overall average for Jammu, Samba and Udhampur districts worked out to be ₹ 1212.50/acre, ₹ 1066.50/acre and ₹ 973.34/acre, respectively for plant protection measures.

As far as the hired human labour was concerned, the overall average worked to be ₹ 1200/acre each for Jammu and Samba districts while as it was ₹ 1500/acre for Udhampur district. The table makes it clear that the blockwise cost incurred on the hired human labour came to be ₹ 1285.00/acre, ₹ 1115.00/acre, ₹ 1300.00/acre, ₹ 1100.00/acre, ₹ 1675.00/acre and ₹ 1325.00/acre for Bhalwal, Marh, Vijaypur, Samba, Udhampur and Chenani, respectively. From the table, it is clear that the total working cost worked to be ₹ 7684.05/acre for Jammu district, ₹ 6757.25/acre for Samba district and ₹ 7883.46/acre for Udhampur district on an average. Interest on working capital @ 6% p.a on an overall average came out to be ₹ 112.60/acre, ₹ 98.32/acre and ₹ 116.22/acre for Jammu, Samba and Udhampur districts, respectively. As in the sample area there was no leased in land that is why, Cost A_1 and Cost A_2 was same as is clear from the table. It was having the overall average of ₹ 7796.65/acre for Jammu district, ₹ 6855.57/acre for Samba district and ₹ 7999.68/acre for Udhampur district. The perusal of data from the table further makes it clear that Cost B_1, Cost B_2, Cost C_1 and Cost C_2 on an average worked to be ₹ 8133.87/acre, 10883.87/acre, ₹ 10533.87/acre and ₹ 13283.87/acre, respectively for Jammu district, ₹ 7520.26/acre, ₹ 9574.80/acre, ₹ 9512.30/acre and ₹ 11974.80/acre, respectively for Samba district and ₹ 8227.66/acre, ₹ 11025.16/acre, ₹ 10477.66/acre and ₹ 13275.16/acre, respectively for Udhampur district. The ultimate Cost D was ₹ 14612.26/acre, ₹ 13172.28/acre and ₹ 14602.68/acre on an average for Jammu, Samba and Udhampur districts, respectively.

Input use and yield from Knolkhol cultivation across various districts of Jammu division

The inputs which were used district wise for the cultivation of knolkhol are presented in Table 2.

Table 2: Input-use and yield from vegetable cultivation across various districts in Jammu and Kashmir (per acre)

Items of Inputs	*Knol-khol*		
	Jammu	**Samba**	**Udhampur**
Seed/Seedlings (kg/No.)	0.4	0.5	0.4
FYM (q)	25	20	20
Urea (kg)	90	90	85
SSP (Kg)	45	40	55
MOP (kg)	4	0	0
Total chemical fertilizers (kg)	139	130	140
Family labour (human days)	16	16	15
Hired labour (human days)	8	8	10
Total human labour (human days)	24	24	25
Yield (q)	55	60	60

The perusal of the data indicated that in Jammu and Udhampur districts, 0.4 kg./acre of seed was used, while as in Samba district it was 0.5kg./acre. The usage of FYM was highest for Jammu district (25q/acre). The data further indicated that the amount of urea used in Jammu and Samba district was highest (90kg./acre) as compared to Udhampur (85kg./acre). The table further revealed that MOP utilization was only in Jammu district (4kg./acre). The human labour utilization was highest in Udhampur district (25 human days/acre), whereas it was 24human days/acre for Jammu and Samba district each. The yield was found to be highest for Samba and Udhampur district (60q/acre). The data further indicated that total chemical fertilizers (urea, SSP and MOP) used was to the tune of 139kg./acre, 130kg./acre and 140kg./acre for Jammu, Samba and Udhampur districts, respectively.

Economics of knol-khol cultivation in different districts of Jammu division

The per acre economics of knol-khol cultivation in different districts of Jammu division is shown in

Table 3. The data from the table indicated that the cost of cultivation worked out to be ₹ 7796.65 /acre (overall) with ₹ 7743.27/acre for Bhalwal block and ₹ 7850.02/acre for Marh block for Jammu district, in Samba district, the overall average was ₹ 6855.57/ acre with ₹ 6416.38/acre for Vijaypur block and ₹ 7294.76 for Samba block and it was ₹ 7999.68/acre (overall average), ₹ 8166.21/acre (Udhampur block) and ₹ 7833.15/acre (Chenani block) in Udhampur district. The per quintal production cost was highest for Jammu district with overall average of ₹ 141.76 followed by Udhampur district with ₹ 133.33 and then by Samba district with ₹ 114.26. Among the blocks, the data showed that Bhalwal block was having highest cost of production with ₹ 154.87/q, followed by ₹ 151.23/q by Udhampur block, then by Marh block with ₹ 130.83/q, then by Chenani block with ₹ 118.68/q, then by Vijaypur block with ₹ 114.58/q and the lowest cost of production per quintal was for Samba block with ₹ 113.98. As far as the yield was concerned, the overall average for Jammu district was 55 qlts/acre, 60qlts/acre for Samba and Udhampur districts each. The block-wise yield worked out to be 50qlts/acre, 60qlts/acre, 56qlts/acre, 64qlts/acre, 54qlts/acre and 66qlts/acre for Bhalwal, Marh, Vijaypur, Samba, Udhampur and Chenani, respectively. The Table further indicated that the per quintal price received was ₹ 505.00 for Bhalwal block, ₹ 525.00 for Marh block and the overall average of ₹ 515.00 in Jammu district, for Samba district it was ₹ 495.00 for Vijaypurblock, ₹ 540.00 for Samba block and the overall average of ₹ 517.50 while as for Udhampur block it was ₹ 500 for Udhampur block, ₹ 550.00 for Chenani block and ₹ 525.00 as the overall average. The further perusal of data indicated that respective gross returns were ₹ 25250.00/acre, ₹ 31500.00/acre, ₹ 27720.00/acre, ₹ 34560.00/acre, ₹ 27000.00/acre and ₹ 36300.00/acre for Bhalwal, Marh, Vijaypur, Samba, Udhampur and Chenani blocks whereas the overall average for Jammu, Samba and Udhampur districts were ₹ 28325.00/acre, ₹ 31050.00/acre and ₹ 31500.00/ acre, respectively. The data made it clear that the net returns ₹ 350.13/q for Bhalwal block, ₹ 394.17/q for Marh block whileas it was ₹ 373.24/q as the overall average for Jammu district. Similarly, for Samba district, it was ₹ 380.42/q for Vijaypur block, ₹ 426.02 for Samba block with the overall average of ₹ 403.24/q. For Udhampur district, Udhampur block had shown the net returns of ₹ 348.77/q for Udhampur block, ₹ 431.32 for Chenani block and the overall average of ₹ 391.67/q.

Technical efficiency

Jammu district: It was observed that about 90 per cent i.e., 36 of the total 40 knol-khol farmers under assumption of constant returns to scale performed with efficiency level equal to 0.80 or greater in Jammu district which is clear from table 3. The average efficiency score was 0.9100. Based on this, it could be inferred that remaining 4 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 9.00 per cent and maintain the same level of knol-khol production as achieved by 90 per cent of the farmers. When the assumption of constant returns to scale was

Table 3: Economics of knol-khol cultivation across different districts of Jammu division (per acre)

Particulars	Jammu			Samba			Udhampur		
	Bhalwal	Marh	Overall Avg.	Vijaypur	Samba	Overall Avg.	Udhampur	Chenani	Overall Avg.
Cost of cultivation (₹/ acre)	7743.27	7850.02	7796.65	6416.38	7294.76	6855.57	8166.21	7833.15	7999.68
Average Yield (q/acre)	50	60	55	56	64	60	54	66	60
Average cost of production (₹/q)	154.87	130.83	141.76	114.58	113.98	114.26	151.23	118.68	133.33
Average price received (₹/q)	505.00	525.00	515.00	495.00	540.00	517.50	500.00	550.00	525.00
Gross returns (₹/acre)	25250.00	31500.00	28325.00	27720.00	34560.00	31050.00	27000.00	36300.00	31500.00
Net returns over cost A1 (₹/acre)	17506.73	23649.98	20528.35	21303.62	27265.24	24194.43	18833.79	28466.85	23500.32
Net returns (₹/q)	350.13	394.17	373.24	380.42	426.02	403.24	348.77	431.32	391.67

relaxed and the model with variable returns to scale was calculated, the impact of production scale on technical efficiency level was visible. In knol-khol farms, the number of efficient farms increased to 95.0 per cent and the average technical efficiency score increased to 0.9870. These better results from the model with variable returns were mainly due to the inclusion of scale efficiency, which the previous model did not take into consideration. As regards to the scale efficiency, 97.5 per cent of knol-khol farms (39 out of 40 farms) either performed at the optimum scale or were close to the optimum scale (farms having scale efficiency values equal to or more than 0.90).

Udhampur district: The results on efficiency measures (with constant and variable returns) and the descriptive statistics for knol-khol) producing farms in the Udhampur district are given in Table 4. It was observed that in knol-khol farms about 85 per cent i.e., 34 out of the total 40 of knol-khol farms under assumption of constant returns to scale performed with efficiency level equal to or greater than 0.90. The average efficiency score was 0.7981. Based on this, it could be inferred that remaining 06 farmers, who did not operate at the maximum efficiency level, could reduce the input level by 20.19 per cent and maintain the same level of knol-khol production as achieved by 85 per cent of the farmers. When the assumption of constant returns to scale was relaxed and the model with variable returns to scale was calculated, the impact of production scale on technical efficiency level was visible.

Table 4: Target outputs, inputs and estimated slacks of knol-khol in sample districts of Jammu region

Districts	Variables	Original value	Slack Movement		Projected Value
			Absolute	%	
Jammu	O	28325.00	0.00	0.00	28325.00
	I1	565.00	-13.44	2.38	551.56
	I2	2475.00	-88.78	3.59	2386.22
	I3	157.50	0.00	0.00	157.50
	I4	896.50	0.00	0.00	896.50
	I5	1000.00	-91.90	9.19	908.10
	I6	1212.50	-83.67	6.90	1128.83
	I7	1200.00	-45.78	3.82	1154.22
	I8	2400.00	-213.00	8.88	2187.00
Udhampur	O	31500.00	0.00	0.00	31500.00
	I1	592.50	-11.54	1.95	580.96
	I2	2838.50	-200.00	7.05	2638.50
	I3	163.50	0.00	0.00	163.50
	I4	880.00	0.00	0.00	880.00
	I5	800.00	-11.12	1.39	788.88
	I6	973.34	0.00	0.00	973.34
	I7	1500.00	0.00	0.00	1500.00
	I8	2250.00	-89.19	3.96	2160.81
Samba	O	31050.00	0.00	0.00	31050.00
	I1	611.25	-15.46	2.53	595.79
	I2	2562.50	-414.89	16.19	2147.61
	I3	181.00	0.00	0.00	181.00
	I4	795.50	-30.42	3.82	765.08
	I5	800.00	0.00	0.00	800.00
	I6	1066.50	-24.75	2.32	1041.75
	I7	1200.00	0.00	0.00	1200.00
	I8	2400.00	-123.32	5.14	2276.68

In knol-khol farms, the number of efficient farms when variable returns to scale was used increased to 92.5 per cent and the average technical efficiency score increased to 0.8810. These better results from the model with variable returns were mainly due to the inclusion of scale efficiency, which the previous model did not take into consideration. As regards to the scale efficiency, 87.5 per cent of knol-khol farms (35 out of 40 farms) either performed at the optimum scale or were close to the optimum scale (farms having scale efficiency values equal to or more than 0.90).

Samba district: The results on efficiency measures (with constant and variable returns) and the descriptive statistics for knol-khol producing farms in the Samba district are given in Table 5. It was observed that in knolkholfarms about 77.5 per cent i.e., 31 of the total 40 of knolkhol farms under assumption of constant returns to scale performed with efficiency level equal to 0.90 or greater. The average efficiency score was 0.9123. Based on this, it could be inferred that remaining 09 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 8.77 per cent and maintain the same level of production as achieved by 77.5 per cent of the farmers. When the assumption of constant scale was relaxed and the model with variable returns to scale was calculated, the impact of production scale on technical efficiency level was visible. In knol-khol farms, the number of efficient farms when variable scale to returns was used increased to 80.0 per cent

Table 5: Efficiency measures and descriptive statistics for Knol-khol producing farms according to scale of operations in various districts of Jammu division

Districts	Scale of operations	Efficient farms (θ≥90)		Efficiency measures			
		No.	%	Mean	Std. Dev.	Max.	Min.
Jammu	Technical Efficiency (CRS)	36	90.0	0.9100	0.0734	1	0.801
	Technical Efficiency (VRS)	38	95.0	0.9870	0.1012	1	0.820
	Technical Efficiency (SE)	39	97.5	0.9231	0.0523	1	0.889
Udhampur	Technical Efficiency (CRS)	34	85.0	0.7981	0.0943	1	0.776
	Technical Efficiency (VRS)	37	92.5	0.8810	0.1234	1	0.759
	Technical Efficiency (SE)	35	87.5	0.8412	0.1095	1	0.798
Samba	Technical Efficiency (CRS)	31	77.5	0.9123	0.0410	1	0.820
	Technical Efficiency (VRS)	32	80.0	0.9650	0.0123	1	0.799
	Technical Efficiency (SE)	36	90.0	0.9502	0.0422	1	0.831

and the average technical efficiency score increased to 0.9650. These better results from the model with variable returns were mainly due to the inclusion of scale efficiency, which the previous model did not take into consideration. As regards to the scale efficiency, 90.0 per cent of knol-khol farms (36 out of 40 farms) either performed at the optimum scale or were close to the optimum scale (farms having scale efficiency values equal to or more than 0.90).

Returns to scale

Table 6 presents the returns to scale of knol-khol farms.

Table 6: Distribution of *Knol-khol* farms in Jammu region according to types of returns among different scale of operations

Types of return		Jammu	Udhampur	Samba
Increasing returns	Number	4	5	20
	%	10.00	12.50	50.00
Constant returns	Number	36	35	20
	%	90.00	87.50	50.00
Decreasing returns	Number	0	0	0
	%	0.00	0.00	0.00

From the table it is observed that in Jammu district 10 per cent of the farms were having increasing returns to scale while as it was 12.50 per cent for Udhampur farms and 50 per cent for Samba farms. 90 per cent, 87.50 per cent and 50 per cent of the farms had constant returns to scale in Jammu, Udhampur and Samba districts, respectively. As far as decreasing returns to scale were concerned, not a single farm in all the districts had faced this situation.

Marketing of knol-khol

The channel wise decomposition of marketing costs and price spread components for knol-khol in Jammu, Udhampur and Samba district are presented in Table 7. The table revealed that the major items of producer's expenses in all the channels included packing, weighing charges, loading/unloading charges, transportation cost and market fee. In channel – I, commission of the forwarding/ commission agent was also added to the marketing cost in addition to other costs. These costs varied to the extent of ₹ 87.51, ₹ 54.95 and ₹ 12.00 per quintal for channel I, II and III, respectively, in Jammu district where as it was ₹ 95.54, ₹ 60.17 and ₹ 18.45, respectively, in Samba district and ₹ 79.58, ₹ 46.29 and ₹ 12.37, respectively, in Udhampur district. The per quintal highest marketing cost (₹ 95.54) at producer's level in channel – I was found in Samba district. It was further observed from the table that per quintal marketing cost incurred on commission in all the districts was found in channel I only with its value ₹ 32.56, ₹ 35.37 and ₹ 33.29 in Jammu, Samba and Udhampur district, respectively. The cost incurred on other components in channel I and II in all the districts was found to be same. The transportation cost in all the districts was found to be ₹ 18.20 each for channel I and II in Jammu

Table 7: Price Spread of knol-khol through different marketing channels in Jammu, Udhampur and Samba district (₹/qtl)

Particulars	Jammu			Samba			Udhampur		
	Channel I	Channel II	Channel III	Channel I	Channel II	Channel III	Channel I	Channel II	Channel III
Producer's sale price	465.15	465.15	465.15	505.28	505.28	505.28	475.50	475.50	475.50
Producer's expenses									
Packing	18.75	18.75	—	17.90	17.90	—	13.75	13.75	—
Weighing charges	—	—	—	5.00	5.00	—	5.00	5.00	—
Loading/unloading	8.00	8.00	—	10.00	10.00	—	5.00	5.00	—
Transport	18.20	18.20	9.50	17.27	17.27	15.00	12.54	12.54	7.87
Tax/market fee	10.00	10.00	—	10.00	10.00	—	10.00	10.00	—
Commission @7%	32.56	—	—	35.37	—	—	33.29	—	—
Others	—	—	2.50	—	—	3.45	—	—	4.50
Total costs	87.51	54.95	12.00	95.54	60.17	18.45	79.58	46.29	12.37
Spoilage (PH L)	4.40	4.40	12.00	6.50	6.50	10.30	4.25	4.25	13.45
Net sale price	373.24	405.80	441.15	403.24	438.61	476.53	391.67	424.96	449.68
Retailer's level									
Purchase price	465.15	465.15	—	505.28	505.28	—	475.50	475.50	—
Transport	30.00	30.00	—	25.50	25.50	—	27.89	27.89	—
Packing	21.32	21.32	—	15.00	15.00	—	13.50	13.50	—
Loading/unloading	10.00	10.00	—	10.00	10.00	—	10.00	10.00	—
Rehri/ Shop rent	6.30	6.30	—	5.45	5.45	—	4.89	4.89	—
Total costs	67.62	67.62	—	55.95	55.95	—	56.28	56.28	—
Spoilage due to physical injury and rotting, etc. (PHL)	9.20	9.20	—	8.76	8.76	—	11.57	11.57	—
Marketing Margin	188.00	188.00	—	197.00	197.00	—	191.50	191.50	—
Consumer price	729.97	729.97	465.15	766.99	766.99	505.28	734.85	734.85	475.50
Producers' share in consumers' rupee	51.13%	55.59%	94.84%	52.57%	57.19	94.31%	53.30%	57.83%	94.57%

district, ₹ 17.27 and ₹ 12.54 in Samba and Udhampur district, respectively. Whereas in case of channel – III, it was found to be ₹ 9.50, ₹ 15.00 and ₹ 7.87 in Jammu, Samba and Udhampur district, respectively.

Marketing cost borne by the retailer in channel I and II was found to be same with its value ₹ 67.62, ₹ 55.95 and ₹ 56.28, in Jammu, Samba and Udhampur district, respectively. The cost incurred on the various components at retailer's level was found to be same in both the channels. The table further revealed that the per quintal maximum cost was incurred on transportation in all the districts and highest (₹ 30.00) was found in Jammu followed by ₹ 27.89 in Udhampur and ₹ 25.50 in Samba. The perusal of the data further indicated that in channel III whole of the marketing cost was borne by the producer as there was the direct marketing of produce. As far as retailers' purchase price was concerned, it was found to be ₹ 505.28 per quintal in both the channels in Samba district followed by ₹ 475.50 and ₹ 465.15 in Udhampur and Jammu district, respectively.

In this study an attempt has been made to estimate spoilage due to physical injury and rotting (Post harvest losses) of vegetables at different stages of marketing. It was observed from the table that the losses per quintal at producer's level were found to be maximum in channel – III in all the districts. The highest of ₹ 13.45 per quintal was found in Udhampur followed by ₹ 12.00 and ₹ 10.30 in Jammu and Samba district, respectively. At retailer's level, post harvest loss was found to be highest of

₹ 11.57 per quintal in Udhampur district followed by ₹ 9.20 per quintal and ₹ 8.76 per quintal in Jammu and Samba district, respectively.

The producers of Jammu district received the net price of about ₹ 373.24/qtl, ₹ 405.80/qtl, and ₹ 441.15/qtl which were 51.13 per cent, 55.59 per cent and 94.84 per cent of the price paid by the consumer for channel I, II and III, respectively. As far as Samba district is concerned, the net price received by the producer was found to be ₹ 403.24/qtl, ₹ 438.61/qtl and ₹ 476.53/qtl which was 52.57 per cent, 57.19 per cent and 94.31 per cent, of the price paid by the consumer in channel I, II and III, respectively. In case of Udhampur, it was ₹ 391.67/qtl, ₹ 424.96/qtl and ₹ 449.68/qtl which was 53.30 per cent, 57.83 per cent and 94.57 per cent, respectively. The per quintal marketing margin of the retailer was about ₹ 197 in Samba district followed by ₹ 191.50 in Udhampur district and ₹ 188.00 in Jammu district.

Production constraints

The number of production and marketing constraints faced by vegetable growers in Jammu, Udhampur and Samba districts of Jammu region were also identified and analysed. It was found that at production level; more than 80 per cent of the respondents in the Jammu district were of the opinion that high input cost is the major problem followed by high labour cost (72.50 per cent), growth of weeds (70.00 per cent) and high cost of micronutrients (65.00 per cent). In addition to this there were 40.00 per cent of the farmers who were facing the problem of non availability of disease resistant variety. Whereas in Udhampur district, non availability of labour during peak period (90.00 per cent), non availability of disease resistant varieties (82.50 per cent), growth of weeds (77.50 per cent) and high input cost (62.50 per cent) were major problems which were faced by the respondents at production

Table 8: Production and marketing constraints faced by the vegetable growers in Jammu, Udhampur and Samba districts of Jammu region

Sl. No.	Constraints	Number of respondents (N=120)		
		Jammu (N=40)	Udhampur (N=40)	Samba (N=40)
A.	**Production**			
1	High input cost	32 (80.00%)	25 (62.50%)	26 (65.00%)
2	High labour cost	29 (72.50%)	24 (60.00%)	24 (60.00%)
3	Growth of weeds	28 (70.00%)	31 (77.50%)	29 (92.50%)
4	High cost of micro nutrients	26 (65.00%)	20 (50.00%)	24 (60.00%)
5	Non – availability of disease resistant variety	16 (40.00%)	33 (82.50%)	19 (47.50%)
6	Non availability of labour during peak period	12 (30.00%)	36 (90.00%)	31 (77.50%)
7	Educated members go outside and did not take interest in farming	16 (40.00%)	20 (50.00%)	34 (85.00%)
8	Lack of good quality seedlings in sufficient quantity	24 (60.00%)	18 (45.00%)	32 (80.00%)
9	Small holdings	18 (45.00%)	18 (45.00%)	24 (60.00%)
B.	**Marketing**			
1	Trade secrets of middlemen	37 (92.50%)	32 (80.00%)	33 (82.50%)
2	High perishability of vegetables	38 (95.00%)	28 (70.00%)	30 (75.00%)
3	High storage cost	37 (92.50%)	30 (75.00%)	28 (70.00%)
4	Lack of market information	33(82.50%)	34 (85.00%)	24 (60.00%)
5	High commission charges	31(77.50%)	30 (75.00%)	38 (95.00%)
6	Unorganized marketing	29 (72.50%)	26 (65.00%)	38 (95.00%)
7	Packing material is costly	18 (45.00%)	27 (67.75%)	20 (50.00%)
8	Lack of marketing societies	30 (75.00%)	37 (92.50%)	32 (80.00%
9	Not getting remunerative price for the produce	24 (60.00%)	29 (72.50%)	35 (87.50%)
10	High loss of vegetables	30 (75.00%)	28 (70.00%)	37 (92.50%)
11	High transportation cost	20 (50.00%)	26 (65.00%)	28 (70.00%)

** Figure in parentheses is percentage of total.*

level. As far as Samba district was concerned, the highest number of respondents (85.00 per cent) expressed the problem of educated members go outside and did not take interest in farming. Lack of good quality seedlings in sufficient quantity, non availability of labour during peak period, high input cost, high labour cost and small holdings were other major problems which accounted for 80.00 per cent, 77.50 per cent, 65.00 per cent, 60.00 per cent and 60.00 per cent, respectively.

Marketing constraints

At marketing level, trade secrets of middlemen, high perishability and high cost of storage was the major constraints as expressed by more than 90.00 per cent respondents of the Jammu district. Moreover, lack of market information, high commission charges and un-organised marketing were also a major constraints expressed by 82.50 per cent, 77.50 per cent and 72.50 per cent respondents, respectively. Costly packing material was also reported by 45.00 per cent of the total respondents as a major constraint. Whereas in Udhampur district lack of marketing societies was the major constraint as expressed by 92.50 per cent respondents followed by lack of market information (85.00 per cent), trade secrets of middlemen (80.00 per cent) and not getting remunerative price for the produce (72.50 per cent). High perishability and costly packing material were also major constraints expressed by 70.00 per cent and 67.50 per cent respondents, respectively. In Samba district, unorganized marketing, high commission charges, high loss due to spoilage during transportation were the major constraints as expressed by more than 90.00 per cent respondents. Moreover, not getting remunerative price for the produce and trade secrets of middlemen were also major constraints expressed by 87.50 per cent and 82.50 per cent, respectively. About 70.00 per cent of the respondents complained about high cost of transportation and 60.00 per cent pointed out the problem of lack of market information.

CONCLUSION

Economics, input use, yield and technical efficiency have been estimated for one of the important vegetables, viz. knol-khol in Jammu region of J&K state using data envelopment analysis (DEA). The cost and return structure of knol-khol production among various districts of Jammu region indicates that cost C_2 was lowest in Samba district and that is because of less expenses incurred on fertilizers. The pattern of input use in knol-khol production among different districts of Jammu region has given a very bright relation of inputs with yield. There is definitely a chance of increasing more production with advanced technology input use. The per quintal production cost was highest for Jammu district with overall average of ₹ 141.76 followed by Udhampur district with ₹ 133.33 and then by Samba district with ₹ 114.26.

It was observed that about 90 per cent i.e., 36 of the total 40 knol-khol farmers under assumption of constant returns to scale performed with efficiency level equal to 0.80 or greater in Jammu district whereas in Udhampur district about 85 per cent i.e., 34 out of the total 40 of knol-khol farms under assumption of constant returns to scale performed with efficiency level equal to or greater than 0.90. As far as Samba district is concerned about 77.5 per cent i.e., 31 of the total 40 of knol-khol farms under assumption of constant returns to scale performed with efficiency level equal to 0.90 or greater. Therefore farmers may be encouraged to use more inputs to increase the yield of knol-khol.

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