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Ex-ante and Ex-post Evaluation of Advanced Production System Module in Saffron (*Crocus sativus*) in India using Consumer Surplus Model and Propensity Score Matching

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Abstract: A very important breakthrough in saffron cultivation and production was achieved by Sher-e- Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K) when the university developed a production system module in saffron which brought substantial increase in productivity of saffron during last two decades. The adoption of the technology was observed to have a very significant impact on the social dynamics of the saffron producing region demanding its ex-ante and ex-post evaluation vis a vis non adopters of the technology. With this in mind consumer surplus model and propensity score matching methods were employed on a sample of 447 respondents of which 286 were adopters and 161 non-adopters (control group) drawn from a population of 753 saffron growers in the saffron belt of Jammu and Kashmir producing 99% of the total saffron production in the country. The results revealed that average productivity of the spice increased from 2.57 kg.ha^{-1} to 6.05 kg.ha^{-1}, with 1-2 kg.ha^{-1} in the first year to 10-12 kg.ha^{-1} in fourth year against control group, however, the investment cost estimates recorded increase of 5.9% under ex-ante and 13.6% under ex-post evaluation while adopting new technology, which however, got compensated through realizing higher productivity and increased employment to the tune of 40.6 and 28.3 per cent man-days/ha respectively under ex-ante and ex-post evaluation. The results further revealed, NPV, BCR, IRR of Rs. 399 crores, 110, 154% against Rs.249 crores, 69, 134% respectively under ex-ante and ex-post evaluation of the technology.

Keywords: Productivity, Cultivation, Standard of living, New technology.

Introduction

The share of Agriculture in the state agricultural gross domestic product (SGDP) decreased from 50 per cent in 1978-79 to 16.0 per cent during 2018-19 (Economic Survey, 2019) in Jammu and Kashmir having 71 per cent rural population mostly depending on agriculture for their sustenance. However, 48 per cent of the agriculture work force contribute only 21 per cent to the SGDP, against 52 per cent of work force engaged in non-form activities contributing 79 per cent to the SGDP in 2019, (DoE) thus demanding a re-look into the identification of the potential niche areas with capacities to maintain agro-eco system and increasing per unit return of available land resource. Saffron, the costliest spice in the world was cultivated 3-4 centuries before in Arabia and Spain, later spread to Iran, Sweden and India. In India, it is cultivated on an area of 5,707 ha of which more than 66 per cent lies in Kashmir, producing 99 per cent of the total saffron production in the country (UNIDO, 2014). Saffron grown on an area of 3785 hectares producing 13.2 mt (metric tonnes) of saffron is one among various niche crops cultivated in Jammu and Kashmir. The crop experienced a decline in its cultivated area and production from 5707 ha to 3280 ha and 16 mt to 7.70 mt from 1996-97 t0 2008-09 respectively. The decline in production was believed to be due to a long planting cycle of >15 years without proper soil health management inviting high incidence of saffron corm rot disease (46%), damage (10-15 %) by Rodent *Pitymus leucurus* supp. (Khalid, 2018) which is diurnal in nature, use of non-graded and low weight corms for fresh plantation coupled with a low lower seed rate/non maintenance of proper plant density.plant^{-1} geometry were probably the main causes that lead to lower saffron productivity (2.5 kg.ha^{-1}).

Post-harvest handling of saffron, particularly the drying process is critical to the quality of saffron measured by the levels of secondary metabolites viz., Crocin (colour), Picrocrocin (taste) and Safranal (aroma). In addition quick dehydration post-harvest treatment is necessary to convert *Crocus sativus* L., pistil into saffron spice as it prevents bio-degradation of crocin into crocetin which remains a main issue with saffron cultivation in Kashmir Nehvi, *et al*. (2018). The new technology in the form of advanced production module was therefore, conceived and pursued through a consistent research effort made by the scientists of the University working on saffron with a pre-defined goal of achieving higher productivity through addressing the said bottlenecks.

The current study was therefore, undertaken to study the economic feasibility of the new technology by carrying out both ex-ante and ex-post evaluation of the developed production module for devising a pragmatic policy for its development.

Materials & Methods

A. A comprehensive survey of the saffron growing areas was undertaken to assess the impact on ground of production system module in saffron developed by the SKUAST-K. The impact of new technology was assessed by taking before and after adoption of new technology module by a group of farmers which group was treated as non-adopters before the adoption of technology to have a rational assessment of new technology. The saffron producing belt is limited to Pampore area where about 5700 ha were put under cultivation of this crop. The whole tehsil Pampore cultivates saffron and have the agricultural land in the same belt. A total number of 447 farmers were selected from among 753 farmers. The information on area, production and yield over various periods of time viz., period-I (1983-85), period-II (1993-95), period-III (2002-04) and period-IV (2011-13), respectively classified as (terrarium) TE-I, TE-II, TE-III and TE-IV, to estimate triennium wise average of area, production and yield, obtained from the published sources of the state and central government. The primary data for ex-ante evaluation was collected directly from the Scientists involved in developing the package, while as for ex-post evaluation data was collected through survey method**.** Published reports by the concerned agency who executed the package in the saffron growing belt were also perused. The average productivity and input costs were estimated from the field data in the saffron belt while the adoption of the package was assessed using economic surplus model which is widely used to assess the impact of technologies owing to its less restrictive assumptions and minimum data requirements. Given the fact that small open economy assumption owing to the tradability of most of the agricultural products and also non-significant influence of most of the countries on international prices, we chose to estimate the economic surplus due to yield improvement in a small open economic framework. India being 2nd in the production of saffron in the world and accordingly the 2nd in its export, the benefits accruing out of the adoption of improved technology get normally transacted to the producers.

The economic surplus model was utilized together with the research costs to calculate the net present value (NPV), the internal rate of return (IRR), and the benefit-cost ratio (BCR). This model was used to measure the rate of return to the research under various systems. The aggregate economic impact was assessed considering the rate and time of adoption.

Estimation of Benefit

$\Delta CS = P_0Q_0Z\ (1+0.5Z\eta)$

$\Delta PS = P_0Q_0\ (K-Z)\ (1+0.5Z\eta)$

$\Delta TS = \Delta CS + \Delta PS = P_0Q_0K\ (1+0.5Z\eta)$ (Alston *et al*., 1988, 1998, 2000).

Where,

K: is the vertical shift of supply function expressed as a proportion of the initial price,

h is the absolute value of the elasticity of demand

$Z = Ke/(e + h)$ is the reduction in price, relative to its initial (i.e. pre-research) value, due to the supply shift.

e is the elasticity of supply.

ΔCS is change in consumer surplus.

ΔPS is change in producer surplus.

ΔTS is change in total surplus.

In addition, propensity score matching technique was utilised to assess the overall impact of advanced technology on the yield and income of the growers.

B. Propensity score matching

A propensity score is a single summary score that represents the relationship between multiple observed characteristics for group members and treatment group assignment. It has been described as “propensity towards exposure to treatment given the observed covariates” (Rosenbaum & Rubin, 1983). Propensity score considers simultaneously all the relevant characteristics and attempts to reduce selection bias by weighing the characteristics relative to their influence on predicting treatment group assignment (Rudner & Peyton, 2006). The idea underlying propensity score matching is that if a member of the treatment group is matched with a member of the control group, both have the same probability of being in the treatment condition (i.e., the same assumption underlying random group assignment designs) (Henderson & Chatfield, 2011). In observational studies there are often significant difference between characteristics of a treatment group and a controlled group (Essama-Nssah, 2006). Such differences should not exist in randomized trial. These differences must be adjusted in order to reduce treatment selection bias and to determine treatment effect. To reduce these bias different matching methods were used. The goal of randomization is to balance treatment groups on any confounding factors (whether observed or unobserved), eliminating treatment selection bias and ensuring that the groups are comparable (Morgan, 2017). Propensity Score for ith respondent may be symbolically represented as:

$e_i = \Pr(Z_i = 1 \mid X_i)$ (Rosenbaum & Rubin, 1983)

Where Z_i is indicator variable for application or non-application of treatment (0 or 1 respectively). Propensity Scores are generally estimated using a logistic regression model, which in this study, is Probit Regression.

The Average Impact of the Treatment on Treated (ATT) can be estimated, which is defined as the average effect of treatment on those respondents who ultimately received the treatment. ATT could be represented as:

$ATT = E\ (Y_1 - Y_0 \mid Z{=}1)$ (Noe´mi, *et. al*., 2014)

ATT was estimated by using four algorithms i.e. Nearest Neighbor Matching (NNM), Kernel Matching Stratified Matching and Radius Matching (Imbens & Angrist, 1994)

Results & Discussion

Area and production

The area under saffron cultivation increased, declined and again increased by 31.79, -40.50 and 30.38 per cent from TE-I to TE-II ,TE-II to TE-III and TE-III to TE-IV, respectively, against the production registering 31.03, 45.61, 114.03 per cent and yield recording -2.97, 7.39 and 64.31 per cent change respectively, during the period under discussion. Due to increase in both area and yield during the last decade, the production has also witnessed an increase of 7.07 M.T. The figures of estimated CGR in area, production and yield for three decades, registered in the table (1) demonstrated a significant and positive growth of 3.28, 11.18 and 7.73 per cent respectively, during the decade gone (2003-13) which is a very positive outcome of the advanced production module of saffron developed by SKUAST-K. The adoption of new technology (NIAP production module system) has changed the dynamics of crop economics (Jones *et al*., 2009). It has led to changes in input use pattern and labour use. Due to the adoption of new technology the yield of saffron and corms has increased which resulted in the increase in gross and net returns up by 215

Table (1): Triennium wise area, production and yield and decadal growth (CGR) of Saffron in J and K.

Year	Area (ha)	Production (M.T.)	Yield (Kg.ha^{-1})
TE-I	3702	8.70	2.37
TE-II	4879	11.40	2.30
TE-III	2903	6.20	2.13
TE-IV	3785	13.27	3.50
Annual Compound growth rate			
1983-93	2.21	2.03	0.00
1993-03	-5.05	-5.30	-0.42
2003-13	3.28	11.18	7.73

per cent and 472.3 per cent in ex-ante study and 151.6 per cent and 337.3 per cent in ex-post study respectively which intern resulted in increase in marketable surplus substantially.

The cost of cultivation recorded an increase of 13.6 per cent and 5.9 per cent under ex-ante and ex-post studies respectively. The potential of the improved technology could be judged by the fact that its use increased the returns per rupee invested by around 172.2 and 133.3 per cent under ex-ante and ex-post studies respectively. The other social and economic gains were the increase in employment by 40.6 per cent and 28.3 per cent and the domestic consumption by 67.4 per cent under ex-ante and ex-post studies respectively. The overall analysis depicts that due to the adoption of new technology, the socio-economic status of the people (adopters) has increased significantly (Tables 2 and 3).

Partial Budget Estimates

Partial budgeting technique was utilised to assess the impact of improved technology in terms of net economic benefits (Chen & Ravallion, 2003). The results reveal that new technology requires more costs on human/physical labour and inputs in the form of corms accounting for Rs 79522 ha^{-1} and Rs 84892 ha^{-1} under ex-ante and ex-post studies respectively. However, the credit side shows that considerable gains has been acquired by the adopters in the form of boost in saffron yield to the tune of 2.34 $kg.ha^{-1}$ and 3.48 $kg.ha^{-1}$ and corm yield increased by 6 $q.ha^{-1}$ respectively under ex-ante and ex-post studies respectively amounting to the total credit of 401458 $Rs.ha^{-1}$ and 543787 $Rs.ha^{-1}$ respectively.

The net change in returns led to an increased amount of 321936 $Rs.ha^{-1}$ and 458895 $Rs.ha^{-1}$ under ex-ante and ex-post studies respectively. From the analysis of tables (4 & 5) it could be conclude that the adoption of new technology has substantially enhanced the living conditions of the people by generating signifying the quantum of the social gain accrued to the community through adoption of new technology.

Table (2): Impact of improved production system module on saffron growers (Ex-Ante). Impact of new technology on saffron growers.

Particulars	Non-adopter	Adopter	(%) Change
Saffron Yield ($kg.ha^{-1}$)	2.57	6.05	135.4
Corms yield ($q.ha^{-1}$)	9	15	66.7
Gross returns ($Rs.ha^{-1}$)	275591	868000	215.0
Cost of cultivation ($Rs.ha^{-1}$)	154600	175600	13.6
Net returns ($Rs.ha^{-1}$)	120991	692400	472.3
Cost of production ($Rs.kg^{-1}$)	60155	29024	-51.8
Returns per rupee invested ($Rs.ha^{-1}$)	1.8	4.9	172.2
Marketable surplus ($kg.ha^{-1}$)	2.53	5.98	136.4
Employment (human- $days.ha^{-1}$)	219	308	40.6
Domestic consumption ($kg.ha^{-1}$)	0.043	0.072	67.4

Table (3): Impact of improved production system module on saffron growers (Ex-post).

Particulars	Non-adopter	Adopter	(%) Change
Saffron Yield ($Kg.ha^{-1}$) Main Product			
Stigmas	2.57	4.91	91.1
By Product			
Stamens	2.45	4.83	97.1
Petals	23.4	35.7	52.6
Corms yield ($q.ha^{-1}$)	9	15	66.7
Gross returns ($Rs.ha^{-1}$)	275591	693320	151.6
Cost of cultivation ($Rs.ha^{-1}$)	154600	163722	5.9
Net returns ($Rs.ha^{-1}$)	120991	529598	337.7
Cost of production ($Rs.kg^{-1}$)	60155	33345	-44.6
Returns per rupee invest ted ($Rs.ha^{-1}$)	1.8	4.2	133.3
Marketable surplus($kg.ha^{-1}$)	2.53	4.84	91.3
Employment (human- $days.ha^{-1}$)	219	281	28.3
Domestic consumption ($kg.ha^{-1}$)	0.043	0.072	67.4

Table (4): Ex-Ante (Partial Budgeting).

Debit		Credit	
Particulars	Amount ($Rs.ha^{-1}$)	Particulars	Amount ($Rs.ha^{-1}$)
Increase in cost per hectare Corms 3q @ Rs 13464	40392	Increase in income per hectare Main product (Stigmas) Saffron yield 3.48 kg/ha^{-1}@ Rs 132145	459865
Human labour 89 man days @ Rs 500 per day	44500	Corms yield 6 q/ha^{-1} @ Rs 13464	83922
Decrease in income per hectare	0.00	Decrease in cost per hectare	0.00
Total (Rs. ha^{-1})	84892		543787
Net change (Rs. ha^{-1})		458895	

Table (5): Ex-Post (Partial Budgeting).

Debit		Credit	
Particulars	Amount ($Rs.ha^{-1}$)	Particulars	Amount ($Rs.ha^{-1}$)
Increase in cost per hectare Inputs (Corms) Increase in corm use 3.54 q/ha @ Rs 13987	49514	Increase in income per hectare Main product (Stigmas) Increase in saffron yield 2.34 kg/ha^{-1}@ Rs 132145	306163

Inputs (Labour) Increase in human labour 62 man days @ Rs 484 per day	30008	By product (Corms) Increase in corm yield 6 q/ha^{-1} @ Rs 13987	83958
		By product (Stamens) Increase in stamens yield (by product) 1.79 kg.ha^{-1}@ Rs 4003	7045
		By product (Petals) Increase in petals yield (by product) 14.5 kg.ha^{-1}@ Rs 296	4292
Decrease in income per hectare	0.00	Decrease in cost per hectare	0.00
Total (Rs ha^{-1})	79522		401458
Net change (Rs ha^{-1})		321936	

Note: * Price differential = Price after technology – price before technology

Aggregate benefits

Economic surplus model estimates are presented in tables (6 & 7). The price elasticities of demand and supply of saffron were estimated through functional analysis employed on secondary and primary information collected on prices from the producers and consumers (from various income groups) pertaining to various periods of time in a year. The estimates of demand and supply elasticity thus obtained were 0.31 and 0.21 respectively under both ex-ante and ex-post studies. The analysis showed a significant improvement in yield level in the study area on adoption of new technology. Estimates of ESM revealed NPV of Rs. 398 crores, IRR (154 %) and BCR of 110 under ex-ante compared to NPV of Rs. 249 crores, IRR (134 %) and BCR of 69 under ex-post evaluation signifying the quantum of the social gain accrued to the community through adoption of new technology.

Technological gaps

Technological gap is the difference between the potential technologies that can be applied compared to the actual amount of technology being applied (Alonge Adewale Johnson, 1993; Sahu & Das, 2015). Thus in case of adoption of production system module in saffron, high technological gaps ranging from 15.6 per cent to 50 per cent were estimated under three very essential components of the production system like corm (16.6%), potassium (15.6 %) and the highest of 50 per cent in organic fertilizer. It could therefore be construed that the presence of a higher yield gap between existing and recommended level of technology could be reduced if the production system module developed by SKUAST-K in saffron is adopted in full by the growers.

Table (6): Returns from investment on new technology revealed through Estimates of Economic Surplus Model (Ex-ante).

Particulars	**Values**
Yield change/ha^{-1}	3.48
Variable cost change/unit of output	1.36
Target area (%) to be covered in 2020	75
Time to achieve maximum adoption	2014-2020
Elasticity of supply	0.21
Elasticity of demand	0.31
Annual growth in area (%) during 1983-2013	0.08
Prob. Success	1
NPV(cr.)	399
IRR (%)	154
BC Ratio	110

Table (7): Returns from investment on new technology revealed through Estimates of Economic Surplus Model (Ex-post).

Particulars	**Values**
Yield change Kg.ha^{-1}	2.34
Variable cost change per ha^{-1}	1.47
Target area to be covered in 2020	70
Time to achieve maximum adoption	2014-2020
Elasticity of supply	0.21
Elasticity of demand	0.31
Prob. Success	0.7
NPV(cr)	249
IRR (%)	134
BC Ratio	69

Propensity score matching

A propensity score is a single summary score that represents the relationship between multiple observed characteristics for group members and treatment group assignment. It has been described as "propensity towards exposure to treatment given the observed covariates" (Rosenbaum & Rubin, 1983; Westreich *et al*., 2010) Propensity score considers simultaneously all the relevant characteristics and attempts to reduce selection bias by weighing the characteristics relative to their influence on predicting treatment group assignment (Rudner & Peyton, 2006). The idea underlying propensity score matching is that if a member of the treatment group is matched with a member of the control group, both have the same probability of being in the treatment condition (i.e., the same assumption underlying random group assignment designs). In observational studies there are often significant difference between characteristics of a treatment group and a controlled group. Such differences should not exist in randomized trial. These differences must be adjusted in order to reduce treatment selection bias and to determine treatment effect (Table 8).

In this study the total number of 447 respondents was taken for analytical purpose. Out of total 286 were non-treated (controlled group) and 161 were treated. Table (9), it becomes evident that out of 286 non-treated respondents; 45, 161, 78, and 2 and out of 161 treated respondents: 8, 89, 61 and 3 fall in the p-score (propensity score) 0.1, 0.2, 0.4 and 0.6 respectively.

Table (8): Extent of technological gaps on improved production system module in saffron (Ex-post).

Adoption of technology	Corm	N	P	K	FYM	Organic fertilizer
Before	-77.7	-92.3	-89.4	-86.7	-10.2	-94.8
After	-16.6	31.1	8.3	-15.6	34	-50

Table (9): Inferior bound, number of treated and the number of controls for each block.

Inferior of block of pscore	Untreated (0)	Treated (1)	Total
0.1	45	8	53
0.2	161	89	250
0.4	78	61	139
0.6	2	3	5
Total	286	161	447

For estimating propensity score from any distribution few steps are involved to complete the total procedure, firstly, the overall propensity score of the whole distribution needs to be estimated, secondly, the data in the distribution needs to be matched on the basis of estimated propensity score Third, the whole balancing property of the group must be satisfied in order to ensure the proper matching among control and treated groups. Fourth, and the final step involved in propensity score matching is that it can be analysed to estimate average treatment (ATT) effect.

The analysis of table (10) after regression of income with the treatment and the controlled variables, the average income of the farmers in the distribution turned out to be Rs. 340156.9/- with a standard error of 14051.71 having a t-value 24.21 at 5% level of significance against the income of control group of Rs. 144690/- with a standard error of 8172.195 and a t-value 17.71 at 5% level of significance.

Table (11) shows the average treatment effect on treated with different matching methods. The four different matching methods employ different procedures for getting the proper match among the distribution, the nearest neighbour method or nn’ match method shows that in the total observation number of treated observation were 161 and it could only find 120 control variables whole propensity score has been matched with an ATT of 3.56, standard error 19226.196 and a t-value 18.502 meaning thereby that there a significant impact at 5 per cent level of significance (Kurth, *et al*., 2006).

The Kernel, radius and stratification matching methods, took 161 treated observations with 286 control observation each for mating and there ATT, standard error and t-value comes out as 3.32, 3.36 and 3.28, 16261.87, 15242.326 and 17225.349 and 20.392, 22.063 and 19.00 respectively at 5% level of significance.

Table (10): Regression of income with the treatment group.

Y	Coef.	Std. Err.	T	P>|t|	[95% Conf. Interval	
Trt	340156.94	14051.71	24.21	0.000	312545.5	367768.3
_cons	144690	8172.195	17.71	0.000	128631.8	160748.2

Table (11): Average treatment of treated with different matching methods.

Matching Methods	n. treat	n. contr.	ATT	Std. Err.	T
ATT estimation with Nearest Neighbour Matching Method (attnd)	161	120	3.56e+05	19226.196	18.502
ATT estimation with Kernel Matching Method (attk)	161	286	3.32e+05	16261.876	20.392
ATT estimation with Radius Matching Method (attr)	161	286	3.36e+05	15242.326	22.063
ATT estimation with Stratification Matching Method (atts)	161	286	3.28e+05	17225.349	19.00

Table (12) shows the average treatment effect on treated (ATT) calculated from different matching methods employed to the set of observations (Blundell & Costa-Dias, 2000; Ho *et al*., 2011). The ATT estimated from nearest neighbour method by doing 100 replications to the data set comes out to be Rs. 355727.8/- with a bias of -5979.628 and standard error of 15843.56 at 5% level of significance, indicating that by using advanced production system module farmers increased their income by Rs.355727.8. Similarly, the average treatment effect of treated (ATT) estimated through kernel matching method, radius matching method and stratification matching method by doing 100 replications each realizing a gain of Rs. 331619.3/-, 336284.4, 327965.2 with a bias of 2401.869, -1006.632, 2787.328 and a standard error of 16261.87, 151163.9 and 117225.35 at 5% level of significance respectively revealing that farmers increased their income by Rs.17225.35, 336284.4 and 327965.2 respectively by using advanced production system module.

Propensity Score Graph (ps-graph)

The propensity score matching graph was used to explain the number of treated and untreated observations that got support and those which did not get support in the distribution (Dehejia & Wahba, 2002). Ps graph demonstrated the treated cases in green on top, the controlled cases in brown at bottom and the blue bars show the untreated cases devoid of the support.

Table (12): Showing estimation of average treatment effect on treated (ATT) using different matching methods.

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]		
Attnd	100	355727.8	-5979.628	15843.56	324290.7	387164.8	(N)
					323426.6	376936.1	(P)
Attk	100	331619.3	2401.869	16261.87	299352.2	299352.2	(N)
					308295.6	376920.3	(P)
					308295.6	376920.3	(BC)
Attr	100	336284.4	-1006.632	151163.91	306195.9	366372.9	(N)
					307478.9	362641.3	(P)
					308352.7	364066.5	(BC)
Atts	100	327965.2	2787.328	17225.35	293786.4	362144	(N)
					299254.6	362676.2	(P)
					295842.1	360398.9	(BC)

Note: N = normal, P = percentile and BC = bias corrected

The fig. (1) looks promising, because, almost all the controlled and uncontrolled cases had propensity score ranging from 0.1 to 0.6 and there seems to be lesser cases having propensity score greater than 0.6. Similarly some of the case were found without any support in the distribution, likewise some cases in the treatment group found no support in the controlled group.

Kernel density

Estimating the density with a histogram is easy but it is not smooth enough to have a fairly good picture of the distribution. In order to get a smoother picture kernel density method is employed. In kernel density the data are divided into non-overlapping intervals, and counts area made of the number of data points within each interval. In more general kernel density estimates, the range is still divided into intervals, and estimates of the density are produced at the centre of intervals. From the fig. (2), it can be seen that the density ranges from 0 to 4 as is shown along the y-axis and the scale of propensity is shown along x-axis. The area under the brown line (non-adopters) whose propensity ranges from 0.1 to 0.7 and the majority of the adopters (grey line) also fall in that range, that means almost 70 to 80 per cent of the adopters are falling within the range and find their common support in the data set while as few of the observations did not find their support in the data set

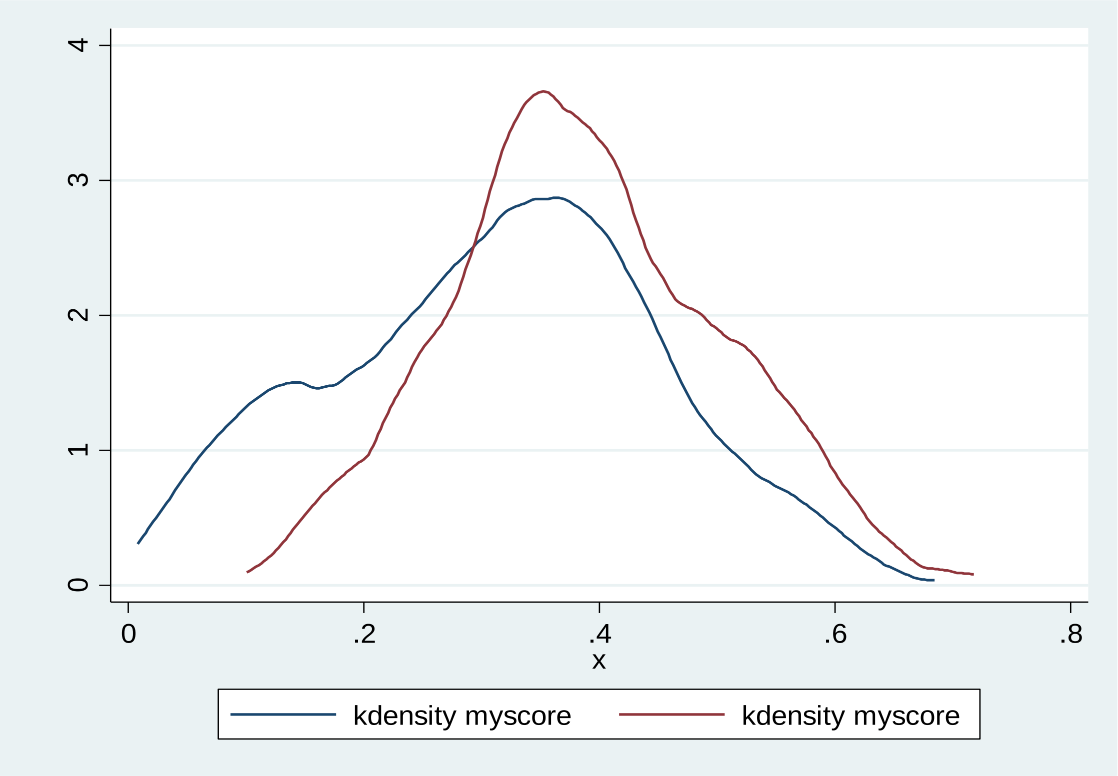

Fig. (1): Propensity score matching graph.

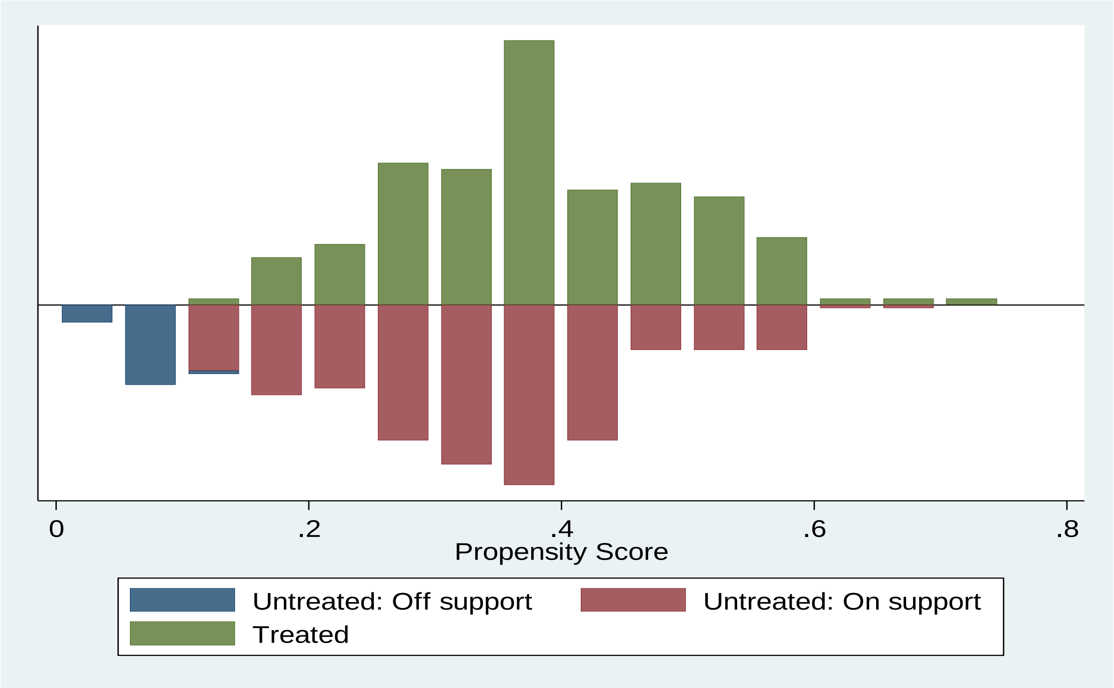

Fig. (2): Two way kernel density graph.

Conclusions

The study concludes that average productivity of saffron increased from 2.57 kg.ha^{-1} to 6.05 kg.ha^{-1}, with 1-2 kg.ha^{-1} in the first year to 10-12 kg.ha^{-1} in fourth year against non-adopters. The higher investment cost of 5.9% and 13.6% under ex-ante and ex-post evaluation got compensated through realizing higher productivity and increased employment. The realization of NPV, BCR and IRR of Rs. 399 crores, 110 and 154% against Rs.249 crores, 69 and 134% respectively under ex-ante and ex-post evaluation of the technology was considered very encouraging towards increasing the living standard of the people in the area. The estimates of the propensity score matching too confirmed the results of increasing the wellbeing and living standard of the general public in the saffron growing region. The results suggest that the post-harvest handling of saffron is an important area involved in its production and marketing demanding establishment of processing units and labs for its post-harvest handling especially drying and packing. The study further suggests that policies need to be evolved by the Government of India towards its efficient grading, branding and labelling which were observed to be important determinants of its trade and are expected to help in competing in the international market.

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التقييم السابق واللاحق لنظام الإنتاج المتقدم لنات الزعفران *Crocus sativus* في الهند باستخدام نموذج فائض المستهلك ومطابقة درجة الميل

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[1]رئيس قسم الدراسات المعاصرة وسبل العيش والامن الغذائي جامعة شير- اي- كشمير للعلوم والتكنولوجيا الزراعية كشمير- الهند

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المستخلص: تقدمت مراحل زراعة وإنتاج الزعفران من قبل جامعة شير كشمير للعلوم والتكنولوجيا الزراعية في كشمير (SKUAST-K) عندما طورت الجامعة وحدة نظام لانتاج الزعفران والتي حققت زيادة كبيرة في إنتاجية الزعفران خلال العقدين الماضيين. لوحظ أن اعتماد التكنولوجيا له تأثير كبير للغاية على الصعيد الاجتماعي للمنطقة المنتجة للزعفران مما تطلب تقييمها قبل وبعد تبني هذه العملية مقارنة بعدم الاعتماد على هذه التقنية. ولاجل التقييم ،تم استخدام نموذج فائض المستهلك وطرق مطابقة درجات الميل على عينة مكونة من 447 مشاركًا ، منهم 286 متبنين و 161 غير متبنين (مجموعة سيطرة)، تم اختيارهم من 753 مزارعًا للزعفران في حزام زراعة الزعفران في جامو وكشمير والتي تنتج 99٪ من إجمالي إنتاج الزعفران في الدولة. أظهرت النتائج أن متوسط إنتاجية التوابل زاد من 2.57 كجم /هكتار إلى 6.05 كجم / هكتار ، بمعدل 1-2 كجم / هكتار في السنة الأولى إلى 10-12 كجم / هكتار في السنة الرابعة مقارنة بمجموعة السيطرة (من غير المتبنين للعملية) ، مع ذلك ، سجلت تقديرات تكلفة الاستثمار زيادة بنسبة 5.9٪ تحت التقييم المسبق و 13.6٪ تحت التقييم اللاحق مع تبني التكنولوجيا الجديدة، والتي تم تعويضها من خلال تحقيق إنتاجية أعلى وزيادة التوظيف لتصل إلى 40.6 و 28.3 في المائة من أيام العمل / هكتار على التوالي في إطار التقييم المسبق واللاحق. كشفت النتائج كذلك ، NPV، BCR، IRRـ Rs. 399 كرور ، 110 ، 154٪ مقابل 249 كرور روبية ، 69 ، 134٪ على التوالي بموجب التقييم المسبق واللاحق للتكنولوجيا.

الكلمات المفتاحية: إنتاجية ، زراعة ، مستوى معيشي ، تكنولوجيا جديدة.