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Economic Sustainability and Valuation of Agro-Systems of Kashmir Valley: Production Frontier Approach

Shabeer A. Ganaie, M. H. Wani, S. H. Baba, Arshad Bhat

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Abstract The amount of a good or service that producers will supply, depends on the cost of producing it and the price offered for its purchase. The amount that consumers demand depends on how well they like it and its price of sale. Economic methods for estimating the values of non-marketed ecosystem services seek to capture such type of market relationships. Economic valuation of ecosystem services uses methods that attempt to capture the effects of relevant markets. Those markets may be real or imagined. The relevant market for an ecosystem service varies with the scale over which people experience that ecosystem service. The present study deals with the economic valuation of agro-ecosystems in Kashmir valley. The whole valley was divided into four agro-ecosystems namely field crop based, fruit crop based, livestock based and cash crops based agro-ecosystems. Rigorous survey and data collection was done for making this study more scientific and result oriented. The highly sophisticated statistical tools were employed to reach logical conclusions. The results reveal that all the four agro-ecosystems are dominant in the sampled districts, but in totality and comparative analysis, fruit crop based agro-ecosystem is dominant and much ruminative for the respondents followed by cash crop agro-ecosystem, field crop and livestock based agro-ecosystems.

Keywords Sustainability, Valuation, Agro-ecosystems, Consumer surplus, Production function.

Shabeer A. Ganaie[1], M. H. Wani[2], S. H. Baba[1], Arshad Bhat[2]*
[1]Assistant Prof.
School of Agri-Econ and Marketing
and Horti-Business Management,
SKUAST-K, Shalimar, Srinagar,
Jammu and Kashmir, India
[2]Professor and Post Doctorate Research Associate,
Rajiv Gandhi Chair, SKUAST-K, Shalimar,
Srinagar, Jammu and Kashmir, India
e-mail : bhatarshadog@gmail.com
*Corresponding author

Introduction

An ecosystem is a natural unit of living things (animals, plants and micro-organisms) and their physical environment. Its living and non-living elements function together as an interdependent system-if one part is damaged it can have an impact on the whole system. Ecosystem can be terrestrial or marine, inland or coastal, rural or urban, crops or plants and may also vary in scale from the global to the local. Closer to home we might think more in terms of different types of habitats (e.g. woodlands, grassland, marshes, health lands, rivers) though this can also extend to the urban environment (e.g. parks and gardens, rivers and streams). In many cases, ecosystems overlaps and perform numerous functions. Many of those functions are valued by humans because they deliver us ecosystem services. Ecosystem include such processes as biological control of pests, weeds/diseases, pollination of crops, amelioration of flooding, wind erosion, provision of flood, hydropower for electricity generation, landscapes and capture of carbon dioxide by plants and soil, landscapes that are enjoyed by residents and tourists among others.

The economic valuation is the key element for deciding the allocation of various resources as it helps the institutions in amelioration and management of resources. Further, valuation studies reveal information on both the structure and functioning of ecosystem and the varied complex roles of ecosystem in supporting human welfare. In current era of crop production, the debate over the environmental consequences of agriculture production moved beyond arguments. Further, the greatest challenges facing agriculture for foreseeable future is to resolve the conflict caused by growing competition for the services of its components of its ecosystem indeed, the actual or potential benefits arising from its use are often the main incentive for the conservation of agriculture. Steps must be taken to ensure that the world can conserve and build the agricultural biodiversity needed to adapt global food and farming under an evolving landscape of climate change and increased competition for space and water. The science of agroecology and its concepts provides a foundation for examining the interactions and relationships among the diverse components of the system (Baba et al. 2010) which may contribute to the emergence of a sustainable framework for integrating social, economic, political and ecological perspectives for sustainable development. Ecosystem and the interplay of its components may vary across regions consistent upon number of factors. The mountains, owing to various specificities, may have different setting that allowed its performance different from that of plains. Indian mountainous regions are fragile zone though it is bestowed with natural components (biotic and abiotic) that adds to the value of its ecosystem and agro-ecosystem in particular. The components of agro-ecosystems in the Kashmir valley can broadly be divided into four major categories, viz., field crop based, fruit crop based, livestock based and cash crops based agro-ecosystems.

Field crop based agro-ecosystem

The field crop based ecosystem in Kashmir valley, demonstrated predominance of paddy in the area, which could be due to the best suited agro-climatic conditions of the region for the crop. Kashmir province dominates in production and consumption of rice and contribute the highest area under rice compared to other crops.

Fruit crop based agro-ecosystem

In Kashmir valley the fruit crop based ecosystem is predominant in district Shopian owing to various topographical and environmental conditions which offer comparative advantage to the production of various horticultural products. In some cases it enjoys monopoly in the production of some fresh fruits (apple) and dry fruits (walnut).

Livestock based agro-ecosystem

The livestock based ecosystem is prevalent in all the districts of Kashmir but the number of animals per household was more under livestock based agro-ecosystem compared to cereal based ecosystems.

Cash crop based agro-ecosystem

Vegetables are also grown under the all agro-ecosystems however their cultivation remained limited to the family consumption in general except district Budgam where vegetables are grown commercially. The higher proportion of cropped area under vegetables in Budgam was due to assured irrigation facilities and favorable agro-climatic conditions.

The valley has a distinction in terms of its diversity, which made it to provide biotic or abiotic environment to the number of agro-ecosystems. Only few studies, examining few ecosystems or part of ecosystem is available in literatures which directed us towards a necessity of a comprehensive study for holistic approach towards sustainable ecosystem management. Therefore, economic valuation and sustainability issues for betterment of agriculture need an attention. Since, little efforts have been made in this direction in Jammu and Kashmir State, therefore current study was aimed to investigate economic valuation and sustainability issues of temperate agro-ecosystem of Jammu and Kashmir with following objectives: 1. To identify the components of agro-ecosystem, 2. To asses the value of goods and services in agro-ecosystem.

Materials and Methods

The present study investigates the agro-ecosystems of the Kashmir valley. For the selection of study area and sample respondents, the Kashmir valley was divided into four agro-ecosystems viz. field crop based ecosystem (FLCES), fruit crop based ecosystem (FRCES), livestock based ecosystem (LSCES) and cash crop based ecosystem (CCES) based upon prominent production system.

A multi-stage random sampling technique was adopted for the selection of sample respondents. In first stage of sampling, four districts of the southern part of the valley were taken into consideration for conducting the base line survey and extensive observations for collection of necessary data and information. One district representing each ecosystem was selected purposively based upon predominant production system. The district Anantnag was purposively selected on the basis of dominant field crop production system, district Shopian was selected on the basis of dominant fruit crop production system, similarly, district Pulwama was selected on the basis of dominant livestock production system and district Budgam was selected on the basis of dominant of cash crop production system. In the second stage of sampling, two blocks from each district were randomly selected to form a total of eight blocks. In third stage of sampling, a cluster of three villages were selected from each block in order to form six villages from each district and a total of twenty four villages. In fourth and final stage of sampling, twenty five respondents were selected from each village cluster so as to make the total sample size of 50 in each district and overall total sample of 200 respondents.

Data collection

The study envisages both primary and secondary data. The primary data was collected from the respondents with the help of pre-tested questionnaire. The secondary data was collected from various published and unpublished records of State Government which include Annual reports, Digest of Statistics (DE&S, J & K Govt.), Economic Survey (DE&S, J & K Govt) and other periodicals.

Analytical model

Production frontier

Frontier production represents the maximum possible output for any given set of inputs making use of the best available technology and thus sets a limit or frontier on the observed values of decedent variables; no observed value of output is expected to lie above this frontier. Any deviation of a farm from the frontier indicates the extent of farmer's inability to produce maximum output from the given set of inputs and hence represents the degree of technical inefficiency.

The stochastic frontier production function is defined by Equation (1) :

$$Y_i = f(x_i; \beta) \exp(v_i - u_i), \ {}_{i=1, 2.... N} \qquad (1)$$

Where, Y_i=production of the i^{th} farm, X_i=A suitable function of the vector X_i of inputs for he i^{th} farm, β=the vector of unknown parameters, v_i=Symmetric component of the error-term and u_i=Non-negative random variable which is under the control of the farm. Given the density function of u_i and v_i, the frontier production function can be estimated by Maximum Likelihood Technique.

Technical efficiency of n individual farm is defined in terms of the ratio of the observed output to the corresponding frontier output, given the levels of inputs used by that farm. Thus the technical efficiency of farm in the context of the stochastic frontier production function (1) is:

$$TE_i = Yi/Yi^*$$
$$= f\ (x_i;\ \beta)\ \exp\ (v_i - u_i)/f\ (x_i;\ \beta)\ \exp\ (v_i)$$
$$= \exp\ (-u_i).$$

Following Baltese and Coelli (1988) and Thomas and Sundaresan (2000), when output is measured in logarithms, the farm-specific technical efficiency can be estimated by Equation (2):

$$TE_i = = \exp\ (-u_i) \qquad ...(2)$$
$$i = 1, 2, 3 \ldots n,\ 0 \le TE_i \le 1$$

The primary advantage of the stochastic frontier production function is that it enables the estimation of u_i and thereby the farm-specific technical efficiencies Reddy and Sen (2003) and Mythili and Shanugan (2003). The measure of technical efficiency is equivalent to the ratio of the production of the i^{th} farm to the corresponding production value if the farm effect u_i were zero.

A production process may be inefficient in two ways, only one of which can be detected by an estimated product on frontier. It can be technically inefficient, in the sense that it fails to produce maximum output from a given input bundle. The other type of inefficiency could be allocative inefficiency in the sense that the marginal revenue product of input might not be equal to the marginal cost of that input even though the technology is efficient. Allocative inefficiency results in utilization of inputs in the wrong proportion with the given input prices. Since, estimation of production frontiers is carried out with observations on output and inputs only, such an exercise cannot provide evidence on the matter of allocative inefficiency and cannot be used to draw inferences about the total or economic inefficiency (Schmidt and Lovell 1979; Banik 1994 and Chattopadhyay and Sengupta 2001).

The technical efficiency in production was estimated by using the stochastic frontier production function, which was independently proposed by Aigner et al. (1977) and Meeusen and Van Brock (1977). The estimation of stochastic frontier production function enabled us to find whether the derivation in technical efficiency from the frontier output is due to the firn-specific factors or external random factors (Baltese and Coelli 1988).

Baltese and Coelli (1988) suggest that the technical efficiency of firm I, associated with panel data model with time-invariant firm effects, be defined as the ratio of its men production given tits level of inputs and its realized firm effect, u_i, to the corresponding men production if the firm effect, u_i, had value zero (and so the firm was fully efficient). This definition yields the same measure of technical efficiency as that given in the text.

Jondrow et al. (1982) have demonstrated that the farm specific technical efficiencies can be estimated from the error-terms. It is possible because $\varepsilon = v_i + u_i$, can be estimated and it obviously contains information on u_i, one can evaluate be considering the conditional distribution of u_i in the given ε_i, this distribution contains all the information ε_i. yields about u_i, for the commonly used cases of half-normal and exponential u_i, these expressions can be easily evaluated Kalirajan and Chand (1989). In the case of half-normal model, for each farm, the technical efficiency is the expected value of u_i conditional on ε_i.

Model specification

Two models were specified to conduct the analysis. One model was specified for field crop based, fruit crop based and cash crop based and other was specified for livestock based farming system. This was required owing to the fact that under different farming systems the variables are different. In both the models specified the variables included in the models were different.

Model: 1 Specified for field crop based, fruit crop based and cash crop based farming system.

The stochastic frontier production function of the Cobb-Douglas type with the following specification was used for this study is;

$$Y_i = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \beta_6 \log X_6 + v_i - u_i$$

Where, Y_i=Total output (yield/ha), β_0=Constant term,

Table 1. Parameter estimates for frontier production functions for paddy (Anantnag), apple (Shopian) and cash crop (Budgam). Source : Calculation based on Field Survey (2012-14), * and ** denote significance at 1% and 5% levels, respectively.

Variables		Symbol	FLCES (paddy) Bo	t-value	FRCES (apple) Bo	t-value	CCES (veg) Bo	t-value
Constant term		β_0	0.2855	1.508985	0.6415	1.759945	0.1063	1.551825
Value of capital services	(Rs/ha)	β_1	0.5134	2.425811**	0.7599	4.094289**	0.1032	3.339806**
Manure	(Rs/ha)	β_2	0.1461	2.387255*	0.4895	2.290594*	0.2614	2.1657*
Fertilizer	(Rs/ha)	β_3	0.1302	1.826087	0.4273	2.18456*	0.1776	1.855799
Seed/P. Material	(Rs/ha)	β_4	0.9258	2.026708*	0.2415	2.217*	0.8424	2.099178*
P. Protection	(Rs/ha)	β_5	0.1474	2.070225*	0.1533	3.311015**	0.2753	1.478518
Labor	(mandays/ha)	β_6	0.1357	2.485348**	0.6458	1.812009	0.9904	2.46675**
Sigma square		σ^2	0.1644	102.75	0.5577	2178.51	0.3755	651.909
		λ	10.135	253.375	46.66	2916.79	25.529	1063.715
		γ	0.95		0.91		0.73	
Total observations			50		50		50	

X_1=Value of capital services (Rs/ha), X_2=Farmyard manure (Rs/ha), X_3=Value of fertilizers (Rs/ha), X_4=Seed rate (kg/ha), X_5=Value of plant protection chemicals (Rs/ha), X_6=Labor use (man days/ha) and, u_i=Specific technical related factors, v_i=Random variable, I=1, 2, 3... n.

Model: 2 Specified for livestock based farming system.

The stochastic frontier production function of the Cobb-Douglas type with the following specification was used for this study are

$$Y_i=\beta_0+\beta_1 \log X_1+\beta_2 \log X_2+\beta_3 \log X_3+\beta_4 \log X_4+\beta_5 \log X_5+\beta_6 \log X_6+v_i-u_i$$

Where, Y_i=Total output (production/HH), β_0=Constant term, X_1=No. of livestock (No./HH), X_2=Feed (dry) (Rs/HH), X_3=Feed (fresh) (Rs/HH), X_4=Concentrate (Rs/HH), X_5=Medicines (Rs/HH), X_6=Labor use (man days/HH) and u_i=Specific technical related factors, v_i=Random variable, I=1, 2, 3.... n. The specific technical efficiencies were estimated from the residuals.

Results

Estimates of the frontier

Model : 1 Specified for field crop based, fruit crop based and cash crop based farming system.

The estimates of Cobb-Douglas type stochastic frontier production function revealed that the estimate of λ (10.135) under FLCES was significantly different from zero, Table 1, indicating a good fit and the correctness of the distributional assumption. The variance ratio (Υ) revealed 95% of the difference between the observed and the frontier outputs which could be due to differences not related to the random variability, but with the factors under the control of the farmers. With an upward shift in the constant term, the coefficient of seed rate, labor, value of FYM and value of capital services were significant as revealed by the stochastic production function. It implies that the farmers could use more of seed, labor and FYM and capital services. The estimate of λ (46.66) turned out significantly different from zero under FRCES, and the variance ratio (Υ) demonstrated 91% of the differences between the observed and the maximum level of technical efficiency of production sector, that varied with different management practices. This was however not related to random variability. With a positive shift in the intercept term, the coefficient of value of capital services, value of FYM, value of fertilizers and plant protection chemicals turned significant in the stochastic production function. It implied that the farmers could use more of the fertilizers, FYM and plant protection chemicals and reduce the use of labor.

Similarly, in case of CCES (vegetables) the estimate of λ (25.529) was significantly different from zero,

Table 2. Parameter estimates for frontier production functions for cash crop (saffron). Source: Calculation based on Field Survey (2012-14), * and ** denote significance at 5% and 1% levels, respectively.

Variables		Symbol	Bo	t-value
Constant term		β_0	0.345	3.735
Value of capital services	(Rs/ha)	β_1	0.213	2.321*
Manure	(Rs/ha)	β_2	0.075	2.625*
Fertilizers	(Rs/ha)	β_2	-0.201	-2.613*
Seed	(Rs/ha)	β_3	0.365	4.521**
P. Protection	(kg/ha)	β_4	0.374	2.352*
Labor	(days/ha)	β_6	0.462	1.452
Sigma square		σ^2	0.346	474.62
		λ	22.69	840.46
		Υ	0.71	
Total observations			50	

Table 3. Parameter estimates for frontier production functions for livestock (Pulwama). Source: Calculation based on Field Survey (2012-14), * and ** denote significance at 5% and 1% levels, respectively.

Variables		Symbol	Bo	t-value
Constant term		β_0	0.3798	1.573974
Livestock	(No./HH)	β_1	0.7477	2.299908*
Feed (Dry)	(Rs/HH)	β_2	0.3013	1.76612
Feed (Fresh)	(Rs/HH)	β_3	0.1372	2.2349*
Concentrates	(Rs/HH)	β_4	0.1158	2.786775**
Medicines	(Rs/HH)	β_5	0.1206	2.02349*
Labor	(man days/HH)	β_6	0.1861	1.376479
Sigma square		σ^2	0.1223	48.338
		λ	6.9522	183.216
		Υ	0.69	
Total observations			50	

indicating a good fit and the correctness of the distributional assumption. The variance ratio (Υ) showed that 73% of the difference between the observed and the frontier outputs was due to differences not related to the random variability, but with the factors under the control of the farmers.

The estimated results of Cobb-Douglas production function in case of CCES (saffron) (Table 2) revealed that value of λ (22.69) was significantly different from zero, indicating a good fit and the correctness of the distributional assumption. The variance ratio (Υ) showed that 71% of the difference between the observed and the frontier outputs was due to differences not related to the random variability, but with the factors under the control of the farmers.

Model : 2 Specified for livestock based farming system.

The estimates of λ (6.952) under LSES were significantly different from zero, with indicated a good fit and the correctness of the distributional assumption. The variance ratio (Υ) 69% of the difference between the observed and the frontier outputs which could be demonstrated due to differences not related to the random variability, but with the factors under the control of the farmers (Table 3). With an upward shift in the constant term, the coefficients of no. of livestock, value of feed (fresh), concentrates and value of medicines were significant in the stochastic production function. It implied that the farmers could use more number of livestock, feed fresh, concentrates and medicines. The values of dry feed and labor are insignificant with positive relationship and revealed reduced use of dry feed and labor.

The values obtained are summarized by reporting the frequencies (and percentages) of different agro systems of sampled districts of Kashmir valley in new technical efficiencies ranged from 18 to 52% in FLCES, 36 to 44 in FRCES, 16 to 44 in LSES whereas for 20 to 48 in CCES with mean efficiency of 0.75, 0.71, 0.64 and 0.67 respectively Table 4.

The percentages of inputs that could be increased to reach to the optimal level for inefficient farmers are given below in Table 5. These figures in-

Table 4. Frequencies and percentages of technical efficiencies for different agro-systems of sampled districts of Kashmir valley. Source: Calculation based on Field Survey (2012-14).

Efficiency	FLCES	FRCES	LSES	CCES
Low (60–80)	9	18	8	10
	(18.00)	(36.00)	(16.00)	(20.00)
Medium (81–90)	26	22	2	24
	(52.00)	(44.00)	(44.00)	(48.00)
High (91–99)	15	10	20	16
	(30.00)	(20.00)	(40.00)	(32.00)
Mean	0.75	0.71	0.64	0.67
Total	50 (100)	50 (100)	50 (100)	50 (100)

Table 5. The percentages of inputs that could be increased to reach to the optimal level for inefficient farmers. Source: Calculation based on Field Survey (2012–14).

Inputs	FLCES	FRCES	CCES	Inputs	LSES
Value of capital services	0.022	0.048	0.024	No. of livestock	0.134
Manures	0.036	0.075	0.105	(Feed) Dry	0.401
Fertilizers	0.133	0.125	0.612	(Feed) Fresh	0.315
Seed	0.054	0.102	0.164	Concentrate	0.087
Plant production	0.051	0.052	0.689	Medicine	0.361
Total labor	0.013	0.136	0.032	Total labor	0.573
Inefficiency	0.051	0.089	0.270		0.311

dicate that there is a lot of scope to increase the efficiency by increasing the inputs.

Discussion

Estimates for frontier production functions

The estimates of Cobb-Douglas type stochastic frontier production function revealed that the estimate of λ (10.135) under FLCES was significantly different from zero, Table 1, indicating a good fit and the correctness of the distributional assumption. The variance ratio (Υ) revealed 95% of the difference between the observed and the frontier outputs which could be due to differences not related to the random variability, but with the factors under the control of the farmers. With an upward shift in the constant term, the coefficient of seed rate, labor, value of FYM and value of capital services were significant as revealed by the stochastic production function. It implies that the farmers could use more of seed, labor and FYM and capital services. The results are in conformity to those of Nasurudeen and Mahesh (2004) who observed similar results in case of transplanting method in rice. Who observed that estimate of λ was significantly different from zero with variance ratio show in 99% of the differences between the observed and the frontier output was due to difference not related to random variability, but with the factors under the control of the farmers. With a positive shift in the intercept term, the coefficient of labor, value of FYM and fertilizers and plant protection chemicals remained significant in the stochastic production function. It implied that the farmers could use more of the fertilizers and FYM and reduce the use of labor and plant protection chemicals, hence confirming our results.

The estimate of λ (46.66) turned out significantly different from zero under FRCES, and the variance ratio (Υ) demonstrated 91% of the differences between the observed and the maximum level of technical efficiency of production sector's, that varied with different management practices. This was however not related to random variability. With a positive shift in the intercept term, the coefficient of value of capital services, value of FYM, value of fertilizers and plant protection chemicals turned significant in the stochastic production function. It implied that the farmers could use more of the fertilizers, FYM and plant protection chemicals and reduce the use of labor.

Similarly, in case of CCES the estimate of λ (25.529) was significantly different from zero, indicating a good fit and the correctness of the distributional assumption. The variance ratio (Υ) showed that 73% of the difference between the observed and the frontier outputs was due to differences not related to the random variability, but with the factors under the control of the farmers. With an upward shift in the constant term, the coefficient seed rate, labor, value of FYM and value of capital services remained significant in the stochastic production function. It implied that the farmers could use more of seed, labor and FYM and capital services. The value of fertilizers and plant protection chemicals are insignificant but show positive relationship and reduce the use of fertilizers and chemicals. The estimates of regression function have revealed that the vegetable production and net price received by producers, the value of capital services, manures, seed, and labor were the significant and positive determinants of CCES, while fertilizers and plant protection at the farm level had a negative contribution to the improvement of cash crops (vegetables). The regression estimate of vegetable production λ (25.529) and efficiency 73% emphasize that the efficient utilization of production capacities to increase the overall production of vegetables in the study area. The production may be increased by efficient use of fertilizers, plant protection, expanding area and improving productivity. It could be inferred that the area under vegetables needs to be expanded and the crops to be cultivated on scientific lines for the improvement of productivity. Returns to farmers improve their economic status and encourage them to adopt various input innovations that ultimately lead to increased production. Baba et al. 2010, observed that the estimates of R^2 and F statistics revealed that the model was a best fit and the explanatory variables specified in it could collectively explain about 85% of variations in the marketed surplus of vegetables, hence confirming our results. The estimated results of Cobb-Douglass production function of cash crop (saffron) revealed that value of λ (22.69) was significantly different from zero, indicating a good fit and the correctness of the distributional assumption. The variance ratio (ϒ) showed that 71% of the difference between the observed and the frontier outputs was due to differences not related to the random variability, but with the factors under the control of the farmers. With an upward shift in the constant term, the coefficients of seed (Qtls/ha) were found to be significant at 1% level suggesting a very good relationship with the yield per hectare. It implies that a 1% increase in the level must lead to 0.365% increase in the level of yield per ha. Further the value of capital services, manures, fertilizers and plant protection variables also show a positive relationship with the output and were significant at 5% level but the contribution of labor seems to be statistically insignificant. Furthermore, one important observation from the model is negative relationship between fertilizer application and its impact on the productivity (yield per ha). This result is in conformity with our observations from the field survey where in indiscriminate use of fertilizer application in general was found inconsistent with the standard practice and recommendations. According to agricultural scientists, different types of fertilizers i.e. Nitrogen, Phosphate and Potash (NPK) should be used in a balanced proportion to maintain the productivity of soil. It is recommended to use a mixture of 40 kg nitrogen, 50 kg phosphorus and 30 kg potassium per hectare but no such practice was followed by the farmers. It could be concluded that the farmers do not fallow the recommended fertilizer doses.

Parameter estimates for frontier production functions for livestock (Pulwama). The estimates of λ (6.952) under LSES were significantly different from zero, which indicated a good fit and the correctness of the distributional assumption. The variance ratio (ϒ) 69% of the difference between the observed and the frontier outputs which could be demonstrated due to differences not related to the random variability, but with the factors under the control of the farmers. With an upward shift in the constant term, the coefficients of no. of livestock, value of feed (fresh), concentrates and value of medicines were significant in the stochastic production function. It implied that the farmers could use more number of livestock, feed fresh, concentrates and medicines. The values of dry feed and labor are insignificant with positive relationship and revealed reduced use of dry feed and labor. The labor and feed elasticity estimates are larger due to the significant amount of hand feeding during the winter months in order to avoid incurring penalties of not maintaining monthly quotas. The elasticity estimate for labor is also significantly greater. The women are mainly engaged with milking, feeding of animals and overall health care and maintenance. The entire populations of animals in the district are partly grazed and partly stall fed except some parts of livestock especially the milch animals, which are only stall-fed. The animals are more grazed and less stall fed during summer and stall fed during winter. Mir and Khan (2008) also reveals that 29.2% of women labor was utilized in the six blocks, 30.89% of men, 7.7% of children and 32.7% of hired labor were utilized in district Pulwama, hence confirming our results.

Specific technical efficiencies of different agro-ecosystems

The results of specific technical efficiencies estimated with their frequency distribution is presented in Table 4. The results reveal that FLCES (paddy) had 15%

most efficient (91–99%) farms and 18% least efficient (60–80%) with a mean technical efficiency of 75%. Under FRCES (apple) 20% of the farms were most efficient (91–99%) and 8% least efficient (60–80%) with a mean technical efficiency of 71%. Similarly under LSES, 40% of the farms were most efficient (91–99%) and 16% were least efficient (60–80%) with a mean technical efficiency of 64% as against CCES (vegetables) 32% of the farms were most efficient (91–99%) and 20% were least efficient (60–80%) with a mean technical efficiency of 67%. Therefore, in short-run it is possible to increase paddy yield on an average by 25% in FLCES, 29% in FRCES, 36% in LSES and 33% in CCES by adopting better management practices used by the best performers. Similar results were observed by Nasurudeen and Mahesh (2004) in transplanting method of paddy. He further reported that in short-run it is possible to increase paddy yield on an average by 21.36% by improved transplanting methods and by adopting better management practices used by the best performers.

Conclusion

The main conclusion drawn from study are enumerated below:

Rice cultivation in the agro-ecosystem has been found to be more productive with low cost of production. Rice cultivation is having higher marketable surplus and engages both unskilled and semi-skilled human labor compared to other agro-ecosystem. Results of the study reveal the possibility to increase the productivity of paddy by 25% in the case of FLCES. In short-run it is possible to increase fruit yield on an average by 29% in FRCES by adopting better management practices used by the best performers. The livestock sector has turned more productive by way of its potential to push returns 36% if scientific system of management is followed. Yield can be increased up to 33% in the case of CCES by adopting better management practices used by the best performers.

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