IJTA © Serials Publications

National Academy of Agricultural Science (NAAS) Rating : 3. 03

Sustainability of Farming Systems in Kolar District of Karnataka

Dr. G.N. Nagaraja[1*], Somashekarappa H.E.[2], Shruthi J[3] and Mamatha Girish[4]

ABSTRACT: *The present paper aims to identify appropriate farming system models for achieving sustainability in agricultural production among the farmers in Kolar district of Karnataka state. The sample size was 120 comprising of different categories of farmers based on the size of land holdings. Spatial sustainability at the farm level was measured by Multi Criteria Approach and the six sustainability indicators used for the present analysis are gross income per unit, Benefit-Cost ratio, fertilizer productivity, plant protection chemicals productivity, cost of eco-friendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation. Garret's ranking technique was used to identify the importance of each of the six components based on which the Composite Sustainability index was calculated. The ranking of the components forming the sustainability index by experts showed that Benefit-Cost ratio was given the highest relative importance followed by plant protection chemicals productivity and fertilizer productivity. Cost of eco-friendly inputs and cost of owned inputs to total cost of cultivation were given equal importance. It was found that Crop+Dairy+Sheep+Forestry, Crop+Dairy systems in respect of marginal and small farmers respectively and Crop+Dariy+Sericulture+Poultry+Sheep system among medium and large farmers had greater sustainability index. The medium farmers were more sustainable with highest Composite Sustainability index of 0.87 followed by small and marginal farmers. On the contrary, the farming systems followed by large farmers were relatively unsustainable.*

Keywords: *Farming systems, sustainability, sustainability index.*

INTRODUCTION

In recent times, it is advocated that farming system that are ecologically, biologically and socio-economically sound not only involve crop production but are also dependent upon their integration with other enterprises like dairy, poultry, sericulture, piggery, sheep, goat, fisheries and bee-keeping. At its origin the farming system improves productivity and profitability besides maintaining sustainability of the farming system. The ultimate goal of sustainable agriculture is to develop farming system that are productive and profitable, conserve the natural resource base, protect the environment and enhance health and safety.

The present paper aims to identify appropriate farming system models for achieving sustainability in production in the farming system among the various categories of farmers in Kolar district in the eastern dry zone of Karnataka.

'Sustainability', the term when referred to agriculture sector, becomes synonymous to the ability of farming system to maintain its productivity and utility indefinitely. The Food and Agricultural Organization has defined "sustainable agriculture" as the management and conservation of the resource base and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development should be environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

The term sustainability possesses various dimensions–it can be economical, social and political (Stenholm and Waggoner, 1990). Due to this

[1&3] Professor and Research Associate, Dept of Agril. Marketing, Cooperation & Business Management, GKVK Campus, UAS, Bangalore-5600 65, respectively.
[*] *E-mail : dr_nagarajag@hotmail.com*
[2] Senior Marketing Supervisor, Agricultural Produce Market Committee, Challakere, Chitradurga District.
[4] Asst. Professor of Agril. Economics, College of Agriculture, V. C. Farm, Mandya, Karanataka.

abundance of existing dimensions, it is unlikely that a single approach to measure sustainability will ever be found.

One can see a certain amount of truth to these arguments. Yet, as a practical matter it is humanly impossible to deal with any problems (not just the sustainability problem) incorporating all of the real world complexity. In addition, the experience of farming systems suggests that often it is possible to quantify and model complex systems without unacceptable loss of realism (Harrington, 1992).

The need of a sustainability measurement can be felt more intensively while looking to its ecological dimension. Present profitability or productivity of a farming system, is hardly a necessary condition to achieve long term productivity or sustainability at the field, farm or national level. Degradation of environmental quality through management practices that pollutes soil, water and air precludes the ecological sustainability of a landscape or regional agricultural system, which will ultimately lead to a situation of low productivity and profitability. To foresee this and to take curative measure, the examination and quantification of sustainability of a system are inevitable proceedings. Hence, the present paper attempts to measure the sustainability of various farming systems existing in the Kolar district of Karnataka.

METHODOLOGY

Kolar district is one of the major agrarian districts of Karnataka state in India, where the farmers are adopting field crops; one combined with allied enterprises. Hence, Kolar district was purposively selected to assess the sustainability of farming systems.

The primary data required for the sustainability analysis of the farming system were collected from 120 randomly selected farmers by personal interview with the help of a pre-tested comprehensive schedule. The data on cropping pattern, size of operational holdings, existing farming system, cost of cultivation, inputs used, yield of crops, price of output, expenses and income from different enterprises were gathered. Besides, the secondary data on land utilization pattern, area under principal crops, agro-climatic conditions, rainfall, population, workforce, size of holdings, irrigation sources, livestock population etc., were collected from the records of the State Development Departments, Directorate of Economics and Statistics and Directorate of Census (Somashekarappa, 2002).

Spatial sustainability at the micro/farm level was measured by Multi Criteria Approach developed by Boggia and Abbozzo (1998), after modifying to suit to the farming conditions of the study area. The sustainability indicators used for the present study are described as follows.

(a) **Gross income per hectare :** This is the indicator reflecting the effect of different farming systems on production capacity.

Gross income per hectare (Rs.)

$$= \frac{\text{Monetary value of total output (Rs.)}}{\text{Area under cultivation (ha.)}}$$

(b) **Benefit-Cost ratio :** Benefit–Cost (B-C) ratio indicates the economic viability of farm as a unit. For economic viability B-C ratio above 1.0 is necessary.

$$\text{B-C ratio} = \frac{\text{Total value of output (Rs.)}}{\text{Total cost of cultivation (Rs.)}}$$

(c) **Fertilizer productivity :** It indicates the quantity of product obtained per each fertilizer unit.

$$\text{Fertilizer productivity} = \frac{\text{Yield obtained (Kg)}}{\text{Fertilizer used (Kg)}}$$

(d) **Pesticide productivity :** It is the ratio of product obtained per each rupee invested in plant protection chemicals.

Pesticide productivity

$$= \frac{\text{Yield obtained (Kg)}}{\text{Total cost of plant protection chemicals (Rs.)}}$$

(e) **Cost of eco-friendly inputs in total cost of cultivation :** Eco-friendly inputs includes farmyard manure, bio-pesticides, labour force etc. that are found to sustain agricultural production in the long run, by maintaining the production environment relatively healthy (Sreenivas, 2000). The high percentage of these inputs indicates the sustainable condition of those farming situations.

(f) **Cost of owned inputs to the total cost of cultivation :** If the value of owned inputs to purchased inputs is higher, then that situation can be considered as sustainable as the crop is highly dependent on internal sources. The scarcity or fluctuations in the price of any of the factors will not seriously affect the crop production consequently the yields of the crop.

Combining Component Scores of Sustainability (SI_i)

The above mentioned six components have been measured and expressed in different units. Hence, the values were converted into unit values (U_{ij}) by using simple range and variability as given below:

$$U_{ij} = \frac{Y_{ij} - Min\,Y_j}{Max\,Y_j - Min\,Y_j}$$

Where, Y_{ij} is the value assigned by i^{th} respondent on j^{th} component

Min Y_j is minimum score on j^{th} component

Max Y_j is maximum score on j^{th} component

U_{ij} is unit value of i^{th} respondent on j^{th} component

These unit values are unit less and ranged from 0 to 1. When Y_{ij} is maximum, unit value will be 1 and when Y_{ij} is minimum, unit value will be zero (Anonymous, 2005).

Relative Weights of Sustainability Components

The six components were presented and described to few experts and were asked to rank them in the descending order according to their relative importance. Garret's ranking technique (Garret, 1952) was used to identify the importance of each component. The ranks assigned were transformed into per cent using the formula,

Per cent Position = 100 – [(100*R* – 50)/N]

where *R* is the rank position counting number one as highest and *N* as lowest.

The percentage positions were transformed into scores on a scale of 100 points. From the scores so obtained, the average score was derived. This is termed as scale value (S_j) of each component. The unit values (U_{ij}) for each combinations and category of farmers were multiplied by respective component scale value, summed up and divided by total scale value to get Sustainability Index (SI_i) of each of the combinations in different categories of farmers.

$$SI_j = \frac{\sum_{i=1}^{n} U_{ij} X S_j}{\sum_{i=1}^{n} S_j}$$

Where

SI_i is sustainability index of i^{th} respondent

U_{ij} is unit value of i^{th} respondent on j^{th} component

S_j is scale value of j^{th} component

The value of SI_i is percentage. Higher the SI_i higher will be the sustainability of the farming systems.

RESULTS AND DISCUSSION

Measurement of Sustainability of Farming Systems

It is an indexing approach and six components were utilized for constructing the Compound Sustainability Index. The relative weightage for different components of sustainability index was analyzed using Garret ranking (the ranking was done by the experts in different fields of agricultural sciences) and the results are presented in Table 1.

The analysis shows that the Benefit-cost ratio of farming systems had prime importance in the sustainability status of the system and its relative weightage was found to be 0.944 (the relative weights ranged from 0 to 1 depending upon its importance). Next importance was given to the plant protection chemicals productivity, which had a relative weightage of 0.833.

Fertilizer productivity ranked third with a weightage of 0.722 and the fourth rank was shared by the twin components *i.e.*, cost of eco-friendly inputs and cost of owned inputs in the total cost of cultivation with 0.61 weightage each. The least importance was assigned for gross income per unit.

The six components cited above were added, after giving the relative weightage for each and then formulating the composite sustainability index for different categories of farmers.

Components of Farming System Sustainability Index of Different Combination of Enterprises Under Different Farming Systems

The components mentioned in Table 1 were quantified for for mulating the Composite sustaina bility index of different farming systems. The results are as shown in Table 2.

Table 1
Ranking of components of sustainability index of different farming systems

Sl. No.	Components	Relative weights	Rank
1.	Gross income per unit	0.388	5
2.	Benefit – cost ratio (B-C ratio)	0.944	1
3.	Fertilizer productivity	0.722	3
4.	Plant protection chemicalsproductivity	0.833	2
5.	Cost of eco-friendly inputs total cost of cultivation to(Rs.)	0.611	4
6.	Cost of owned inputs to total cost of cultivation (Rs.)	0.611	4

Table 2
Components of farming sustainability index under different categories of farmers

Sl. No.	*Components*	*Mean value*	*Maximum value*	*Minimum value*
Marginal farmers (<1 ha)				
1.	Gross income per unit (Rs.)	11,306	12,061	10,511
2.	Benefit-cost ratio	1.60	1.66	1.56
3.	Fertilizer productivity	21.32	22.46	19.78
4.	Plant protection chemicals productivity (Rs / Kg)	7.80	–	–
5.	Cost of eco-friendly inputs to total cost of cultivation (Rs./kg)	0.63	0.69	0.60
6.	Cost of owned inputs to total cost of cultivation (Rs./kg)	0.25	0.45	0.31
Small Farmers (1 to 2 ha)				
1.	Gross Income per unit (Rs.)	10,343	11,244	9691
2.	Benefit-cost ratio	1.91	1.99	1.86
3.	Fertilizer productivity	19.11	21.48	17.85
4.	Plant protection chemicals productivity (Rs. /Kg)	15.60	–	–
5.	Cost eco-friendly inputs to total cost of cultivation (Rs./kg)	0.53	0.60	0.49
6.	Cost of owned inputs to total cost of cultivation (Rs./kg)	0.43	0.49	0.38
Medium Farmers (>2 to 5 ha)				
1.	Gross income per unit (Rs.)	16,630	17,509	16,257
2.	Benefit-cost ratio	2.26	2.30S	2.20
3.	Fertilizer productivity	39.74	41.59	39.38
4.	Plant protection chemicals productivity (Rs / Kg)	6.50	–	–
5.	Cost of ecofriendly inputs to total cost of cultivation (Rs./kg)	0.60	0.68	0.54
6.	Cost of owned inputs to total cost of cultivation (Rs./kg)	0.43	0.51	0.41
Large Farmers (>5 ha)				
1.	Gross income per unit (Rs.)	14,149	15,124	13,526
2.	Benefit-cost ratio	2.21	2.30	2.14
3.	Fertilizer productivity	27.91	28.9	27.43
4.	Plant protection chemicals productivity (Rs / Kg)	4.35	–	–
5.	Cost of eco-friendly inputs to total cost of cultivation (Rs./kg)	0.59	0.62	0.57
6.	Cost of owned inputs to total cost of cultivation (Rs./kg)	0.59	0.62	0.57

Marginal Farmers (Land Holding < 1 ha)

The mean gross income per unit for the sample farmers was Rs. 11,306 (averaging from different combination of enterprises) and it ranged between Rs. 10,511 and Rs. 12,061 [the maximum and minimum limits were specified in order to fabricate the percentage values (U values) devoid of units, ranging from 0 to1]. The mean B-C ratio was 1.60 and it ranged between 1.56 and 1.66. The mean value of fertilizer productivity was 21.32, which is nothing but the average product of particular input. Plant protection chemicals productivity was 7.8 kg per rupee invested. While the mean value of cost of ecofriendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation were 0.63 and 0.25, respectively.

Small Farmers (Land Holding 1-2 ha)

The mean gross margin per unit was found to be Rs. 10,343 and the B-C ratio was of 1.91. The mean value of fertilizer productivity was 19.11, which is nothing but the average product of particular input. Plant protection chemicals productivity was 15.6 kg per rupee invested. While the mean value of cost of eco-friendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation were 0.53 and 0.43, respectively.

Medium Farmers (Land Holding 2-5 ha)

The mean gross margin per unit was found to be Rs. 16,630 and the B-C ratio was of 2.26. The mean value of fertilizer productivity was 39.74, which is nothing but the average product of particular input. Plant protection chemicals productivity was 6.5 kg per rupee invested. While the mean value of cost of eco-friendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation were 0.60 and 0.43, respectively.

Large Farmers (Land Holding > 5 ha)

The mean gross margin per unit was Rs. 14,149 and the B-C ratio was of 2.21. The mean value of fertilizer productivity was 27.91, which is nothing but the average product of particular input. Plant protection chemicals productivity was 4.35 kg per rupee invested. The mean value of cost of eco-friendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation were 0.59 and 0.59, respectively.

The ranking of the components forming the sustainability index by experts showed that Benefit-Cost ratio was given the highest relative importance compared to other components followed by Plant protection chemicals productivity and fertilizer productivity.

Cost of eco-friendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation were given equal importance and finally the gross income per unit. It was found that all the categories of farmers and all the combination of enterprises had B-C ratio more than unity indicating profitability of the system and it was found to be maximum (2.26) in the case of medium farmers indicating their efficiency in utilization of resources. The Plant protection chemicals productivity (15.60) and fertilizer productivity (39.74) were found to be maximum for small farmers and medium farmers respectively, while the medium farmers had maximum gross income at Rs. 16,630. Maximum value of cost of eco-friendly inputs to total cost of cultivation (0.63) was in marginal farmers followed by 0.60 in medium farmers and not much difference was observed with respect to this component among the various categories of farmers, large farmers had higher value of cost of owned inputs to total cost of cultivation (0.59) indicating the less dependence on external sources.

Composite Sustainability Index Among Different Combination of Enterprises in all the Categories of Farmers

The six components sited in Table 1 were added, after giving respective weightage obtained for each and then the composite sustainability index was formulated. Table 3 shows the mean composite sustainability index computed for different combination of enterprises among different categories of farmers.

Among the marginal farmers Crop + Dairy + Sheep + Forestry (C + D + Sh + F) system had the highest composite sustainability index of 0.64 indicating the sustainability of this combination of the enterprises compared to other combinations. In small farmers C + D system had higher composite sustainability index (0.55) followed by C + D + S (0.47). The medium farmers had higher composite

Table 3
Composite sustainability index among various combinations of enterprises under different categories of farmers

Sl. No.	*Farming systems*	*Marginal farmers*	*Small farmers*	*Medium farmers*	*Large farmers*
1.	C + D	0.24	0.55	–	0.52
2.	C + D + S	0.27	0.47	0.60	0.45
3.	C + D + Sh + F	0.64	0.42	–	–
4.	C + D + P + Sh + F	–	0.42	0.58	0.25
5.	C + D + S + P + Sh	0.18	0.28	0.78	0.58
6.	C + D + S + P + Sh + F	–	–	0.56	0.50

Note: C = Crop, D = Dairy, S = Sericulture, P = Poultry (unit), Sh = Sheep (unit), F = Forestry

sustainability index for C + D + S + P + Sh system (0.78) followed by C + D + S system of 0.60. Lastly, in case of large farmers, C + D + S + P + Sh and C + D system had composite sustainability index of 0.58 and 0.52, respectively.

Mean sustainability index of different categories of farmers

The average sustainability index among different categories of farmers are calculated and presented in Table 4. The sustainability index were calculated for each category as a whole irrespective of the combinations of enterprises and it was found that the medium farmers had higher sustainability index of 0.87 followed by the small farmers (0.78) and marginal farmers (0.71) indicating that medium farmers contributed more to the sustainable agriculture. Higher sustainability index of medium farmers was due to higher profitability level, higher amount of eco-friendly inputs and owned inputs to total cost of cultivation. The farming systems under large farmers were relatively unsustainable.

The ranking of the components forming the sustainability index by experts showed that Benefit-Cost ratio was given the highest relative importance compared to other components followed by plant protection chemicals productivity and fertilizer productivity. Cost of eco-friendly inputs to total cost of cultivation and cost of owned inputs to total cost of cultivation were given equal importance and finally the gross income per unit.

Table 4
Composite sustainability index of farming systems among different categories of farmers

Sl. No.	*Category of farmers*	*Sustainability index*
1.	Marginal farmers	0.71
2.	Small farmers	0.78
3.	Medium farmers	0.87
4.	Large farmers	0.56

CONCLUSION

The sustainability index calculated for different categories of farmers indicated that the medium farmers were more sustainable with the highest Composite sustainability index followed by small and marginal farmers. Higher sustainability index of medium farmers was due to higher profitability level, higher amount of eco-friendly inputs and owned inputs in total cost of cultivation and hence they contributed more to sustainable agriculture.

The farming systems followed by large farmers were relatively unsustainable. Among the different combination of enterprises in all the categories of farmers, it was found that Crop + Dairy + Sheep + Forestry system in marginal farmers, Crop + Dairy system in small farmers and Crop + Dairy + Sheep + Poultry + Sheep in medium and large farmers had a greater sustainability index.

REFERENCES

Anonymous, (2005), Farming system modeling: Resource management for sustainable agriculture in Eastern dry zone of Karnataka, the project report submitted to Indian Council of Agricultural Research, New Delhi, P. 194.

Boggia, A. and Abbozzo, P., (1998), *Assessing sustainability in agriculture: A multicriteria approach.* Paper presented at Sixth Joint Conference on Food, Agriculture and Environment, Menneapolis, Minnesota, August 31 September 2, 1998.

Garret, H. E., (1952), *Statistics in psychology and education.* Longman Green and Company, New York.

Harrington, L. W., (1992), Measuring sustainability and alternatives. *Journal of farming system research and extension*, **31**(1): 3-20.

Somashekarappa, H. E., (2002), An economic study of appropriate farming system models for sustainable agriculture in Kolar district of Karnataka. *M.Sc. (Agri) thesis (unpublished)* submitted to the University of Agricultural Sciences, Bangalore.

Sreenivas, B.T., (2000), Implications of biodiversity on and around farms: A study of economic sustainability of farms and Intersectoral linkages. Unpublished M. Sc. *thesis* submitted to the University of Agricultural Sciences, Bangalore.

Stenholm, Charles, W., Waggoner, Daniel, B., (1990), Lower-input sustainable agriculture-Myth or Method? *Journal of Soil and Water Conservation*, **45**(1): 13-17.

❍❍❍