Tropical Agricultural Research Vol. 9 1997, 330-339

Behavioural Determinants of Sustainable Rice Farming

M.J.C. Gowda and K.M. Jayaramaiah[1]

Indian Institute of Horticultural Research
Hessaraghatta, Bangalore – 560 089, India

ABSTRACT. *Sustainable farming as a concept has been widely used but rarely operationalized and measured as a variable. It is a complex phenomenon and hence has to be measured indirectly through indicators. In this case, sustainability of rice farming has been quantified with the help of nine indicators covering ecological, economic and social dimensions. Being a complex issue, sustainable farming ought to be influenced by several factors. An attempt has been made to identify the behavioural aspects of rice farmers that determine sustainability of rice farming. Two hundred rice growers representing canal irrigated, rainfed lowland, rainfed upland and tank irrigated (tankfed) rice ecosystems were studied for their performance on indicators of rice farming sustainability as well as 17 behavioural characteristics. Correlation, multiple linear regression and step-wise selection were used to identify the characteristics of farmers that have a significant role in managing their rice farms sustainably. Mean sustainability index values of the four ecosystems reveal that rainfed lowland is the most sustainable and rainfed upland is the least sustainable system. Farmers representing the most sustainable system were characterized by higher family education, smaller families, larger farm size, low rice farming intensity and moderate levels of motivation and strong linkage with extension system. The pooled data analysis indicated that attitude towards sustainable farming, rice farming commitment extension system link and innovativeness were the positive determinants of sustainable rice farming. On the other hand, economic motivation and rice farming intensity proved to be the negative determinants. The study indicates an increased role for the extension system to work closely with farmers to bring in favourable attitudes and commitment towards sustainable farming. Increased crop diversification may reduce the influence of negative determinants on sustainable farming.*

---

1 University of Agricultural Sciences, G.K.V.K., Bangalore - 560 065, India.

INTRODUCTION

India has greatly benefited by the 'green revolution'. The nation became self sufficient for food in a very short period. Milk, silk and livestock production increased at a fast pace. Buffer stocks improved to give confidence to the administrators to expand the public distribution system. But, of late, a question that is asked is: "achievement at what cost"? It is felt that economic considerations alone have occupied the centre stage relegating the equally and sometimes more important ecological and social considerations to the back stage. Thus arises a need for reorientation and rethinking on the approach to farming.

Sustainable farming has been widely welcomed because of its regional orientation, emphasis for farm level input sufficiency and output efficiency and because of its equal recognition to ecological, economic and social dimensions of farming. It is a complex phenomenon and hence a composite index consisting of several indicators only can give a realistic estimate.

Agricultural sustainability in general and rice farming sustainability in particular, of a region, state or nation, depends very much as how each farm is managed. Sustainable management of rice fields is influenced by several factors among which farmers' behavioural aspects play a significant role. Many a times, ecological and economic considerations are influenced by opposite behavioural patterns. Hence an attempt has been made to study the characteristics of rice growers in four rice ecosystems and to identify the factors influencing rice farming sustainability.

MATERIALS AND METHODS

Sustainable farming is a complex phenomenon which cannot be measured directly and hence measured through a set of indicators. Indicators were identified through scientific procedure (scanning of literature, discussion with professionals and practitioners, scrutinizing for operationalization and ease of measurement, and subjecting to judges rating). Nine indicators which were found relevant by more than two third of the judges were again subjected to experts' ranking to know the relative importance of these indicators in measuring sustainability of rice farming. Ranks were converted into scale values (Sj) by using Guilford (1954) technique. Information on nine indicators was collected with the help of standardized questionnaires. Score cards were prepared in consultation with experts in respective fields. Scores on indicators,

measured through different approaches and expressed in different units were brought to uniformity by converting into standard scores ($Zij = Xij\text{-}Min\ Xj / Max\ Xj - Min\ Xj$). Then, sustainability index values for each farmer were calculated by using the following formula.

$$S.Ii = \frac{\sum Zij.Sj}{Total\ Scale\ Value} \times 100$$

$$I = 1, \ldots\ldots, 200$$
$$j = 1, \ldots\ldots, 9$$

$S.Ii$ = Sustainability index value for i^{th} farmer
Zij = Standard scores of i^{th} farmer for j^{th} indicator
Sj = Scale value of j^{th} indicator
Xij = Raw score of i^{th} farmer on j^{th} indicator

The seventeen behavioural attributes were measured either by using already available scales or through the procedures developed for the study. Two hundred rice growers equally representing four ecosystems served as respondents. Sustainability of rice farming as dependent variable was subjected to correlation and regression analysis with 17 behavioural attributes as independent variables. Means of all the variables were tested for their differences among four systems by applying ANOVA test. Stepwise regression analysis was applied to delineate the significant variables and their extent of influence on sustainability of rice farming.

RESULTS AND DISCUSSION

The four ecosystems have been arranged in their order of sustainability (Table I). Rainfed lowland ecosystem with a mean sustainability index of 52.44 and rainfed upland ecosystem with a mean of 46.16 have occupied the 'most sustainable' and the 'least sustainable' positions. The differences among the four systems were marginal as it is evident from 0.05 level of significance for ANOVA test.

A closer look at the table reveals some of the behavioural attributes of farmers that could differentiate the most sustainable and the least sustainable rice ecosystem. Higher level of family education, small families, larger holdings, better socio-economic status, low rice farming intensity, moderate

Table 1. Distinctive behavioural profile of rice growers in different ecosystems.

	Ecosystems			
	Most sustainable	Moderately sustainable		Least sustainable
	Rainfed lowland	Canal irrigated	Tankfed	Rainfed upland
Mean sustainability index	52.44	51.65	50.86	46.16
Independent variables				
1. Family education (yrs.)	9.55	7.49	6.02	8.16
2. Family size (No.)	5.58	6.22	7.50	7.44
3. Farm size (ha.)	8.36	3.42	3.00	0.97
4. Socio-economic status (30)	19.60	18.84	18.32	18.34
5. Rice farming intensity (100)	43.45	73.67	60.69	73.64
6. Achievement motivation (30)	18.92	22.04	18.56	17.40
7. Economic motivation (6)	3.76	4.44	4.14	3.24
8. Extension system link	8.44	12.84	14.74	4.76

Values are averages for 50 farmers in each system.
Values in parenthesis indicate maximum possible on respective scales.

levels of achievement and economic motivation and strong linkage with the extension system are the characteristics of farmers belonging to the most sustainable system. Rice farming in India has always been a family affair and all the members need to possess certain level of education that enable them to take rational and timely decisions. All the members would be doing different activities at different times and the education empowers them to think and act according to the demand of the situation. Larger holdings which is a part of better socio-economic status provided ample scope for farmers to go for diversified crop and livestock enterprises resulting in increased sustainability. If commercial crops could provide economic stability, rotation of crops induces ecological stability. Exploitation of resource base is naturally reduced without affecting the family needs. On the other hand, smaller holdings are the bane of Indian agriculture which are neither economically viable nor offer social stability to the practising farm families. Low rice farming intensity is on obvious indicator of reduced pressure on land. It may also indicate crop

diversification which is an important factor that differentiate sustainable agriculture from others (Jackson, 1990). Crop diversity contributes to greater farm, regional and environmental sustainability (Lyson and Welsh, 1993).

Too high or too low scores in motivations like achievement motivation and economic motivation have proved to be detrimental to sustainability. Moderate levels of achievement motivation and economic motivation are necessary to keep farming moving as they can be powerful stimulants (Mosher, 1966). A farmer must have a vision of a better way of life, but expecting too much too soon certainly does not fall in line with sustainable farming. Low level of motivations make farmers to live far below their expectations and

Table 2. Correlation and regression coefficients of behavioural variables with sustainability of rice farming.

Sl. No.	Variables	Correlation	Regression	
		'r'	β	t
1	Age	0.186**	0.018	0.25
2	Rice farming experience	0.165*	-0.011	0.16
3	Family education	0.158*	0.006	0.05
4	Family size	0.096	-0.069	0.35
5	Farm size	0.212**	0.035	0.67
6	Decision making pattern	0.474**	0.070	1.37
7	Socio-economic status	0.229**	-0.092	0.65
8	Rice farming intensity	-0.292**	-0.053*	2.05
9	Achievement motivation	0.259**	0.307	1.40
10	Attitude towards sustainable farming	0.586**	0.313**	3.65
11	Economic motivation	-0.252**	-2.502**	4.45
12	Level of aspiration	0.076	-0.076	0.35
13	Innovativeness	0.386**	0.879*	2.26
14	Farming commitment	0.559**	0.416**	3.50
15	Value orientation	0.236**	-0.136	0.56
16	Linkage with extension system	0.288**	0.203	1.83
17	Linkage with research system	0.263**	-0.008	0.05

* Significant at 0.05 level
** Significant at 0.01 level

R^2 = 0.5454
F = 12.64**

capacities. Stronger extension linkage provides farmers an access to the latest developments in knowledge generating systems as well as the experiences of other farmers.

Table 2 brings out the relationship of the farmers behavioural attributes with their level of sustainable rice farming as indicated by correlation coefficients.

Except family size and level of aspiration, all the other 15 attributes had significant relationship with sustainability of rice farming. The regression coefficients indicate the influence of behavioural attributes on the dependant variable. Only five attributes showed significant influence, of which attitude towards sustainable farming, innovativeness and farming commitment had positive influence. Economic motivation and rice farming intensity had negative influence on sustainability of rice farming. All the variables put together explained 54.54% of the variation in the dependent variable.

When the same data were put to stepwise selection, in addition to the five factors, linkage with extension system was also found to possess significant influence as evident in Table 3. Six factors put together explained 52.71% of the R^2 value of 54.54%. Attitude towards sustainable farming alone contributed 34.35% followed by farming commitment with 7.59% and 4.29% due to economic motivation. The key attribute of an attitude is its evaluative dimension (Aizen, 1989). So, when a farmer possesses favourable attitude towards sustainable farming, the farmer would have naturally evaluated its positive and negative implications of practising the same on his farm. As Beus and Dunlop (1994) have proved in their attitude-behaviour relationship study, farmers attitude was the single most powerful variable that explained farmers overall behaviour. Strong attitudes are likely to bring about phenomenal changes to do a task with commitment. Accordingly, rice farming commitment has entered in the second step with an influence of 7.59 percent. It is a sort of dedication not only to earn a living but also to keep the resource base alive and to earn the living on a continued basis. As a study on crisis management (Gowda, 1991) has revealed, dedicated farmers with a strong desire to stay in farming would adapt themselves to precarious situations.

Economically highly motivated farm families tend to overlook long range utility of resources. They do not hesitate to use any amount of fertilizers and chemicals in order to produce more. This is exactly the scenario in irrigated ecosystem where an IRRI report (1993) states that "Some 10 million

Table 3. Step-wise selection of behavioural variables influencing sustainability of rice farming.

Sl. No.	Variables	Regression coefficient	Progressive R^2 value	R^2 value in each variable
1	Attitude towards sustainable farming	0.5861	0.3435	0.3435
2	Farming commitment	0.6099	0.4194	0.0759
3	Economic motivation	-2.3804	0.4623	0.0429
4	Linkage with extension system	0.2335	0.4888	0.0265
5	Innovativeness	1.0509	0.5118	0.0230
6	Rice farming intensity	-0.0572	0.5271	0.0153

R^2 = 0.5271 F = 35.86**

ha of highly productive irrigated rice lands - 10% of the total irrigated area planted to rice in the world - are showing signs of fatigue. Up to 40% more nitrogenous fertilizer is required to produce the same amount of rice as ten years ago".

Farmers who keep regular contact with extension system by participating in field days, field visits, exhibitions and agricultural fairs are likely to get exposed to practices of sustainable farming. They learn through sharing experiences of the fellow farmers and interacting with extensionists. The zeal to learn sustainable ways of rice farming comes in the form of innovativeness.

Economic motivation in a resource endowed situation like canal irrigated rice ecosystem (Table 4) lead to intensive farming with short-sighted approach. Earlier research studies have compared the relation and influence of economic motivation on consequent factors like farm productivity, economic performance and management efficiency and found a positive and significant relationship. However, economic considerations are only part of the larger concept of sustainability in which ecological and social considerations have been weighed prominently, and hence the reversed trend is justified here. Even under well endowed situations farming commitment may inhibit over-exploitation of the resource base. With all the temptations, committed farmers have resorted to sustainable farming because of long term considerations. Better socio-economic status is an indicator of better family education, large

holdings and livestock wealth among others. All these components must have acted independently or in combination to practice irrigated rice farming with ecological responsibility.

In rainfed low lands, favourable attitude towards sustainable farming and collective decision making pattern in families have contributed significantly for sustainable rice farming. In this particular ecosystem, farmers need not depend upon rice for economic gains as they have more remunerative plantation crops for the purpose. But these plantation crops need lot of labour, wherein wages are paid in the form of grain also, in addition to food. Such being the case, farmers need to keep their rice fields ever productive. Their co-existence with thick forest and wild life has made them to be nature-friendly in their approach to rice farming.

Table 4. Step–wise selection of behavioural variables influencing sustainability in different ecosystems.

Sl. No.	Variables	R^2 values for each variable			
		Rainfed low land	Canal irrigated	Tankfed	Rainfed up land
1	Attitude towards sustainable farming	0.6692	-	-	0.5799
2	Farming commitment	-	0.1370	0.5393	-
3	Economic motivation	-	-0.4888	-0.0707	-
4	Socio-economic status	-	0.0535	-	-
5	Decision making pattern	0.0542	-	-	-
6	Rice farming experience	-	-	0.0366	-

The farm families of this particular ecosystem differ from other systems in their involvement and participation in farming activities which has been reflected in collective decision making. Collective decisions are more likely to be rational as they emanate out of the consensus reached among members of a family having divergent views. Such decisions enhance commitment among family members to practice farming activities single-mindedly. So, the influence of collective decisions driven by favourable attitudes on sustainable farming is well understood.

The lonely influence of attitudes in rainfed uplands may be because of the weak influence of other motivational aspects. Uplands are generally low productive and farmers must have avoided putting much pressure on resource base. Their limited aspirations and motivations must be the consequence of such an understanding. In the tankfed system, farmers' rice farming commitment, economic motivation and rice farming experience have shown significant influence on sustainability of rice farming. The role of first two factors has already been adequately justified in some other context. Experience makes man perfect. As Dale (1961) has theoretisized in 'cone of experience', farmer as a learner would gain mastery through broad based experiences. Tankfed rice farming is the most uncertain of the four systems under study. If it is true that tankfed rice farming needs wide ranging adaptability than other systems, then it is also true that experience plays a vital role. Tanks may or may not get filled up, may get filled early but may not last if further rains fail, may get filled up late, sometimes so late that crop is never transplanted. The farmer would have allocated the resources but utilization may not get materialized. Years of experience of one or the other kind makes the farmer a judicial decision maker. As Barnett (1953) has remarked, a farmer is never again what he was before experience, because it in someway becomes part of them. Experiences condition farmers to behave in a way that their resources do not go waste which is the crux of sustainable farming.

CONCLUSIONS

Rice farming in the four ecosystems is only moderately sustainable. Profile analysis of the respondent farmers reveals that farmers belonging to 'most' and 'least' sustainable systems were differing at least on eight characteristics which gives us a hint that behavioural aspects do have a role in sustainable management of rice fields. Pooled analysis revealed that favourable attitudes, strong commitment and linkage with extension system influence rice farming sustainability positively. The negative influence has come from economic motivation and rice farming intensity. The dual role for the policy makers and extensionists is well defined in the form of building favourable attitudes and farming commitment through meaningful extension contacts on one hand and to educate farmers on the adverse effects of thinking only of the economic return from rice farming.

ACKNOWLEDGEMENTS

The senior author acknowledges the Director, Indian Institute of Horticultural Research for granting study leave to complete the studies.

REFERENCES

Ajizen, I. (1989). Attitude structure and behaviour. *In*: Pratkanis, S., Buckler and Green World, A. (Eds). Attitude Structure and Function, Hillsdale, NJ : Lawrance Erlbaum Associates.

Barnett, H.G. (1953). Innovation : The Basis of Cultural Change, McGraw Hill Book Company Inc., New York.

Beus, C.E. and Dunlop, R.E. (1994). Agricultural paradigms and the practice of agriculture. Rur. Soc. 59(4): 620-635.

Dale, E. (1961). Audio-visual Methods in Teaching. Holt. Rinlhart and Winston Inc., New York.

Gowda, B.L.R. (1991). Crisis management by farmers - An analysis, Ph.D. Thesis (unpub), University of Agricultural Sciences, Bangalore.

Guilford. C. (1954). Psychometric Methods, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

IRRI. (1993). Rice in Crucial Environments, Int. Rice Res. Inst., Philippines.

Jackson, W. (1990). Making sustainable agriculture work. *In*: Clark, R. (Ed). Our sustainable table, North Print Press, San Fransisco.

Lyson, T.A. and Welsh, R. (1993). The production function, crop diversity and the debate between conventional and sustainable agriculture. Rur. Soc. 58(3): 424-439.

Mosher, A.T. (1966). Getting Agriculture Moving : Essentials for Development and Modernization, Frederick A Praeger Publishers, New York.