



Development and application of an integrated sustainability index for small-holder dairy farms in Rajasthan, India



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ABSTRACT

In agrarian economy of developing nations like India, smallholder dairy production is an important enterprise and its sustainability is vital for ensuring livelihood and nutritional security to the masses. Studies on methodological aspects of farm sustainability at micro-level are limited, either confined to a particular dimension of sustainability or based on complex data requirement which is not feasible to obtain in the context of smallholder dairy farms. This study has developed a multi-attribute farm level sustainability assessment method encompassing economic, social and ecological dimensions of sustainability and has applied it to assess the sustainability of dairy farming in north-western part of India. Based on data from 120 dairy farms located in rural area of Jaipur district from the state of Rajasthan, the study computed the composite Sustainable Dairy Farming Index (SDFI). The overall substantiality status of the smallholder dairy farms in the study area was not encouraging, implying that it may not be viable for future generation to take up the enterprise. Among the three dimensions of sustainability, the average scores of ecological dimension were highest followed by the economic and social sustainability scores. Some of the core attributes like feed productivity, management of animal genetic potential and gender equality are particularly weak aspects of the dairy production system in India. The direct relationship of economic sustainability with herd size suggests for farmers with very small herds (one to two) animals, increasing the number of dairy animals to about five to six, would be a good strategy to economize on input costs and generate more marketed surplus of milk.

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1. Introduction

The issue of sustainability of agriculture came under the spotlight after publication of the Brundtland Commission Report (WECD, 1987). The sustainability of agricultural system can be evaluated in terms of its ability to maintain certain well-defined level of performance over time, and enhance the same through linkages with other systems without damaging the ecological integrity of the system (Jodha, 1991). The FAO (1991) defined sustainable agriculture very comprehensively as, “The management and conservation of resource base and the orientation of technological and institutional changes in such a manner as to ensure the attended and continual satisfaction of human need for present and future generations. Such development is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.”

Although many definitions for sustainable agriculture can be found in literature, yet there is a broad consensus that a holistic appraisal of sustainability should integrate its ecological, economic, and social dimensions (Becker, 1997; Häni et al., 2003; Van Calker et al., 2006). Accordingly, a more precise operational definition of sustainability is necessary to work at the farm level. Many publications, pertaining to the sustainability of farms (Andreoni and Tellarini, 1999; Bonny and Vijayaragavan, 2001), consider an enterprise to be sustainable if its development contributes to societal sustainability, that is, the farms adopt practices that enable a sustainable use of resources at the societal level. However, in doing so, they overlook the possibility that an enterprise itself can also be developed in a sustainable or unsustainable way. Mann and Gazzarin (2004), therefore, emphasize that at the farm level, the sustainable development of an enterprise implies that it is managed in a way that allows the next generation to take it over.

In order to make the concept of agricultural sustainability operational, the development of its indicators is an essential tool. The total factor productivity (TFP) growth is a widely used indicator for drawing inferences about the sustainability of the agricultural

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system (Ehui and Spencer, 1990; Whitaker and Lalitha, 1993; Kumar et al., 2004; Kumar and Mittal, 2006). The other indicators considered by the studies for the economic performance include, cash flow, investments, farm income, etc. (Häni et al., 2003; Sydorovych and Wossink, 2007); while, the environmental and social attributes of agricultural sustainability are reflected in soil health, status of water resources, air quality, health condition of workers, provision of safe food, and several other indicators (Jha, 2004; Girardin et al., 1999; Taylor et al., 1993; Rigby et al., 2000; Ikerd, 2006).

The micro-studies on agricultural sustainability have largely focused on the crop production enterprises, while those pertaining to dairy farms are limited, particularly in the context of small-holder dairy production system prevalent in India and other developing countries. Most of the studies on dairy enterprise (Berentsen et al., 1998; Van Huylenbroeck et al., 2000; Van Calker et al., 2004, 2005) have covered only the economic and environmental aspects of dairy farming, while few (Häni et al., 2003; Mann and Gazzarin, 2004) have developed models for sustainability assessment of dairy at farm level covering all three main dimensions of sustainability. Response-Inducing Sustainability Evaluation (RISE) approach developed by Häni et al. (2003) was used to evaluate Swiss mixed crop and livestock farms and Chinese dairy farms. Mann and Gazzarin (2004) constructed a composite index to analyze the sustainability of Swiss dairy farms.

In developing countries like India, where dairy farming is characterized by small herds of low producing dairy animals, managed mostly by family labor, under situation of input and capital constraints, and without any subsidy support from the government; the attributes of sustainability need to be defined in accordance with the prevailing bio-physical and socio-economic conditions in these nations. Therefore, the objectives of this study are: (1) to select the attributes of economic, social and ecological dimensions of sustainability in the context of small-holder dairy farming situation in developing countries; (2) to determine the indicators/yardsticks to measure the selected attributes; (3) to delineate a method to aggregate the various indicators to quantify sustainability and (4) to apply the model for assessing the sustainability of small-holder dairy farms in India.

Section 2 presents the attribute and indicators selected for sustainability assessment, and the approach adopted for constructing composite sustainability index. The subsequent sub-section gives a brief overview of the study area wherein the developed model has been applied. The third section presents and discusses the results of the study, followed by the concluding section.

2. Materials and methods

2.1. Selection of attributes and indicators of sustainability

The review of literature had explicitly brought out that a holistic approach of sustainability assessment should encompass all the three dimensions viz. economic, social and ecological aspects. Within each aspect of sustainability, attributes were identified and one or more measurable indicators for each attribute were selected (Table 1). The selection of attributes was based on two important criterion; one, the ability to measure each attribute on the farm by means of an indicator and two, the ability of the farmer and the farm system to influence the level of the attribute.

2.1.1. Economic indicators

The production of milk is the main economic activity on the dairy farms. The small-holder dairy farmers market raw milk without any value addition. Most of the farms do not maintain systematic

Table 1
Attributes and indicators for sustainability assessment of smallholder dairy farms.

Dimension	Attributes	Indicators
Economic	Production costs	• Cost of milk production
	Input productivity	• Labor productivity • Capital productivity • Feed productivity
Social	Family labor income	• Family labor income per capita relative to consumption expenditure per capita
	Gender equality	• Women empowerment measure
	Drudgery of work	• Carrying of weight • Sharing of work burden • Off days from work
Ecological	Animal waste management	• Proportion of dung production used for fuel
	Greenhouse gas emission potential	• Enteric methane emissions
	Maintenance of genetic potential of animals	• Adoption of scientific animal breeding practices

farm accounts which limit the choice of economic attributes and indicators.

Production cost reflects the profitability of dairy enterprise and ultimately the sustainability of the farm. Higher cost makes the enterprise less profitable, and hence, negatively affects sustainability of dairy farming. In the developing countries, the small-holder farmers are an unorganized lot with hardly any bargaining power in ascertaining the farm gate prices of milk. Hence, their ability to enhance net farm income is limited to controlling the cost of production. Therefore, instead of net farm income, production cost was taken as an attribute for measuring economic sustainability.

Input productivity indicates the efficiency of inputs used for producing milk. Higher productivity means more efficient use of inputs and therefore, greater economic sustainability of the farm. The indicators used were productivity of three major dairy inputs, viz. labor, capital and feed.

2.1.2. Social indicators

In developing countries, the dairy farms are mostly managed by family labor with predominant role of female workforce (Niamir-Fuller, 1994; Kristjanson et al., 2010). Mann and Gazzarin (2004) contend that when there is dominance of family farming in an enterprise that is carried out mostly in the countryside, the income of the entrepreneurs might be considered as a social indicator, as a sufficient income is one of the main reasons that farms keep working and, fulfil their social obligation of living in rural areas for supplying milk to the urban consumers. The criterion of “sufficient” income has been taken in relation to prevailing wage rate in the study area. On somewhat similar lines, Häni et al. (2003) also considered the relation between labor compensation on the farm and the minimum regional income to assess the social situation of family workers and employees. Taking the cue from these studies, the family labor income from dairy (FLI) was therefore, taken a social attribute. An indicator of its adequacy in per capita terms has been seen in relation to the average per capita consumption expenditure in the rural areas. The higher the per capita FLI vis-a-vis consumption expenditure, greater would be social sustainability of the enterprise.

As both, male and female workforce is engaged in dairying; gender equality is an important attribute of social dimension of sustainability. In patriarchic, highly male-centric social systems prevalent in most developing countries, when females are making important contribution to any enterprise, women empowerment is an obvious indicator of gender equality.

Another important attribute of social sustainability is the extent of drudgery of work involved in enterprise that is, the conditions

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