Sustainability Analysis of Farming Systems in Dry Tracts of Telangana: Evidence from Wanaparthy District

ABSTRACT

Aims: The study evaluates and compares the economic sustainability of prevailing farming systems in the dry tracts of Telangana using the Sustainability Value Index (SVI), with specific reference to Wanaparthy district.
Study Design: Cross-sectional farm-level economic analysis.
Place and Duration of Study: The study was conducted in Wanaparthy district of Telangana state during the agricultural year 2024-25.
Methodology: A multistage sampling technique was adopted. Wanaparthy district was purposively selected, followed by random selection of mandals and villages. A stratified proportionate random sampling technique was employed to select 150 sample farmers practicing two major farming systems, namely crops only and crops + dairy systems. Primary data were collected through personal interviews using a pre-tested schedule. Sustainability was assessed using the Sustainability Value Index (SVI), computed from average net income, maximum net income, and income variability measured through standard deviation and coefficient of variation.
Results: The results revealed substantial differences in economic performance and sustainability between the two farming systems. The crop + dairy farming system recorded significantly higher average net income and maximum net income compared to the crop-only system. More importantly, the integrated system exhibited lower relative income variability, as reflected by a lower coefficient of variation. Consequently, the Sustainability Value Index was notably higher for the crop + dairy system (0.38) than for the crop-only system (0.27), indicating superior economic sustainability. The integration of dairy farming provided regular and stable income flows, reduced dependence on seasonal crop income, and enhanced resilience against climatic and market risks prevalent in dryland agriculture.
Conclusion: The study conclusively demonstrates that crop–dairy integrated farming systems are economically more sustainable than crop-only systems in the dryland regions of Telangana. The higher Sustainability Value Index observed for the integrated system reflects not only superior income levels but also enhanced income stability arising from diversification and regular cash flows from dairy enterprises. These findings highlight the role of crop-livestock integration as an effective risk mitigation strategy in rainfed agriculture, where farm households are highly vulnerable to climatic and market uncertainties. The results provide strong empirical support for promoting integrated farming systems through appropriate policy interventions, extension services, and institutional support, with the aim of enhancing livelihood resilience and long-term sustainability of farm households in dryland areas.

Keywords: {Farming systems, Sustainability Value Index, crop–dairy integration, dryland agriculture, Telangana}

1. INTRODUCTION

Dryland agriculture occupies a significant share of India's cultivated area and supports the livelihoods of a large proportion of small and marginal farmers. These regions are characterized by erratic rainfall, limited irrigation infrastructure, fragile soils, and high production risks, leading to unstable farm incomes and livelihood insecurity. In such environments, the sustainability of agricultural systems depends not only on income levels but also on income stability and resilience to climatic and market shocks. (Rao, 2011; FAO, 2018). Farming systems research provides a holistic framework for analysing agricultural sustainability by integrating crops, livestock, resources, and farm households into a single analytical unit. (Ellis, 2000; Nambiar *et al*., 2010). Several studies have emphasized that integrated crop–livestock systems enhance income diversification, improve employment generation, and reduce vulnerability compared to specialized crop-based systems, particularly in rainfed regions. (Birthal *et al*., 2015; Singh *et al*., 2012).

Telangana, one of the youngest states of India, is predominantly semi-arid and highly dependent on monsoon rainfall. Wanaparthy district represents a typical dryland agro-ecosystem of the state (ICAR, 2019), with dominance of small landholdings, cultivation of paddy and groundnut, and increasing adoption of dairy farming as a supplementary enterprise. Despite the recognized role of integrated farming systems in stabilizing farm income, empirical evidence quantifying their sustainability performance at the micro level in dryland regions remains limited. Sustainability assessment using composite indices such as the Sustainability Value Index (SVI) enables evaluation of farming systems by accounting for both income magnitude and variability (Nambiar *et al*., 2010; FAO, 2011). Against this background, the present study attempts to assess and compare the sustainability of crop-only and crop + dairy farming systems in Wanaparthy district using SVI as an analytical tool. While farm income is often used as the primary indicator of agricultural performance, income alone does not adequately reflect the sustainability of farming systems, particularly in dryland regions where production and market risks are high (FAO, 2011). Sustainability in agriculture encompasses not only the level of income generated but also the stability and resilience of that income over time. Farming systems characterized by high income variability may expose farm households to greater vulnerability, even when average income levels appear satisfactory (Nambiar *et al*., 2010).

In this context, composite sustainability indices provide a more robust framework for evaluating farming systems by integrating multiple dimensions of economic performance. The Sustainability Value Index (SVI) is particularly useful as it combines average net income, income variability, and maximum income potential into a single measure, thereby capturing both income magnitude and stability (Nambiar et al., 2010; FAO, 2011). Previous studies have employed SVI to compare cropping systems, integrated farming systems, and livelihood strategies in rainfed and marginal environments, highlighting its relevance for policy-oriented sustainability assessment (Singh *et al*., 2012; Mandal *et al*., 2020).

Dryland regions such as Wanaparthy district of Telangana present an ideal setting for the application of SVI-based analysis. Frequent rainfall uncertainty, limited irrigation, and predominance of small and marginal landholdings amplify income risks, making sustainability a central concern for farm households (ICAR, 2019). In such environments, integration of livestock enterprises, particularly dairy farming, has been widely recognized as an effective strategy for stabilizing income through regular cash flows and diversification of livelihood sources (Ellis, 2000; Birthal *et al*., 2015; FAO, 2018). However, systematic empirical evidence quantifying the sustainability advantage of integrated farming systems at the micro level remains limited, particularly in the context of Telangana's dry tracts, thereby justifying the present study.

2. MATERIALS AND METHODS

2.1 Selection of Study Area

Wanaparthy district of Telangana state was purposively selected for the present study due to its representative dryland agro-ecological characteristics and predominance of rainfed agriculture. The district is characterized by erratic and uneven rainfall, limited irrigation coverage, and frequent exposure

to climatic and market risks, making farm households highly vulnerable to income instability. Agriculture in the district is largely dominated by cereal–oilseed cropping systems, with paddy and groundnut being the major crops, along with a growing prevalence of livestock-based livelihood diversification. The coexistence of crop-only and crop–dairy integrated farming systems under similar agro-climatic conditions provides an appropriate setting for comparative economic sustainability analysis. Hence, Wanaparthy district was considered suitable for examining the performance and sustainability of different farming systems in dryland regions of Telangana.

2.2 Sampling Procedure

A multistage sampling design was adopted for the selection of sample farmers. In the first stage, Wanaparthy district was purposively selected. In the second stage, three mandals were selected randomly from the district to ensure spatial representation. In the third stage, two villages were randomly selected from each selected mandal. In the final stage, farmers within each selected village were stratified based on the farming system practiced, namely crop-only and crop + dairy systems.

A stratified proportionate random sampling technique was employed to select farmers from each village in proportion to the relative prevalence of the farming systems. Accordingly, a total sample of 150 farmers was selected, comprising 105 crop-only farmers (70 per cent) and 45 crop + dairy farmers (30 per cent). This approach ensured adequate representation of both farming systems while maintaining proportionality across villages and mandals, thereby improving the reliability and comparability of the results

2.3 Data Collection

Primary data were collected through personal interviews using a well-structured and pre-tested survey schedule. The schedule was designed to capture comprehensive farm-level information related to socio-economic characteristics, landholding size, cropping pattern, livestock composition, input use, costs of cultivation, returns from crops and dairy enterprises, and household characteristics. Data on production and marketing constraints faced by farmers were also collected to supplement the economic analysis.

Prior to the final survey, the interview schedule was pre-tested in a non-sample village to ensure clarity, relevance, and consistency of questions. Necessary modifications were made based on the pre-test results. Data were collected through face-to-face interviews to improve accuracy and facilitate cross-verification of responses. Special care was taken to validate information on costs and returns through repeated probing and comparison with prevailing local practices and prices, thereby enhancing the reliability of the collected data.

2.4 Estimation of Sustainability Value Index

The sustainability of the prevailing farming systems was assessed using the Sustainability Value Index (SVI), a composite economic indicator that integrates income level and income stability into a single measure. The SVI was originally conceptualized within the framework of sustainability assessment to capture not only the magnitude of farm income but also the degree of variability associated with it, thereby reflecting the economic resilience of farming systems under conditions of uncertainty (Nambiar et al., 2010; FAO, 2011).

In the present study, the Sustainability Value Index was computed using the following formula:

$$SVI = \frac{ANI - (1.96 \times SD)}{MNI}$$

where:
ANI = Average Net Income (₹)
SD = Standard Deviation of Net Income (₹)
MNI = Maximum Net Income (₹)

The term *(1.96 × SD)* represents the confidence interval around the mean income, assuming a normal distribution, and serves to penalize farming systems exhibiting high income variability. As a result, systems with unstable or highly fluctuating incomes receive lower SVI values, even if their average income is relatively high. This feature makes the SVI particularly suitable for evaluating farming systems in risk-prone environments such as dryland agriculture, where income instability is a major concern.

In addition to the SVI, the coefficient of variation (CV) was calculated to assess the relative variability of net income across farming systems. The CV provides a standardized measure of dispersion and facilitates comparison of income stability between systems differing in income magnitude. Together, the SVI and CV offer a robust analytical framework for comparing the economic sustainability of alternative farming systems by jointly considering income level, variability, and risk.

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2.5 Rationale for Using Sustainability Value Index

The Sustainability Value Index (SVI) was selected as the primary indicator of sustainability in this study due to its ability to incorporate both income level and income variability in a single measure. Unlike conventional indicators such as net returns or benefit-cost ratios, SVI penalizes farming systems with high income variability, thereby reflecting economic risk faced by farm households. This feature is especially relevant in dryland agriculture, where year-to-year fluctuations in rainfall and output prices significantly influence farm income stability. By integrating average net income, standard deviation, and maximum net income, SVI provides a conservative yet comprehensive measure of economic sustainability. The inclusion of a confidence factor (1.96 × SD) ensures that systems with unstable income streams receive lower sustainability scores, even if their average income is high. Thus, SVI is well suited for comparative evaluation of farming systems under risk-prone environments

3. RESULTS AND DISCUSSION

3.1 Sustainability Performance of Farming Systems

The sustainability analysis revealed marked differences between the two farming systems. The crop-only system recorded a lower average net income and higher income variability due to dependence on seasonal crop production and exposure to rainfall uncertainty and price fluctuations.

In contrast, the higher SVI observed for the crop + dairy system reflects the stabilizing effect of dairy income, which reduces income volatility associated with rainfed crop production. Regular milk income provided a stable cash flow, reducing dependence on crop income alone. Consequently, the crop + dairy system recorded a higher Sustainability Value Index (0.38) compared to the crop-only system (0.27), indicating superior economic sustainability. The lower coefficient of variation observed in the integrated system further confirms its resilience under dryland conditions. These findings are consistent with earlier studies that reported improved sustainability of integrated crop–livestock systems in rainfed regions due to income diversification and risk buffering effects.

The sustainability performance of the two farming systems was assessed using the Sustainability Value Index (SVI), which incorporates average net income, income variability, and maximum income potential. The computed SVI values along with their components are presented in Table 1

Table 1. Sustainability value index of farming systems

Particulars	Crops Only System	Crops + Dairy System
Average Net Income (ANI) (₹)	37,000	1,36,000
Maximum Net Income (MNI) (₹)	83,000	2,95,000
Standard Deviation (SD) (₹)	15,800	48,500
Coefficient of Variation (CV) (%)	42.7	35.6
Sustainability Value Index (SVI)	0.27	0.38

Source: Field survey data 2024-25

It is evident from Table 1 that the crop + dairy farming system recorded a higher Sustainability Value Index (0.38) compared to the crop-only system (0.27). Although the integrated system exhibited higher absolute income variability, its substantially higher average and maximum net incomes resulted in lower relative variability, thereby enhancing overall economic sustainability.

The Sustainability Value Index values presented in Table 1 reveal a clear distinction between the two farming systems. The crop-only system recorded a lower SVI value (0.27), reflecting moderate average income combined with relatively high-income variability. Dependence on seasonal crop production and exposure to rainfall uncertainty contributed to greater income fluctuations, thereby reducing overall sustainability. In contrast, the crop + dairy system recorded a higher SVI value (0.38), indicating superior economic sustainability. Although absolute income variability was higher in the integrated system due to larger income magnitude, the relative variability, as measured by the coefficient of variation, was lower. This highlights the stabilizing effect of dairy income, which provides regular cash flows independent of cropping seasons. The results demonstrate that integration of dairy farming not only enhances income levels but also improves income stability, a critical determinant of sustainability in dryland regions.

These findings are consistent with earlier empirical studies that reported higher sustainability of integrated farming systems compared to specialized cropping systems in rainfed areas (Nambiar et al., 2010; ICAR-IIFSR, 2018). The predominance of buffalo-based dairy farming in the study area further strengthens sustainability due to higher milk fat content, better market prices, and adaptability of buffaloes to local climatic conditions.

3.2 Implications of Dairy Integration on Sustainability

Dairy integration played a crucial role in stabilizing farm income by providing daily or periodic returns independent of cropping seasons (Singh et al., 2012; Birthal et al., 2015). The use of crop residues as fodder and recycling of manure into crop production enhanced resource-use efficiency, contributing to sustainability. The predominance of buffalo-based dairy farming, adapted to local conditions, further strengthened the economic viability of the integrated system.

3.3 Implications of SVI Results for Dryland Agriculture

The higher SVI value of the crop + dairy system underscores the importance of enterprise diversification as a risk management strategy in dryland agriculture. In regions characterized by production uncertainty, farming systems that combine crop production with livestock enterprises are better positioned to withstand income shocks. The SVI results suggest that policies promoting integrated farming systems can contribute not only to income enhancement but also to income stabilization, thereby strengthening livelihood resilience.

The findings also indicate that sustainability gains from dairy integration are achievable even at small and medium landholding levels, provided adequate institutional support for animal health, fodder availability, and market access is ensured. Thus, SVI-based analysis provides valuable empirical evidence for designing targeted interventions aimed at enhancing sustainability of dryland farming systems.

4. LIMITATIONS

The present study, while comprehensive in scope, is subject to certain limitations inherent in farm-level economic analysis. The analysis is based on cross-sectional primary data collected for a single agricultural year, which may not fully capture inter-annual variations in production, prices, and climatic conditions. The study relies on farmers' recall and self-reported information regarding costs, returns, which may be influenced by recall bias and individual perception. However, efforts were made to minimize such bias through repeated cross-verification of responses, use of standard cost concepts, and careful scrutiny of collected data.

Furthermore, the analysis primarily focuses on the economic dimension of sustainability. Ecological and social dimensions such as soil health, water use efficiency, environmental externalities, and social equity were not explicitly incorporated due to data limitations. Despite these limitations, the methodological rigor and analytical framework adopted in the study ensure that the findings remain reliable and relevant for understanding the sustainability of farming systems in dryland regions.

5. CONCLUSION

The present study provides empirical evidence on the comparative economic sustainability of crop-only and crop + dairy farming systems in the dry tracts of Telangana, with specific reference to Wanaparthy district. The analysis clearly demonstrates that farming systems integrating dairy enterprises with crop production outperform crop-only systems in terms of income level, income stability, and overall sustainability. The higher Sustainability Value Index observed for the crop + dairy system highlights the stabilizing influence of dairy integration, which generates regular cash income and reduces dependence on seasonal crop production. While crop-only systems remain highly vulnerable to rainfall variability and price fluctuations, integrated systems benefit from income diversification and risk buffering, thereby enhancing livelihood resilience under dryland conditions. The lower coefficient of variation recorded for the integrated system further confirms its ability to mitigate income instability, a critical concern in rainfed agriculture.

The findings underscore the importance of enterprise diversification as a sustainable development strategy for dryland regions. Even under limited landholding conditions, integration of dairy farming with cropping activities can significantly improve economic sustainability without requiring expansion of land resources. The predominance of buffalo-based dairy farming in the study area further contributes to sustainability through better adaptability to local conditions and higher market value of milk. Overall, the study establishes that crop–dairy integrated farming systems offer a viable pathway for enhancing income stability, reducing vulnerability, and promoting sustainable agricultural livelihoods in dryland areas. The results provide strong empirical support for policy initiatives and extension efforts aimed at promoting integrated farming systems as a means of achieving long-term sustainability and resilience of farm households in rainfed regions of Telangana.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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