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Comparison of sustainability index of onion cultivation in selected districts of North Karnataka

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Abstract

Onion is one of the most important commercial cash crops cultivated across India, particularly in the northern districts of Karnataka, where it has long been an integral part of the farming system. However, increasing market price fluctuations, climate change and the need for efficient resource management have made sustainable onion cultivation a significant challenge. The present study assessed the sustainability of onion cultivation in selected districts of North Karnataka by developing a Sustainability Index (SI) encompassing three dimensions: environmental (production), economic and social sustainability. The findings revealed that the production dimension recorded relatively better sustainability across all three districts, with an overall sustainability index of 55.31, indicating a fair level of sustainability. Similarly, the economic dimension also achieved sustainability indices exceeding 50.00 in all the districts. In contrast, the social dimension recorded comparatively lower sustainability, with indices slightly above 40.00 across the study area, highlighting the need for greater emphasis on social aspects of sustainable farming. The study provides valuable insights for planners, policymakers, extension professionals, administrators and other stakeholders to formulate appropriate interventions for enhancing the sustainability of onion cultivation. The findings will also serve as a useful reference for researchers and stakeholders in future studies and policy applications.

Keywords: Sustainability index, production dimension, economic dimension, social dimension

Introduction

Onion (*Allium cepa*) is one of the most important commercial vegetable crops cultivated by farmers across all categories in India. It is an indispensable ingredient in Indian cuisine and is widely used as a condiment in most households. The crop is valued for its green leaves, immature bulbs, and mature bulbs, all of which are consumed either raw or cooked. Onions are commonly eaten as salads and are prepared in various forms such as frying, boiling and roasting. In addition to fresh consumption, onions are processed into value-added products including pickles, powder, paste, flakes and dehydrated slices. Besides their culinary importance, onions possess significant therapeutic and medicinal properties, making them an economically and nutritionally valuable crop.

The major onion-producing states in India include Maharashtra, Madhya Pradesh, Karnataka, Rajasthan, Uttar Pradesh, Gujarat, Tamil Nadu, Andhra Pradesh, Telangana, Haryana, and Bihar. Among these, Maharashtra is the leading producer, contributing 13.66 million tonnes, which accounted for 43.13 per cent of the country's total onion production during 2021–22 (Anon., 2022). Karnataka ranked second in area under onion cultivation (0.23 million hectares) and third in production (2.77 million tonnes), with a productivity of 11.99 tonnes per hectare (Anon., 2022). Although Maharashtra, Madhya Pradesh, and Karnataka occupy the top three positions in onion cultivation in terms of area and production, Karnataka's productivity remains considerably lower than that of the other leading states. During 2021–22, the productivity of onion was 24.10 tonnes per hectare in Madhya Pradesh, 14.46 tonnes per hectare in Maharashtra, and only 11.99 tonnes per hectare in Karnataka, which is also below the national average productivity of 16.33 tonnes per hectare (Anon., 2022). This substantial productivity gap highlights the need for adopting improved cultivation practices to enhance onion production

In the state. The nation's onion production has significantly decreased, according to the Union Agriculture Ministry. According to the latest record, onion production dropped by 19.84% amounting to 242.15 lakh tones in 2023-24, as compared to 2022-23 amounting of 302.08 lakh tones. This marks a continuous decline over the past two years, with production falling by 23.59% since 2021-22 when it was 316.87 lakh tones.

The decrease in production has been notably severe in key onion-producing states. Maharashtra, the largest producer, experienced a 28% decline, producing only 86.02 lakh tones in 2023-24 compared to 120.33 lakh tones in the previous year. Karnataka saw a dramatic 38% reduction, with production falling from 26.65 lakh tones in 2022-23 to 16.38 lakh tones in 2023-24. Similarly, Madhya Pradesh reported a 20% decrease, with production down to 41.66 lakh tones from 52.62 lakh tones last year.

Inappropriate agricultural methods, input costs for production, inadequate facilities for storing, restricted availability of better onion seeds, Exorbitant transportation costs and market price fluctuations. These are the main causes of decline in the onion production. (agsure.in 2024) ^[1]. The increasing population and growing demand for onions, sustaining and improving productivity has become a major concern. Sustainable onion cultivation requires the adoption of appropriate production technologies, including the selection of suitable varieties, scientific tillage practices, balanced nutrient management, efficient fertilization, effective water management, integrated plant protection measures and proper harvesting and post-harvest management practices. Furthermore, challenges such as fluctuating market prices, increasing production costs, and the adverse impacts of climate change have made sustainable onion cultivation more complex and demanding.

Sustainability in onion cultivation refers to achieving higher productivity and profitability while minimizing adverse environmental and social impacts. It encompasses three fundamental dimensions: environmental sustainability, economic viability and social well-being. Assessing sustainability helps identify strengths and weaknesses in existing production systems and provides guidance for developing suitable interventions. In this context, the present study aims to compare the sustainability index of onion cultivation across selected districts of Northern Karnataka, thereby providing insights into the level of sustainability and the factors influencing it.

Materials and methods

The present study employed an ex-post facto research design. Three districts of Northern Karnataka, namely Vijayapura, Bagalkote, and Gadag, were purposively selected based on the highest area under onion cultivation. From each selected district, two taluks were chosen using the same criterion. Further, three villages were randomly selected from each taluk and 15 onion growers were randomly selected from each village, resulting in a total sample size of 270 respondents. In the present study, the sustainability of onion cultivation was operationally defined as the process by which farmers manage on-farm resources to enhance and sustain productivity while meeting the present and future needs of the farm and family without adversely affecting the production environment. A Sustainability Index (SI) for onion cultivation was developed following a systematic procedure. The development process involved item pooling, item scrutiny and judges' evaluation of the identified indicators. Indicators with a relevancy coefficient of 0.75 or above were

retained for inclusion under the production, economic and social dimensions of sustainability. Subsequently, an overall Sustainability Index was computed by integrating these dimensions. The developed index was tested for its reliability and validity to ensure its consistency and accuracy. Data were collected from the selected respondents using a structured and pre-tested interview schedule.

Results and Discussion

Dimension wise sustainable index of onion cultivation in northern dry zone of Karnataka.

Data in Table 1 reveals dimension wise sustainable index of onion cultivation. It clearly showed that the production dimension recorded sustainability indices above 50.00 in all the three selected districts, indicating a moderate level of sustainability in onion production practices. Among the districts, Vijayapura registered the highest production sustainability index (58.08), followed by Bagalkote (56.28) and Gadag (51.58). The overall sustainability index for the production dimension was 55.31, reflecting a fairly sustainable production system. The relatively higher scores may be attributed to the adoption of suitable onion varieties, improved methods of sowing and planting, and the implementation of integrated pest management practices by the farmers. These findings are in agreement with the observations of Pretty (2008) ^[6], who reported that the adoption of improved crop management practices enhances agricultural sustainability and productivity. Similarly, Rigby *et al.* (2001) ^[7] emphasized that technological interventions and efficient crop management practices significantly contribute to improving production sustainability.

The economic dimension also exhibited fairly sustainable performance across all the study districts, with sustainability indices exceeding 55.00. Vijayapura recorded the highest economic sustainability index (56.39), followed by Gadag (55.96) and Bagalkote (55.17), resulting in an overall economic sustainability index of 55.84. The better performance under this dimension may be attributed to higher input productivity, improved post-harvest management, and better marketing practices adopted by the farmers. Efficient utilization of production inputs and improved market access have been widely recognized as important determinants of farm profitability and economic sustainability. Similar findings were reported by Hayati *et al.* (2010) ^[4].

In contrast, the social dimension recorded comparatively lower sustainability indices across all the districts. Bagalkote achieved the highest social sustainability index (41.69), followed by Vijayapura (40.81) and Gadag (40.21), with an overall index of 40.90. The relatively lower social sustainability could be attributed to poor institutional support, limited access to extension services, inadequate farmer organizations, and insufficient resource ownership among the respondents. These findings corroborate the results of Hayati *et al.* (2010) ^[4], who emphasized that weak institutional support and limited social capital often constrain the social sustainability of agricultural systems. Strengthening extension services, farmer cooperatives, and institutional linkages could therefore improve the social sustainability of onion cultivation in the study area.

Comparison of dimensions of sustainability index of onion cultivation in Vijayapura district

The comparison of the sustainability dimensions presented in Table 2 revealed a highly significant difference among the production, economic, and social dimensions in Vijayapura district at the one per cent level of significance. The analysis

showed that the social dimension viceversa to recorded the highest mean score (43.65), followed by the production dimension (29.77) and the economic dimension (17.87). The calculated F-value (462.42) was significant, with a critical difference (CD) of 1.670, indicating that the differences among the three sustainability dimensions were statistically significant. The relatively higher mean score observed for the social dimension in Vijayapura district may be attributed to the farmers' lower dependence on external resources, better access to government schemes and institutional support, and greater awareness regarding sustainable onion cultivation practices. Since onion cultivation is both labour- and resource-intensive, farmers in the district might have effectively utilized subsidies, credit facilities, agricultural inputs, and extension services provided through various government programmes. Such institutional support and community participation are known to strengthen the social component of agricultural sustainability. The findings are in line with those of Hayati *et al.* (2010)^[4], who reported that social sustainability is greatly influenced by farmers' access to institutional support, extension services, and participation in local organizations. Similarly, Pretty (2008)^[6] emphasized that stronger institutional linkages, knowledge sharing, and community participation significantly enhance the sustainability of agricultural production systems by improving farmers' adaptive capacity and resource management.

Comparison of dimensions of sustainability index of onion cultivation in Bagalkote district

The comparison of sustainability dimensions for Bagalkote district, as presented in Table 3, revealed a highly significant difference among the production, economic, and social dimensions of sustainability. The social dimension recorded the highest mean score (36.42), followed by the production dimension (32.32) and the economic dimension (17.85). The analysis of variance indicated a highly significant F-value of 193.13, with a Critical Difference (CD) of 1.954, confirming significant variation among the three sustainability dimensions. The relatively higher mean score for the social dimension in Bagalkote district may be attributed to better access to information and technical knowledge regarding onion cultivation, as the district is one of the major onion-producing regions in the Northern Dry Zone of Karnataka. Farmers in the district are likely to possess greater experience in onion production and may rely more on locally available resources, thereby reducing dependence on costly external inputs. Such practices not only lower the cost of cultivation but also contribute to strengthening the social sustainability of the farming system through enhanced self-reliance and efficient resource utilization.

These findings are consistent with those of Hayati *et al.* (2010)^[4], who reported that access to knowledge, institutional support, and efficient utilization of local resources are key determinants of social sustainability in agriculture. Similarly, Pretty (2008)^[6] emphasized that farmers' knowledge, community participation, and reduced dependence on external inputs contribute significantly to the long-term sustainability of agricultural production systems.

Comparison of dimensions of sustainability index of onion cultivation in Gadag district

Dimension-wise comparison of the sustainability of onion cultivation in Gadag district (Table 4) revealed a highly significant difference among the sustainability dimensions at the 0.01 per cent level of significance. Among the three dimensions,

the social dimension recorded the highest mean score (33.60), followed by the production dimension (24.63) and the economic dimension (17.90). The analysis of variance yielded an F-value of 459.74, while the critical difference (CD) was 1.022, indicating significant variation among the dimensions.

The higher score observed for the social dimension may be attributed to the long-standing tradition of onion cultivation in the district. Since onion cultivation has been practiced for generations, farmers have acquired substantial practical knowledge and experience, reducing their dependence on external sources of information. This is further supported by the fact that more than one-third (37.74%) of the onion growers belonged to the old-age category, suggesting that experienced farmers relied more on their accumulated knowledge than on formal advisory services. Additionally, onion cultivation in Gadag district is predominantly rainfed, which encourages farmers to utilize locally available resources and indigenous management practices to minimize the cost of cultivation. These factors may have contributed to the relatively higher sustainability score under the social dimension compared to the production and economic dimensions.

Overall comparison of dimensions of sustainability index of onion cultivation

The comparison of the dimensions of the sustainability index (Table 5) revealed a significant difference among the production, economic, and social dimensions. The social dimension recorded the highest mean score (37.89), followed by the production dimension (28.91) and the economic dimension (17.87). The calculated F-value (698.87) was significant, with a critical difference (CD) of 0.924, indicating statistically significant variation among the three dimensions. The relatively higher mean score for the social dimension may be attributed to the fact that the majority of the respondents belonged to the middle age group, possessed moderate farming experience, and had attained a better level of education. Despite their relatively low income, they involved family members in onion cultivation, maintained regular contact with extension personnel, and utilized mass media as an important source of agricultural information, thereby enhancing their knowledge and adoption of sustainable onion cultivation practices. These findings are in agreement with the observations of Pretty (2008)^[6], who emphasized that farmer knowledge, social participation, and extension support are key determinants of sustainable agricultural development, and FAO (2014), which highlighted that education, access to extension services, and family labour significantly strengthen the social sustainability of farming systems.

District wise comparison of production dimension of sustainability index of onion cultivation

It was evident from Table 6 that the production dimension of the sustainability index of onion cultivation differed significantly among the three districts, namely Vijayapura, Bagalkote, and Gadag, at the one per cent level of significance. The highest mean production sustainability score was recorded in Bagalkote district (32.32), followed by Vijayapura (29.77) and Gadag (24.63). The calculated CD and F values were 2.187 and 24.851, respectively, indicating a statistically significant difference among the districts. The superior production sustainability observed in Bagalkote district may be attributed to the adoption of recommended production practices, including the selection of suitable varieties according to the season, use of quality seed from reliable sources, application of farmyard manure (FYM)

and micronutrients, and implementation of prophylactic plant protection measures. These practices contribute to improved crop productivity and long-term sustainability by enhancing soil fertility, optimizing nutrient use, and minimizing pest and disease incidence. Similar findings were reported by Umanath and Suresh (2019) ^[9], who observed that the adoption of improved production technologies significantly enhanced crop productivity and sustainability. Likewise, Kumar *et al.* (2018) ^[5] reported that scientific cultivation practices, balanced nutrient management, and integrated crop management interventions substantially improved vegetable productivity and resource-use efficiency.

District wise comparison of economic dimension of sustainability index of onion cultivation

The results presented in Table 7 revealed that there was no significant difference in the economic dimension of sustainability of onion cultivation among the three selected districts. This may be attributed to land productivity, which was approximately one-third in Gadag district and less than half in both Vijayapura and Bagalkote districts. Since land productivity is a key determinant of the economic sustainability of onion cultivation, the relatively low productivity levels might have contributed to the observed non-significant differences. Similar findings were reported by Sunita (2015).

District wise comparison of social dimension of sustainability index of onion cultivation

Table 8 revealed a highly significant difference in the social dimension of the sustainability index of onion cultivation among the three districts, namely Vijayapura, Bagalkote, and Gadag, at the one per cent level of significance. Among the districts, Vijayapura recorded the highest mean score (43.65), followed by Bagalkote (36.42) and Gadag (33.60). The analysis showed a critical difference (CD) of 1.348 and an F-value of 47.145, indicating significant variation in the social sustainability of onion cultivation across the study area. The higher social sustainability score observed in Vijayapura district may be attributed to the greater reliance of farmers on their own resources and accumulated farming experience rather than on external inputs, which helped reduce the cost of cultivation. Since nearly one-third of the onion growers belonged to the old-age category, their long-term experience in onion cultivation may have enabled them to adopt locally suitable and resource-

Table 1: Dimension wise sustainability index of onion cultivation

Sl. No.	Dimensions	Sustainability of onion cultivation			
		Vijayapura (n ₁ =90)	Bagalkote (n ₂ =90)	Gadag (n ₃ =90)	Overall (n=270)
		Index			
I.	Production dimension	58.08	56.28	51.58	55.31
II.	Economic dimension	56.39	55.17	55.96	55.84
III.	Social dimension	40.81	41.69	40.21	40.90

Table 2: Comparison of dimensions of sustainability index of onion cultivation in Vijayapura district n=90

Sl. No.	Dimensions	Mean	F Value	SEM	CD value
I.	Production dimension	29.77	462.42**	1.272	1.670
II.	Economic dimension	17.87			
III.	Social dimension	43.65			

** Significant at 1 per cent level * Significant at 5 per cent level
NS Non-significant

conserving practices. These experienced farmers were also likely to guide other family members in efficiently utilizing available farm resources and minimizing dependence on outside agencies. In addition, effective utilization of government schemes, subsidies, and extension support might have further strengthened the social sustainability of onion cultivation in the district. These findings are in agreement with Pretty (2008) and Kumar *et al.* (2018) ^[5, 6].

Comparison of overall sustainability index of onion cultivation in northern dry zone of Karnataka

The results presented in Table 9 revealed a highly significant difference in the overall sustainability index of onion cultivation among the three study districts at the one per cent level of significance. Vijayapura district recorded the highest overall sustainability index (91.31), followed by Bagalkote (86.60) and Gadag (76.13). The analysis showed a critical difference (CD) of 3.15, indicating that the differences among the districts were statistically significant.

The comparatively higher overall sustainability index of Vijayapura district may be attributed to its superior performance in the production dimension. Farmers in the district were found to adopt several recommended cultivation practices, including improved sowing and planting methods, application of organic manures along with balanced chemical fertilizers, use of protected irrigation systems, and timely implementation of both prophylactic and curative plant protection measures. Effective insect pest management and weed control through hand weeding as well as the judicious use of herbicides may have further contributed to enhanced productivity and sustainability. The adoption of these improved agronomic practices not only increased production efficiency but also promoted the long-term sustainability of onion cultivation. These findings are in agreement with FAO (2014), which emphasized that sustainable crop production depends on the adoption of integrated crop management practices, balanced nutrient application, efficient water management, and integrated pest management to enhance productivity while conserving natural resources. Similar results were reported by Kumar *et al.* (2018) ^[5], who observed that farmers adopting recommended production technologies, including improved irrigation, nutrient management, and scientific crop protection measures, achieved significantly higher sustainability in horticultural production systems.

Table 3: Comparison of dimensions of sustainability index of onion cultivation in Bagalkote district n=90

Sl. No.	Dimensions	Mean	F Value	SEM	CD value
I.	Production dimension	32.32	193.13**	1.488	1.954
II.	Economic dimension	17.85			
III.	Social dimension	36.42			

** Significant at 1 per cent level * Significant at 5 per cent level
NS Non-significant

Table 4: Comparison of dimensions of sustainability index of onion cultivation in Gadag district n=90

Sl. No.	Dimensions	Mean	F Value	SEM	CD value
I.	Production dimension	24.63	459.74**	0.779	1.022
II.	Economic dimension	17.90			
III.	Social dimension	33.60			

** Significant at 1 per cent level * Significant at 5 per cent level
NS Non-significant

Table 5: Overall comparison of dimensions of sustainability index of onion cultivation n=90

Sl. No	Overall	Mean	F value	SEM	CD Value
1.	Production dimension	28.91	698.87**	1.39	0.924
2.	Economic dimension	17.87			
3.	Social dimension	37.89			

** Significant at 1 per cent level

* Significant at 5 per cent level

NS Non-significant

Table 6: District wise comparison of production dimension of sustainability index of onion cultivation n = 270

Sl. No	Districts	Mean	F value	SEM	C D
1.	Vijayapura	29.77	24.851**	0.786	2.187
2.	Bagalkote	32.32			
3.	Gadag	24.63			

** Significant at 1 per cent level

* Significant at 5 per cent level

NS Non-significant

Table 7: District wise comparison of economic dimension of sustainability index of onion cultivation n = 270

Sl. No	Districts	Mean	F value	SEM	C D
1.	Vijayapura	17.87	0.012NS	0.201	0.559
2.	Bagalkote	17.85			
3.	Gadag	17.90			

** Significant at 1 per cent level

* Significant at 5 per cent level

NS Non-significant

Table 8: District wise comparison of social dimension of sustainability index of onion cultivation n = 270

Sl. No	Districts	Mean	F value	SEM	C D
1.	Vijayapura	43.65	143.51**	0.485	1.348
2.	Bagalkote	36.42			
3.	Gadag	33.60			

** Significant at 1 per cent level

* Significant at 5 per cent level

NS Non-significant

Table 9: Comparison of overall sustainability index of onion cultivation in the northern dry zone Karnataka n = 270

Sl. No	Districts	Mean	F value	SEM	C D
1.	Vijayapura	91.31	47.145**	1.131	3.15
2.	Bagalkote	86.60			
3.	Gadag	76.13			

** Significant at 1 per cent level

* Significant at 5 per cent level

NS Non-significant

Conclusion

The study concludes that onion cultivation in the selected districts of northern Karnataka exhibits a moderate level of sustainability. Among the three dimensions assessed, the production (environmental) and economic dimensions demonstrated relatively better sustainability, while the social dimension showed comparatively lower sustainability, indicating the need for greater attention to improving farmers' social well-being, access to institutional support, and capacity-building initiatives. The developed Sustainability Index proved to be an effective tool for assessing the sustainability status of onion cultivation and identifying areas requiring improvement. Strengthening sustainable production practices, enhancing market access, promoting climate-resilient technologies, and improving extension services can further enhance the overall sustainability of onion cultivation. The findings of this study provide valuable inputs for policymakers, agricultural planners, extension agencies, and researchers in designing appropriate strategies and interventions for achieving sustainable onion production in the region.

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