

Assessing the Economic Impact of Watershed Management in Kerala: Farmer Perspectives on Agricultural and Livestock Enhancement

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Received: 06 Oct 2023; Revised accepted: 30 Nov 2023; Published online: 19 Dec 2023

Abstract

The present study investigates the economic implications of Watershed Management in Kerala, with a particular emphasis on the perceptions of farmers on the influence on their livestock and agricultural operations. The study's analysis of the participants' perspectives shows that the community strongly supports programmes like Coconut Husk Burial and Earthen Bunds, which are in line with farmers' desires. Vermin composting and rabbit rearing, on the other hand, scored lower, indicating the need for programme modifications. The statistical research highlights the intricate interaction between perceptions and economic results by demonstrating that there is no significant correlation between perception scores and income variances. Women encounter barriers in obtaining these programmes, even though they are an essential weapon in the fight against water scarcity. Time restrictions cause participation to decline with time, but the study highlights the benefits of awareness campaigns. Middle-aged people work in agriculture; Panchayat oversee implementation; Krishibavan creates awareness. In order to promote sustainable agricultural practices for higher productivity and better livelihoods, the study highlights the relationship between program-provided loans and increased revenue and suggests tailored restoration measures.

Key words: Watershed management, Farmer perspectives, Livestock enhancement, Agricultural operations

The sustainable utilization of resources relies heavily on the efficient management of watersheds, especially where agriculture, livestock management, and environmental sustainability intersect. Watershed Development and Management Practices (WDMP) have become increasingly crucial in promoting the development of rural livelihoods and ensuring sustainable resource utilization [1]. Despite the widespread recognition of their significance, these practices are frequently overlooked. Hence, it is crucial to bridge this gap by evaluating the economic influence of watershed management in Kerala and understanding farmers' viewpoints on improving agricultural and livestock practices. Developing countries have been implementing watershed development and management activities to support their livelihoods, as these activities have the potential to improve and develop the socio-economic and natural resource base of degraded watershed areas [2]. A watershed refers to an area that channels water to a common outlet and facilitates the movement of water either through the surface or underground to a drainage system. It encompasses both the bio-physical and socio-economic components, including all natural resources, individuals, and their socio-economic activities within the boundaries of the drainage divide.

The size of a watershed can vary from a small region to thousands of square kilometres [3]. The development and management of watersheds aim to organize and regulate the utilization of land, water, and other natural resources within a watershed, ensuring the provision of goods and services while

minimizing any detrimental impacts on soil and watershed resources [4]. This process involves the intricate interactions between soil, water, and land on various levels, including socio-economic, human-institutional, and biophysical aspects.

Objectives of the study

- To analyze the participating farmers' perceptions regarding various activities implemented in the Watershed Management Programme.
- To identify key factors influencing farmers' attitudes and opinions toward the different aspects of watershed management initiatives.
- To evaluate the level of awareness and understanding among participating farmers regarding the impact of watershed management on agricultural and livestock activities.

Watershed management programme

The Watershed Management Programme is based on the idea of effectively managing resources within a watershed to achieve sustainable production without causing any harm to the environment. The natural and socio-economic components of watershed resources are of utmost importance in providing ecosystem services and ensuring the food, social, and economic security of individuals [5]. The agenda aims to address issues such as watershed degradation, improper land use, imbalanced cropping patterns, and soil erosion. By implementing this programme, land productivity is improved, water availability for irrigation is ensured, and there is an increase in the

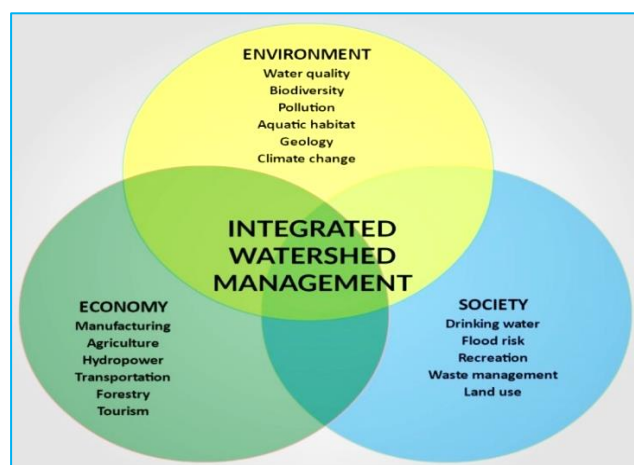
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Citation: Muhammed Navas K. A, Juliet M. 2023. Assessing the Economic Impact of Watershed Management in Kerala: Farmer Perspectives on Agricultural and Livestock Enhancement. *Res. Jr. Agril. Sci.* 14(6): 1963-1967.

availability of fodder, fuel, and fiber. The significance of adopting a watershed approach to development planning was recognized during the sixth plan, and pilot watershed development programmes were initiated in the early 1970s.

From an agricultural perspective, watershed management plans serve as blueprints for implementing measures to protect and restore the ecosystem, thereby sustaining agriculture. The scheme's objective is to restore the ecological balance by conserving and developing degraded natural resources such as soil, vegetation, and water. The outcomes of this project include the prevention of soil erosion, regeneration of natural vegetation, rainwater harvesting, and replenishment of groundwater. This enables the implementation of multiple cropping systems and the introduction of various agro-based activities, which in turn provide sustainable livelihoods for the people living in the watershed area. The projects are implemented in a comprehensive manner, focusing on family-based livelihood activities within specific clusters, with the aim of bringing significant relief to farmers.

The Watershed Development Project, supported by NABARD, aims to unify multiple Watershed Management Programmes into a single national initiative through the involvement of village-level institutions and project facilitating agencies. The primary goals of the program encompass various aspects such as maximizing productivity by efficiently utilizing resources and technologies, promoting organic farming, empowering women through agro-based self-employment initiatives, establishing a sustainable system for procuring and marketing agricultural produce with or without value addition, conserving and managing soil and water resources to mitigate drought and other natural disasters, and enhancing the capacity of human resources through skill development.



Source: <https://conservationontario.ca/Conservation>
Fig 1 Policy priorities of integrated watershed management

Watershed management initiatives mainly benefit the capacity, innovation and coordination of relevant institutions involved in investment preparation, governance, assessment, control, monitoring of watershed and erosion-related activities, as well as flood risk management. It will include climate action and mitigation elements that will help strengthen Africa's theoretical foundation for managing climate change and its ecological and environmental impacts. The ultimate goal of watershed management is to balance social, economic, and environmental watershed functions, contribute to long-term development, and minimize negative externalities in the area of operation. This assumes that the right policies, regulations and institutions are in place and respected at the local level. This objective establishes a framework for achieving key watershed management objectives, including maintaining beneficial use of

water resources and other related resources, achieving specific management objectives for water and related resources, and avoiding, identifying and avoiding adverse off-site impacts on water and related resources. It promotes social and economic growth conserves natural resources and the environment, reduces, or improves local vulnerability to climate change.

The above objectives for watershed management depend on the specific circumstances of each country and the priorities of higher-ranking development programs and projects. This includes, but is not limited to, the establishment of institutions that support the formulation and enactment of relevant policies and legislation. Controlling river flow can reduce riparian erosion, reduce sediment transport and accumulation, and improve water quality. Furthermore, this approach contributes to biodiversity conservation, regulation of aquatic habitats, and climate change mitigation/adaptation, as illustrated in (Fig 1). Also, controlling river flow can help prevent natural disasters like floods, erosion, weather, drought and landslides.

Whereas integrated watershed management utilizes natural resources effectively to mitigate negative impacts and consequences, prevent environmental degradation, enhance water yield, and promote biomass production. It advocates for appropriate agricultural and forestry land-use practices, along with soil and water conservation measures that ensure sustainable production levels while minimizing long-term detrimental effects on the watershed's natural resources. This approach fosters economic and human development by creating employment and income-generating opportunities. It also encourages the utilization of indigenous technical knowledge and materials through simple, accessible, and cost-effective technological solutions and institutional frameworks. By doing so, it significantly improves the economic and social conditions of the impoverished and resource-constrained individuals while also facilitating equitable distribution of the benefits derived from land and water resources development among all environmental stakeholders.

Some of the previous studies reveal that, the wetland development and management practices are widely recognized as a strategy to enhance the livelihood security of rural communities in various regions across the globe. By adopting a sustainable livelihood perspective, we can delve into the ways in which watershed development and management influence the lives of impoverished individuals and identify measures to mitigate any adverse effects [6]. The implementation of watershed development and management initiatives can enhance various capital assets based on the requirements of the local populace, such as bolstering food security, agricultural output, social amenities and infrastructure, employment opportunities, technology dissemination, and financial savings and credit [7].

In India, like in numerous other developing nations, a significant portion of agricultural land and rural inhabitants are concentrated in rain-fed regions that have already experienced an agricultural transition. With the diminishing prospects of enhancing productivity in more favourable areas, it becomes crucial to allocate resources towards the development of rain fed areas. These regions continue to face pressing challenges such as widespread rural poverty, water scarcity, and degradation of the resource base [8]. The degradation of watersheds is a significant issue in numerous countries across sub-Saharan Africa, primarily due to its impact on subsistence agriculture, which serves as the main source of livelihood for approximately 75 percent of the population [9].

Another study focus on the impact of extensive soil erosion on natural resources not only disrupts the bio-physical environment but also jeopardizes the agricultural livelihood of

the local population. To address this issue, a range of integrated watershed management intervention strategies have been implemented since 2008 through the Sustainable Land Management Program in partnership with international non-governmental organizations GTZ. These initiatives aim to mitigate land degradation and enhance agricultural productivity [10].

MATERIALS AND METHODS

This study concentrating Maleriumthodu watershed region, which falls under the jurisdiction of the Kottopadam Grama Panchayat, is primarily dedicated to agriculture. Spanning across 620 hectares, this area is characterized by hilly terrain, slopes, and soil erosion. The local population relies on three main occupations: agriculture, animal husbandry, and fishery. However, the majority of residents are impoverished farmers who face significant challenges in making a sustainable living. Unfortunately, the land in this region is not being utilized in a sustainable manner, leading to various issues. These challenges include limited access to drinking water, soil erosion, severe droughts, low agricultural productivity, declining prices of agricultural products, extreme weather conditions, and unscientific farming practices. To address these issues, the implementation of an effective Watershed Management Programme is crucial.

A simple random sample was utilized to collect data from 120 farmers in Kottopadam Panchayat where the Maleriumthodu Watershed Management program was conducted. Out of the 120 farmers, only 83 participated in the program while the rest were unaware of it. Therefore, the study focuses on the participation level of the farmers, making the population 83. Both primary and secondary data were collected, with interview and questionnaire methods used for the selected 83 farmers for primary data, and data from the Panchayat and Krishibavan for secondary data. The collected data was analysed using appropriate statistical tools such as the perception index and chi-square test. The perception index of each activity was calculated by assigning five points for a strongly agree response, four points for an agree response, three points for a neutral response, two points for disagree response, and one point for a strongly disagree response. The total perception score of a respondent was calculated by adding the score obtained for each activity.

The perception index of each activity of the watershed management program was calculated using the formula provided.

$$\text{Perception index (PI)} = \frac{\text{Score obtained by the respondent in an activity}}{\text{Maximum obtainable score}} \times 100$$

The Chi-Square analysis is a statistical method used to examine the relationship between factors, such as the association between gender and income. It is commonly employed to evaluate Tests of Independence through cross tabulation, which presents the distributions of two categorical variables simultaneously. The intersections of the variable categories are displayed in the cells of the table. The Test of Independence determines whether there is an association between the two variables by comparing the observed pattern of responses in the cells to the expected pattern if the variables were independent of each other. By calculating the Chi-Square statistic and comparing it to a critical value from the Chi-Square distribution, we can determine if the observed cell counts significantly differ from the expected cell counts.

The formula for calculating the Chi-Square statistic is as follows:

$$\frac{\sum (f_o - f_e)^2}{f}$$

f_o Is the observed frequency (the observed counts in the cells) and f_e is the expected frequency if no relationship existed between the variables.

As depicted in the formula, the Chi-Square statistic is based on the difference between what is actually observed in the data and what would be expected if there was truly no relationship between the variables. The study participants' demographic composition reveals a significant gender disparity, with approximately 82 percent identified as male and around 18 percent as female. This gender skew emphasizes the prevailing gender dynamics within the agricultural sector in the study area, prompting a closer examination of how these imbalances may impact the experiences and outcomes of watershed practitioners. The income distribution among respondents highlights a predominant trend of low income, which can be attributed to factors such as low land productivity, poor soil fertility, and water scarcity. These challenges underscore the urgent need for targeted interventions to address the underlying agricultural constraints that contribute to the economic struggles faced by farmers in the study area.

RESULTS AND DISCUSSION

The primary occupations of the respondents are agriculture, animal husbandry, and fishery, indicating the agrarian nature of the community. This breakdown of occupations sets the stage for evaluating the specific impacts of the Watershed Management Programme (WMP) on these key sectors, providing insights into how the program aligns with and influences the predominant livelihood activities in the area. The disbursement of loans through the Panchayat, facilitated by the Watershed Management Programme, emerges as a noteworthy aspect of the financial landscape. Understanding the purposes for which these loans were obtained, mainly for agricultural and animal husbandry ventures, lays the foundation for assessing the effectiveness of financial support in bolstering targeted economic activities crucial for the community's livelihood.

The examination highlights a crucial problem in the form of water scarcity in the study area. This widespread challenge requires attention, as it has extensive implications for the productivity of agriculture and, consequently, the economic well-being of the farmers. Resolving this issue of water scarcity may require incorporating solutions into the broader strategies of Watershed Management Programs to ensure long-lasting impact. Analysis of land use patterns reveals that although all farmers in the study area possess cultivable land, there is significant variation in their cropping practices.

Approximately 39 percent engage in cross-cropped areas, 35 percent practice single cropping, and around 27 percent adopt double cropping. Understanding these differences provides valuable context for evaluating the diverse agricultural practices and their potential impact on the overall success of watershed initiatives. Lastly, the study observes that approximately 50 percent of farmers maintain a neutral stance towards the Watershed Management Programme. This neutral perception raises questions about the effectiveness and acceptance of the program within the community, prompting an exploration of factors influencing farmer attitudes and potential areas for program improvement.

The information displayed in the following table shows respondents felt about the various activities included in the

watershed programme. Earthen bunds, with a perception rating of 72.29, was the activity with the highest score, closely followed by coconut husk burial, with 71.81. Planting trees got 66.75 on the perception rating, whilst water percolation obtained a score of 60.83. Conversely, with a perception rating

of 34.46, Rabbit Rearing earned the lowest score. The activities with the lowest perception index scores were backyard poultry, building vermin compost, promoting organic kitchen, and fodder cultivation grassing, with scores of 37.79, 58.316, 57.11, and 56.39, respectively.

Table 1 Perception of participating farmers about the different activities of watershed management programme for improve the agricultural / livestock activities

Activity	Total score	Mean score	Perception index	Rank
Well renovation	272	3.28	65.54	5
Water percolation pits	283	3.41	68.19	3
Coconut basin and husk burial	298	3.59	71.81	2
Earthen bunds	300	3.61	72.29	1
Construction of vermin compost	242	2.92	58.316	6
Fodder cultivation grassing	234	2.82	56.39	8
Plating trees	277	3.34	66.75	4
Promotion of organic kitchen garden	237	2.86	57.11	7
Backyard poultry	156	1.88	37.79	9
Rabbit rearing	143	1.72	34.46	10

These results suggest that the practices of backyard poultry, fodder cultivation, grazing, and promoting organic kitchens should be adjusted to better suit the needs and preferences of farmers. To conclude, the diverse perception ratings assigned to different activities in the watershed program provide valuable insights into the preferences and attitudes of respondents. Earthen Bunds and Coconut Husk Burial have emerged as highly favoured practices, received the highest scores and indicated a positive reception from the community.

On the other hand, rabbit rearing received the lowest perception rating, suggesting a need for reconsideration or adjustment in its implementation. The lower scores associated with backyard poultry, building vermin compost, promoting organic kitchen, and fodder cultivation grassing highlight potential areas for improvement and adaptation to better align with the needs and preferences of farmers. Going forward, program planners and implementers should consider these perception ratings as crucial feedback, using them as a guide to

refine and tailor activities to enhance overall acceptance and effectiveness within the community. This participatory approach ensures that the watershed program not only addresses environmental concerns but also resonates with the local population, fostering a sustainable and mutually beneficial impact on both the ecosystem and the livelihoods of the farmers [11].

With four degrees of freedom and at 5 percent significance level, the P value of 0.10 was not significant. Out of the four respondents with a poor perception score, the data in the table shows that 9.09 percent had a high rise in income, 8% had a medium increase, and 2.13 percent had a low increase. Of the 26 respondents who scored in the middle, 0 percent reported a high-income rise, 40 percent reported a medium income increase, and 34.04 percent reported a low-income increase. Lastly, of the 53 respondents who scored highly, 90.01 percent reported a high-income rise, 52% reported a medium income increase, and 63.83 percent reported a low-income gain.

Table 2 Perception of the participating farmers about the activities of the watershed programme to improve the agricultural / livestock activity

Investment activity								
Increased in income	Perception of farmers						Total	
	Low		Medium		High			
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Low (7000-21000)	1	2.13	16	34.04	30	63.83	47	56.63
Medium (22000-36000)	2	8	10	40	13	52	25	30.12
High (37000-52000)	1	9.09	0	0	10	90.91	11	13.25
Total	4		26		53		83	

At four degrees of freedom and a five percent significance threshold, the Chi-Square test was used and the results showed that it was not significant. Consequently, the null hypothesis was accepted, and it can be said that there is no meaningful correlation between perceptions of the watershed program's influence on agricultural and livestock activity and higher income. In conclusion, the statistical analysis, conducted with four degrees of freedom at a 5 percent significance level, revealed a P value of 0.10, which was deemed not significant. Subsequent exploration of perception scores and their correlation with income changes among respondents further affirmed this finding [12].

Despite variations in perception scores—categorized as poor, middle, and high—no statistically significant association was found between these perceptions and income changes. The detailed breakdown of income rise percentages within each

perception category demonstrates a lack of consistent patterns or trends that could establish a meaningful relationship. Moreover, the Chi-Square test, also performed at four degrees of freedom and a five percent significance threshold, yielded non-significant results. This outcome led to the acceptance of the null hypothesis, reinforcing the conclusion that there is no substantive correlation between respondents' perceptions of the watershed program's impact on agricultural and livestock activities and the observed variations in income levels. These findings underscore the importance of considering multiple factors and nuanced perspectives when assessing the effectiveness of watershed programs. While perception scores may reflect individual attitudes, their connection to concrete outcomes, such as income changes, appears to be more complex. As watershed programs aim to enhance both environmental sustainability and socio-economic well-being,

future investigations could benefit from a more nuanced exploration of the intricate interplay between perceptions, program impact, and economic outcomes [13].

CONCLUSION

A thorough grasp of respondents' perspectives on the numerous initiatives under the watershed programme is provided by the perception analysis of these activities. Notably, the community overwhelmingly approved both Earthen Bunds and Coconut Husk Burial, as indicated by their highest perceived scores. These are well-respected practices that closely correspond with respondents' preferences and views. In contrast, the perception scores for Rabbit Rearing, Backyard Poultry, Creating Vermin Compost, Encouraging Organic Kitchen, and Fodder Cultivation Grassing were lower, indicating the need for programme modifications to better meet the requirements and preferences of farmers. This research highlights how crucial it is to match programme activities to community attitudes in order to increase acceptance and efficacy. A non-significant P value of 0.10 was found by statistical analysis, which included the Chi-Square test with four degrees of freedom at a five percent significance level. Subsequent investigation examining variations in income among participants with varying perception scores revealed no significant association. Although respondents who scored well on views of the program's influence on agriculture and livestock operations reported higher income increases, the lack of statistical significance indicates that perceptions of the program's impact on these activities do not consistently predict changes in income levels. This result emphasizes the necessity for a nuanced approach when assessing the complex effects of

watershed programmes on socioeconomic well-being and environmental sustainability. It also highlights the intricacy of the relationship between perceptions and tangible economic consequences. The programme for watershed management is an essential weapon in the battle against water scarcity. Current research indicates that farmers benefit from this programme. On the other hand, it has also been found that women frequently miss these programmes because of informational gaps, employment obligations, and domestic duties. In spite of this, participants in the watershed management programmes are receiving beneficial awareness-raising, training, and capacity-building opportunities. Although a lot of people were initially interested in attending these programmes, over time, participation has decreased due to a shortage of free time. The research findings suggest that individuals in their middle age primarily engage in agricultural activities. Krishibavan raises awareness about watershed management among farmers, but the actual implementation of these activities is carried out by the Panchayat. There seems to be no significant correlation between an increase in income and the perception of the effectiveness of the watershed program in enhancing agricultural and livestock activities. However, there is a correlation between the loan amount provided by the watershed management program and an increase in income. The restoration of various elements such as the well, water percolation pit, coconut basin, husk burial, and earthen bunds should be tailored to meet the specific needs and interests of the farmers. It should be feasible for farmers to obtain sufficient loans to support their farming operations. For farmers seeking to enhance productivity, improve their standard of living, and cultivate organic kitchen gardens, backyard chickens, and rabbits, vermin compost is the optimal choice.

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