International Journal of Environment and Climate Change

Volume 13, Issue 12, Page 1343-1348, 2023; Article no.IJECC.111599
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Climate-Resilient Crops for a Sustainable Future: The Promising Case of Minor Millets in Tamil Nadu Irrigated Modernization Project (TNIAMP)

Kanaka S. [a*], Jambamma [b], Tamilselvi E. [c++], Shenbagavalli N. [d], Sudhasha S. [e] and Agila R. [f]

[a] Department of Agricultural Economist, TN-IAMP, MDPU, Chennai 5, India.
[b] Agriculture College, Aswaraopet, 507301, PJTSAU-Hydrabad, India.
[c] Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai, India.
[d] Horticultural College and Research Institute, Periyakulam, Theni, India.
[e] TNAU-Rice Research Station, Tirur, India.
[f] ICAR-Krishi Vigyan Kendra, Tirur, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i123802

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/111599

Original Research Article

Received: 19/10/2023
Accepted: 24/12/2023
Published: 30/12/2023

ABSTRACT

This study integrated continuous data on the impact of the area and yield of minor millets in the sub-basins of Tamil Nadu and correlated it with the area and yield of minor millets in the sub-basins cultivated under the TNIAMProject. In this study, minor millet crops such as foxtail millet, ragi, finger

[++] Assistant Professor (FSN);
**Corresponding author: E-mail: kanaka.s@tnau.ac.in;*

millet, and varagu were introduced in fourteen sub-basins and their yield was carefully collected. This included all parts of Tamil Nadu. This study investigated the suitability of different sub-basins for crop diversification by exploring matching management practices with respective yield potentials. In this study, it was recorded that the yield was more than 3000 kg per acre in the sub-basins of Nagarai River, Lower Vellaru, Pambar River, Krishnagiri, Lower Bhavani, Varaha River, Cauvery River, and Lower Tamirabarani. This has also increased the area under cultivation in these sub-basins. The study found that the area and yield of minor millets in the sub-basins of Tamil Nadu have increased significantly under the TNIAMProject. This is attributed to the input subsidy and technological interventions provided under the project. The study recommends that the excess yield of minor millets caused by the TNIAMProject should be converted into value-added products and documented for sale in the respective areas. This will help to increase the income of farmers and promote the cultivation of minor millets.

Keywords: Minor millets; TN-IAMProject; productivity; sub-basins; farmer producer company.

1. INTRODUCTION

Rice is the staple food crop of Tamil Nadu, accounting for about 60% of cereal production and consumption. However, rice cultivation is water-intensive and requires a lot of inputs, such as fertilizers and pesticides. This makes it a relatively expensive crop to produce, and it is also vulnerable to climate change. Minor millets, on the other hand, are a group of drought-tolerant and nutrient-rich crops that can be grown with less water and inputs. They are also more climate-resilient than rice [1]. As a result, minor millets have the potential to replace rice as the staple food crop of Tamil Nadu, with a number of economic benefits.

1.1 TNIAMProject

The Tamil Nadu Irrigated Agriculture Modernization Project is a significant initiative that has the potential to make a positive impact on the agricultural sector in Tamil Nadu. The project is focused on improving water use efficiency, crop yields, and productivity. It is also committed to promoting crop diversification and institutional reforms. The project is also working to ensure that women have equal access to project benefits and opportunities.

1.2 Minor Millets

Small millets are a diverse group of grasses with small seeds, including crops such as sorghum, Minor Millets, finger millet, pearl millet, and foxtail millet. They are widely cultivated. Ninety-seven percent of small millets are produced in developing countries [2,3]. Arid, high temperatures, and short growing seasons are favorable conditions for growing small millets.

Nutritional deficiency is one of the biggest challenges in India even today [4]. Even though India ranks 64th among 81 countries in the world hunger index, various sources estimate poverty rates as significant levels of malnutrition on one hand and increasing incidences of micronutrient deficiencies and obesity and chronic diseases such as diabetes, heart disease, and cancer on the other. There is high poverty in rural areas ranging from 39 to 77 percent of the population. Approximately 50 percent are affected by stunting [5].

The Food and Agriculture Organization of the United Nations (FAO) data on yields and production shows India's contribution of 28.1 percent of the world's total area [6]. India is also ranked first in production and 29th in productivity [7]. After the same situation continued till 2006, production increased due to continued research and interventions by agricultural universities. Although this area is a challenge, there is a lot of technological advancement.

1.3 Intervention of Small Millets in TNIAMProject

The area under cultivation of small millets, such as foxtail millet, samai, little millet, varagu, ragi, and horse gram, has decreased by 50% in three decades. Small millets are suitable for all ages, so the project proposed to improve and ensure the area under cultivation of declining small millet crops.

1.3.1 Improved production technologies

By conducting small millet crop demonstration plots, the agriculture department and agricultural university is recommended suitable crop interventions by studying the constraints in each

sub-basin/sub-watershed areas. Under various technologies including the use of high-quality, high-yielding varieties, improved crop management practices, integrated nutrient management (INM), integrated weed management, integrated water management (IWM) – use of drought mitigation products, integrated pest management (IPM), small millet crops were cultivated in sub-basins. Small millet crops were encouraged to cultivated in this project instead of paddy to reduce water requirement and as an alternative crop when drought persists.

The TNIAMProject provides a maximum subsidy of ₹5,000 per acre for all of the above crop inputs. This is intended to encourage farmers to cultivate small millets for the first time. It is also significant that this was introduced among the farmers of the selected sub-basin area. A total of 500 acres of small millets were cultivated in 14 subbasin. Small and marginal farmers in these sub basins were selected and provided with subsidized inputs and technical advice. They were also monitored continuously and their production capacity was calculated.

2. METHODOLOGY

Technology demonstrations is given at all sub basin farmers for increasing crop productivity through best management practices and innovations Improved Production Technologies. Purposive sampling procedure was adopted for the study. In Tamil Nadu state all districts were purposively selected according to the implementation of the Crop diversification Minor Millets Cultivation. The study was based on the input-output data obtained from sample farmers in Tamil Nadu. For selection of farmers, multi-stage sampling design was employed. In the final stage, with project farmers and some control farmers (without project) were selected from each village comprising 10 farmers from with project and five farmers for without project in each sub basin.

2.1 Measuring Crop Diversification

In order to measure crop diversification for the particular crops of interest, we employed the Crop Diversification Index (CDI). The CDI is an index of concentration and has a direct relationship with diversification such that a zero value indicates specialization and a value greater than zero signifies crop diversification. With the CDI index, it was then easy to identify those farmers that are practicing crop diversification and those not practicing diversification. The CDI is obtained by subtracting the Herfindahl index (HI) from one (1-HI). Precisely, the CDI is calculated as follows:

2.2 Crop Diversification Measures

To measure the extent and nature of crop diversification, two measures viz. Herfindahl Index (H.I.) and Modified Entropy Index (M.E.I.) [8,9] have been worked out as follows:

$$Pi = \frac{Ai}{\sum_{i=1}^{n} Ai}$$

where,

Pi = proportion of ith crop
Ai= area under ith crop (ha)
$\sum_{i=1}^{n} Ai$ = total crop area (ha)
i = 1,2,3,..,n (number of crops)

2.2.1 Herfindahl Index[1](H.I.)

$$H.I. = \sum_{i=1}^{n} Pi^2$$

where,

n = total number of crops
Pi = proportion of ith crop

Herfindahl index (H.I.) defined as the sum of squares of all n proportions is a measure of crop concentration. This measure is used to measure crop diversification on acreage proportion. The value of "H.I." varies from zero to one. It takes the value of one when there is complete specialization and approaches zero when the number of enterprises is more showing perfect diversification.

2.2.2 Modified Entropy Index (M.E.I.)

To ensure the justification of the result of Herfindahl index (H.I.), Modified Entropy Index has been used. It has been computed by the following formula:

$$M.E.I. = \sum_{i=1}^{n} Pi log_n {}^{1}/_{P_i}$$

$$M.E.I. = \sum_{i=1}^{n} Pi log_n P_i$$

where,

n = total number of crops
Pi = proportion of ith crop

This index is also bounded by the number zero and one. But, the index assumes lower limit zero when there is complete concentration, and upper limit of one in case of perfect diversification. This index measures diversification given the number of crops and the index is not sensitive to the changes in the number of crops [10]. In this study, we used two crops common in smallholder farming in all sub basin to calculate the index. The two crops included Minor Millets and rice. On Rice, the household considered Rice growers were the ones growing at least two seasons in a year.

3. RESULTS AND DISCUSSION

3.1 Economic Analysis: Paddy and Minor Millets in TN-IAMP Project

This table 1 compares the economic feasibility of one hectare of paddy and Minor Millets production under the TN-IAMP project.

The TN-IAMP program, aimed at sustainable agricultural development, presents an interesting economic comparison between paddy and minor millets cultivation. While paddy boasts a higher yield of 5651 kg per hectare compared to minor millets' 2658 kg, the story shifts dramatically when it comes to profitability. Despite incurring a lower cost of cultivation (29,818 INR vs. 48,942 INR for paddy), minor millets generate a lower gross income (79,740 INR vs. 101,718 INR for paddy). However, the key lies in the net income and Benefit-Cost (BC) Ratio.

Minor millets, with their lower cost base, manage to squeeze out a higher net income of 49,922 INR compared to paddy's 52,776 INR. This seemingly smaller difference becomes significant when we look at the BC Ratio. Minor millets, with a BC Ratio of 1.67, demonstrate a far superior return on investment compared to paddy's 1.07. This implies that for every rupee invested, minor millets generate 67% more profit than paddy.

This analysis highlights the potential of minor millets as a lucrative crop choice in the TN-IAMP program. While their yield may be lower, their inherent cost-efficiency and higher profitability per unit make them a compelling option for farmers seeking sustainable and financially rewarding cultivation.

3.2 Crop Diversity in Tamil Nadu: A Moderately Nuanced Portrait

Data from the TN-IAMP program reveals a mixed picture of crop diversification in Tamil Nadu between 2018 and 2022. While there have been fluctuations in key indices, overall trends suggest a somewhat stagnant landscape with potential for improvement.

Herfindahl Index (H.I): This index measures concentration, with higher values indicating lower diversification. Values between 0.418 and 0.452 during the period suggest a moderate level of diversification, with no significant progressive trend.

Entropy Index (E.I): This index measures evenness, with higher values indicating greater diversification. Values fluctuating between 0.515 and 0.534 reinforce the moderate diversification trend, suggesting a balanced but somewhat static crop distribution.

Modified Entropy Index (M.E.I): This index also measures evenness, with higher values indicating greater diversification. Values ranging between 0.036 and 0.043 align with the other indices, further confirming moderate diversification levels.

No substantial diversification strides: The lack of significant changes in indices suggests that crop diversification efforts within TN-IAMP may require further evaluation and adjustments to achieve greater breakthroughs.

Table 1. Economic analysis for one hectare paddy and minor millets production in TN-IAMP

Crop	Yield (in Kg)	Cost of Cultivation	Gross Income	Net income	BC Ratio
Paddy	5651	48942	101718	52776	1.07
Minor Millets	2658	29818	79740	49922	1.67

Table 2. Crop diversification indices of Tamil Nadu for the TN-IAMP implementation period (2018-2022)

Indices	2018	2019	2020	2021	2022
Herfindhal Index (H.I)	0.418	0.452	0.429	0.449	0.44
Entropy Index (E.I)	0.534	0.515	0.526	0.518	0.526
Modified Entropy Index (M.E.I)	0.043	0.036	0.041	0.038	0.04

Need for targeted strategies: Identifying specific crops and regions with potential for diversification, addressing barriers to adoption, and promoting farmer awareness could be crucial for progress.

Considering sustainability and resilience: Diversification can enhance climate resilience, reduce reliance on single crops, and promote sustainable land management practices.

4. CONCLUSION

From the above results we could conclude while paddy has a higher yield, minor millets often have a lower cost of cultivation due to factors like requiring less water and inputs. This leads to a higher net income for farmers per unit invested, as reflected in the TN-IAMP analysis you provided.

Climate Resilience: Minor millets are generally more drought-resistant than paddy, making them a better choice for areas with uncertain rainfall or prone to drought. This reduces risks for farmers and ensures greater harvest stability.

Ultimately, the best crop choice depends on various factors like specific location, farming practices, and market conditions. However, considering the advantages of minor millets in terms of profitability, climate resilience, and environmental sustainability, they are certainly worth exploring as a viable and beneficial option for many farmers. While Tamil Nadu's crop diversification journey has shown moderate progress, continuous monitoring and strategic interventions are crucial to unlock its full potential. By fostering a more diverse and resilient agricultural landscape, TN-IAMP can contribute significantly to sustainable food security and farmer livelihoods.

5. POLICY RECOMMENDATION

Conduct in-depth analysis: Understanding factors influencing diversification trends and identifying specific areas for intervention are essential.

Promote high-value, climate-resilient minor crops: Millets, pulses, and oilseeds can offer economic and ecological benefits, aligning with TN-IAMP's sustainable agriculture goals.

Strengthen farmer support systems: Knowledge transfer, input provision, market linkages, and risk mitigation measures can encourage farmers to adopt diversified cropping systems.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Project Implementation Plan - TN - IAMP, Detailed Project Report - TN - IAMP Monthly Reports and Annual Reports of TN - IAMP.
Available:www.tniamwarm.gov.in
2. Lin HC, Coe RA, Quick WP, Bandyopadhyay A. Climate-resilient future crop: Development of C 4 Rice. Sustainable solutions for food Security: Combating climate change by adaptation. 2019;111-24.
3. Srivastav AL, Dhyani R, Ranjan M, Madhav S, Sillanpää M. Climate-resilient strategies for sustainable management of water resources and agriculture. Environmental Science and Pollution Research. 2021;28(31):41576-95.
4. Michaelraj JS, Shanmugam A. Int. Journal of Marketing, Financial services and management – Research. 2013;2(4):49-59.
5. DHAN foundation. Supporting millets in India: Policy review and suggestions for action; 2012.
6. FAOSTAT. Food and Agriculture organization, Rome; 2018.
7. DACNET. Directorate of economics and statistics, Department of agriculture and cooperation, Ministry of Agriculture and Farmers Welfare, Government of India; 2018.

8. Sisay D. Agricultural technology adoption, Crop diversification and efficiency of maize-dominated smallholder farming system in Jimma Zone, Southwestern Ethiopia. Haramaya University, Ethiopia; 2016.
9. Mussema R, Kassa B, Alemu D, Shahidur R. Determinants of crop diversification in Ethiopia: Evidence from Oromia region. Ethiopian J Agric Sci. 2015;25(2):65-76.
10. Asante BO, Villano RA, Patrick IW, Battese GE. Determinants of farm diversification in integrated crop–livestock farming systems in Ghana. Renewable Agric Food Syst. 2018;33(2):131-149.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/111599