

Evaluating the Effectiveness of the National Millet Mission in India

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ABSTRACT

Aims: To study the impact of NMM policies on the millet production and yield since their launch.

Study design: Evaluated by running relevant statistical tests on the data extracted from various government websites.

Place and Duration of Study: Global R-Hub, between November 2025 to April 2026

Methodology: This study uses data of Finger millet (ragi), Pearl millet (bajra), Sorghum (jowar) and an aggregate of the three for the 25 years - from 2000 to 2024. The data was arranged in time-series format for production ('000 tonnes), area ('000 Hectares), yield, average temperature and Minimum Support Price (MSP) of the top four states (Rajasthan, Karnataka, Maharashtra and Uttar Pradesh) only. Independent two-sample t-test and time-series regression models were run to determine if the policy had a change and what other variables affected the production and to what measure.

Results: T-tests showed insignificant yield improvements for finger millet (.8 P Value), while the rest showed significant improvement. Four regression models had mixed results with the policy co-efficient being the largest one (22.06 for overall production) while MSP was significant for Pearl millet only (.041). Temperature had a consistent negative coefficient while the insignificant yield improvement of Finger millet has also reflected in a low policy presence co-efficient of only 5.12.

Conclusion: The effect of the policy has been unevenly distributed with no significant impact on Finger millet. This stresses a crop-specific approach with the cooperation of the central and state government. Even with varied impact, the effect of structural support is highly significant for other crops while financial factors do not have a similar impact. This might indicate that

farmers are attracted more if the market is growing and not merely because of reduced costs. Lastly, the consistent negative co-efficient of temperature highlights the need to develop climate-focused policy.

Keywords: National Millet Mission, Bajra, Jowar, Ragi, Agricultural sustainability, Government policy effectiveness, Pearl Millet, Sorghum, Finger Millet

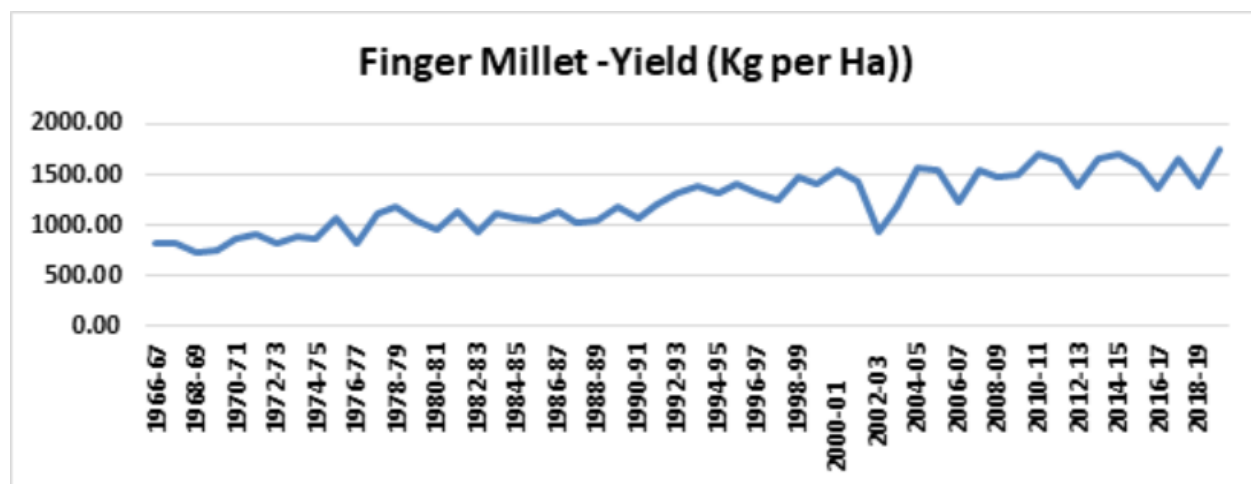
1. INTRODUCTION

Sustainable agriculture, particularly through climate-resilient, nutrient-rich millets, is a crucial area of interest for India's food security and nutrition amid climate change challenges and resource scarcity ((Philip et al., 2025), (Chauhan & Von Wehrden, 2025)). As a Karnataka native, where millets are an integral part of the daily diet, the researcher has observed a dramatic decline in millet consumption post-Green Revolution, despite their exceptional nutritional density (proteins, minerals, and fiber) and drought resilience compared to rice and wheat ((Bandyopadhyay & Patnaik, 2025), (Nelson et al., 2019)). This observation led to see the cause of the decline in consumption and if the trend is changing. An initial literature review revealed that millets thrive despite high temperatures and water scarcity, making them ideally suited to India's warming climate, a potential "Brown Revolution" to complement the Green Revolution's rice-wheat focus. Concurrently, the Government of India launched the National Millet Mission policy framework (2018 onwards, rebranded nationally as Shree Anna policy in 2023) under the National Food Security Mission framework ((Jain, 2024), (Gireesh et al., 2025)). This inspired the researcher to rigorously evaluate whether NMM policies have effectively reversed the decline in millet consumption in India's top millet-producing states, particularly in the selected states of Karnataka, Maharashtra, Uttar Pradesh, and Rajasthan, which together account for ~70% of national millet output (Banerjee et al., 2025).

Primarily, despite government promotion under Shree Anna/National Millet Mission, millet production in India's top four states - Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, accounting for ~70% of output (Factly. 2023, February)- remains significantly below maximum potential (Rajasthan achieves only ~45–55% of its maximum), with farmer incomes stagnating despite policy interventions since 2018 (NFSM-Nutri Cereals) and 2023 (Shree Anna rebrand).

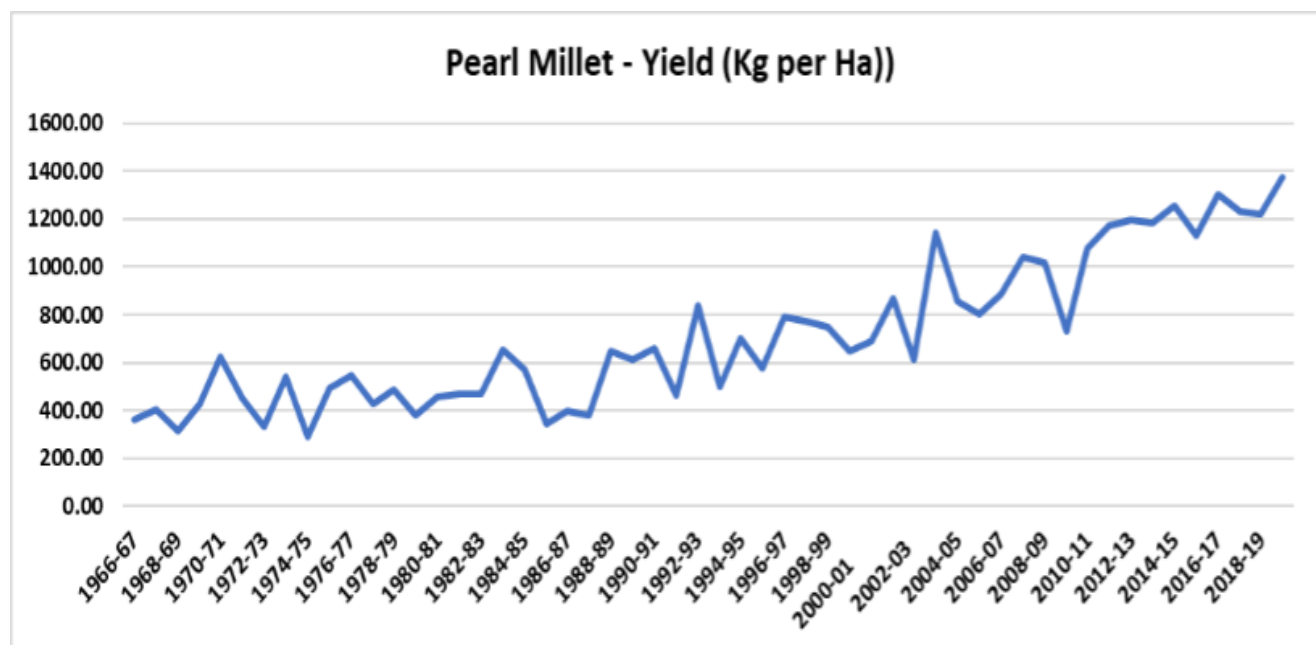
Secondly, a critical paradox emerges: while millet yields have increased (per hectare productivity rising ~20-30% in some states via improved varieties), cultivated area has decreased. This area-yield trade-off suggests weak demand - farmers are producing more per hectare but on shrinking acreage, implying constant or declining total production relative to potential.

Fig 1 – Finger Millet – Yield (Kg/Ha)



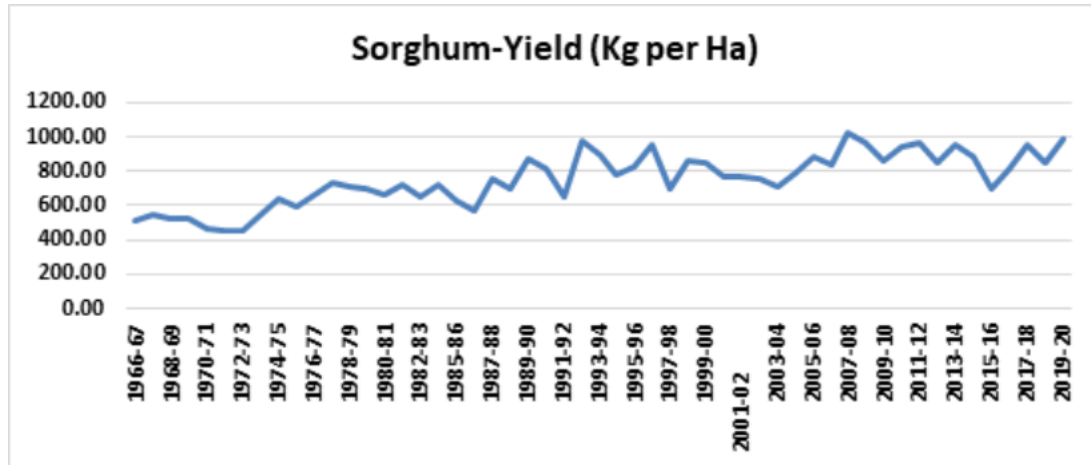
Source :- (Download Center | Millet Statistics by ICAR (Indian Council of Agricultural Research) & IIMR (Indian Institute of Millet Research)., n.d.)

Fig 2- Pearl Millet – Yield (Kg/Ha)



Source :- (Download Center | Millet Statistics by ICAR (Indian Council of Agricultural Research) & IIMR (Indian Institute of Millet Research)., n.d.)

Fig 3 – Sorghum Millet Yield (Kr/Ha)



Source :- (Download Center | Millet Statistics by ICAR (Indian Council of Agricultural Research) & IIMR (Indian Institute of Millet Research)., n.d.)

An important factor affecting demand is the price of substitutes. If the price of a substitute falls, the demand for our product should fall. So, including the prices of rice and wheat will show us if millets are seen as inferior with respect to these (Ansari et al., 2025).

As millets are climate-resilient crops essential for India's adaptation to global warming and nutritional security, a significant research gap exists in rigorous national-level causal evaluation, isolating policy effects from climate and economic confounders. This study addresses the issue using twenty-four years of data on area, yield, production, average temperature and MSP data via econometric methods.

As discussed above, millets are climate-resilient cereals which have been cultivated for the last 1,000 years. They are highly nutritious, and play a major role in food security. However, during the Green Revolution, with the rise in rice and wheat production, millet production declined. Countries like India, Nigeria and China account for 60% of the global output (Muskan et al., 2025). Using National Sample Survey Organisation (NSSO) data, it was found that socio-economic factors significantly affect pearl millet intake, and it was also observed that consumption is declining more among urban and affluent households (Ansari et al., 2025). Unfortunately, small millets, despite being climate-resilient crops that can combat hunger, malnutrition and climate- related risks, have not been fully recognised. They can be integrated into mainstream agriculture to unlock full potential. UN declared 2023 as International Year of Millets, aiming to promote Zero Hunger. India leads the global millets production, and due to its richness in antioxidants, vitamins, minerals, and bioactive compounds, along with low glycemic

index and gluten-free nature it can help prevent diseases such as diabetes and cardiovascular disorders (M. Mohanan et al., 2025).

Using 23 years of yield and weather data of Rajasthan in India across nine districts, a model was tested based on R-square and nRMSE which indicated that ensemble Elastic Net (ELNET) and individual random forest (RF) were the best-performing models. Some of the models outperformed ensemble in certain cases, and the finding suggested that location-specific model selection is crucial for accurate agricultural forecasting. ELNET was found out to be the most consistent model (Alsaber et al., 2025). Using long term field experiment data from Niger and Senegal to calibrate Agricultural Production Systems Simulator (APSIM) for pearl millet and rice, the model showed strong performance and accurate stability patterns across different variables like date, density, fertilizer and residue intension. It was found out that combining fertilizer with crop residue improved millet stability, while season-specific nitrogen reduced rice yield variability (Kouadio et al., 2025).

According to the life cycle assessment of 18 items across five food categories, it was suggested that shifting diets towards nutrient-rich grains like millet and sorghum could reduce environmental impact by 62-79% (Parvathy et al., 2025). In Nepal, a study analysed millet production trends from 1988 to 2019 using dynamic ordinary least square method. It was found out that fertilizer usage, cultivated area and rural population significantly impact production, whereas temperature negatively influences the production but insignificantly. It was also observed that climate change has not significantly affected millet yields, and it was suggested that due to millet's superior nutrition value and adaptability it can strengthen sustainable and equitable agri-food systems (Timilsina et al., 2025).

In Senegal, food security is a major concern due to poor soil, low rainfall, and the fact that 70% of the food is imported. Using the simulation models for millet, sorghum and rice it was found that improved nitrogen management can increase sorghum and millet yield by 40% -100 %, while fixation can boost the yield by 20% -100% (Baethgen et al., 2025). Since agriculture is the backbone of Indian economy, helping farmers for procurement, processing and marketing play a key role in supporting them. Using data of 450 millet farmers from 15 Farmers Producers Organization (FPO) across three states it was found using structural modelling and Matrice d'impacts croisés multiplication appliquée á un classment (MICMAC) analysis that post-harvest technology and knowledge transfer are drivers for FPO success. This helps farmers achieve economies of scale, improved market linkage, business planning, branding and bargaining power (Dudekula et al., 2025).

Awareness among farmers is also very important for the millet adoption. A study using the data from 477 farmers in Tamil Nadu, India, found that age, education, farm size, and experience

influence the non-adoption of millet farming. After intervention, the mean adoption score significantly increased and awareness programs effectively encouraged informed decision and sustainable farming practice (M & Manimozhi, 2024). Using the data from 132 respondents and applying fuzzy set qualitative comparative analysis factors influencing lean supply chain performance (LSCP) for millet distribution it was found that market linkage, inventory control and waste reduction are most effective pathway to high performance, while their absence leads to poor outcomes (Maharana et al., 2025). In fact, pearl millet is emerging as a next-generation climate resilient smart crop with great potential for sustainable farming and nutrition, and has the power to fight hunger and malnutrition (Satyavathi et al., 2021).

It has been several years since the launch of the National Millet Mission policy and two years since its rebranding as the Shree Anna policy. To effectively take further steps and decisions, we must evaluate if the objectives of the policy are being fulfilled and consider improvements or changes if there are gaps in meeting the objectives (Bureau Government of India, 2025). That is a crisp summary of what is being done in this paper. The results will indicate whether the policy is having a statistically significant impact on the production or yield of millets, and also identify the factors that have the greatest effect on production.

Based on the background above, this research aims to evaluate the effectiveness of the National Millet Mission in India (PROMOTION OF MILLET BASED PRODUCTS, n.d.). Hence, the objectives of the study are as follows:

The three objectives based on the above two research questions are -

1. To study the effect of NMM policies on the millet production since their launch
2. To study the impact of NMM policies on the yield since their launch
3. To study the trend of the yield since the launch of NMM policies

2. Methodology

The study is structured with an introduction to the problem related to the National Millet Mission, a related review of the literature pertaining to agriculture and millet production in India. For this study, only the top four states have been selected - Karnataka, Rajasthan, Maharashtra, and Uttar Pradesh; these states contribute ~70% of the total millet production annually ((Factly, 2023, February). This study uses the data for the 25 years of duration - from 2000 to 2024. The data was arranged in time-series format for total production ('000 tonnes), total area ('000 Hectares) and yield was calculated as production divided by area. Data was also collected for different kinds of millets such as pearl millet, sorghum, finger millet from 2000 to 2024 for

production and area similarly yield was calculated. The descriptive statistics of the data have been presented in Table 1 below.

Table 1: - Descriptive Statistics

Variable	Mean	Standard Deviation
Total Yield	1.07	0.19
Pearl millet Yield	1.12	0.26
Sorghum Yield	0.91	0.14
Finger Millet Yield	1.49	0.19

Since the study aims to analyze the effectiveness of NMM policy, we use independent two-sample t-test to test the following hypothesis at the 5% significance level. The normality of the data was tested using Shapiro-Wilk test at the 0.05 level and it was found that the data was normally distributed and the following hypothesis was tested (Table 2).

Table 2: Hypothesis

S.No	Hypothesis
1	H ₀ : There is no statistically significant mean difference between the yield of millet before and after NMM policy H ₁ : There is a statistically significant mean difference between the yield of millet before and after NMM policy
2	H ₀ : There is no statistically significant mean difference between the yield of pearl millet before and after NMM policy H ₁ : There is a statistically significant mean difference between the yield of pearl millet before and after NMM policy
3	H ₀ : There is no statistically significant mean difference between the yield of sorghum before and after NMM policy H ₁ : There is a statistically significant mean difference between the yield of

	sorghum before and after NMM policy
4	H₀: There is no statistically significant mean difference between the yield of finger millet before and after NMM policy H₁: There is a statistically significant mean difference between the yield of finger millet before and after NMM policy

2.1 Data Analysis

To analyze the data and hypothesis further, the above hypothesis was tested using independent two-sample t-test. Since NMM was launched in the year 2018, so 2019-2024 has been considered as post-NMM while 2000 to 2018 has been considered as pre-NMM. The output of the hypothesis has been depicted in table 3 below.

Table 3: Hypothesis Output

Sl.No.	Hypothesis	P value	Interpretation
1	H₀: There is no statistically significant mean difference between the yield of millet before and after NMM policy H₁: There is a statistically significant mean difference between the yield of millet before and after NMM policy	< .001	There is a statistically significant mean difference between the yield of millet before and after NMM policy
2	H₀: There is no statistically significant mean difference between the yield of pearl millet before and after NMM policy H₁: There is a statistically significant mean difference between the yield of pearl millet before and after NMM policy	<.001	There is a statistically significant mean difference between the yield of pearl millet before and after NMM policy
3	H₀: There is no statistically significant mean difference between the yield of sorghum before and after NMM policy	.006	There is statistically significant mean difference between

	H ₁ : There is a statistically significant mean difference between the yield of sorghum before and after NMM policy		the yield of sorghum before and after NMM policy
4	H ₀ : There is no statistically significant mean difference between the yield of finger millet before and after NMM policy H ₁ : There is a statistically significant mean difference between the yield of finger millet before and after NMM policy	.8	There is no statistically significant mean difference between the yield of finger millet before and after NMM policy

2.2 Regression

In order to analyze the factors impacting total millets yields, we collected some data such as the percentage change in average temperature for the years 2000 to 2024 (Chatterjee, 2026), minimum support price (MSP) /inflation ((Sharma, 2021), (*World Bank Open Data*, n.d.)) and a dummy variable indicating whether NMM existed or not in a binary form. Other variables such as prices of rice and wheat, per capita income and prices of these millets were dropped from the final models as these complicated the analysis and were unsuitable. Some could also be considered beyond the scope of the research and were irrelevant. Using time series multiple regression, the following hypothesis was tested: multicollinearity was checked using variance inflation factor (VIF), autocorrelation was tested using Durbin-Watson test and found to be within the acceptable range for all the models, and unit root analysis confirmed that the data is stationary. Keeping yield as the dependent variable and MSP as the independent variable, with others such as average temperature and the dummy variable as control variables, the hypothesis was tested and estimated at the 5% significance level.

H₀: Variables have no statistically significant effect on total millets yield

H₁: Variables significantly affect the yield of millets

The below table shows the results of the multiple regression models that were run.

Table 4: Regression Results

Sl. No.	Model	R ²	Adjusted R ²	Intercept	Temperature	MSP	Policy Presence
1	Overall	.64	.64	95.3	-4.36 (.035)	0.02 (.083)	22.06 (.011)
2	Finger millet	.16	.02	145.73	-5.298 (.166)	0.01(.663)	5.17 (.743)
3	Pearl millet	.61	.54	92.94	-5.27 (.096)	0.07 (.041)	21.63 (.082)
4	Sorghum	.569	.497	88.49	-2.97 (.068)	-0.01 (.443)	22.88 (.001)

3. Results and Discussion

3.1 T-Tests

The independent two-sample t-test results showed that the policy introduction led to a statistically significant increase in total millet production and pearl millet production. Finger millet yields did not experience any significant change, which indicates that the policy advantages have been distributed unevenly among the different millet varieties. Finger millet productivity failed to show any significant improvement because of structural limitations, which include decreasing cultivated areas, ongoing negative growth patterns, and production hazards previously identified in earlier studies.

3.2 Regression

3.2.1 Aggregate Millets

The model for overall yield explained yield variations through time with reasonable strength, as its Adjusted R² value of .64 indicated that the selected variables successfully explained most of the yield changes which happened during the observation period. Percentage change in average temperature and existence of NMM policy (dummy) was found to be statistically significant, whereas average MSP price was found to be statistically insignificant at 5% confidence level. The proposed equation is found to be:

Total Yield = 95.3 – 4.36 (%change in average temperature) + 0.02 (average MSP) + 22.06 (existence/non-existence of NMM policy)

As per the above equation existence of the policy has the highest co-efficient and also statistically significant at 5% (.011). Temperature was significant (.035) with a coefficient of -4.36, whereas average MSP has a small co-efficient 0.02 and not statistically significant at 5% (.083) probability level.

3.2.2 Finger millet

The R^2 value was .16 and the adjusted R^2 value was .02, comparatively lower to other models because of the reduced impact of NMM policy on Finger millet. Percentage change of temperature, the existence of NMM policy variables and MSP showed no significance with coefficients of -5.298 (.166), 5.106 (.743) and 0.011 (.663)

Total Finger millet Yield = 145.7 – 5.3 (%change in average temperature) + 0.01 (average MSP) + 5.17 (existence/non-existence of NMM policy)

The small policy presence co-efficient supports the lack of significant change in yields of Finger millet in the t-tests. The policy coefficient was substantially smaller than that observed in the aggregate millet model, and none of the three explanatory variables was statistically significant. This shows that the policy should further focus more on Finger millet and implement Finger millet-specific or Karnataka-Andhra Pradesh specific policies as these are the major consumers and producers of Finger millet. What further worsens the situation is that none of the three variables were significant.

3.2.3 Pearl millet

The R^2 value was .61 and the adjusted R^2 value was .54. Both percentage change of temperature and the existence of NMM policy variables showed insignificance with p values of .096 and .082 respectively. The p values are close to .05 and given the limited number of annual observations, these estimates may be subject to reduced statistical power and greater uncertainty. The results should therefore be interpreted cautiously. In light of this possibility, the true effects of the above variables can only be seen when enough data is collected. However, MSP was significant with a coefficient of 0.069 (.041) showing a positive correlation, which might be as a result of effective procurement and structural efficiency, though the impact of its presence is not relatively huge.

Total Pearl millet Yield = 92.943 – 5.27 (%change in average temperature) + 0.069 (average MSP) + 21.63 (existence/non-existence of NMM policy)

Pearl millet has only one variable as significant, whereas results of temperature and policy presence can only be seen as suggestive rather than indicative of an association.

3.2.4 Sorghum

The R^2 value was .569 and the adjusted R^2 value was .497. Similar to Pearl millet, Sorghum's Temperature P value is .068 and is close to .05 showing another case of uncertain results. Therefore, considering this variable as suggestive evidence, policy presence had a significant coefficient of 22.88 with a P value of .001, while MSP was insignificant with a coefficient of -0.01 (.443) showing a negative correlation, highlighting no significant impact on sorghum yield and production.

Total Sorghum Yield = 88.487 – 2.97 (%change in average temperature) - 0.01 (average MSP) + 22.88 (existence/non-existence of NMM policy)

Sorghum has a subtle negative relation with MSP showing it has no impact, underscoring ineffective procurement which is scattered.

The regression results identify that the NMM policy indicates the strongest positive association with yield, except for the case of finger millets. Temperature changes produce a negative impact throughout, demonstrating that millet production is climatically sensitive. Minimum Support Price (MSP) showed a positive correlation, but researchers found it statistically insignificant at the 5% significance level, except for Pearl millet, which indicates that price incentives had no major effect on yield results during the research period.

The study results demonstrate that environmental factors and policy presence have a stronger effect on millet productivity than price incentives. The findings show that support price policies provide small benefits that lead to better yields, but structural factors - including institutional support, extension services, technology implementation and climate change adaptation strategies - serve as the main elements driving yield increases. The NMM policy successfully boosted total millet production but its effects differed between different crop types. The upcoming policy framework requires crop-specific methods to enhance market and production systems while addressing climate-related threats to achieve sustainable development for all types of millet.

NMM boosts yields ~22% via infrastructure, but unevenness (finger millet failure) ties to Karnataka-specific issues like shrinking acreage/low margins—recommending state-tailored or crop-specific strategies. Global warming and rising temperatures rise the importance of developing more temperature resilient varieties of millets.

3.3 Directions for Further Research

This study acts as a foundational evaluation of the NMM policy, but several gaps remain for further research. Firstly, a state-specific analysis with emphasis on the soil type, irrigation

methods would deepen our understanding of the specific needs of individual millet species. For example, an analysis on why the policy has an insignificant effect on Karnataka and Finger millet can be done and taken forward. District level data might isolate the variables that are critical for Finger millet's improvement.

Additionally, a similar analysis on the demand-side variables like consumer behaviour, changes in millets' inclusion in diet of different communities and the effect of prices on consumer behaviour can be undertaken. This study will answer the area-yield paradox that is seen in this paper. Thus, more effective action can be taken and resources can be channelled to the weaker variables.

And lastly, a study on the welfare of farmers growing millets remains. This study can focus on surveying the farmers who are growing millets and finding if they are receiving enough returns, government support such as MSP, and can also be used to find out why they refer to grow millets instead of other crops. A control group of farmers who do not grow millets can also be surveyed to find out what would make them grow millets.

3.4 Policy Implications and Recommendations

This study's findings can be converted to better policy by the government, at both national and state level. Four areas emerge for this paper's empirical findings.

Firstly, sustaining and expanding structural policy support rather than relying more on price mechanisms is primary. The consistently greater regression coefficient of around 22.06 of NMM policy except for Finger millet is the largest, while MSP has the smallest coefficient being significant with Pearl millet only. Moreover, structural policy support drives long-term improvement in production while financial support has constrained short-term impact. It is also necessary to make sure, as mentioned above, that the benefits of MSP are reaching to the farmers.

To emphasise more on how to expand the policy, developing crop-specific policies will be of immense benefit for the yield and the farmers. A unified policy design led to insignificant yield improvement for Finger millet. Therefore, crop-specific policies developed by the states where it is majorly grown like Karnataka, Telangana and Andhra Pradesh can expand finger millet production significantly and sustainably.

To go even further, integrating climate adaptation explicitly into agricultural policy design will give a significant boost to the farmers. The statistically significant negative coefficient for temperature change (-4.36) confirms that rising temperatures meaningfully suppress millet yields, even for crops widely regarded as heat-tolerant. Specifically, the government should

increase investment to developing more climate-resilient millet varieties through research organisations and labs. Prioritising this is crucial as temperature is forecasted to increase due to global warming.

Lastly with more need for precise literature, addressing the demand gap through awareness, further research, survey and price analysis will aid in incentivising the farmers to grow more millets. Supply-side gains will remain finger millet if the demand gap is not simultaneously addressed. The persistent area-yield paradox - where productivity per hectare is rising while cultivated area shrinks — suggests that farmers do not perceive strong enough market pull to expand acreage. The government should accelerate inclusion of millets in the Public Distribution System (PDS) and Mid-Day Meal schemes at scale, as these represent guaranteed off-take that directly improves farmer income expectations. The Food Safety and Standards Authority of India (FSSAI) should be tasked with facilitating clearer nutritional labelling for millet-based processed foods to support premium market development. Additionally, state nutrition missions and POSHAN Abhiyaan should incorporate millets into dietary guidelines and complementary feeding programmes, creating an institutional demand base that can sustain farmer confidence in expanding millet cultivation over the long term.

The discussion should not repeat the results, but provide detailed interpretation of data. This should interpret the significance of the findings of the work. Citations should be given in support of the findings. The results and discussion part can also be described as separate, if appropriate.

4. Conclusion

The findings indicate that the National Millet Mission (NMM) has had a positive but uneven effect on millet productivity. Overall millet, pearl millet, and sorghum yields showed statistically significant improvements following the introduction of the policy, whereas finger millet showed no significant improvement. Further research demonstrates that the presence of the NMM had a strong positive association with overall millet, pearl millet, and sorghum yields, while its effect on finger millet remained weak and statistically insignificant. Temperature changes had a significant negative relationship with overall millet yield, highlighting the growing importance of climate resilience in millet cultivation. MSP, in contrast, had a limited effect on productivity, being statistically significant only for pearl millet. Overall, the findings suggest that structural policy support under the NMM has contributed more strongly to millet productivity than price incentives, but the uneven response across crops indicates that future agricultural policies need to address crop-specific and climate-related constraints.

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