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Analyzing the Reasons Behind the Decline of Millet Farming in India With a Focus on Change in Policy, and the Way Forward

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ABSTRACT

Millet production in India has been rapidly declining in the past 50 years, yet the importance of millets must not be forgotten. Recently, there has been an increase in efforts by the Indian government to boost the production of millets, concentrated on raising awareness about the benefits of millets to the general populace. This paper, firstly discusses the importance of millets against the backdrop of climate change, finding it to have moderate nutritionally benefits and immense environmental benefits. Secondly, the paper finds three key reasons for the historic decline of millet production : The Green Revolution, Government Policies - specifically the MSP policy and lastly demand related factors. Thirdly, this paper analyzes the efficacy of current government initiatives to promote millets on three criteria - Awareness, Production and Yield, finding the policies to be successful in raising awareness, unsuccessful in raising production and results inconclusive in raising yield. Lastly, this paper uses statistical data to analyze the impact of various factors on the yield of millets, finding Net Irrigated Area to have a strong, positive correlation with yield. Policy recommendations such as conducting a large scale survey with farmers are also given.

Keywords: Millets, Agriculture, Decline of Millets, Government Policy towards Millets, Public Policy and Millets, Green Revolution

1. Introduction

Being one of the oldest crops to be cultivated, millets find their roots in ancient India. Traditionally consumed in India, millets constituted around 40% of all cultivated grain prior to the Green Revolution. However, this number drastically reduced to just 20% post the Green Revolution. Millets majorly consist of jowar or sorghum, bajra or pearl millet, ragi or finger millet), jhangora or barnyard millet, barri or common millet, kangni or foxtail, kodra or kodo millet and other minor millets. India leads the world when it comes to millet production,

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constituting 17.68% of the total world millet production. Recognising the importance of millets, India has been at the forefront of the worldwide push to promote millets and raise awareness on it. 2023 has been named the International Year of Millets (*Roa et al, 2021*), and India has named millets 'Shree- Anna', or blessed foods. Furthermore, India has implemented a slew of policies to bolster millet production and consumption such as allowing states to distribute millets in the Public Distribution System, subsidizing millet production and including millets on the National

Food Security Mission. This paper will explore the benefits of millets, the reasons behind its decline and finally evaluate the policies by the Indian government to increase production of millets and recommend future guidance for policies.

1.0 - Importance of Millets

Millets and the potential rise in its consumption has several key benefits for all stakeholders involved, which are particularly important given the food and climate crisis the world is going through right now, exacerbated by global supply chain shortages.

1.1 - Ecological Benefits

Millets, compared to other staples such as rice and wheat, are climate resilient and ecologically sustainable crops. Most millet production does not traditionally use or require chemical pesticides since they are less prone to insect attacks (*Gupta et al, 2017*). Historically, millets have been farmed without the use of fertilizers, and unlike rice and wheat, were not genetically changed during the Green Revolution, meaning they grow well without fertilizers (*Devkota et al, 2016*). Thus, millets are not only more accessible for the average farmer to produce, but are also relatively more organic and cause less harm to both the environment and our bodies.

Additionally, millets are characterized by their low use of water and energy. In fact, millets use 70% less water than rice, and require 40% less energy in processing (*Gujral, 2017)*. This is particularly important in semi-arid and arid regions where water is not plentily available, making millets one of the most suitable crops for drought-ridden areas. As a result millets are more profitable for farmers both since water and energy are often major costs as well as due to the fact that its sturdiness limits the chances of crop failure. Further, according to ICRISAT, millets can help reduce the carbon emissions of agriculture by up to 30% (*Girgoankar, 2023*). Pearl millets, for example, are C4 plants, which means they avoid photorespiration in the process of photosynthesis. This makes them 50% more efficient at converting carbon dioxide to oxygen than C3 plants such as rice in hot and humid climates (*Wang et al, 2012)*. Lastly, millets can grow and survive in high temperatures as well, which uniquely equips them with the ability to grow even in the current context of global warming. UNRIC (2023) notes that millets can flourish up till 64℃, whereas rice, for example, can only grow till around 37℃, which makes it

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more vulnerable to climate change. Moreover, millets have a relatively shorter time required for it to grow of 60–90 days as compared to rice which has a growth time of 120–140 days (*Hulse et al, 1980*). This means that more millets can be produced, both increasing profitability as well as reducing food shortage.

1.2 - Nutritional Benefits

Millets also provide immense nutritional value and food security, which is especially important given about 16.6% of India is malnourished. Macro-Nutritionally, millets are similar to other major cereals such as maize or wheat, though much more nutritious than rice. Their unique benefits include being highly fibrous, having a low glycemic index, and being rich in bioactive compounds (*Kannan et al, 2013*). For example, kodo millets have 37% dietary fiber content, 785% more than that of rice and wheat, which can help in healthy digestion and bowel movements. They also contain a far higher mineral content - 1.7 to 4.3/100g - than wheat 1.5/100g - or rice - 0.6/100g - (*Kumar et al, 2018*). Millets, moreover, have a glycemic index of 52.7, which is 36% lower than that of rice, and 14–37 GI lower than that of maize (*ICRISAT, 2022*) which means that they raise one's glucose level less than other staples, indicating that they are better for diabetics.

All these benefits are particularly relevant to India's Public Distribution System, which distributes food staples at subsidized prices. Since rice is heavily prioritized in the PDS, it has led to an excessive consumption of starch and a de-prioritisation of essential nutrients, which has contributed towards "hidden hunger" among Indians, a phenomenon where people are fed, but still malnourished. A shift to millets could help make the average Indian far healthier and far more resistant to diseases.

Fig1.1 - Macronutrient Profile of Millets as compared to other grains (Gowda et al)

Table 1

Nutritional profile of millets in comparison with cereals (per 100 g).

Grains	Energy (kcal)	Protein (g)	Carbohydrate (g)	Starch (g)	Fat(g)	Dietary Fiber (g)	Minerals (g)	Ca (mg)	P (mg)
Sorghum	334	10.4	67.6	59	1.9	10.2	1.6	27	222
Pearl millet	363	11.6	61.7	55	5	11.4	2.3	27	296
Finger millet	320	7.3	66.8	62	1.3	11.1	2.7	364	283
Proso millet	341	12.5	70.0	-	1.1	-	1.9	14	206
Foxtail millet	331	12.3	60.0	-	4.3	-	3.3	31	290
Kodo millet	353	8.3	66.1	64	1.4	6.3	2.6	15	188
Little millet	329	8.7	65.5	56	5.3	6.3	1.7	17	220
Barnyard millet	307	11.6	65.5	-	5.8	-	4.7	14	121
Maize	334	11.5	64.7	59	3.6	12.2	1.5	8.9	348
Wheat	321	11.8	64.7	56	1.5	11.2	1.5	39	306
Rice	353	6.8	74.8	71	0.5	4.4	0.6	10	160

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Fig 1.2 - Micronutrient Profile of Millets as compared to other grains (Kumar et al)

Cereal grain	Calcium	Iron	Phosphorus	Zinc	Thiamine	Niacin	Riboflavin
Rice	0.12±0.07	1.25±0.78	0.52±0.02	0.5	0.50±0.13	5.56±1.76	0.06±0.02
Wheat	43.41±3.69	5.24±0.80	357.74±26.54	2.9	0.44±0.05	4.31±1.00	0.10±0.01
Sorghum	35.23±7.42	5.29±1.28	266.30±32.3	3.01±0.89	0.28	5.19	0.05
Pearl millet	35±8.9	10.3±7.0	339	–	0.30±0.1	1.11±1.3	1.48±1.9
Foxtail millet	31±11	3.5±1.2	300	60.6	0.60	0.55±0.6	1.65±2.2
Finger millet	348±3.5	4.27±0.6	250	36.6±3.7	0.40±0.1	0.80±0.9	0.60±0.7
Barnyard millet	18.33±6.0	17.47±2.0	–	57.45±1.9	0.33	0.10	4.20
Proso millet	10±3.5	2.2±1.2	200	–	0.41	4.54	0.28
Kodo millet	32.33±4.6	3.17±1.3	300	32.7±2.2	0.15	0.09	2.0

2.0 - Key reasons for the decline of Millets

Millets have seen a stark decline over the past century in India, declining from about 40% of total production to closer to 20%. There are several reasons for this.

2.1 - The Green Revolution

The decline of millet consumption and production has its roots in the Green Revolution of the 1960s. After the Indian independence, India faced severe food shortage, especially in the aftermath of the Bengal famine of 1943 which left 4 million dead. The food availability for the average Indian was just 417 grams a day, and the situation was so bad that then Prime Minister, Lal Bahadur Shastr, had to call on Indians to skip at least one meal a week in an effort to preserve grain (*Ghosh, 2012*). Against this backdrop, the Green revolution took place in order to increase food production and crop productivity. It was characterized by a transition to High Yielding Varieties (HYV) seeds such as IR-8, an increased usage of artificial fertilizers and pesticides and increased infrastructure and irrigation systems (*Brainerd and Menon , 2014)*. India imported a majority of HYV rice and maize seeds from Mexico and Philippines respectively, and the use of NPK fertilizers increased by more than 450% (*Eliazer Nelson et al, 2019)*.

On one hand, this shift successfully tripled crop production with just just a 30% increase in land usage (*John & Babu, 2021)*, the problem, however, was that this caused an increased focus on wheat and rice, to the detriment of other crops such as millets or indigenous rice varieties. In fact, it is estimated that over 1000 rice varieties were lost. The data is clear here, with the total area under millet cultivation in India decreasing from 37.67 to 24.1 million hectares (MHA),

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while the area of rice cultivation increased from 30.81 to 45.8 MHA and that of wheat from 9.75 to 31.1 MHA.

Fig 2.1.1 - Area of various cereals as per Oak, 2021

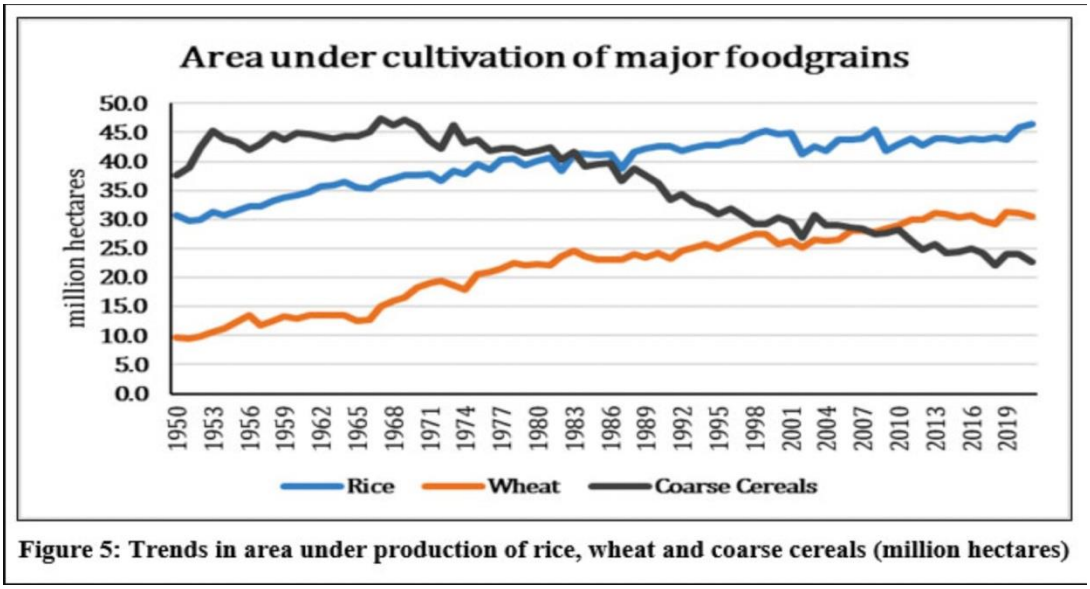
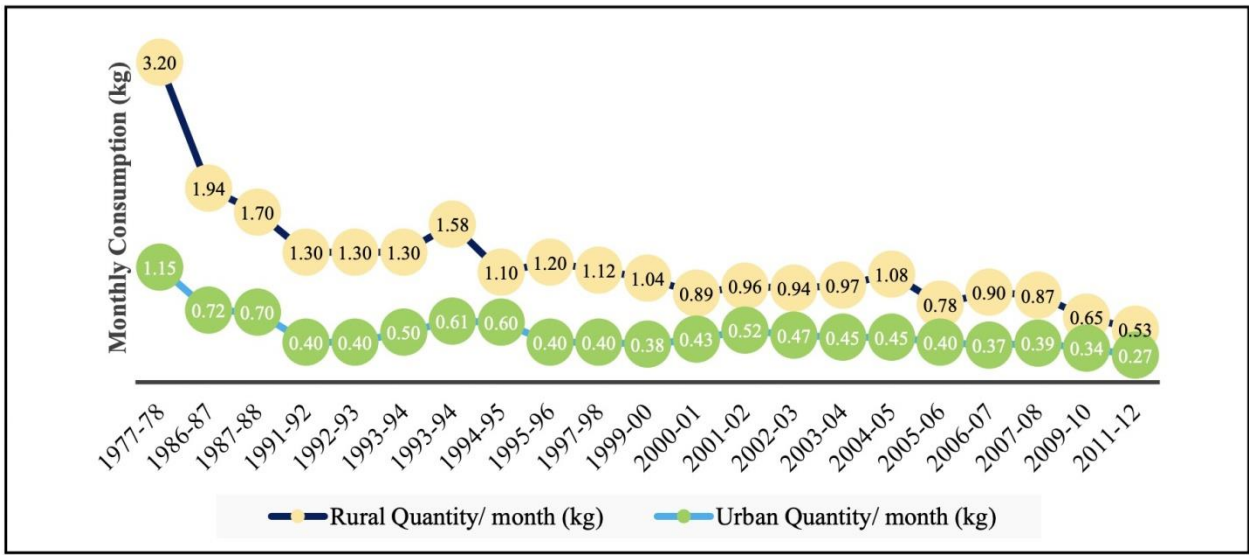


Figure 5: Trends in area under production of rice, wheat and coarse cereals (million hectares)

Moreover, total millet consumption decreased from 3.2 kg/month and 1.15kg/month in 1977 for rural and urban households respectively, to 0.53kg/month and 0.27kg/month (*Bisen et al, 2023*).

Fig 2.1.2 - Amount of millets consumed as per ICAR report based on NSSO Household Consumption Surveys



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While net millet production has indeed increased over the past 70 years, the amount by which it has increased is low, especially when compared to the amount other grains such as rice and wheat have increased in production. This indicates that rice and wheat have crowded millets out of an Indian's daily diet. Importantly, all of these changes happened in the mid 1970's, the exact time wherein the effects of the green revolution was taking place.

Fig 2.1.3 - As per Oak, 2021

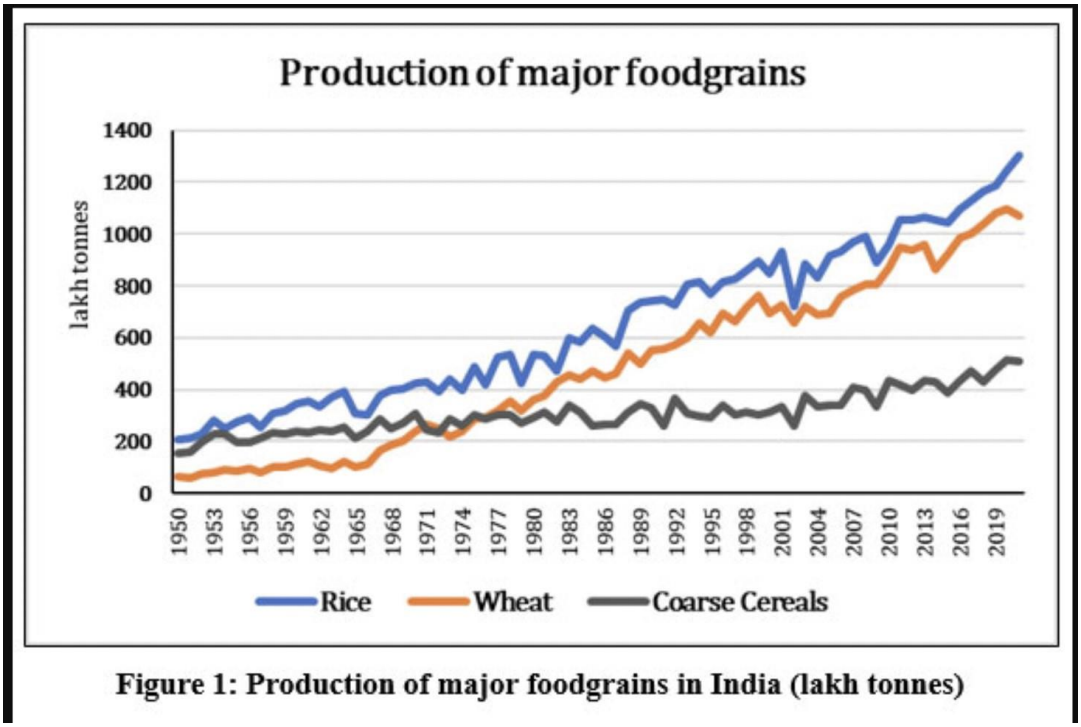

Figure 1: Production of major foodgrains in India (lakh tonnes)

Specifically, the green revolution caused an increase in productivity for wheat and rice, much more than it did for millets. This meant that growing rice or wheat, rather than millets became much more profitable for farmers - due to the higher output and therefore revenue- which caused many farmers to switch from growing millets to rice or wheat - as seen by the substantial decline in area under millet cultivation (*Sen et al, 2023*). As of 2020–2021, the yield of rice is 2717 kg/ha, whereas that of Jowar is 1099 kg/ha, that of Bajra 1420 kg/ha and that of small millets is just 781 kg/ha (*Agricultural and Processed Food Products Export Development Authority*). This has resulted in extremely low profits for millet farmers, disincentivizing them from further farming. In fact, according to data from the Commission for Agricultural Crops and Prices, Maharashtrian Jowar farmers made profit in only 10 out of the 37 years between 1971 and 2019, and Rajasthani Bajra farmers profited of their crops only for 2 out of 41 years (*Narayanamoorthy, 2023*).

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This exclusive increase in productivity and consequently profitability in rice and wheat but not millets may have happened due to HYV seeds and Fertilizers –

2.1.1 - HYV Seeds

The new HYV seeds, imported from Mexico and Philippines had 20% more grain than organic seeds, which increased yield and therefore encouraged farmers to grow more rice and wheat at the expense of millets *(Eliazar Nelson et al, 2019*). Millets, on the other hand, suffered from a lack of availability of high-yielding seeds varieties (*Srivastava et al, 2020*), which limited both its profitability as well as its value to India since it could not be mass produced. This, in all likelihood, was due to the relative unimportance and unpopularity of millets at the global stage at the time of Green Revolution, which meant that global agriculture agencies at the forefront of agri-technology research had little incentive to develop millets crops due to the lack of global production. Moreover, India would have been unduly influenced by the agricultural practices of the West, foregoing the superior millet for the western crop. Infact, millets are considered to be 'minor cereals' in most FOA statistics, and about 97% of millets are grown by developing countries, with very little of its cultivation being done by traditional technological powerhouses (*McDonough et al, 2020).* This indicates a lack of research on millets and therefore a lack of technological advancements for them. This indicates that millet's productivity was advancing much slower than other crops. All of this shows how technological advancements in HYV enabled rice and wheat to crowd out millets

Fig 2.1.4 - Yield growth rate of major cereals as per Oak, 2021

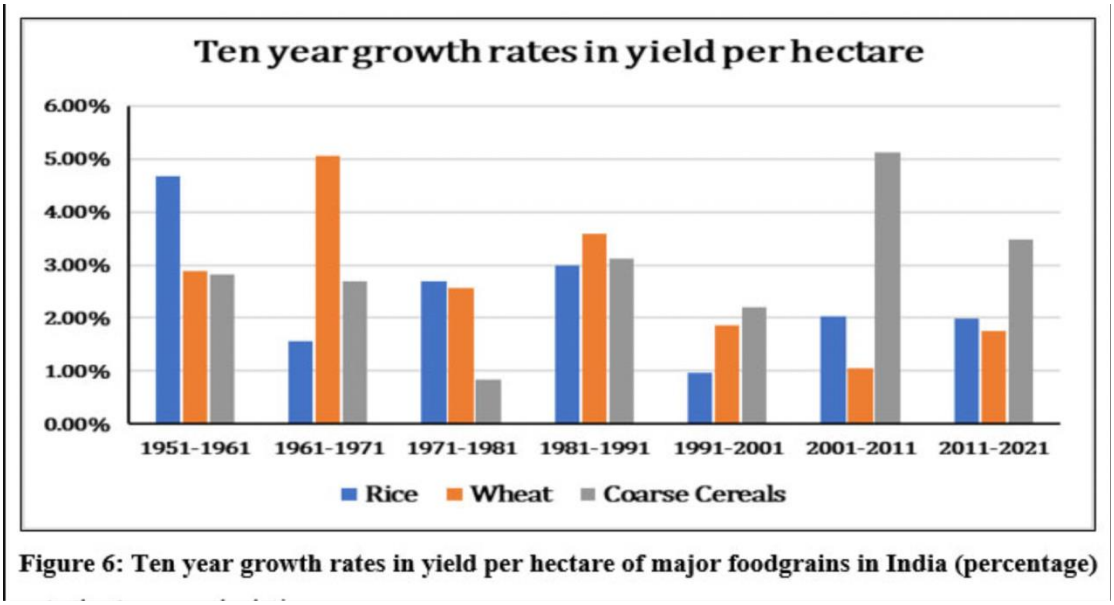

Figure 6: Ten year growth rates in yield per hectare of major foodgrains in India (percentage)

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2.1.2 - Fertilizers

The rise of fertilizers and pesticides was imperative to increasing the yield of crops. For example, it is estimated that average corn yields in the US would decline by 40% without the usage of Nitrogen fertilizers (*Mikkelsen, n.d.*). However, millets were unable to access the benefits of fertilizers. Empirically, millets use far less fertilizers than other major crops such as rice and wheat. The Food and Agriculture Organization of the United Nations et al, (2005) shows that on average, pearl millets consumed 28.2kg/ha of fertilizers, while paddy rice consumed 119.1kg/ha and wheat consumed 136.7 kg/ha. This may have been due to several reasons. Firstly, fertilizers were often tailored specifically to HYV'S - IR-8, for example, benefited from specific fertilizers - and therefore could not be cross-applied towards millets. Secondly, millets, historically, are less responsive to fertilizers both because they have lower Nitrogen requirements due to their ability to fix nitrogen as well as their efficient root systems which enables them to extract more nutrients. Lastly, infrastructure and systems such as Irrigation largely benefited rice and wheat exclusively. Therefore, the productivity, and thus profitability, of millets was limited by the lack of access to fertilizers.

2.2 - Government Policies

There has been a historic bias of Indian policy on agriculture towards rice and wheat, and away from traditional grains such as millets.

This is primarily due to the Minimum Support Price for millets in comparison to rice or wheat is one of the main policy factors that lead to the decline of millets. The problem isn't a massive price differential in the MSP of the two, they are often within the same range, with millets such as ragi even having higher MSP's at times. Nor is the problem of a growth in the MSP price between 2010-11 and 2022-2023, the MSP of maldandi jowar increased by 232% , that of ragi by 271% and that of bajra by 167% (*Department of Agriculture & Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, 2023*)

The real problem is twofold. Firstly, many smaller millets are not even part of the MSP scheme in the first place. Only jowar, bajra and ragi are currently covered under MSP (*M&M, 2023*). Recently, however, there have been efforts to change this and incorporate even minor millets into MSP. Secondly and much more importantly, is the fact that the government is not procuring millets at the MSP. This is problematic since private buyers are unwilling to buy millets at the MSP, and the government is not buying millets either at that price. This means that, due to the lack of demand, millet farmers are forced to sell at far below the MSP, making it redundant and ineffective. Less than 4% or 1.57LMT of all Jowar produced was procured by the government in 2021–22, while a staggering 41% or 433LMT of wheat and 68% or 857LM of rice was procured

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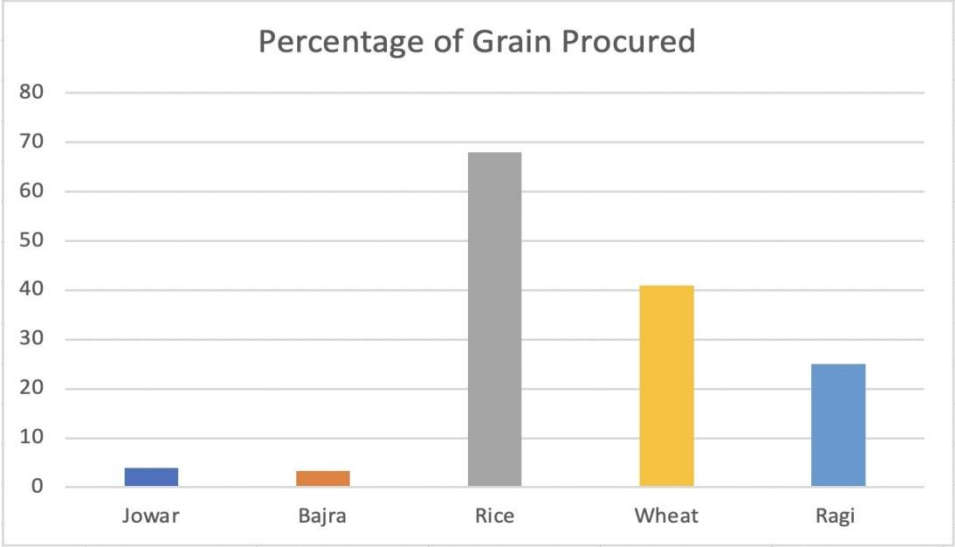
during the same year. Overall, less than 5% of course cereals are procured by the government (*Reserve Bank of India, 2022; Jyoti & Ministry of state for rural development and consumer affairs, food and public distribution, 2022).* This means that no matter how much higher the MSP is hiked, without the government willing to spend money and procure millets, it will be futile.

The situation worsened in 2014 when state subsidies for procurement of coarse cereals were restricted in order to constrain the fiscal deficit (*Hussain, 2018).* Though recent efforts have been made to increase the level of procurement of millets, the historical damage can still be observed.

Fig 2.2.1 - Based on the author's own calculations. Data as per RBI 2022 report and Data from the Ministry of Consumer Affairs and Public Distribution



Ultimately, these issues have adverse effects on India's Public Distribution System (PDS) and Integrated Child Development Service (ICDS) since millets were not included in them. PDS in India is a series of government owned ration shops which sell subsidized, or even free, essential food staples to citizens. This is essential to ensuring food security in India, with nearly 800 million people being covered under PDS for food grains, and more than half a million shops operating under the scheme (*Puri et al, 2021*). Thus, the grains sold by the PDS is one of the primary ways in which Indians procure grains and get accustomed to different types of grains. Therefore, the lack of millets in the PDS and ICDS prevented Indians from becoming familiar with millets in the first place, preventing the mainstreaming of them.

2.3 - Demand

The low demand - as shown by the reduced consumption of millets despite the increase in raw production - of millets is a major cause for its decline too.

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An extensive survey of 15139 individuals in India regarding their millet consumption (*Kane-Potaka et al, 2021*) reveals a slew of problems with demand for millets. Firstly, there appeared to be a massive awareness problem among Indians on the health benefits of millets. While 91% of respondents were health conscious, only 40% of them were convinced of the health benefits of millets, indicating that if awareness grew, then so would consumption, especially since 28% of people consumed millets due to its health benefits and 15% did so since they wanted to lose weight. Moreover, 40% of people said that they didn't consume millets since they often were not made at home. This implies that millets not being normalized and people not being familiar with it especially in urban households is a major problem. Lastly, 22% of people cited bad taste as a reason not to consume millets. Thus, investing in better tasting millet products could drastically increase millet consumption.

Moreover, price is a problem. Millets, in their raw form, are significantly more expensive than rice or wheat, costing about 80–100 rupees per kilo compared to 40–60 rupees per kilo. This locks out many customers from buying millets who can either not afford to pay this high price or are unwilling to spend their income on grains. Unfortunately, the inverse is true as well. Millets lack high value products like Basmati rice. Compared to other grains such as basmati rice, consumers see millets as low quality and are unwilling to spend money on them, which results in lower profits for millet farmers (*Mahera et al, 2022*). Because of this, a large number of millets end up as fodder for cattle rather than for consumers to eat. Moreover, the unfortunate perception of millets as food for lower castes and tribal communities, compared to the association of rice with upper castes along with the lack of usage in western culture from which many Indians are influenced by means that demand for millets remains low.

3.0 - Current Policies and the Way forward

Several policies have been undertaken by the Indian government in the context of millets. This paper will evaluate them across three criteria - effectiveness in raising awareness, effectiveness in raising production of millets and effectiveness in raising yield of millets.

3.1 Awareness

Raising awareness on the health benefits of millets is a crucial policy measure to increase its consumption. Here, the Indian Government has been successful through a host of policies.

(1) Renaming millets to nutri-cereals to highlight its nutritional benefit.

(2) Declaring 2018 as the National Year of the Millets.

(3) Naming 2023 the International Year of Millets.

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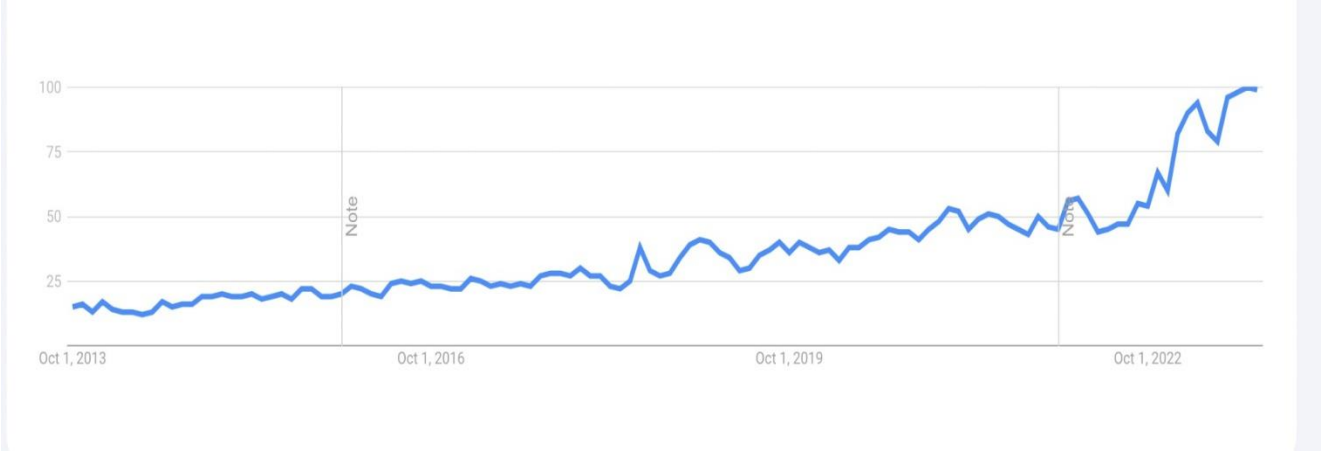
(4) Creating the Sub Mission on National Food Security Mission (NFSM) which raises awareness about millets among farmers through demonstrations and training; also includes the setting up of Centers of Excellence.

(5) Promoting millets through eating meals made out of them at national and international events such as G20.

(6) Promoting Millet startup culture with more than 500 startups working in this industry to use innovative ways to increase the value-added chain of millets; the government, started the Production Linked Incentive Scheme which aims to spend 10,900 crore Rupees , over seven years to support Indian food brands, specifically high value millet products (*Ministry of Agriculture and Farmers Welfare, 2022*).

The success of this awareness campaign is evidenced through the spike of popularity of the word ‘millet’ on google (seen via google trends), indicating that there has been a rise in the number of people interested in millets in India. However, this may be limited to only the privileged elite, and may not reflect the reality for a majority of Indians. Moreover, it is unclear whether this increased awareness led to an actual increase in demand. Thus, while it strongly seems as if the government's awareness campaign has been successful, its actual effects remain unclear and difficult to measure.

3.1.1 - The popularity of the word ‘millet’ on google scored from 0 to 100



Data source: Google Trends (https://www.google.com/trends).

3.2 Production

As can be seen in the graph below (*Department of Agriculture and Farmers Welfare, 2023*) the production of millets has stagnated over the past ten years, being 160.3 lakh tonnes in 2012-13

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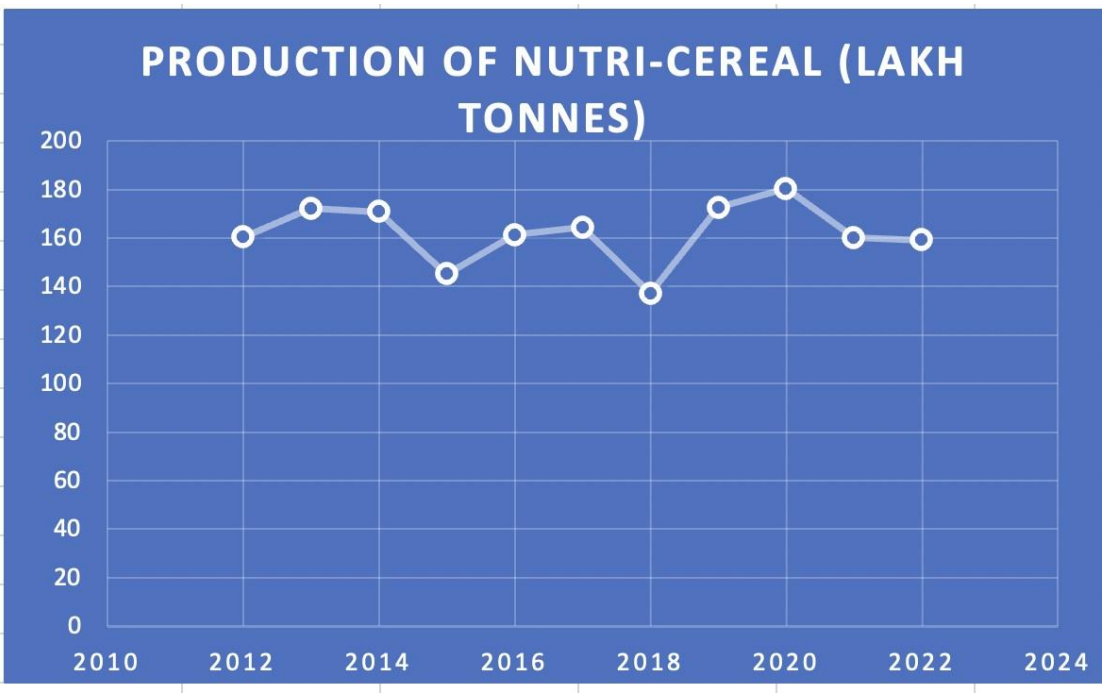
and predicted to be 159.09 Lakh Tonnes in 2022-23. However, there has been an increase in millet production ever since the Government started to focus on millets, increasing from 137.11 to 159.09 Lakh Tonnes, in other words, a 16% increase over 4 years. While this might seem promising, the production of rice increased by 12.4% at the same time, and that of wheat increased by 8.3%, suggesting that the increase in production was not due to any special government initiatives. Nevertheless, it seems to be a realistic possibility that India could reach its goal of producing 200 Lakh tones of millets by 2025, or at least in the next 5 years.

Fig 3.2.1 - Production of Nutri Cereals. Based on Author's own calculations. Data as per Ministry of Agriculture and farmers welfare. Based on Authors own calculations



This highlights that the key problem is the lack of government support in procuring and distributing millets. Without this, no matter how much awareness is created or how much the MSP is raised, given the volatility of the agriculture industry, farmers won't switch to millets without a guaranteed price. Despite the government's push to incorporate it into its PDS increasing the time for procurement of millet to 10 month - and subsidize it through various schemes such as Sub Mission On Agricultural Mechanisation, Rashtriya Krishi Vikas Yojana and National Food Security Mission, in reality very little is being done : The central government's target was to procure a mere 13.28 Lakh tonnes for the year 2022-2023, just 8% of overall production, which is far below what is needed. Yet, even that target seems unlikely to be achieved, with forecasts estimated that just 7.43 Lakh tonnes will be procured, in other words

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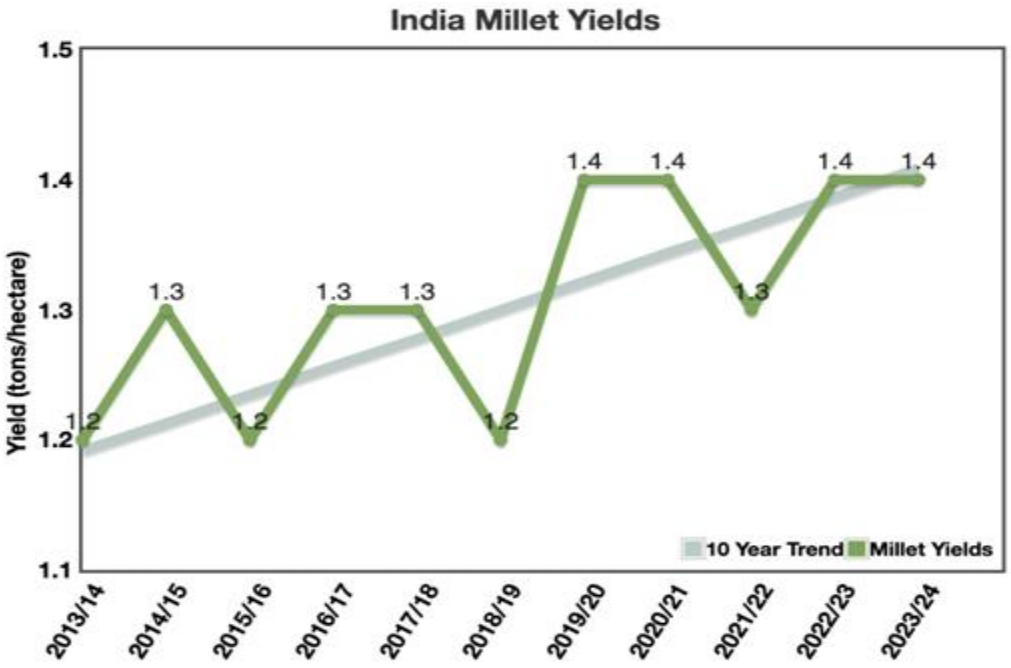
just 60% of the target (*Sharma, 2023*). What must be done to mainstream millets is to ramp up procurement such that it encourages farmers to produce millets and introduces consumers to millets through the PDS.

3.3 Yield

As can be seen in the graph below (*US Department of Agriculture & International Production Assessment Division , 2023*) the per hectare yield of millets has increased from 1.2 tons in 2018, to 1.4 tons in 2022, marking a 16.7% increase in yield. This is certainly significant, however, it is once again in doubt whether the increase in yield was due to the targeted interventions of the government or would have happened naturally.

The overall problem seems to be that while the Indian government has done a lot in raising awareness about millets and helping fund millet startups, it has been relatively unsuccessful at incentivising farmers to grow millets and increasing their yield.

Fig 3.3.1 - Variation of yield of India millets



Interestingly, there is a large difference in the yield of millets across different states in India. For instance, the yield of jowar in 2020-2021 was 1938 kg/ha in Madhya Pradesh, while it was just 1054 kg/ha in Rajasthan. Similarly, the yield of bajra in 2020-2021 was 2221 kg/ha in Uttar Pradesh, while it was just 761 kg/ha in Maharashtra. This trend continues among the major

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producers of millets, with Madhya Pradesh, Uttar Pradesh and Karnataka typically having larger yields, and states such as Rajasthan and Maharashtra having lower productivity for millets. Three differing factors were analyzed as potential reasons for this difference. In this paper six states were considered – Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Tamil Nadu and Madhya Pradesh – since together they constitute a vast majority of India's millet production.

State	Millet Type	Area (lakh ha) (Mean of 2017 - 2022)	Production (Lakh tonnes) (Mean of 2017-2022)	Yield (kg/ha) (Mean of 2017-2022)	Net Irrigated Area (2018-2019)	Net Sown area (2018-2019)	Percentage Net Irrigated Are	Credit (2021)	Credit per Lakh Hectare of area	Fertilizer per Hectacre of area (2021)
Rajasthan	Bajra	41.58	41.12	989						
Rajasthan	Jowar	5.81	4.81	829						
Rajasthan	Small Millets	0.09	0.06	717						
Rajasthan Total		**47.48**	**45.99**	**968.6183656**	8283	17778	46.59129261	104797	5.894757566	67.46
Madhya Pradesh	Bajra	3.21	7.29	2275						
Madhya Pradesh	Jowar	1.38	2.67	1935						
Madhya Pradesh	Small Millets	0.98	0.85	867						
Madhya Pradesh Total		**5.57**	**10.81**	**1940.754039**	11349	15205	74.63992108	81506	5.360473528	96.4
Uttar Pradesh	Bajra	9.06	18.95	2092						
Uttar Pradesh	Jowar	1.66	2.35	1416						
Uttar Pradesh	Small Millets	0.08	0.06	723						
Uttar Pradesh Total		**10.8**	**21.36**	**1977.777778**	14392	16538	87.02382392	159257	9.629761761	188.96
Karnataka	Bajra	2.21	2.55	1154						
Karnataka	Jowar	8.46	9.65	1141						
Karnataka	Ragi	7.16	11.26	1573						
Karnataka	Small Millets	0.31	0.24	786						
Karnataka Total		**18.14**	**23.7**	**1306.504961**	4032	10664	37.80945236	121196	11.36496624	135.52
Tamil Nadu	Bajra	0.61	1.53	2502						
Tamil Nadu	Jowar	4.05	4.54	1122						
Tamil Nadu	Small Millets	0.24	0.32	1335						
Tamil Nadu	Ragi	0.81	2.75	3346						
Tamil Nadu Total		**5.71**	**8.84**	**1548.161121**	2565	4582	55.97992143	223007	48.67023134	157.88
Maharashtra	Bajra	6.57	5.29	805						
Maharashtra	Jowar	19.76	15.56	787						
Maharashtra	Ragi	0.82	0.95	1154						
Maharashtra	Small Millets	0.42	0.2	466						
Maharashtra Total		**26.75**	**21.05**	**786.9158879**	3145	16815	18.70353851	102900	6.119536128	129.19

Figure 3.3.2 - Data on Production, Yield and Area of millets along with Net Irrigated Area, amount of Agricultural Credit taken and NPK Fertilizers used per hectare for Rajasthan, Madhya Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka and Maharashtra. Source : Agricultural and Processed Food Products Export Development Authority and Reserve Bank of India Handbook of Statistics on Indian States 2021-2022. Based on authors own calculations

The first potential factor was the percentage of agricultural area that was irrigated. To calculate this, the Net Sown Area of a state was divided by the Net Irrigated area of the state. Correlating this value with the yield of millets from the state indicated that there was a strong, positive linear correlation between the two with a R square value of 0.865 and a correlation coefficient of 0.93 ($r = 0.93$, $R^2 = 0.865$) This indicates that states which have a large proportion of their total sown area irrigated, tend to have a higher yield for millets. For instance, Rajasthan, which had the lowest yield of just 787kg/ha also had the lowest irrigation rate of 18.7%, while Uttar Pradesh had the highest yield of 1978kg/ha and also the highest irrigation rate of 87%. This may imply causation as well, since irrigation allows for easier distribution of water to crops, thereby increasing the efficiency of cultivating crops. Therefore, expanding and making improvements to irrigation can help increase the yield of millets

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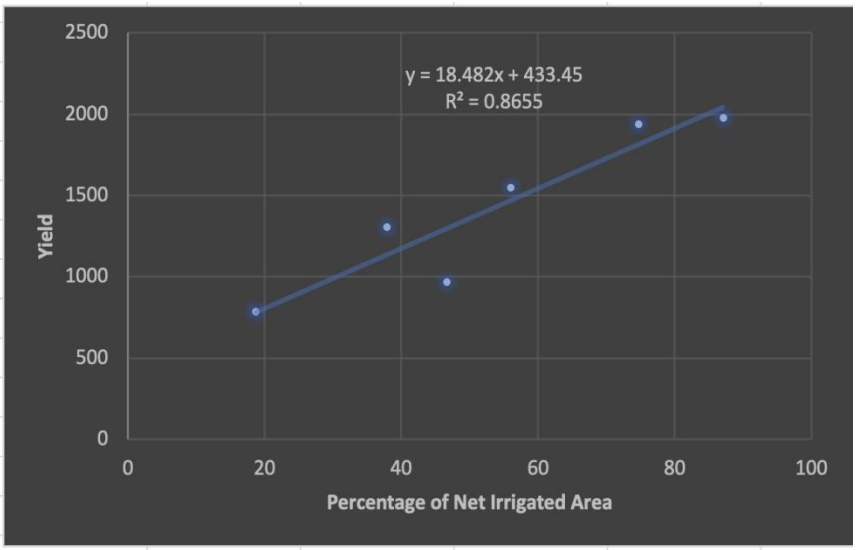
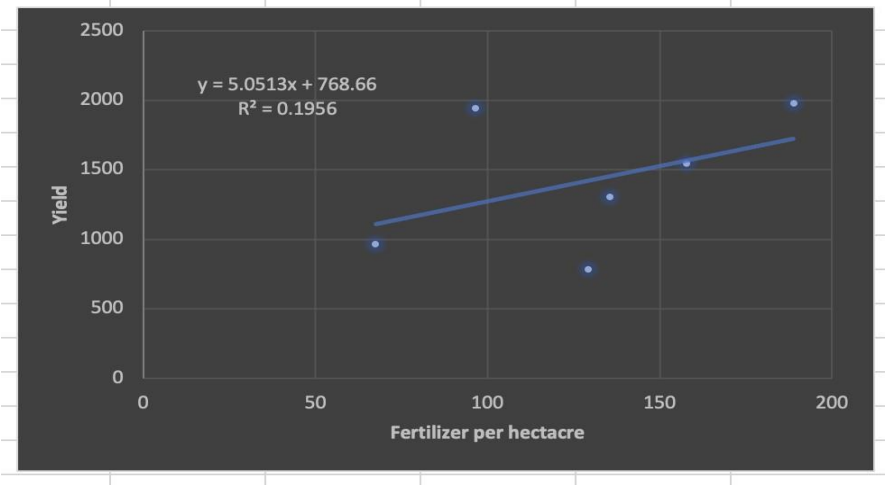
Fig 3.3.3 - Graph of Percentage of Net Irrigated Area and Yield of millets plotted on Excel. Based on authors own calculations



The second potential reason for this difference could be the amount of fertilizers used per hectare since conventionally it is believed that fertilizers increase the productivity of crops. After correlating the two variables for each of the 6 states, a weak, positive, linear correlation between the two emerges with a R square value of 0.196 and a correlation coefficient of 0.44 ($r = 0.44$, $R^2 = 0.196$)This indicates that whilst fertilizers could be one of the factors that contribute to this yield differential, they are unlikely to be the primary factor.

Fig 3.3.4 - Graph of NPK Fertilizers used per hectare and yield of millets plotted on Excel. Based on authors own calculations



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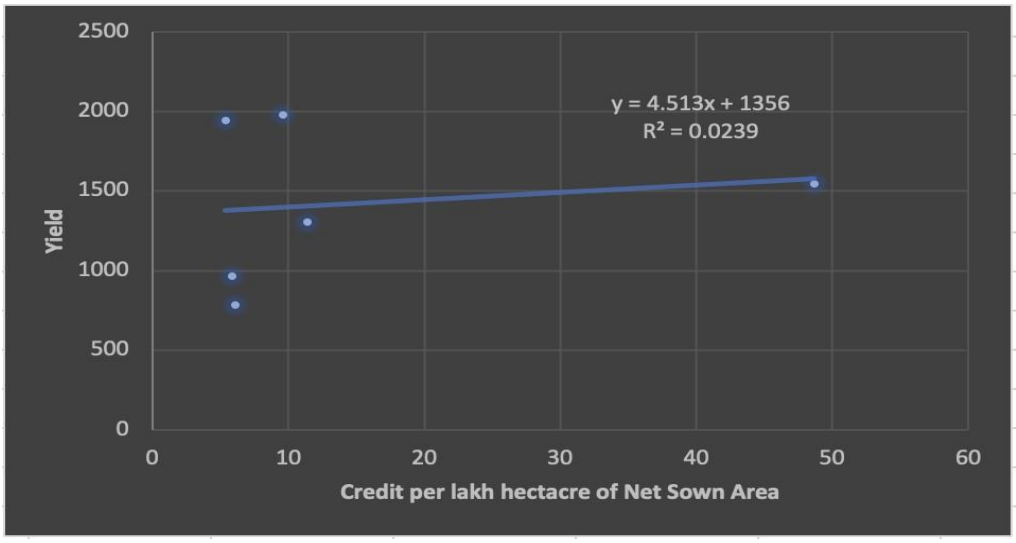
The third factor could be the differing amount of agricultural credit given to states by scheduled commercial banks. This may be because states that get a greater amount of credit are able to invest more into infrastructure and technology, which increases the yield of millets. For this analysis, the total amount of credit has been divided by the Net Sown Area of the state, to account for natural differences due to the differing sizes of states. However, an exceptionally weak correlation can be seen between the two variables with a R square value of 0.024 and a correlation coefficient of 0.15 ($r = 0.15$, $R^2 = 0.024$), which indicates that this is a negligible factor contributing to the difference.

Fig 3.3.5 - Graph of Credit per lakh hectare of Net Sown area and Yield of millets plotted on Excel. Based on authors own calculations



Three policies are further recommended to increase the yield of millets :

- The usage of hybrid seeds, which requires two further actions. Firstly, investing more into the research of millets in order to develop high-yielding seeds. Secondly forming a robust distributing framework to ensure that farmers are able to access these seeds at low costs
- The development of modern techniques to enhance the irrigation and harvesting process ,which is currently inefficient. These techniques must be properly delivered and taught to farmers through outreach workshops. Inspiration can be taken from successful efforts to increase crop yield throughout the world, specifically the techniques used in the US to increase the corn yield and techniques from the successful Odisha Millet Mission can be replicated as well

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- Most importantly, an extensive large scale survey, with both millet farmers and non-millet farmers is recommended. By surveying and interviewing millet farmers, one can learn more about the specific challenges that they face, which can help identify the problems and areas that need to be targeted. Interviewing non-millet farmers can also provide valuable information regarding the barriers to switching to millet farming and the MSP required to incentivise farmers.

4.0 - Conclusion

Though once thought to be traditional and high in demand in India, the consumption and production of millets are slowly declining. This paper finds The Green Revolution, Government Policies and Demand side issues to be the primary factors contributing to the decline in Millets.

It is clear that millet production must be promoted in India, both due to millet's nutritional and environmental value. The government of India has been attempting to do just that, however has only been successful in raising awareness about the issue. More must be done, as suggested in the paper, in the sphere of policy towards millets, specifically on the lines of investing more in irrigating land.

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