A COMPREHENSIVE STUDY OF ECONOMIC VIABILITY OF MILLET CULTIVATION IN INDIA

PROF.MUSILEK
Assistant Professor, Department of Management Studies,
National P.G. College, Lucknow, Uttar Pradesh, India

Abstract

This study conducts an in-depth analysis of the economic viability of millet cultivation in India, aiming to provide valuable insights for agricultural sustainability and rural development with the discussion of influencing factors to the cultivation of millets in India. Through comprehensive research, factors influencing the feasibility of millet cultivation have been examined, including input costs, yield potential, and climate resilience. Comparative analyses against traditional crops offer critical perspectives on the economic competitiveness of millets.

The objectives of the study are Studying the assessment of input costs of millets provides valuable insights into the economic dynamics of their cultivation. Additionally, delving into the nutritional benefits and challenges associated with millet cultivation sheds light on their importance in promoting food security and health. Analyzing the economic feasibility of millet cultivation in India is crucial for understanding its potential as a sustainable agricultural practice, considering factors such as yield, market demand, and resource allocation. The study is based on secondary data which have been collected through different published sources of information and the statistical data have been presented through graphs for analysis purpose.

In conclusion, achieving economic viability in millet cultivation in India demands holistic solutions and collaborative efforts. By addressing challenges, leveraging opportunities, and adopting sustainable approaches, we can unlock millets' economic potential, improve farmer livelihoods, and enhance food security and nutrition, transforming India's agricultural landscape for present and future generations.

Keywords: *Millet cultivation, Economic viability, Input cost of millet cultivation, determinants of millet cultivation.*

1. Introduction

1.1. Overview of Millets:

Millets are basically a group of small-seeded grasses, which cultivated as cereal crops for human consumption and animal feed. They are traditionally grown in semi-arid regions of Africa and Asia, including India, Nigeria, Niger, and Mali. Millets have gained recognition for their resilience to harsh environmental conditions, nutritional benefits, and potential contribution to food security and sustainable agriculture.

In other words, Small-seeded grasses called millets are cultivated as grains or cereal crops for human use and fodder. They are a fantastic source of nutrients, abundant in vitamins, minerals, and proteins, and high in fibre. Additionally free of gluten, millets are perfect for people with celiac disease or other dietary sensitivity issues.

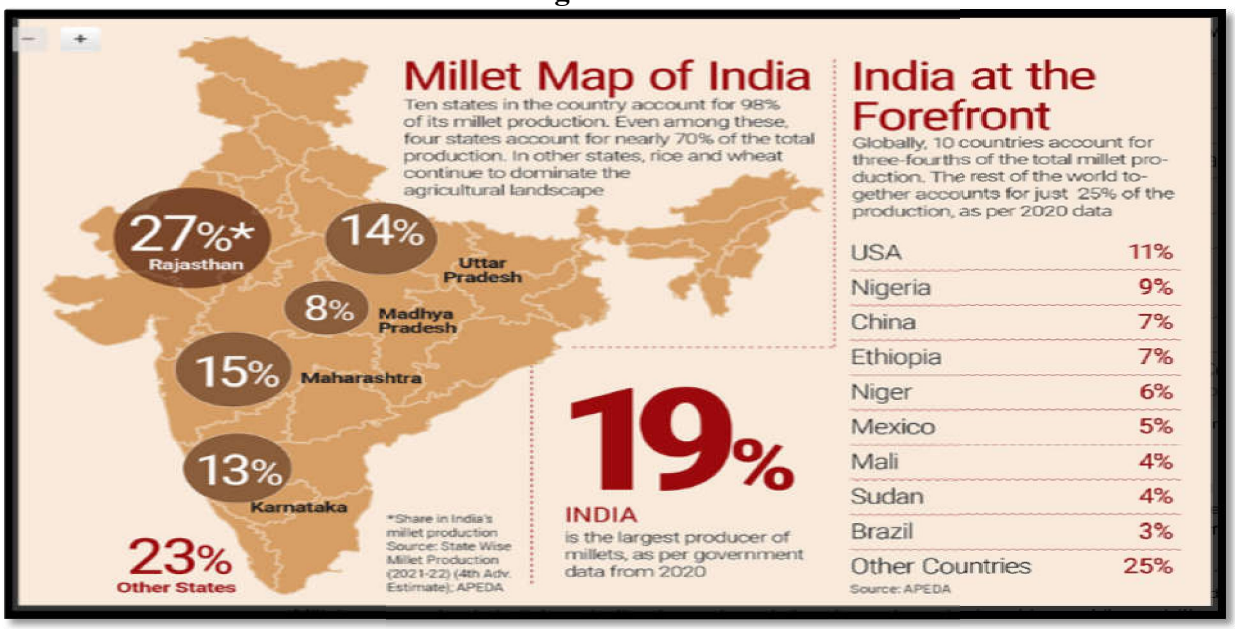
Where other crops would fail in dry, arid climates, millets can be produced because they are drought-tolerant. They can thrive in regions that receive little soil fertility and moisture, such as arid zones or areas that receive rain. Millets are grown on mountainous, tribal, low-fertile soil that receives rain.

Millions of people who live in arid and dry regions of the world rely heavily on millets as a source of energy and sustenance. Roughly 60 crore people in Asia and Africa traditionally eat them, and they are farmed in roughly 131 countries. With 20% of the world's total and 80% of Asia's production, India is the world's biggest millet producer.

Millets are rich in dietary fibre and nutrients. They are an excellent source of phytochemicals, minerals, and protein. 7–12% protein, 2-4% fat, 65-75% carbs, and 15-20% dietary fibre are included in millets.

The Ministry of Agriculture and Farmers Welfare acknowledged the importance of millets and designated them as "Nutri-Cereals" for production, consumption, and trade. These millets included Sorghum (Jowar), Pearl Millet (Bajra), Finger Millet (Ragi/Mandua), and Minor Millets, such as Foxtail Millet (Kanngani/kakun), Proso Millet (Cheena), Kodo Millet (Kodo), Barnyard Millet (Sawa/Sanwa/Jhangora), Little Millet (Kutki), Brown Top Millet, and two pseudo-millets, Buck-wheat (Kuttu), and Amaranth (Chaulai).

Figure no. 1



Source: *APEDA*

1.2. Nutritional Value of Millets:

Millets are highly nutritious, offering a range of essential nutrients such as protein, dietary fiber, vitamins, and minerals. They are gluten-free, making them suitable for individuals with celiac disease or gluten intolerance. Additionally, millets have a low glycemic index, making them ideal for managing blood sugar levels, particularly for individuals with diabetes. Sorghum, pearl millet, finger millet, foxtail millet, and proso millet are among the most commonly consumed millet varieties, each offering unique nutritional benefits. For instance, finger millet is rich in calcium, iron, and fiber, while pearl millet is a good source of protein and micronutrients.

1.3. Cultivation Practices:

Millets are well-adapted to diverse agro-ecological conditions, including regions with low rainfall and poor soil fertility. They require minimal water and can thrive in marginal lands where other crops struggle to grow. Millet cultivation practices vary depending on the specific variety and environmental conditions. Generally, millets are sown during the rainy season and harvested after maturation. Traditional farming methods such as intercropping and mixed cropping are commonly used to maximize yield and enhance soil fertility. Millets are often cultivated by smallholder farmers using sustainable practices that minimize the use of chemical inputs and promote biodiversity.

1.4. Economic Importance:

Millets play a crucial role in the livelihoods of millions of people, particularly in developing countries where they serve as staple food crops. They contribute to food security and income generation for smallholder farmers, providing a source of livelihood even in challenging agro-climatic conditions. Additionally, millets have economic potential beyond subsistence farming, with opportunities for value addition and commercialization. Millet-based products such as flour, breakfast cereals, snacks, and beverages are gaining popularity in urban markets, creating new market opportunities for farmers and entrepreneurs.

1.5. Role of Millets in Sustainable Agriculture:

Millets are considered a sustainable crop due to their low resource requirements and minimal environmental impact. Their ability to grow in marginal lands reduces pressure on prime agricultural areas and helps preserve biodiversity. Millet cultivation promotes soil health and water conservation, contributing to ecosystem resilience and climate change mitigation. Furthermore, millets have a shorter growing cycle compared to other cereals, allowing for multiple cropping systems and improved crop rotation practices. As sustainable agriculture gains traction globally, millets are increasingly recognized as a valuable component of agro-ecological farming systems.

1.6. Addressing Global Challenges:

Millets have the potential to address several pressing global challenges, including food security, malnutrition, and climate change. As climate-resilient crops, millets offer a viable solution for mitigating the adverse effects of climate variability on agriculture. Their nutritional qualities make them important allies in the fight against malnutrition, especially in areas with limited access to a variety of nutrient-dense meals. Furthermore, millets support sustainable land management techniques and the preservation of biodiversity, which is in line with the Sustainable Development Goals of the United Nations.

1.2. Economic Viability of Millet Cultivation:

Assessing the economic viability of millet cultivation is of paramount importance for farmers, policymakers, and stakeholders for several compelling reasons:

- **Farmers' Prosperity:** Understanding the economic feasibility of millet cultivation empowers farmers to make informed decisions about crop selection, resource allocation, and investment strategies. By assessing the profitability and potential returns associated with millet cultivation, farmers can optimize their agricultural practices to maximize income and improve their overall livelihoods.

- **Diversification of Income:** For many smallholder farmers, millet cultivation serves as a critical source of income diversification. By assessing the economic viability of millets, farmers can identify opportunities to diversify their crop portfolios and reduce dependence on single crops, thereby mitigating the risks associated with market fluctuations, adverse weather conditions, and pest outbreaks.
- **Food Security:** Millets play a crucial role in ensuring food security, particularly in regions where they serve as staple food crops. Assessing the economic viability of millet cultivation enables policymakers and stakeholders to identify opportunities for increasing production, enhancing market access, and promoting sustainable agricultural practices, thereby contributing to food security at the household, community, and national levels.
- **Market Development:** Understanding the economic viability of millet cultivation is essential for the development of vibrant and sustainable markets for millet-based products. By assessing market demand, consumer preferences, and value chain dynamics, policymakers and stakeholders can identify opportunities for market development, value addition, and market linkage, thereby creating new avenues for income generation and economic growth.
- **Sustainable Agriculture:** Assessing the economic viability of millet cultivation within the framework of sustainable agriculture is critical for promoting environmentally friendly farming practices. By evaluating the cost-effectiveness of sustainable agricultural techniques, such as organic farming, agro-ecological approaches, and water-efficient irrigation methods, policymakers and stakeholders can incentivize the adoption of practices that promote soil health, conserve water resources, and enhance ecosystem resilience.
- **Resilience to Climate Change:** Millets are known for their resilience to climate variability and extreme weather events, making them an important crop for climate change adaptation. Assessing the economic viability of millet cultivation in the context of climate change helps farmers and policymakers identify resilient crop varieties, agronomic practices, and risk management strategies, thereby enhancing the resilience of agricultural systems to climate-related risks.

1.3. Research Methodology:

The descriptive study is based on secondary data collected through different official authentic publications available on government, news papers and other institutional website. The data have been presented in tabulation and graphical form.

1.3.1. Importance of Study:

The study on the economic viability of millet cultivation in India holds significant importance on various fronts. Firstly, millets are traditional grains that have been cultivated for centuries in India but have faced neglect in recent times due to the emphasis on high-yielding crops like rice and wheat. Understanding the economic viability of millet cultivation can help in reviving these indigenous crops, promoting agricultural diversity, and ensuring food security. Moreover, millets are highly resilient to climatic variations and require fewer inputs such as water and fertilizers compared to other cereals, making them suitable for sustainable agriculture and mitigating the impacts of climate change. Additionally, the study can shed light on the potential income generation for farmers, particularly those in rain-fed and marginal areas where millet cultivation could be more feasible. It can also inform policymakers about the need for supportive policies, incentives, and market interventions to encourage millet cultivation and create a conducive environment for farmers to adopt these crops. Overall, the analytical study of the economic viability of millet cultivation in India is crucial for promoting agricultural sustainability, diversification, and rural livelihood enhancement in the country.

1.3.2. Objectives of the study:

The objectives of the study are following-

1. To get insight into the assessment of input cost of millets.

2. To enlighten the nutritional benefits and challenges of millets cultivation.

3. To study the economic feasibility of millets cultivation in India.

1.4. Cost Analysis:

1.4.1. Land Preparation Costs for Millets Cultivation:

The process of land preparation for millet cultivation typically involves several key steps to ensure optimal conditions for germination, growth, and yield. Below is an overview of the general process:

1. **Selection of Land:** Choose a suitable plot of land that receives adequate sunlight and has good drainage. Millets can grow in various soil types, but well-drained sandy loam or loamy soil with good organic matter content is ideal.

2. **Clearing the Land:** Remove any existing vegetation, weeds, rocks, or debris from the selected area to create a clean and uniform surface for planting. This can be done manually using tools such as hoes, machetes, or mechanical equipment like tractors.

3. Ploughing: Plough the land to break up the soil and loosen it to a depth of about 15-20 centimetres. Ploughing helps improve soil aeration, root penetration, and water infiltration, creating a favourable environment for seed germination and root development.

4. Harrowing: After ploughing, harrow the soil to further break up clods, level the surface, and create a fine seedbed. Harrowing also helps incorporate organic matter and fertilizers into the soil, promoting nutrient availability for plant growth.

5. Soil Testing and Amendment: Conduct soil tests to assess nutrient levels, pH, and other soil properties. Based on the test results, amend the soil with organic matter, such as compost or manure, and mineral fertilizers to optimize soil fertility and balance nutrient deficiencies.

6. Bed Preparation: In some cases, raised beds or ridges may be formed to improve drainage, prevent water logging, and promote root development. Bed preparation can be done manually or with mechanical equipment, depending on the scale of cultivation.

7. Final Smoothing: Once the soil has been ploughed, harrowed, and amended, the surface should be smoothed to create a uniform seedbed. This can be done using hand tools or implements such as land levellers or rollers to ensure even seed distribution and uniform germination.

8. Marking Rows or Furrows: Depending on the planting method (broadcasting or row planting), mark rows or furrows in the soil at appropriate spacing intervals using stakes, ropes, or mechanical markers. This helps guide the planting process and ensures uniform plant spacing.

9. Pre-Planting Irrigation: If necessary, irrigate the prepared land to moisten the soil and create favorable moisture conditions for seed germination. Avoid overwatering, as excessive moisture can lead to water logging and root rot.

10. Mulching: Applying an organic mulch layer—such as grass clippings, straw, or agricultural residues—can help control soil temperature during the germination and early growth stages, inhibit weed growth, and preserve soil moisture.

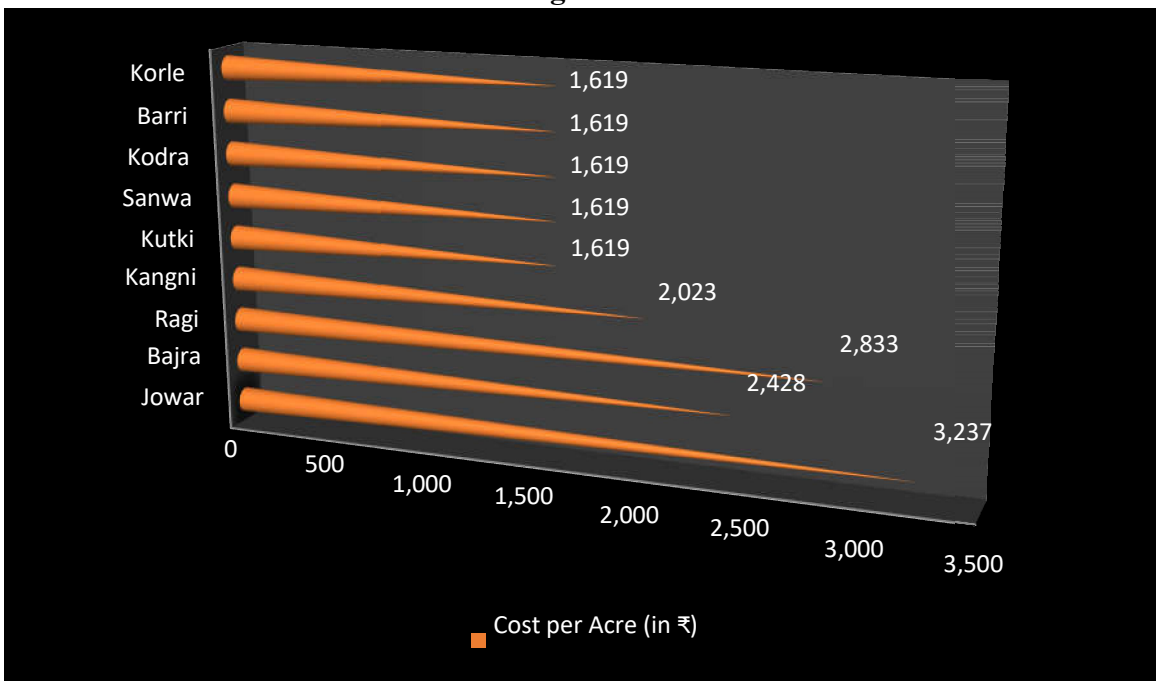
Table no. 1

Millets Type	Cost per Acre (in ₹)
Jowar	3,237
Bajra	2,428
Ragi	2,833
Kangni	2,023

Kutki	1,619
Sanwa	1,619
Kodra	1,619
Barri	1,619
Korle	1,619

Source: https://www.asiafarming.com

Figure no. 2



Source: https://www.asiafarming.com

1.4.2. Cost of seeds and planting:

The primary expenses associated with millet production include manpower costs, equipment costs, irrigation costs, seed and planting materials, fertilisers, manure, and other miscellaneous costs. For pearl millet cultivation, the cost of seed and planting is ₹ 1,000 per acre, or roughly 29% of the entire cultivation cost.

1.4.3. Nutrient Management Costs:

In India, the entire cost of nutrient management and fertiliser for millet farming ranges from ₹1,600 to ₹3,500 per hectare. The type of millet and the source of nutrients and fertilisers used determine the cost. A few examples of managing nutrients are:

- Testing of manure and soil
- Plant tissue testing throughout the growing season
- Fertiliser products with increased efficiency
- Separate application

1.4.4. Irrigation cost of Millets Cultivation:

Compared to other grains, millet requires less water, which is one of its main advantages. While certain cultivars require at least 40 cm of rainfall annually for maximum yield, millets

can thrive with less than 35 cm of precipitation annually. Because of this, millets can be used in rain fed agricultural systems in areas with limited or unpredictable irrigation resources. The price of irrigation for millet farming is contingent upon a number of variables, including the water source, the type of millet, the area under cultivation, the frequency and duration of irrigation, and the irrigation method.

In India, irrigation for millet farming typically costs Rs. 600 per acre. Nevertheless, a number of variables affect the price, such as:

- source of water
- Method of irrigation
- The length and frequency of irrigation
- The area used for farming
- kind of millet

For irrigated ragi, the average cultivation cost per hectare is Rs. 57,874, whereas for rain fed ragi, it is Rs. 43,706 per hectare. This is due to the fact that irrigated ragi needs more work irrigation, fertiliser, and FYM.

A crop that can withstand droughts and requires less water to flourish is millet. It can withstand mild alkalinity and grow in a variety of soil types, from extremely poor to quite fertile.

1.4.5. Disease Management Cost:

In India, the average cost of managing pests and diseases during millet cultivation is approximately Rs 654 per acre, or 9% of the overall cultivation cost.

Since millets are produced in low-input agricultural settings, it is not advised to use chemicals to control disease. Mostly preventive actions are employed instead. The following are a few obstacles to millet production:

- Drought and inadequate fertility of the soil
- Hermonthica Striga
- Chief miners' birds
- Downy mildew
- Aspects of society and economy
- Pressure from diseases and pests

1.4.6. Cost of labour and Equipments in Millets Cultivation:

A 2019 analysis estimates that the labour costs for cultivating foxtail millet in India are approximately Rs 400. Furthermore, ploughs may cost farmers Rs 1,600 for every acre of land. According to researchjournal.co.in the machine labour costs Rs 2,371 per hour for the manufacturing of pearl millet.

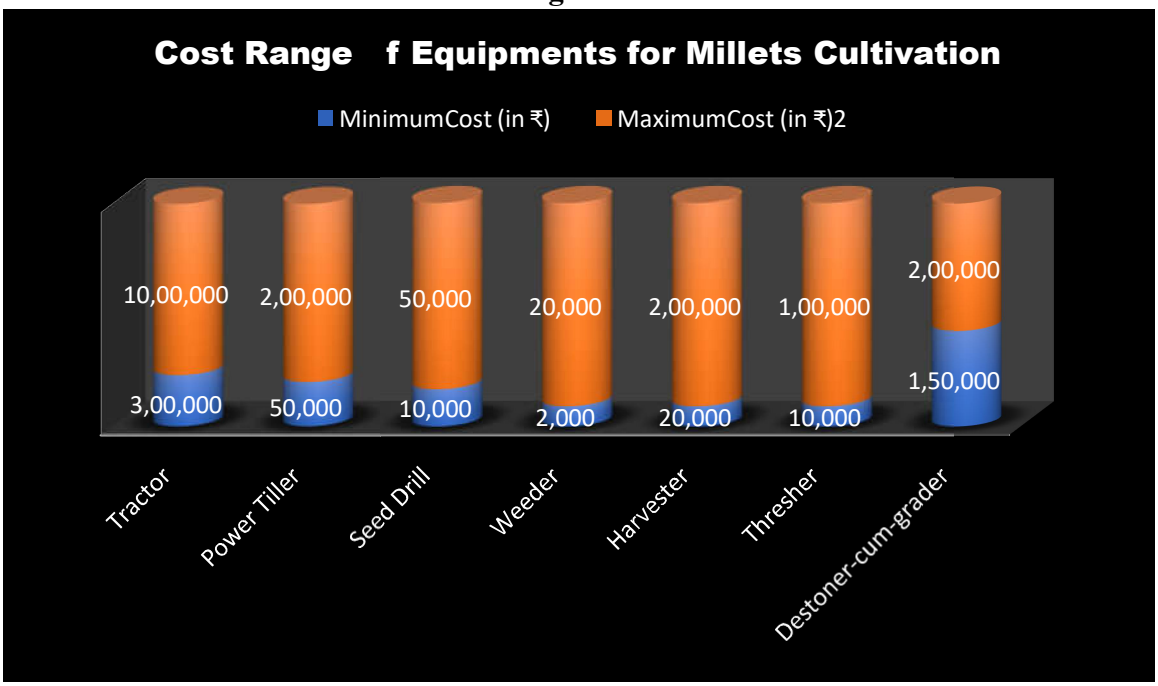
Table no. 2

Cost of Equipments used in Millets cultivation

Equipments	Range of Cost (in ₹)
Tractor	3 Lac – 10 Lac
Power Tiller	50 K – 2 Lac
Seed Drill	10 K – 50 K
Weeder	2 K – 20 K
Harvester	20 K – 2 Lac
Thresher	10 K – 1 Lac
Destoner-cum-grader	Lump-sum 2 Lac

Source: https://www.asiafarming.com

Figure no. 3



Source: https://www.asiafarming.com

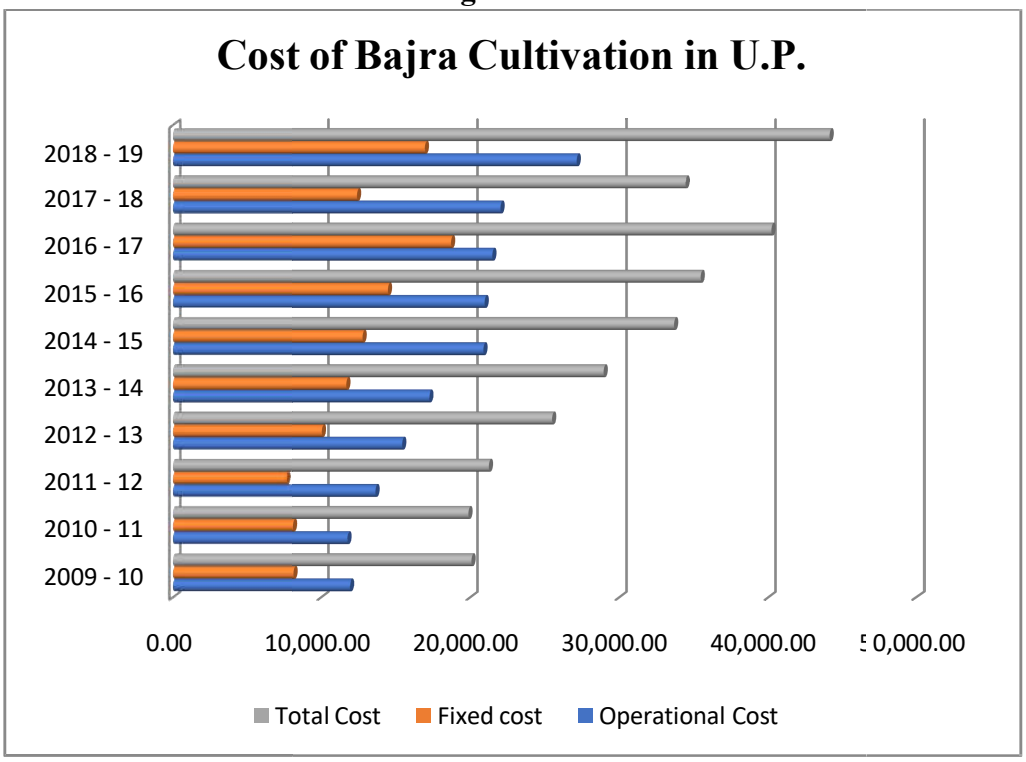
Table no. 3

1.4.7. Cost of Bajra Cultivation in Uttar Pradesh

Year	Operational Cost	Fixed cost	Total Cost
2009 - 10	11,943.01	8,157.30	20,100.31
2010 - 11	11,773.30	8,121.42	19,894.72
2011 - 12	13,657.94	7,608.90	21,266.84
2012 - 13	15,450.51	10,057.30	25,507.81
2013 - 14	17,263.40	11,702.76	28,966.16
2014 - 15	20,900.29	12,792.73	33,693.02
2015 - 16	20,982.30	14,493.43	35,475.73
2016 - 17	21,498.63	18,728.87	40,227.50
2017 - 18	22,045.62	12,418.18	34,463.80
2018 - 19	27,159.10	16,968.94	44,128.04

Source: https://www.milletstats.com/coc-stats/

Figure no. 4



Source: https://www.milletstats.com/coc-stats/

Table no. 4

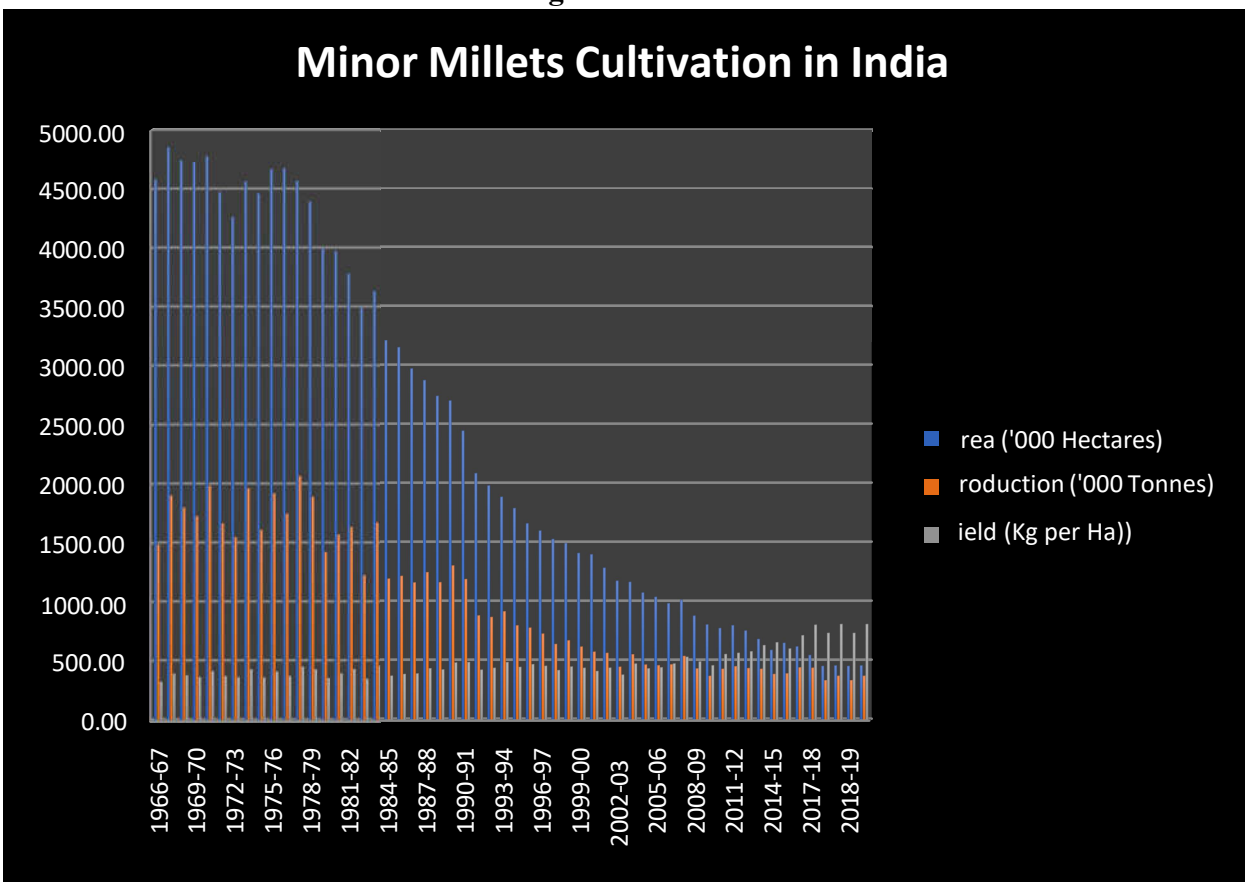
1.4.8. Trend of Cultivation of Minor Millets

Year	Area ('000 Hectares)	Production ('000 Tonnes)	Yield (Kg per Ha))
1966-67	4584.00	1488.50	324.72
1967-68	4857.20	1907.20	392.65
1968-69	4746.20	1803.70	380.03
1969-70	4732.70	1732.00	365.96
1970-71	4782.90	1987.80	415.61
1971-72	4477.30	1669.40	372.86
1972-73	4265.20	1552.20	363.92
1973-74	4567.10	1965.90	430.45
1974-75	4466.30	1613.40	361.24
1975-76	4672.50	1924.10	411.79
1976-77	4679.50	1751.80	374.36
1977-78	4573.80	2069.80	452.53
1978-79	4396.80	1893.90	430.75
1979-80	4001.70	1424.70	356.02
1980-81	3976.30	1574.60	396.00
1981-82	3786.10	1638.40	432.74
1982-83	3499.40	1229.10	351.23
1983-84	3637.40	1675.40	460.60
1984-85	3213.80	1194.20	371.59

1985-86	3154.80	1217.20	385.82
1986-87	2974.60	1161.50	390.47
1987-88	2875.70	1248.60	434.19
1988-89	2742.50	1163.50	424.25
1989-90	2703.10	1305.50	482.96
1990-91	2447.40	1190.00	486.23
1991-92	2087.60	882.10	422.54
1992-93	1983.00	868.80	438.12
1993-94	1887.50	917.10	485.88
1994-95	1791.70	798.00	445.39
1995-96	1662.20	778.80	468.54
1996-97	1601.10	728.20	454.81
1997-98	1529.40	639.90	418.40
1998-99	1494.60	670.80	448.82
1999-00	1410.90	618.20	438.16
2000-01	1399.80	575.00	410.77
2001-02	1286.10	564.80	439.16
2002-03	1176.20	447.40	380.38
2003-04	1166.40	552.80	473.94
2004-05	1076.00	465.92	433.01
2005-06	1039.30	459.60	442.22
2006-07	985.20	467.60	474.62
2007-08	1014.20	538.70	531.16
2008-09	880.20	432.80	491.71
2009-10	805.63	370.02	459.30
2010-11	774.93	429.97	554.84
2011-12	798.78	451.53	565.28
2012-13	754.09	435.65	577.72
2013-14	682.30	429.91	630.09
2014-15	589.59	385.87	654.47
2015-16	649.80	390.84	601.48
2016-17	619.11	441.94	713.84
2017-18	546.27	438.99	803.60
2018-19	453.75	333.00	734.00
2019-20	458.35	370.81	809.00
2018-19	453.75	333.00	733.88
2019-20	458.35	370.81	809.01

Source: https://www.milletstats.com/minor-millets/

Figure no. 5



Source: https://www.milletstats.com/minor-millets/

Table no. 5

1.4.9. Minor Millets Cultivation in Uttar Pradesh

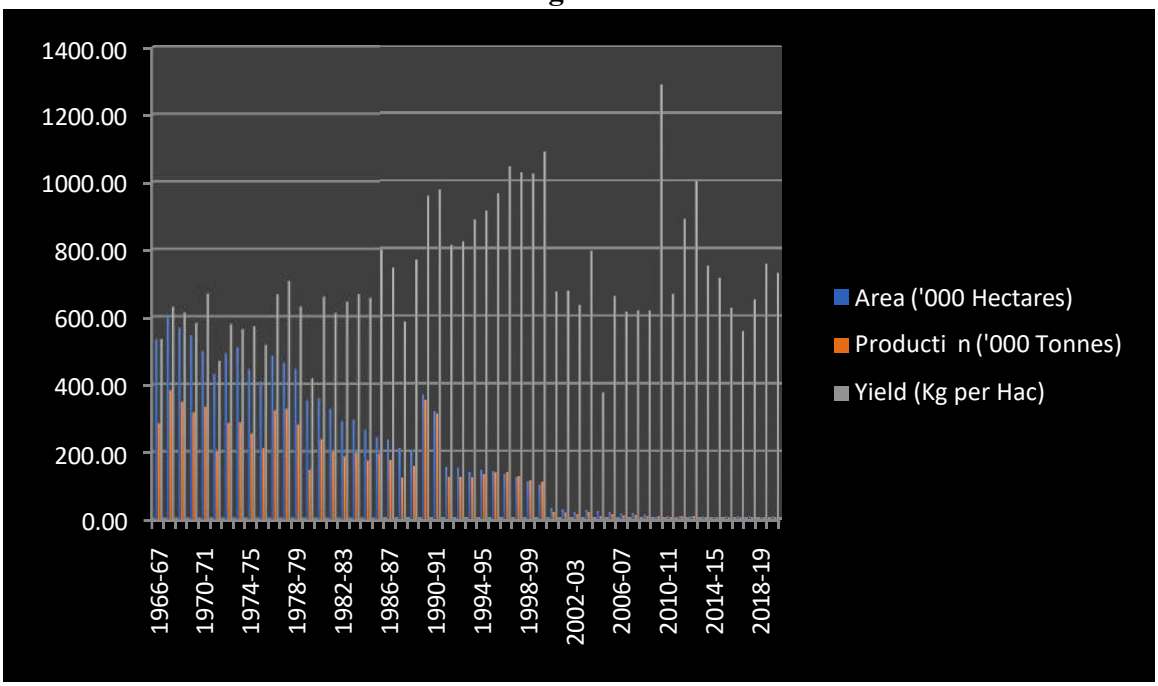
Year	Area ('000 Hectares)	Production ('000 Tonnes)	Yield (Kg per Ha))
1966-67	534.00	285.60	534.83
1967-68	607.30	382.90	630.50
1968-69	568.40	348.80	613.65
1969-70	545.30	317.40	582.06
1970-71	499.60	334.40	669.34
1971-72	431.40	202.70	469.87
1972-73	493.10	285.40	578.79
1973-74	510.20	287.80	564.09
1974-75	445.60	255.10	572.49
1975-76	408.70	211.50	517.49
1976-77	485.30	323.80	667.22
1977-78	464.10	328.00	706.74
1978-79	446.30	281.70	631.19
1979-80	352.50	147.50	418.44

1980-81	360.20	237.80	660.19
1981-82	328.50	201.10	612.18
1982-83	291.70	188.30	645.53
1983-84	296.00	197.60	667.57
1984-85	266.00	174.80	657.14
1985-86	244.50	194.90	797.14
1986-87	235.30	175.20	744.58
1987-88	210.80	123.20	584.44
1988-89	205.20	157.60	768.03
1989-90	369.00	353.00	956.64
1990-91	320.00	312.00	975.00
1991-92	155.10	125.80	811.09
1992-93	152.40	125.20	821.52
1993-94	139.30	123.60	887.29
1994-95	146.30	133.60	913.19
1995-96	143.00	137.90	964.34
1996-97	134.30	140.20	1043.93
1997-98	124.60	127.80	1025.68
1998-99	112.10	114.60	1022.30
1999-00	102.00	110.90	1087.25
2000-01	32.80	22.10	673.78
2001-02	29.30	19.80	675.77
2002-03	22.10	14.00	633.48
2003-04	27.70	22.00	794.22
2004-05	24.00	9.00	375.00
2005-06	21.80	14.40	660.55
2006-07	17.10	10.50	614.04
2007-08	19.10	11.80	617.80
2008-09	13.60	8.40	617.65
2009-10	7.00	9.00	1285.71
2010-11	9.00	6.00	666.67
2011-12	9.00	8.00	888.89
2012-13	9.00	9.00	1000.00
2013-14	8.00	6.00	750.00
2014-15	7.00	5.00	714.29
2015-16	8.00	5.00	625.00
2016-17	9.00	5.00	555.56
2017-18	9.00	5.85	650.00
2018-19	6.00	4.53	755.00

2019-20	8.00	5.82	728.00

Source: https://www.milletstats.com/coc-stats/

Figure no. 6



Source: https://www.milletstats.com/minor-millets/

1.5.1. Nutritional Benefits of Millets:

Millet grains are a better option than cereal grains since they are higher in minerals like calcium, potassium, magnesium, iron, manganese, zinc, and B complex vitamins and richer in nutrients like protein, carbohydrate, dietary fibre, and good-quality fat.

- Additionally, millets include a number of bioactive phyto-chemicals, such as phenolic substances (ferulic acid, caffeic acid, and quercetin), β-glucan, inulin, resistant starch, lignans, and feraxans. Research has substantiated the involvement of poly-phenols in antioxidant, anti-carcinogenic, anti-inflammatory, antiviral, and euro-protective properties. These attributes collectively demonstrate the potential to mitigate the risk of various diseases, including cancer, cardiovascular disease, diabetes, hypertension, hypercholesterolemia, inflammatory disorders, metabolic syndrome, and Parkinson's disease.
- Because of their phyto-chemical concentration, millets are also thought to offer antibacterial and DNA damage protective properties. Dietary fibre and non-starch polysaccharides, which aid in controlling weight, make up a fairly large percentage of

millet grains. Because they release glucose gradually, millets are a great dietary option for those with diabetes.

- A great source of slowly digesting carbohydrate and fibre, millets are beneficial to the gut microbiota, which is home to trillions of bacteria, including Lactobacillus acidophilus, rhamnosus GG, Actinobacteria, and Bifido species. Millets include non-starch polysaccharides that contribute significantly to dietary fibre. These polysaccharides degrade resistant starch to produce short-chain fatty acids and are also a great source of pre-biotics.
- Millets' higher fibre content contributes to their lower glycemic characteristics. While food matrices, component composition, processing methods, food shape (grain or flour), etc., all affect a dish's glycemic characteristics, most millet recipes may be made to have a low glycemic index.

1.5.2. Challenges in Millets Cultivation

The millet industries have been confronted with a number of issues related to production, processing, value addition, marketing, and consumption. These issues have made it more difficult to promote millet as a staple grain globally. The following are some of the main issues that have been found when processing and adding value to millet.

- **Low Productivity of Millets:** Millets are not as prolific as wheat, rice, and maize in the country. Their rain-fed farming on marginal soils and their reluctance to accept improved cultivars are blamed for this. The vast majority of the millets output disparity can be attributed to farmers' farming practices, which have space for improvement. Between 2009 and 2014, the nation's average yield gaps for bajra, ragi, rabi sorghum, kharif sorghum, and small millets were 58%, 151%, 62%, 183%, and 156%, respectively.
- **Resistance to pests & diseases:** Few pests and diseases affect millets, but some often cause significant losses in sorghum (shoot fly, stem borer, grain mould), pearl millet (downy mildew and blast), and finger millet (blast). There are no productive cultivars that are highly resistant to these pests and diseases, and the available management options are mainly restricted to agronomic and chemical methods.
- **Area expansion in non-traditional areas:** Increasing the area planted to millets is another essential step in increasing production; fallow and wastelands, as well as unconventional sites, are especially important because they are more sustainable and do not compete with highly profitable crops.

- **End-product specific cultivars:** Enhancing the quality of the final product and increasing the value addition by the large processors requires evaluating the geometrical and nutritional characteristics of most cultivars accessible in all millet growing geographical regions and matching with the appropriate end-use.
- **Seed hubs & breeder seed production:** It is essential to identify several cultivars that are appropriate to a given product and establish seed hubs for breeding and producing these seeds in order to establish demand-driven manufacturing. Establishing seed hubs that can provide premium seed at high production levels is a crucial intervention.
- **Challenges faced in the Processing of Millets:**
  - Only 70–80% of the grain is recovered by the inefficient machinery now in use; the remainder is made up of broken and unhulled grains.
  - Each variety of millets differs largely in size, shape, and husk composition, so it is not appropriate to use the same type of dehuller unit for all of them.
  - Hull separation and collection are time-consuming processes that leave a mess on the workspace and may mix in with the final hulled product.
  - The efficiency of dehulling millet is highly influenced by the speed of the impeller. It is necessary to include a clause regulating the speed at which machines operate.
  - Since gluten is absent, gelatinization of starch by hydrothermal treatment, extrusion, etc., is used to diversify value addition; nonetheless, it is still difficult to produce some goods, such as bread, buns, etc., using only millet.
  - Both comprehensive data on the effects of various processing methods on nutritional features and a framework outlining the best technologies for boosting nutrient availability and reducing anti-nutritional contents are missing.
  - The comparison of modified food's physiologically active biochemicals to raw millets' polyphenols and antioxidant capacity; resistant starch; investigation of the health advantages of millets' anti-inflammatory qualities; and millets' prebiotic and probiotic capabilities.

1.6.1. Economic feasibility of millets cultivation:

The economic feasibility of millets cultivation encompasses various aspects related to input costs, market prices, government support, access to resources, and overall profitability. Millets, often considered as neglected crops, gained the attention in recent years because of its nutritional value, climate resilience, and potential for sustainable agriculture. Understanding the economic feasibility of millets is crucial for farmers, policymakers, and other stakeholders in making informed decisions about their cultivation.

1.6.1.1. Input Costs:

The economic feasibility of millets cultivation is influenced by input costs, including seeds, fertilizers, pesticides, labour, and irrigation. Millets are known for their low input requirements compared to other crops, as they are adapted to diverse agro-climatic conditions and require minimal external inputs. However, the cost of inputs can vary depending on factors such as soil fertility, water availability, pest and disease pressure, and farm management practices. Farmers need to carefully manage input costs to optimize profitability and ensure economic viability.

1.6.1.2. Market Prices:

Market prices play a crucial role in determining the economic feasibility of millets cultivation. While millets have traditionally been considered low-value crops, there has been a growing demand for them in recent years due to their nutritional benefits and suitability for diverse food products. As a result, market prices of millets have been on the rise, incentivizing farmers to cultivate them. However, price volatility and market uncertainties can pose risks for farmers, especially those with limited market access or bargaining power. Strengthening market linkages, promoting value addition, and establishing transparent trading mechanisms can help mitigate price risks and improve market outcomes for millet farmers.

1.6.1.3. Government Support:

Government policies and support programs can significantly influence the economic feasibility of millets cultivation. In many countries, including India, governments have introduced various initiatives to promote millet cultivation and consumption. These initiatives may include subsidies, price support mechanisms, procurement programs, research and development investments, and extension services. Government support can help reduce input costs, mitigate risks, and enhance market access for millet farmers, thereby improving their overall profitability and economic viability.

1.6.1.4. Access to Resources:

Access to resources such as land, water, seeds, and credit is essential for the economic feasibility of millets cultivation. Farmers need access to suitable land for cultivation, adequate water resources for irrigation, quality seeds for planting, and financial resources for purchasing inputs and managing farm operations. Additionally, access to extension services, technical know-how, and market information can enhance farmers' ability to adopt best practices, optimize resource use, and improve profitability. Ensuring equitable access to resources and support services is critical for promoting the economic viability of millets cultivation, especially among smallholder farmers and marginalized communities.

1.6.1.5. Overall Profitability:

The economic feasibility of millets cultivation ultimately depends on its overall profitability. While millets may offer lower yields compared to other crops, their lower input requirements, climate resilience, and nutritional value can contribute to sustainable and profitable farming systems. By adopting efficient farm management practices, leveraging market opportunities, and accessing government support programs, farmers can enhance the profitability of millets cultivation and improve their economic well-being.

In conclusion, the economic feasibility of millets cultivation depends on a range of factors, including input costs, market prices, government support, access to resources, and overall profitability. By carefully managing these factors and adopting sustainable and market-oriented approaches, farmers can enhance the economic viability of millets cultivation and contribute to food security, nutrition, and sustainable agriculture. Millets have the potential to play a significant role in promoting agricultural diversification, resilience, and inclusive growth, and by investing in their economic feasibility, For the sake of both the current and upcoming generations, we can realise their full potential.

1.7. Conclusion:

Millets represent a valuable resource for agriculture and food systems, offering nutritional benefits, resilience to environmental stress, and economic opportunities for smallholder farmers. Their cultivation supports sustainable agriculture practices, enhances food security, and addresses global challenges such as malnutrition and climate change. As the world seeks more resilient and sustainable food systems, millets have emerged as a promising solution with the potential to transform the way we grow, consume, and value food. Efforts to promote millets' cultivation, consumption, and commercialization are essential for harnessing their full potential and realizing their role in building a more sustainable and equitable future.

Assessing the economic viability of millet cultivation is essential for promoting sustainable agriculture, enhancing food security, diversifying income sources for farmers, and building resilient agricultural systems. By understanding the costs, benefits, and risks associated with millet production, farmers, policymakers, and stakeholders can work together to harness the potential of millets to improve livelihoods, enhance food security, and foster inclusive and sustainable economic development.

The economic viability of millet cultivation holds immense significance not only for farmers but also for policymakers, consumers, and the broader agricultural sector in India. Millets, often termed as coarse grains or neglected crops, have been experiencing a resurgence in popularity due to their numerous benefits ranging from nutritional richness to climate resilience. In this conclusion, we will delve deeper into the economic aspects of millet cultivation, examining its challenges, opportunities, and the pathways towards enhancing its economic viability.

At its core, the economic viability of millet cultivation hinges on several key factors, including input costs, market prices, government support, access to markets, and yield potential. These factors collectively influence the profitability of millet farming and determine its attractiveness as a crop choice for farmers.

Input costs play a crucial role in the economic equation of millet cultivation. Farmers incur expenses on seeds, fertilizers, pesticides, labor, and irrigation, among other inputs. Managing these costs efficiently is essential for optimizing returns and ensuring profitability. Additionally, access to quality inputs such as seeds and fertilizers can significantly impact yield potential, highlighting the importance of ensuring availability and affordability of inputs for millet farmers.

Market prices of millets fluctuate based on supply-demand dynamics, consumer preferences, government policies, and global market trends. While the increasing consumer awareness of millets' nutritional benefits has led to a rise in demand and prices, price volatility remains a concern for farmers, especially those with limited market access or bargaining power. Strengthening market linkages, promoting value addition, and establishing transparent trading mechanisms can help mitigate price risks and improve market outcomes for millet farmers.

Government support plays a crucial role in enhancing the economic viability of millet cultivation. Policies and programs aimed at promoting millet cultivation, such as subsidies, price support mechanisms, procurement programs, and research and extension services, can provide much-needed support to farmers and encourage investment in millet farming. Moreover, policy interventions that prioritize millets in public distribution systems and

nutrition programs can create additional demand and stabilize market prices, further enhancing the economic feasibility of millet cultivation.

Access to markets is another critical determinant of the economic viability of millet cultivation. Reliable market access ensures that farmers can sell their produce at fair prices and minimize post-harvest losses. Improving market infrastructure, facilitating market linkages, and promoting farmer-producer organizations can enhance market access for millet farmers and enable them to capture a larger share of the value chain.

Despite the numerous opportunities that millet cultivation offers, there are also challenges that need to be addressed to unlock its full economic potential. Limited market integration, lack of quality inputs, pests and diseases, competition from other crops, and access to credit and insurance facilities are some of the challenges faced by millet farmers. Addressing these challenges requires a concerted effort from various stakeholders, including governments, agricultural organizations, research institutions, and the private sector.

Millets are inherently resilient crops that require minimal inputs and can thrive in marginal lands with low rainfall. By promoting agroecological farming practices such as organic farming, conservation agriculture, and integrated pest management, farmers can reduce input costs, improve soil health, and enhance crop resilience, ultimately leading to higher profitability and sustainability.

Value addition is another area with significant potential for enhancing the economic viability of millet cultivation. Processing millets into value-added products such as flour, flakes, snacks, and beverages can create additional income opportunities for farmers and contribute to the development of vibrant value chains. Moreover, investing in research and innovation to develop millet-based products that cater to diverse consumer preferences can open up new markets and revenue streams for millet farmers.

In conclusion, the economic viability of millet cultivation in India is a multifaceted issue that requires holistic solutions and collaborative efforts from various stakeholders. By addressing challenges, leveraging opportunities, and adopting sustainable and market-oriented approaches, we can unlock the full economic potential of millet cultivation, improve livelihoods for farmers, and contribute to food security, nutrition, and sustainable agriculture in India. We can fully utilise millets' potential for the benefit of both the current and future generations by making investments in their economic viability. Millets have the potential to significantly alter India's agricultural landscape.

1.8. Way Forward:

This study presents a promising trajectory for agricultural sustainability and rural development. Firstly, comprehensive research must delve into the comparative analysis of millet cultivation against traditional crops, assessing factors such as input costs, yield potential, market demand, and resilience to climate change. This analysis will inform farmers and policymakers about the potential profitability and feasibility of transitioning to or incorporating millet cultivation into existing agricultural practices. Additionally, targeted interventions are crucial to enhance the value chain of millet production, including improved access to high-quality seeds, efficient farming techniques, post-harvest management, and market linkages. Furthermore, promoting consumer awareness and demand for millets through nutrition education campaigns and culinary innovations can stimulate market growth and create lucrative opportunities for farmers. Collaborative efforts involving government agencies, research institutions, NGOs, and private sectors are essential for implementing supportive policies, providing financial incentives, and fostering knowledge exchange platforms to facilitate the widespread adoption of millet cultivation across diverse agro-climatic regions of India. By harnessing the economic potential of millets, India can not only improve food security and nutrition but also foster sustainable agricultural practices, empower rural communities, and mitigate the challenges posed by climate change in the long run.

References:

- *Prasad Sati, V. (2023, June 26). ECONOMIC VIABILITY AND PROSPECTS OF OIL PALM CULTIVATION IN MIZORAM, INDIA. Tropical Agrobiodiversity, 4(2), 62–67. https://doi.org/10.26480/trab.02.2023.62.67*
- *Klmata, M., Ashok, E. G., & Seetharam, A. (2000, April). Domestication, cultivation and utilization of two small millets, brachiaria ramosa and Setaria glauca (Poaceae), in South India. Economic Botany, 54(2), 217–227. https://doi.org/10.1007/bf02907825*
- *Kangotra, A., & Chauhan, S. (2014). Economic viability of button mushroom cultivation in Himachal Pradesh, India. Indian Journal of Agricultural Research, 48(2), 134. https://doi.org/10.5958/j.0976-058x.48.2.022*
- *Malaiarasan, U., Paramasivam, R., & Saravanakumar, V. (2022). Choice of millets cultivation in India: An evidence from farm household survey data. Agricultural Economics Research Review, 35(conf), 145–163. https://doi.org/10.5958/0974-0279.2022.00027.1*
- *Gene sequencing promises better days for millets. (2017, September 18). Nature India. https://doi.org/10.1038/nindia.2017.120*
- *García- Granero, J. J., Lancelotti, C., Madella, M., & Ajithprasad, P. (2016, April). Millets and Herders: The Origins of Plant Cultivation in Semiarid North Gujarat (India). Current Anthropology, 57(2), 149–173. https://doi.org/10.1086/685775*
- *Umanath, M. (2018, December 20). Millets' Consumption Probability and Demand in India: An Application of Heckman Sample Selection Model. Economic Affairs, 63(4). https://doi.org/10.30954/0424-2513.4.2018.29*
- *Millets Cultivation Area and Quantity of Consumption Lead to Doubling Farmers Income. (2020, September 19). Adalya Journal, 9(9). https://doi.org/10.37896/aj9.9/044*
- *Shah, D. (2014). Economic viability of soyabean crop cultivation in Maharashtra: Some emerging issues. Indian Journal of Economics and Development, 10(3), 256. https://doi.org/10.5958/2322-0430.2014.00545.9*
- *Comprehensive review of cultivation & production of millets in Madhya Pradesh: IYM 2023. (2023). Bharatiya Vaigyanik Evam Audyogik Anusandhan Patrika, 31(2). https://doi.org/10.56042/bvaap.v31i2.6386*

- *Kr. Morya, G. C., Vinita, V., H.S, M., S., S., Bahadur, R., & K.N., Y. (2017, December 2). Millets: The Indigenous Food Grains. International Journal of Advanced Ayurveda, Yoga, Unani, Siddha and Homeopathy, 6(1), 447–452. https://doi.org/10.23953/cloud.ijaayush.328*
- *Choudhri, H. P. S. (2019, December 25). Resource Use Efficiency of Maize Cultivation in Bahraich District of Uttar Pradesh. Economic Affairs, 64(4). https://doi.org/10.30954/0424-2513.4.2019.5*
- *Anil Shahane, A., & Singh Shivay, Y. (2023, July 1). Millets Cultivation in Non-Conventional Zone- Practices, Possibilities and Prospects. Acta Scientific Agriculture, 7(7), 03–12. https://doi.org/10.31080/asag.2023.07.1274*
- *. B., T.N.J.G, R., V, R., & R.S, B. R. (1984). STUDY ON THE IMPACT OF INTERCROPPING IN BAJRA. Madras Agricultural Journal, 71(November), 705–708. https://doi.org/10.29321/maj.10.a02538*
- *https://www.assocham.org/uploads/files/Report_Millet*