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SUSTAINABILITY OF FOOD GRAINS PRODUCTION: A SPECIAL REFERENCE TO KARNATAKA

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ABSTRACT----------
The Green Revolution, implemented with introduction of new production technologies to sustain food production in India. However, the benefits of this revolution became insipid within a few decades due to the overexploitation of land by chemicals and variations in climate. On the other hand, the new economic policy open the Indian internal economy to the global economy, resulting in the conversion of agricultural land into non-agricultural land, thereby reducing food grain production and promoting the growth of commercial crops for export. Consequently, the per capita availability of food grains declined continuously, impacting human capital through reduced nutrition intake. India is home to at least 15 percent of the world's malnourished population, and according to FAO estimates, over 190 million people go hungry every day in the country. Therefore, ensuring the sustainability of food grain production is a challenging task. Sustainability refers to meeting our own needs without compromising the needs of future generations.

This present paper aims to analyze the reasons for the unsustainability of food grain production in Karnataka state. Variations in climatic and socio-economic conditions are major causes of unsustainable agriculture and food grain production. Using secondary data from various government reports, as well as simple statistical and GIS tools, this paper has identified several findings and suggestions on productive capacity of the soil, conserving soil health, cultivation costs, water conservation methods, food distribution system etc. Additionally, this paper suggests that government policies should focus on the primary sector, particularly on research and innovative ideas

KEYWORDS: *Agriculture, Food Grains Production, Sustainability.----------*

1. INTRODUCTION

The Green Revolution, implemented by the Government of India in 1966-67, aimed to sustain food production within the country and ensure food security for every citizen by introducing new technologies, fertilizers, and improved seeds. However, after a few decades, this initiative faced significant challenges, including soil erosion caused by excessive fertilizer usage, water pollution, and overexploitation of groundwater (Selvam, 2015). The introduction of the new economic policy in 1991 further exacerbated the situation by encouraging the conversion of agricultural land for non-agricultural purposes and promoting the production of commercial crops. In India, where 63 percent of agricultural land relies on rainfall, the uncertainty in agricultural production and yields is exceptionally high. This volatility in production, particularly in the case of food grains, is not only influenced by environmental factors but also by socio-economic conditions, rendering agriculture unsustainable. Kareemulla *et al.* (2017) highlight that suboptimal growth, lack of desirable profits, and a shift of farmers away from the sector are symptoms of agricultural instability. Overall, this Green Revolution initially improved food production, but long-term consequences raise sustainability concerns. Soil erosion, water pollution and land conversion strain agriculture.

India is home to at least 15 percent of the world's malnourished population. According to FAO estimates, over 190 million people go hungry every day in the country. Malnutrition has harmful effects on people's productivity and health. Recently, the 'Global Hunger Index' (GHI) report for 2023 is released, revealing that India ranked 111th out of 125 countries in the hunger index (gained score 28.7 out of 100), classified as serious country in hunger. This position is lower than the previous year 2022nd rank (107th). This alarming situation is a cause for concern among policymakers and researchers.

Karnataka state is among the top ten states in food grain production due to its diverse agro-climatic zones (Comber *et al*., 2015). However, recent trends have shown a decline in food grain production and yields. This can be

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attributed to variations in environmental conditions such as droughts, floods, and temperature increases, as well as socio-economic changes such as fragmentation of large land holdings into marginal ones, reduction in net sown area, and an increase in fallow lands.

2. SUSTAINABILITY IN AGRICULTURE

Given this background, there is a pressing need for sustainability in agriculture, particularly in food grain production, to address this problem. Sustainability, in general, entails meeting our present needs while safeguarding the needs of future generations. Similarly, sustainable agriculture involves ensuring that the land and resources utilized for agriculture today are passed on to the next generation without compromising their food security and the environment (Selvam, 2015; Kareemulla *et al*., 2017). Sustainable agriculture provides assurance for our fundamental requirements and the well-being of future generations.

3. REVIEW OF LITERATURE

Sustainability in food grain production has been widely researched. Kamble and Dipak (2018) conducted a study on the sustainability of Indian agriculture and emphasized the importance of sustainable practices for the long-term development of India. However, they noted that the current conditions indicate a precarious future for the agricultural sector. Selvam (2015) documented that the achievements of the Green Revolution have resulted in environmental pollution, reduced soil productivity due to excessive fertilizer use, and the adverse impact of pesticides on localized health hazards. Achieving sustainability in agriculture requires preventing the diversion of agricultural land for non-agricultural purposes. According to Kareemulla et al. (2017), the strength of sustainability stems from the vibrancy of agro-climatic, social, and economic dimensions.

4. OBJECTIVES AND METHODOLOGY

All of the aforementioned studies emphasize that the sustainability of agricultural production depends on both environmental and socio-economic conditions within a region. However, only a few studies have specifically addressed the sustainability of food grain production. Therefore, the present study aims to analyze the reasons for the unsustainability of food grain production in Karnataka state. This study utilizes secondary data from various government reports and published articles. Average values, percentages, compound annual growth rates and GIS analysis are employed to analyze the data.

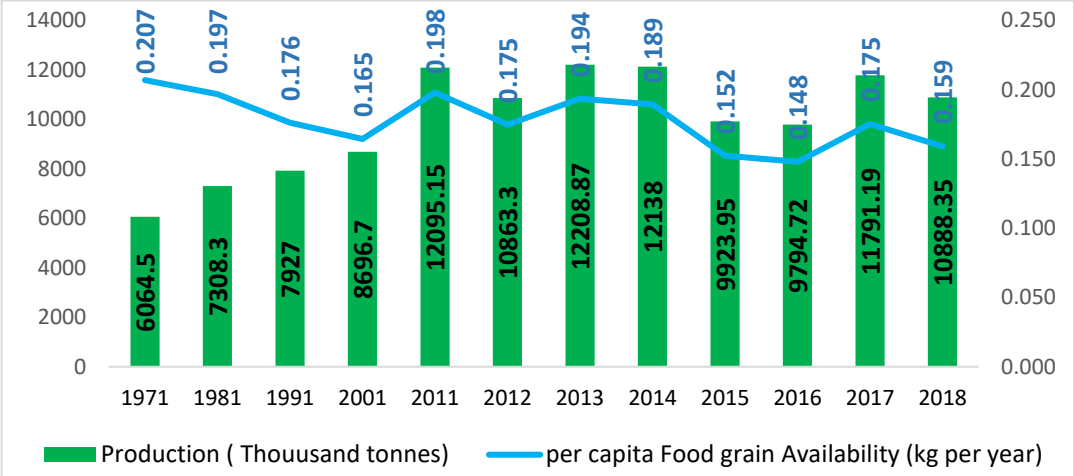
5. DISCUSSION

Sustaining food grain production presents a challenging task, particularly in the context of feeding an expanding population with limited resources. Karnataka, accounting for 5.83 percent of India's total geographical area, is the eighth largest state in terms of size. It comprises four natural regions: North Interior Karnataka (NIK), South Interior Karnataka (SIK), Malnad, and Coastal regions, each characterized by distinct natural conditions. According to the Envis Centre's "State of Environment Related Issues" report, Karnataka's annual food grain production is distributed as follows: 70 percent in the kharif season, 22 percent in the rabi season, and 8 percent during the summer season. The major food grains produced in Karnataka include paddy, jowar, ragi, maize, bajra, red gram, and Bengal gram. In terms of the state's total cultivated area, cereals occupy approximately 33 percent, pulses 42 percent, oilseeds 19 percent, and commercial crops 6 percent (Savitha and Kunnal, 2015). However, as the population increases, the per capita availability of food grains decreases.

Figure 1 depicts the per capita availability of food grains in Karnataka from 1997 to 2018. The production of food grains showed an increase in decadal growth from 1971 to 2011. However, starting from 2011, the annual growth rate fluctuated continuously. Simultaneously, the per capita availability of food grains has been declining due to the growing population. Pavithra (2008, via Kiresur and Chourad, 2015) highlights a decline in the consumption of cereals in both rural and urban areas of Karnataka.

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Figure 1. Per Capita Availability of Food grains in Karnataka



Source: *https://statisticstimes.com/demographics/india/karnataka-population.php* and *Directorate of Economics and Statistics, Dept. of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Govt. of India.*

This phenomenon will have an impact on human dietary practices and their nutritional intake, exacerbating malnutrition, particularly among women and children in rural populations (Kiresur and Chourad, 2015). Malnutrition significantly affects an individual's productive capacity and leads to a decline in human capital, rendering them more vulnerable. Table 1 presents the variation in food grain production from 1962 to 2019. It reveals that the compound annual growth rates of area, production, and yield were 0.35 percent, 1.26 percent and 1.62 percent respectively from 1962 to 1992. However, these rates decelerated to 0.03 percent, 1.58 percent and 1.61 percent respectively over the entire period from 1962 to 2019

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Table 1. Variation in Food grains production in Karnataka (CAGR%)

Year	Area	Production	Yield
1962-1991	0.35	1.26	1.62
1991-2019	0.23	1.14	0.91
1962-2019	0.03	1.58	1.61

Source: *Directorate of Economics and Statistics, Dept. of Agriculture.*

The agricultural sector has the capacity to efficiently provide food for all; however, several factors contribute to its declining capability and sustainability. These factors include variations in rainfall, increased fertilizer consumption, expansion of fallow land, conversion of agricultural land for non-agricultural purposes, fragmentation of land into smaller and marginal plots, stagnant forest cover in the region, and land degradation. These are the main reasons impacting the sector's productivity and sustainability.

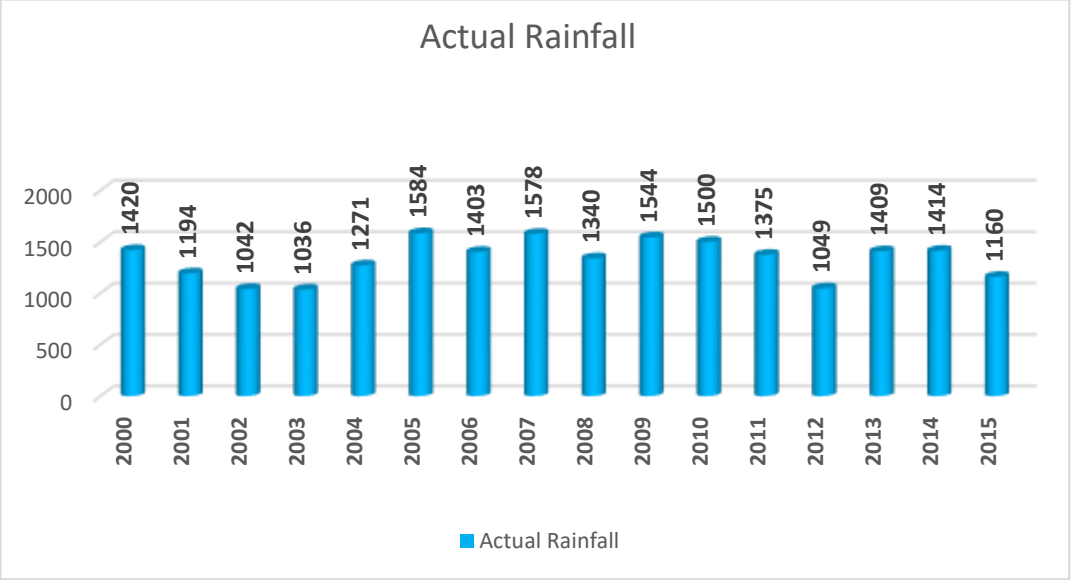
5.1 Reasons of Unsustainability of Food Grain Production:

5.1.1. Variation in Rainfall:

Precipitation plays an important role in agricultural production. More than half of the agricultural land relies on rainfall, and over 70 percent of the rain is received during the monsoon season. However, environmental changes and modern economic growth can have a severe impact on the timing and distribution of rainfall.

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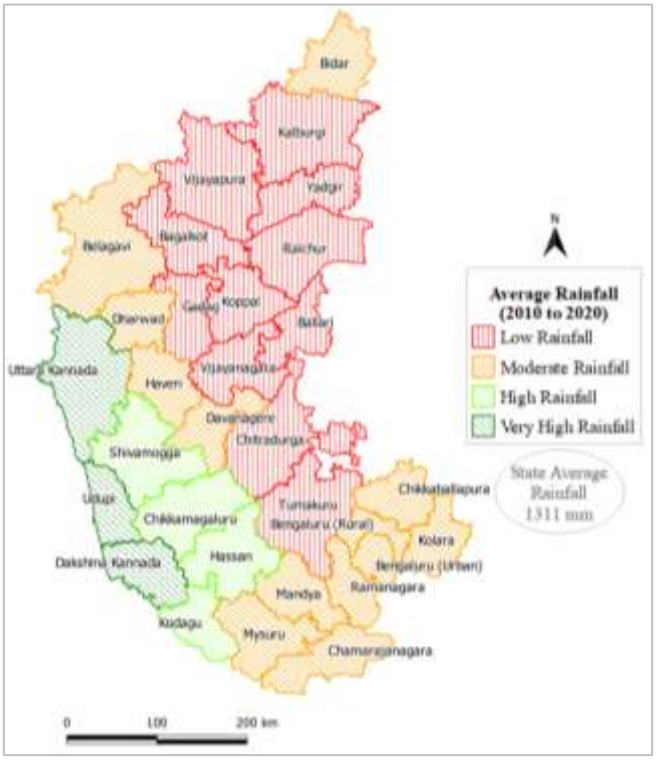
Figure 2. Variation in Actual annual Rainfall in Karnataka from 2000 to 2015



Note: *The average annual rainfall in Karnataka is 1248 mm*
Source: *ARC Division DE&S*

Figure 2 illustrates that the years 2001, 2003, 2012 and 2015 were marked by drought conditions, with rainfall levels falling below the state's annual average. Consecutive droughts have had a severe impact on agricultural yields, particularly affecting the growth of food grain crops. The North Interior Karnataka (NIK) region, known for its conducive environment for producing nutrient-rich crops, has been significantly affected by these consecutive droughts. Map 1 highlights that three-quarters of the districts in the NIK region received rainfall below the total state's annual average.

Map 1. District Wise Average Rainfall in Karnataka (2010-20)



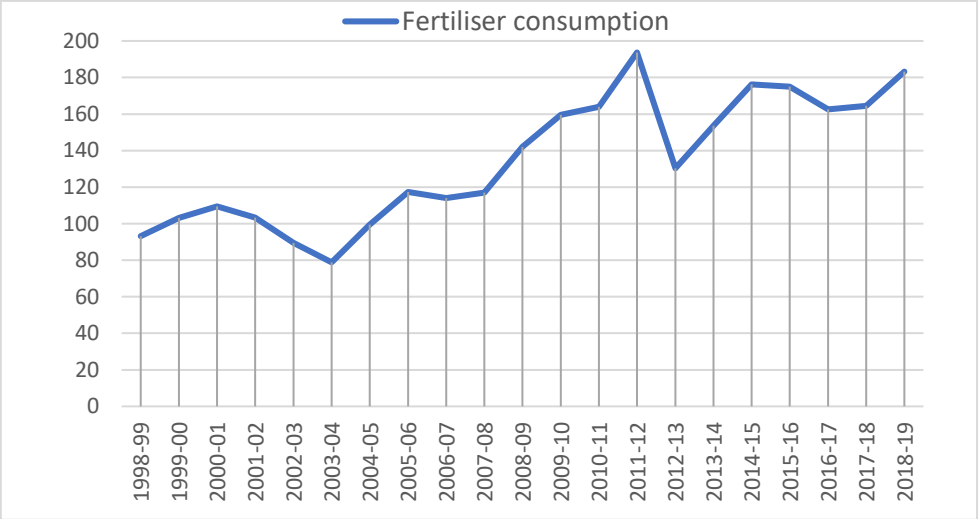
Source: *Karnataka at Glance, Department of Economics and Statistics.*

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5.1.2. Fertilizer Use

The purpose of introducing chemical fertilizers, including those composed of nitrogen, phosphorus, and potassium compounds during the Green Revolution was to increase crop yields. However, farmers began to excessively use fertilizers in the pursuit of higher yields. Unfortunately, after a few decades, it became evident that the expected increase in yield levels was not achieved. This can be attributed to the reduction in the natural productive capacity of the soil and the onset of soil erosion (Selvam, 2015).

Figure 3. Fertilisers Use in Agriculture in Karnataka



Source: *EPWRF India time series*

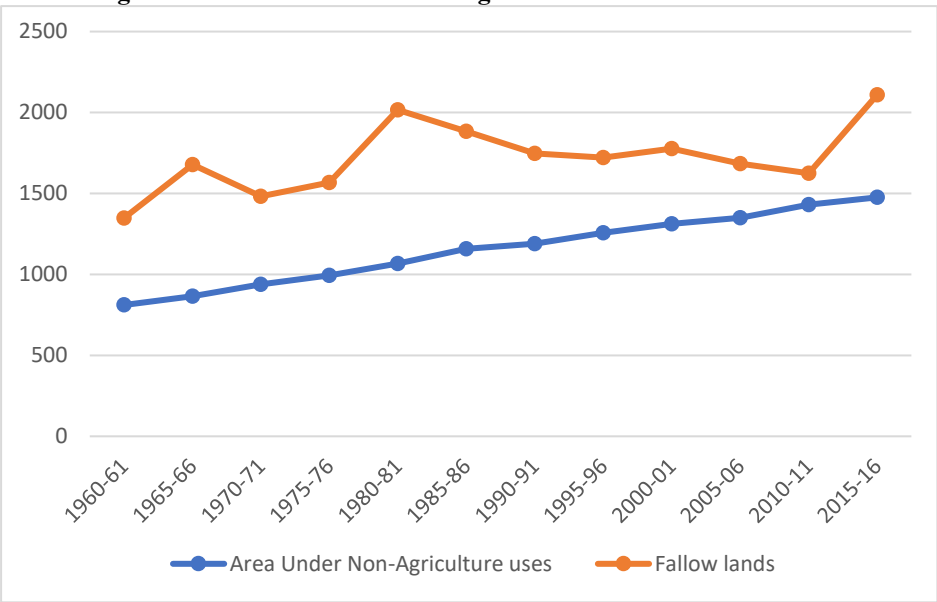
Figure 3 demonstrates the increasing trend in the use of fertilizers in Karnataka's agriculture from 1998 to 2018. However, it should be noted that in 2012, a severe drought year, agricultural activities were reduced. Nevertheless, the overall trend of increasing fertilizer usage has persisted. In recent years, agriculture has become heavily dependent on the use of fertilizers as the soil fertility has been depleted, leading to barren areas in certain places. This trend has resulted in a reduction in the net sowing area and has had an impact on the quality of food grain products due to the effects of chemicals. Furthermore, the use of fertilizers has adverse consequences for the surrounding environment, including water pollution and a decline in beneficial insects, which play a crucial role in achieving high yields.

5.1.3. Increase Non-Agriculture Land and Fallow Land:

Development activities, particularly following the implementation of the new economic policy in 1991, have had a negative impact on agricultural land. Urbanization and industrialization have played significant roles in reducing agricultural land, converting it into non-agricultural uses such as roads, buildings, and bridges. With the introduction of the new economic policy, the government has granted permissions to private investors to establish industries, resulting in the conversion of numerous agricultural lands into non-agricultural purposes. Additionally, fallow land, which refers to arable land not used for sowing, has increased due to factors such as consecutive droughts, soil erosion, land disputes, and a lack of maintenance. These factors collectively contribute to the diminishing availability and productivity of agricultural land.

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Figure 4. Increases land of Non-Agriculture uses and fallow land

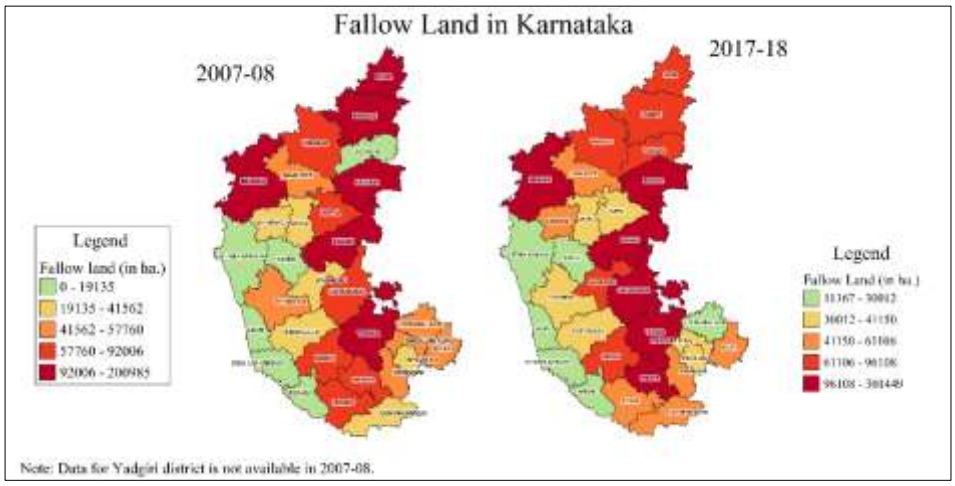


Source: *Directorate of Economics and Statistics, Dept. of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Govt. of India*

Both factors contribute to the reduction of arable land. Figure 4 illustrates an increasing trend in non-agricultural land and fallow lands from 1960 to 2015. While the extent of fallow land has varied, the conversion of land for non-agricultural uses has steadily increased. The low profitability in agriculture has led many farmers to shift away from agricultural activities towards non-agricultural occupations. Additionally, modern economic policies have prioritized industrial development and infrastructure projects, resulting in the conversion of agricultural land for non-agricultural purposes. This ongoing trend of land conversion poses significant challenges to the sustainability and availability of arable land for agricultural purposes.

Most of the food grains, particularly millets, are predominantly produced in the northern districts of Karnataka. The topography and climatic conditions of this region are favourable for food grain production. However, recent climate variability and unpredictable weather conditions have led to fluctuations in food grain yields, which in turn have impacted the cultivable land, resulting in a continuous reduction. Map 2 illustrates the district-wise distribution of fallow lands in 2007-08 and 2017-18. The northern districts of Karnataka, as well as the southern interior Karnataka region, have a higher proportion of fallow lands compared to the other two regions. This can be attributed to the abundant natural resources and above-average rainfall, which enable extensive cultivation in the Malnad and coastal regions.

Map 2. Fallow lands in Karnataka 2007-08 and 2017-18

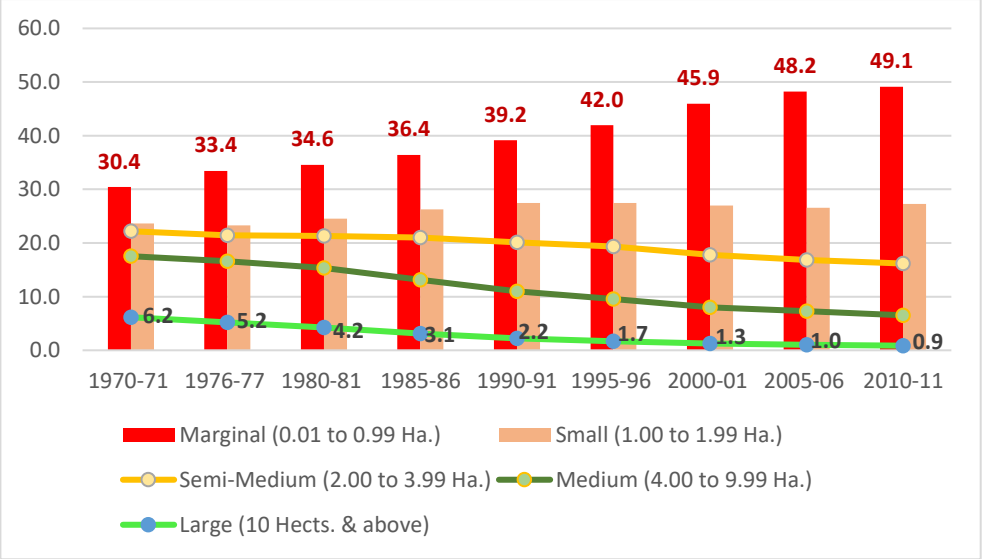


Source: *Directorate of Economics and Statistics, Dept. of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Govt. of India*

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Several factors contribute to agricultural land becoming fallow land, including uncertain rainfall, prolonged droughts, lack of maintenance, land disputes, and particularly the fragmentation of land into smaller and marginal plots. The division of land among brothers is a major reason for the prevalence of small and marginal landholdings. In India, specifically in Karnataka, there has been a continuous increase in the marginalization of land holdings. Figure 5 clearly indicates that since 1970-71, there has been a persistent shift towards marginal landholdings, increasing from 30.4 percent to 49.1 percent by 2010-11, which accounts for a nearly 20 percent change over four decades. Concurrently, large landholdings have consistently reduced from 6.2 percent to 0.9 percent. This trend reflects the changing dynamics and distribution of land ownership within the agricultural sector.

Figure 5. increase in Marginal and Small Land Holdings in Karnataka



Source: *Agricultural Census 2010-11 issued by Directorate of Economics & Statistics.*

The increase in small and marginal landholdings has a negative impact on agricultural production. The limited size of these holdings hinders the adoption of modern technologies and practices, resulting in higher cultivation costs. Consequently, the production and productivity of the land are reduced. Moreover, small and marginal farmers often opt for non-agricultural occupations, leading to the abandonment of these holdings and their transformation into fallow lands. Consequently, agricultural production, particularly the per capita availability of food grains, declines. This trend highlights the challenges faced by small and marginal farmers in sustaining agricultural productivity and contributing to food grain production.

Indeed, there are several other causes that contribute to the unsustainability of agricultural food production. The new economic policy of 1991, which opened India's economy to the global market, has had a significant impact. This shift towards a global market has influenced agriculture to prioritize the production of commercial crops over food grains. The commercialization of agriculture is another factor leading to a reduction in food grain production. Furthermore, the declining profitability in agriculture is a crucial factor in the unsustainability of food grain production. Over the years, the profitability of agriculture has decreased, discouraging farmers from investing in food grain production. Changes in surrounding ecosystems, such as the reduction in forest cover, have also had an adverse impact on agricultural production. Modern economic development strategies often contribute to deforestation through the construction of industries and transportation infrastructure. These activities further contribute to the unsustainability of the primary sector. It is crucial to address these underlying factors and implement sustainable practices and policies to ensure the long-term viability and resilience of agricultural food production.

6. FINDINGS AND SUGGESTIONS

So far, we have discussed the major reasons behind the unsustainability of food grain production. Based on our findings, we have identified several issues and proposed relevant suggestions to improve agriculture production by employing various production methods and addressing obstacles in agriculture. Karnataka is one of the highest food grain-producing states in the country. Data from 1971 to 2018 reveals variations in food grain production, with a concurrent decline in per capita availability of food grains due to a reduction in production and an increasing

population. Factors such as variations in rainfall, drought situations, excessive fertilizer consumption, conversion of agricultural land to non-agricultural uses, existence of fallow lands, fragmentation of land holdings, and stagnant forest cover are the primary reasons for the reduction in agriculture production and yield. The growth rate of area, production, and yield of food grains in Karnataka from 1962 to 2019 indicates a decelerating trend. Therefore, here is need a proper measure to reduce impacts of agriculture productions and sustainability.

Firstly, it is essential to increase the productive capacity of the soil as it is not possible to expand the available land. However, the yield potential of the existing land can be improved. Secondly, soil health conservation can be achieved by reducing the excessive use of fertilizers. Instead, the introduction of organic farming practices can enhance soil health, increase yields, and improve nutritional value. Thirdly, farmers should adopt collective farming methods to reduce cultivation costs, thereby increasing production and minimizing fallow lands. Fourthly, implementing water conservation methods such as rainwater harvesting and farm ponds can help mitigate the effects of drought. Fifthly, regulations should be put in place to prevent the conversion of agricultural land for non-agricultural purposes. Sixthly, the government should improve the food distribution system to address issues of malnutrition. Often, food availability is not the problem, but rather the absence of a proper distribution system that leads to starvation for many people. Seventhly, strong regulations are necessary to combat forest encroachment and ensure the protection and preservation of forests.

Lastly, the government should take action against food wastage by imposing penalties on those who waste food. Simultaneously, promoting a culture of "no waste food" should be encouraged. Additionally, population control measures should be implemented. By implementing these suggestions and incorporating sustainable practices, it is possible to increase agricultural productivity, ensure food security and address the challenges associated with unsustainability in food grain production. According to a study by Indian government's harvest research body, up to 67 million tons of food get wasted every year, a quantity equivalent to that consumed by the entire state of Bihar in a year. Henceforth, there must be create awareness and strict action against wastage of food and natural resources. More importantly, government policies should concentrate on primary sector, especially for research and innovative ideas.

7. CONCLUSION

Feeding the entire population in densely populated countries like India poses a significant challenge. Limited resource availability and underutilization, coupled with continuous population growth, make this task increasingly difficult. Consequently, per capita availability of food grains continues to decrease. Therefore, addressing population control and increasing food grain production have become pressing issues. India, as the second-largest country in terms of population (after China), is home to at least 15 percent of the world's malnourished population. This represents a significant loss in terms of human capital.

With the aim of analyzing the reasons for the unsustainability in food grain production in Karnataka state, this study utilized secondary data from various government reports and websites. The data was analyzed using methods such as averages, percentages, compound annual growth rates, and GIS. Through this analysis, several reasons for the unsustainability in food grain production were identified, including variations in rainfall, persistent droughts, conversion of cultivable land to non-agricultural uses, and marginalization of landholdings. To ensure the sustainability of the agriculture sector, suggestions were made, including improving soil health, adopting organic and collective farming practices, and controlling the conversion of cultivable land into non-agricultural purposes.

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