NAVIGATING FARM SIZE DYNAMICS: CHALLENGES AND STRATEGIES FOR AGRICULTURAL SUSTAINABILITY IN INDIA AND BEYOND

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Abstract

This study aims to investigate the dynamics of farm size in India within the context of global trends and challenges associated with agricultural land use. By drawing on a diverse array of literature, including research on farm size dynamics, agricultural performance and land-use planning, this study elucidates the complexities and implications of shifts in farm size. The changing Indian agricultural environment, characterised by shifts in farm size and distribution, presents both challenges and opportunities. Through a comprehensive review, this study provides a framework to understand the interconnection between farm size dynamics, agricultural challenges, and land-use planning strategies. The key findings emphasise the significance of farmer participation, market-driven reforms, and sustainable land management practices in addressing agrarian challenges and enhancing sector performance. This study contributes to the discourse on agricultural sustainability by offering insights into the Indian context and proposing strategic approaches to effectively navigate farm size dynamics through improved land use planning.

Keywords: Agricultural Challenges, Farm Size Dynamics, Indian Agriculture, Land Use Planning, Sustainability

JEL Classification: L10, L25, Q01, Q15

Introduction

The dynamics of farm size globally reflect a diverse landscape of trends and challenges. A predominant trend from 1960 to 2000 has shown a decrease in global farm size, especially in regions such as Sub-Saharan Africa and Asia, where farm sizes are diminishing (Lowder et al., 2014). Conversely, farm sizes have generally increased in Europe and North America since 1950, whereas Sub-Saharan Africa has witnessed declining farm sizes, with approximately 80% of family farms being small (Ellis, 2005; Djurfeldy and Jirstrom, 2013). South Africa exhibits a dualistic agricultural nature, with commercial farms growing larger and small-scale operations that dominate subsistence lands (Greyling et al., 2015). North America has seen significant increases in farm sizes, with average sizes in the USA and Canada surpassing 170 ha and 314 ha, respectively (Ikerd, 2016). South America, particularly countries such as Brazil, Argentina, and Chile, are characterised by large farmers holding the majority of land holdings (FAO 2014). The European Union shows wide variations in farm sizes, with countries such as the Czech Republic having the largest farms and Romania the smallest (EU, 2018). The Asian and Pacific regions typically have small farm sizes, with China and India representing the majority of small farms (Lowder et. al., 2014; Thapa, 2010).

Farm-size dynamics significantly influence both the economic and environmental performance of agricultural production (Ren, 2019). Smaller farms typically have lower overall profitability and efficiency but higher productivity per acre. (Fan and Chan-Kang, 2005; Sen, 1962). Conversely, larger farms may demonstrate greater profitability and efficiency because of economies of scale (Bojnec and Latruffe, 2013; Bardhan, 1973). However, this relationship is

not universally applicable, as factors such as non-labour use and cooperative movements can affect productivity and efficiency (Rudra, 1968; Rudra and Sen, 1980). Positive correlations between farm size and productivity have been observed regardless of labour scarcity or land availability (Dorward, 2007; Manjunatha et. al., 2013). Additionally, nonlinear relationships exist, where efficiency may initially decrease with farm size before improving (Bhatt and Bhat, 2014). Moreover, a U-shaped relationship has been identified, where farm size affects land productivity differently, based on labour productivity (Savastano and Scandizzo, 2017). Understanding these dynamics is crucial for addressing the related challenges and promoting agricultural sustainability through targeted interventions and strategies.

Building upon the global backdrop of farm size dynamics and their impact on agricultural performance, it becomes evident that challenges emerge with farm size dynamics, significantly impeding agrarian performance. Therefore, addressing these dynamics is essential to enhance agricultural performance and sustainability. This understanding leads to the hypothesis that managing farm size dynamics effectively can mitigate agricultural challenges, thereby improving the overall sectoral performance. Hence, our study aims to explore strategic approaches to navigate farm size dynamics, illustrating the Indian scenario. Understanding farm size dynamics across India is crucial because of its predominantly agrarian economy and diverse agro-climatic zones. While the Asian and Pacific regions typically feature small farm sizes, India stands out for its significant agricultural presence (Thapa, 2010). Therefore, the present study focuses on investigating farm size dynamics in India, along with the associated challenges and potential solutions.

This study contributes to the literature on agricultural sustainability in three ways. First, it offers an analytical framework emphasizing the importance of studying farm size dynamics and providing guidance for controlling the same to address the agricultural challenges of the 21st century. Second, it provides insights into the context of farm size dynamics and associated challenges within India. Third, it explores land-use planning approaches as potential solutions to address the challenges arising from farm-size dynamics, focusing specifically on the Indian context.

Literature Review

The change in farm size, also known as the size structural change within farms, represents a significant spatiotemporal event affecting the agricultural sector. This event brought forth various agricultural challenges (Happe, 2007; Dawe, 2015; FAO, 2017). Presently, farms are expected to perform efficiently to ensure food security and sustainable agricultural development under the constraint of limited land resources. At the same time, strong arguments in favour of balancing equity and efficiency also represent a major challenge in agriculture. This eventually produces long-lasting debates on small versus large farms (Dutta 2021).

Balancing efficiency and equity in agriculture, particularly concerning farm-size dynamics, presents a global challenge (Eastwood et al. 2010, Persson and Tabellini, 1994). Developed nations tend to favour large farms, while agrarian societies often have a prevalence of small farms, leading to socio-economic and environmental consequences (Paulino, 2014). Debates surrounding small and large farms center on key agricultural metrics, such as profitability, efficiency, and productivity (Sen, 1962; Salami et. al., 2010). While experts emphasise the productivity of small farms, which is essential for food security and cultural value, others contend that larger farms demonstrate favourable profitability and growth potential (Macdonald et al., 2013; Eves and Painter, 2008). Furthermore, limited cultivable land, influenced by physical, social, urbanization, population growth, and political factors, poses formidable challenges for agriculture (FAO and UNEP, 1999). This scarcity of land, with only

29% of the Earth's surface available for agricultural use and over 60% designated for non-agricultural purposes, is further compounded by the projected 70% increase in food production by 2050 owing to population growth (FAO, 2009; Alexandratos and Bruinsma, 2012). Additionally, excessive land fragmentation exacerbates agricultural challenges by escalating costs and diminishing yields (Latruffe and Piet 2013; Jha et al. 2005).

In the above discussion, as we delve deeper into the intricate connection between size structural change, evolving challenges, and performance of the agricultural sector, an analytical framework has emerged, thereby substantiating the following hypothesis:

H_0: Agricultural challenges arising from farm-size dynamics can hinder agricultural performance. Thus, addressing farm size dynamics could potentially alleviate these challenges and enhance agricultural performance.

Additionally, Dutta (2021) suggested that proper land use planning can control farm size dynamics and thereby overcome the challenges of agriculture. Addressing issues such as equity, efficiency, and the debate between small and large farms can be facilitated through efficient land-use mechanisms (Cotula et al., 2006; Deininger and May 2000; Osberg, 1995; D'Souza and Ikerd, 1996). Salami et al. (2008) advocated proper land-use planning as a tool to alleviate physical land scarcity. With urbanization and industrialization leading to land scarcity in India, there is a pressing need for rational and judicious land use to meet future demand (Nukala and Muntz, 2015). Land use management significantly impacts environmental sustainability, economic growth, and social inclusion (OECD, 2017). Sustainable land management practices are essential for mitigating environmental issues, such as land degradation, deforestation, desertification, and water quality degradation (INTOSAI, 2013), as well as for achieving global food security (FAO, 2015). In light of these considerations, the following hypothesis was formulated:

H_0: Effective land use planning can control farm size dynamics and address agricultural challenges.

Therefore, the primary objective of this study is to comprehend the dynamics of farm size and develop a viable strategy for land-use planning, with a particular focus on the Indian agricultural landscape. This strategy incorporates an analysis of nation-specific socio-political dynamics, economic conditions, and the unique challenges confronting the agricultural sector. By adopting this approach, we aim to devise a roadmap for sustainable land use that optimises agricultural productivity, fosters social equity, and preserves environmental sustainability.

Methodology

The primary research methodology utilised in the study predominantly relies on descriptive analysis, with a specific focus on India. Analytically, it involves exploring strategies aimed at managing farm size dynamics to mitigate agricultural challenges and enhance agricultural performance and sustainability.

The study draws upon existing literature, including articles, working papers, discussion papers, reports, etc., to achieve its objectives. Secondary data on farm size dynamics are obtained from sources such as the Agricultural Censuses of India, Agricultural Statistics at a Glance, 2022, and other documents released by the Ministry of Agriculture & Farmers Welfare, Government of India (MoA&FW, GoI). This involves analyzing trends, patterns, and variations in farm size across different contexts and over time.

Farm size is a multifaceted concept, as proposed by Ahearn and Yee (2004), and encompasses both output-based metrics, such as real cash receipts per farm or total production per farm, and

input-based metrics, such as acres operated per farm or total labour deployed per farm. Each metric is significant within its specific context (Yee & Ahearn, 2005). Among these metrics, "area operated per farm" is regarded as the most traditional and is commonly adopted as an alternative definition of farm (FAO, 2007; Thapa, 2010; Yee and Ahearn, 2005), which is why this study adheres to the same interpretation of farm size.

Discussion and recommendation

Farm Size Dynamics and Challenges in Indian Agriculture

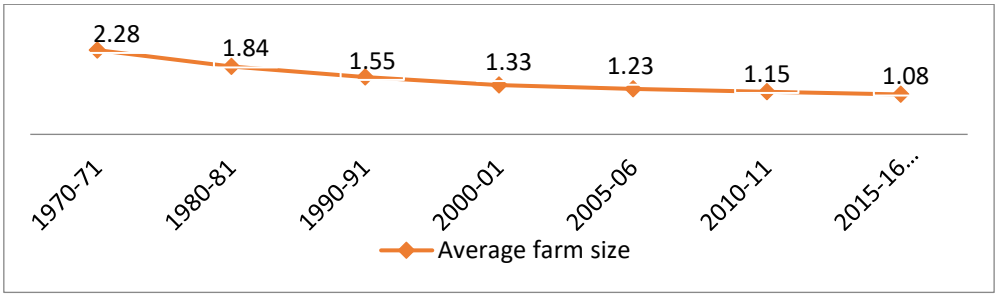
According to data from the Department of Agriculture & Farmers Welfare, Directorate of Economics & Statistics MoA&FW, GoI report (2021), the farm size dynamics of India have undergone significant changes over the past five decades (Table 1). The total number of farm holdings has consistently increased from 71,011 thousand in 1970-71 to 146,454 thousand in 2015-16. However, this growth in farm holdings coincided with a decline in the total agricultural area from 162,178 thousand hectares to 157,817 thousand hectares during that period. Consequently, there has been a steady reduction in the average farm size, dropping from 2.28 hectares in 1970-71 to 1.08 hectares in 2015-16 (Figure 1). This indicates a 6% decrease in the average farm size compared to 2010-11 when it was 1.15 hectares. The data highlight a notable shift in India's agriculture towards smaller farm sizes, which may be attributed to factors such as population growth, land fragmentation, and changes in cultivation practices.

Table 1: Number, Area, and Average farm size in India during 1970-71 to 2015-16

Year	Total		Average farm size (ha.)
	No. of holdings ('000)	Area ('000 ha.)	
1970-71	71011	162178	2.28
1980-81	88883	163797	1.84
1990-91	106638	165507	1.55
2000-01	119931	159435	1.33
2005-06	129222	158323	1.23
2010-11	137757	159181	1.15
2015-16 (Provisional)	146454	157817	1.08

Source: *Author's compilation from the reports of MoA&FW, GoI, 2021*

Figure 1: Decline in average farm size during 1970-71 to 2015-16



Source: *Author's self-construct*

Additionally, the data presented in Table 2 reveals a clear and consistent trend of decreasing average farm sizes across all farm size groups in India from 1970-71 to 2015-16. The average farm size for marginal farms decreased from 0.40 hectares in 1970-71 to 0.38 hectares in 2015-16, while small farms saw a decrease from 1.44 hectares to 1.40 hectares during the same period. Similarly, the average size of semi-medium, medium, and large farms also decreased.

Table 2: Average farm size for the farm size groups during 1970-71 to 2015-16 (in ha.)

Size groups	1970-71	1980-81	1990-91	2000-01	2010-11	2015-16 Provisional
Marginal	0.40	0.39	0.39	0.40	0.39	0.38
Small	1.44	1.44	1.43	1.42	1.42	1.40
Semi-Medium	2.81	2.78	2.76	2.72	2.71	2.69
Medium	6.08	6.02	5.90	5.81	5.76	5.72
Large	18.10	17.41	17.33	17.12	17.38	17.10

Source: *Author's compilation from the reports of Agricultural censuses in India*

Table 3 presents the distribution of states across the different farm size groups in India from 1970-71 to 2015-16. A notable trend emerged, indicating an increasing number of states with smaller farm sizes over the years. In 1970-71, fewer states fell into smaller farm size categories, with more states having larger farm sizes. However, as time progressed, there was a shift towards smaller farm sizes, evident by the rise in the number of states with less than 1 ha and 1 to 2 ha farm sizes. By 2015-16, the majority of states had a significant proportion of farms falling within the less than 1 ha and 1 to 2 ha categories. Conversely, the number of states with larger farm sizes (above 4 hectares) decreased substantially over the years, with no states having farms above 10 hectares by 2015-16. This trend suggests a gradual fragmentation of landholdings and a shift towards smaller-scale agriculture across states in India over the specified period.

Table 3: Number of states across different farm size groups during 1970-71 to 2015-16

Size Groups	1970-71	1990-91	2000-01	2010-11	2015-16 (Provisional)
Less than 1 ha.	5	8	8	9	12
In between 1 to 2 ha.	10	9	12	12	10
In between 2 to 4 ha.	8	8	6	5	4
In between 4 to 10 ha.	3	2	1	1	1
Above 10 ha.	0	0	0	0	0

Source: *Author's compilation from the reports of Agricultural Censuses of India*

Over the past five decades, India has witnessed a rapid increase in the number of small and marginal farmers in states, such as Uttar Pradesh, Bihar, Assam, West Bengal, and Andhra Pradesh, accompanied by a proportional decrease in large farm areas. However, the expected low level of skewness in operational holdings compared with ownership holdings is not always

accurate, as noted by Mearns (1999). Reverse tenancy, in which relatively large farmers lease land from smallholders, is observed in states such as Haryana and Punjab. However, these states also show a declining trend in average farm size according to the agricultural census of India.

Among the states in India, Nagaland boasts the highest average farm size of 5.06 hectares, followed by Punjab (3.62 hectares), Arunachal Pradesh (3.35 hectares), Rajasthan (2.75 hectares), and Haryana (2.22 hectares) as of 2010-11. Gujarat maintained an average farm size between 2 to 4 hectares until 2010-11, but this decreased to 1.88 hectares by 2015-16. Similarly, other states have also witnessed an increase in the number of farms but a reduction in average farm size over time. Currently, 22 out of 27 states in India (excluding Telangana) have farm sizes below 2 ha, indicating that small-scale farming is a predominant feature of Indian agriculture.

Challenges in Indian Agriculture: Small farms in India face numerous challenges in accessing inputs, increasing production, and marketing products (Dev, 2012; Sing et al., 2014; Sivagnanam and Murugan, 2015). Pandey (2009) emphasises the urgent need to boost the productivity of small farmers to increase their marketable surplus and attain reasonable income. Furthermore, marginal and small farmers are increasingly becoming part-time, absentee, peri-urban, and wage earners on part-time or full-time bases. Consequently, these farms become less financially attractive (ag-decision, 2013) and inefficient in resource use (Amodu et al., 2011). To address these challenges in the Indian agricultural sector, experts highly recommend sustainable land use planning and management (Pandey, 2009; Singh, 2016; Nukala and Mutz, 2015).

Land Use Planning for Farm Size Dynamics-Driven Challenges

The analytical framework of this study underscores the significant impact of farm size dynamics on agricultural performance, stressing the importance of understanding these dynamics. After examining farm size dynamics and associated challenges in India, it is essential to explore potential solutions. Experts have suggested addressing farm size dynamics through effective land-use planning. Consequently, the framework hypothesises an approach for proficient land use planning, proposing that it can regulate farm size dynamics and address agricultural challenges. Thus, this section aims to devise a tailored land-use planning strategy suitable for the Indian context to alleviate challenges and enhance agricultural performance and sustainability.

Agrarian reform, a component of broader land reform efforts, aims to modernise rural institutions, although its long-term impact remains uncertain (Deininger et al., 2007). Meanwhile, land use planning, which is critical for optimizing agricultural and rural economies, involves maximizing land utilization for various purposes (Ziadat et al., 2017; Lambin & Meyfroldt, 2011). Despite often involving state intervention, critics argue that it may disregard land user preferences (Walker 2005).

According to FAO (1993), land use planning is a systematic assessment of physical and socio-economic factors, empowering land users to choose options that enhance productivity, sustainability, and societal needs. In contrast to regulatory approaches, FAO's method prioritises land user interests, fostering individual decision-making (FAO, 1976). This aligns with the participatory principles of AGENDA 21 of the United Nations Sustainable Development Goals (SDGs), promoting informed decision-making for sustainable development. Various scholarly works (Happe, 2007; Gali et al., 2000; Eastwood et al., 2010) have illuminated the factors influencing agricultural land use, predominantly managed by farm households (FAO, 1993), thereby shaping regional land-use patterns. Specifically, in

agriculture, these factors impact farm household decisions regarding farm size, contributing to regional farm size dynamics.

In contemporary times, agricultural activities are increasingly viewed as business endeavours rather than traditional ways of life (Lekhi & Singh, 1996), fostering a shift towards capitalist modes of production in the agricultural sector. By the late 1980s, most countries had transitioned from socialist or planned economies to market economies, granting individual farmers greater decision-making power over farming practices. This shift has prompted closer collaboration between agricultural economists and business schools since the 1950s, fostering global growth in farm management practices (Ruttan, 1969). Farm management approaches recognise farm size dynamics as a consequence of farmer decisions, which in turn influence agricultural land use (Johl & Kapur, 2000). The World Bank (2009) underscores the significance of the "willing seller-willing buyer" mechanism in agricultural reforms, particularly in addressing longstanding land issues through voluntary transactions rather than expropriation. This approach encourages socially acceptable land-use patterns and promotes food security, employment, and income security in rural areas. It emphasises the participation of farm households in land use planning (Fresco et al., 1999) and highlights the role of farmers and communities in providing information to governments for land use decision-making (FAO, 1997; Deininger et al., 2004).

Land Use Planning for Farm Size Dynamics in India

Post-independence reforms in India aimed to address the issue of land concentration among large farmers to promote equity. However, the effectiveness of such land-use policies has been mixed. While some anticipated equity gains are caused by increased demand for labour rather than direct land transfers to the poorest in India (Lipton, 1985), analyses by Sharma (1994) reveal that inequality persists despite varying degrees of reduction in land concentration. Land reform laws have resulted in extremely low and non-viable holdings in the country along with increased land fragmentation, degradation, and redistribution of resource ownership (Niroula and Thapa, 2005).

In response to evolving market dynamics and regulatory frameworks, planners have begun to explore alternative approaches to land-use planning, particularly in the agricultural sector. Sen (1977) stressed the importance of farmers navigating market dynamics while considering the advisory and regulatory controls imposed by various administrative bodies. This recognition underscores the need for a nuanced understanding of the interplay between market forces and policy interventions in shaping agricultural land use decisions. Banerjee (1999) introduced the concept of a market-assisted land reform approach, advocating a demand-driven model that prioritises the needs and preferences of land users over traditional top-down reforms. This approach aligns with empowering farmers to make informed decisions about their land use practices and integrating market dynamics into the reform process to create more flexible and responsive policies. Dutta (2021) proposed a model illustrating the relationship between the determinants influencing the decision of farm size changes and the financial performance of farms in Assam. The model aided policymakers in achieving the desired farm size pattern by considering the determinants influencing farm size changes on farmholders. The study suggested that revisiting land rental market arrangements includes favouring variable rental arrangements over fixed rentals to enhance financial efficiency. Additionally, promoting a regulated land exchange market can ensure equilibrium in land supply and demand, reduce information asymmetry, and enable farmers to adjust farm size according to their preferences (Dutta, 2022).

Furthermore, initiatives such as integrating farm management studies into agriculture and food management policies since the 1950s (Mehta, 2011) signify a broader recognition of the importance of integrating economic and managerial principles into land-use planning. This integration allows a holistic approach that considers both the economic viability and sustainability of agricultural practices. The introduction of the new National Land Reform Policy (2013), which encourages farmer participation in land banks for credit access in the land sales market, reflects a shift in the approach of policymakers in India. This policy emphasises the involvement of farmers in decision-making processes related to land use and highlights the role of land banks in facilitating access to financial resources for agricultural development.

This study underscores the importance of participation by land users in planning and supports the "willing seller-willing buyer" mechanism over expropriation in agricultural reforms. Overall, these developments indicate a growing recognition of the need to support and assist land users in achieving desired changes in land use, marking a shift towards more participatory and market-driven approaches to land use planning in India.

Conclusion

In conclusion, the intricate dynamics of farm size and their influence on agricultural performance present both challenges and opportunities for the Indian agrarian landscape. As evidenced by the data and analyses presented, the shift towards smaller farm sizes poses significant challenges such as limited access to inputs, decreased productivity, and fragmented land holdings. However, through strategic land use planning and market-driven approaches, there is immense potential to overcome these challenges and foster sustainable agricultural development. By empowering farmers to make informed decisions about land use, promoting equitable access to resources, and integrating economic and managerial principles into policy frameworks, India can navigate farm size dynamics effectively. This study emphasises the importance of participatory approaches, market mechanisms, and policy reforms in shaping the future of Indian agriculture toward greater productivity, equity, and sustainability.

This study contributes to the discourse on agricultural sustainability by providing insights specific to the Indian context and suggesting strategic measures to navigate farm size dynamics through efficient land use planning. Furthermore, the study encompasses future research directions to address the identified limitations and expand knowledge in the field. Longitudinal analysis tracks farm size dynamics over time, while comparative studies assess the efficacy of different land-use planning strategies across regions. Policy evaluation will examine the effectiveness of existing interventions, while technological integration with remote sensing and GIS will enhance land-use planning accuracy. Enhanced stakeholder engagement aims to ensure inclusive, sustainable land use planning for agricultural development. These avenues aim to deepen the understanding and inform policy formulation for more effective agricultural management.

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