Impact of Land Fragmentation on Agricultural Productivity in the context of Nepal

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Abstract:
Land fragmentation in Nepal, particularly in the agricultural sector, has become a critical issue, significantly impacting productivity and the efficiency of farming practices. Fragmentation is influenced by various factors, including socio-economic, cultural, legal, and demographic conditions. Land fragmentation in Nepal is primarily driven by inheritance laws, which mandate the division of land equally among heirs, and a rapidly growing population reliant on agriculture for their livelihoods. These practices have led to a progressive reduction in the size of individual land parcels, further exacerbating the inefficiency in agricultural production. Studies show that fragmentation leads to several operational challenges, including increased labour and transportation costs, reduced opportunities for mechanization, and difficulties in applying modern agricultural techniques. Moreover, as plots become smaller and more dispersed, farmers struggle with time and resource management, which ultimately hampers productivity.

One of the major impacts of land fragmentation is its effect on the economies of scale in agriculture. Smaller land parcels prevent the efficient use of large-scale farming equipment such as tractors, and make it difficult to introduce advanced farming technologies. This situation is worsened by the fact that fragmented plots are often located far apart, increasing transportation costs and reducing the amount of time spent on actual farming activities. In addition, the inability to consolidate land for larger-scale operations hinders the adoption of modern agricultural practices, which are necessary for improving crop yields and ensuring the sustainable use of land.

A key challenge associated with land fragmentation is its impact on labour input. Fragmented land increases the amount of labour required to manage crops across different plots, as workers need to move between non-contiguous parcels. This not only increases the cost of labour but also reduces its efficiency, as more time is spent on travel rather than productive agricultural activities. Furthermore, the scattered nature of the plots makes it difficult to manage resources such as irrigation, fertilizers, and pest control, all of which are essential for maximizing agricultural productivity.

Land fragmentation also affects the use of fertilizers and other inputs. Farmers in fragmented holdings often apply fertilizers unevenly, prioritizing parcels closer to their homes and neglecting those that are farther away. This uneven distribution of inputs can result in reduced crop yields, as some plots receive inadequate nutrients. Similarly, irrigation is less efficient on

fragmented plots, as it becomes harder to set up comprehensive irrigation systems for scattered parcels. The result is that fragmented farms are less productive than consolidated ones, where inputs can be applied more uniformly and efficiently.

Another significant impact of land fragmentation is its contribution to soil degradation. In fragmented holdings, farmers tend to over-exploit the more fertile plots, leading to soil nutrient depletion over time. The lack of sustainable farming practices on these smaller parcels accelerates land degradation, further reducing the long-term productivity of the land. In regions like the Hindu Kush Himalayas, for instance, farmers have been forced to abandon highly fragmented land due to its declining fertility and poor yields.

Despite the negative impacts of land fragmentation, some advantages have been identified. Fragmentation can reduce the risk of total crop failure, as farmers cultivate plots in different locations with varying soil qualities and micro-climatic conditions. This diversity can help spread the risk of crop diseases or natural disasters affecting the entire yield. Additionally, fragmented plots allow for the cultivation of a variety of crops, which can enhance food security and provide a more stable income for farmers, especially in regions with unpredictable weather patterns.

However, these benefits are often outweighed by the inefficiencies that come with managing dispersed plots. Efforts to address land fragmentation in Nepal have focused on land consolidation programs, which aim to combine small, scattered plots into larger, more manageable units. The challenges of implementing land consolidation are significant, as they require extensive legal, political, and logistical coordination. Moreover, land consolidation can sometimes lead to conflicts among farmers, especially when the redistribution of land is perceived as unfair.

Introduction:

Land fragmentation, also known as pulverization, parcelization or scattering (Bentley, 1987**)** is defined in the literature as the situation in which a single farm consists of numerous spatially separated parcels (McPherson, 1982) or as decrease in the average size of farm holdings, an increase in the scattering of each farmer's land, or a decrease in the size of the individual plots in a farm holding (Mavlankar, 1971). It is characterised as a fundamental rural spatial problem concerned with farms which are poorly organised at locations across space (King & Burton, 1982).

Land fragmentation is a fundamental rural, spatial problem concerned with farms which are poorly organised at locations across space (King & Burton, 1982). Land fragmentation is linked with other problems such as the lack of a road network providing access to a parcel; this is a primary factor favouring abandonment or determining why parcels remain uncultivated. Moreover, this problem causes conflicts among neighbouring landowners (Singh Air, 2022).

Land fragmentation as a phenomenon is very common in Nepal, where lands are continually fragmented and shared among children as inheritance (Niroula & Thapa, 2007). The rational use of agricultural land is influenced by land use limitations. One of the obstacles for agricultural development is land fragmentation (Austin et al., 2012), Land fragmentation is considered as an obstacle to agricultural development because it hinders mechanization, causes inefficient production and involves large cost to alleviate the adverse effects resulting in a reduction in farmers net income (van Dijk, 2007). Dominant problem associated with land

fragmentation is the small size, irregular shape, and dispersion of parcels (Demetriou et al., 2013). Land fragmentation harms land productivities in number of ways; fragmented land holdings can increase transport cost and might also cause difficulties to grow certain crops, and prevent farmers from changing to high profit crops, other costs that are linked to fragmentation is the hindering of economies of scale and mechanization.

Land fragmentation in Nepal significantly impacts agricultural productivity, presenting both challenges and opportunities. Fragmentation leads to smaller land parcels, which can increase input use efficiency but may also hinder overall production efficiency. The following sections elaborate on these effects.

Causes of Land Fragmentation

- Socio-economic Factors: Inheritance practices often result in equal division of land among heirs, leading to smaller plots (Niroula & Thapa, 2007).
- Socio-economic Pressures: Urbanization and population growth contribute to haphazard land division, particularly in peri-urban areas (Singh, 2022).
- Policy Failures: Previous land management policies aimed at redistribution have inadvertently exacerbated fragmentation (Poudel, 2013).
- Environmental Factors: Frequent natural disasters and geographic variations exacerbate fragmentation issues (Singh, 2022).

Policy Responses

Land Use Policy 2012: This policy aims to address fragmentation through regulatory measures like land pooling and zoning, though its implementation faces challenges due to historical non-regulation (Poudel, 2013).

While fragmentation can enhance productivity in certain contexts, it often leads to inefficiencies that constrain agricultural development, highlighting the need for balanced policy interventions.

Objective:

The primary objective of this study is to assess the impact of land fragmentation on agricultural productivity.

The secondary objectives of this project are as follows:

i. To evaluate the relationship between land fragmentation and agricultural productivity,
ii. To explore the challenges and opportunities posed by land fragmentation for smallholder farmers,
iii. To propose policy recommendations for reducing the negative impact of land fragmentation on agricultural productivity,

Desk Study:

The study on land fragmentation and its impact on agricultural productivity in Nepal typically involves a combination of qualitative and quantitative approaches. Researchers utilize both primary and secondary data sources to analyse the causes, trends, and consequences of land fragmentation.

Data Collection Techniques

- Surveys and Interviews: Many studies, such as those by Dhakal & Khanal (2018), involve structured interviews with households to gather socio-economic data and perceptions

regarding land fragmentation Niroula & Thapa (2007) conducted a questionnaire survey covering 184 households to assess input use and crop yield.

- Focus Group Discussions: Engaging with groups of land users helps in understanding local practices and challenges associated with land fragmentation (Niroula & Thapa, 2007).

Analytical Framework

- Statistical Analysis: Researchers often employ statistical methods to analyse the relationship between land fragmentation and agricultural productivity. For instance, Niroula and Thapa's study utilized yield analysis to compare productivity across different land parcel sizes (Niroula & Thapa, 2007).
- Literature Review: Some studies, like that of Ntihinyurwa & de Vries (2021), critically review existing literature to identify gaps and propose models for managing land fragmentation.

Contextual Factors

- Cultural and Economic Influences: Some studies highlight that cultural practices, such as equal land division among heirs, significantly contribute to fragmentation (Niroula & Thapa, 2007). Additionally, economic factors, including land use policies and urbanization pressures, are critical in understanding the dynamics of land fragmentation (Singh Air, 2022).

In Nawalparasi, Dhakal & Khanal (2018) interviewed total of 93 households in three VDCs. Results showed that there has been decreasing productivity of land due to fragmentation of agricultural land. It is mainly due to increasing time of labour input, less opportunity of using modern chemical fertilizer on the one hand and the problem in using modern agricultural equipment such as tractors on the other. The study also concluded that socio-economic, legal and infrastructure development factors are responsible for fragmentation of agricultural land.

Niroula & Thapa (2007) obtained necessary information from discussions with groups and individual land users and a questionnaire survey covering 184 households representing different degrees of land fragmentation. The analyses focused on two staple crops, namely, maize and paddy. It revealed an increasing trend in the number of land parcels and a decreasing trend in the size of land parcels, primarily due to the heredity tradition of equal division of land among the inheritors. In view of the need to also recover the cost of the inputs produced on-farm, it is concluded that land fragmentation leading to small plots has a negative impact on production efficiency, thereby constraining agricultural development.

According to Muhammad (2022), in Adamawa State of Nigeria, they used primary data which were generated from the respondents through the administration of 120 copies of structured questionnaire. The combination of stratified and systematic random sampling was used to administer the questionnaire. Correlation analysis and frequency counts were used to analysed the generated data and to test the relationship between Fragmentation and agricultural productivity. The result indicated that 53%, 52% and 7% pattern of land ownership. The study further reveals that R=0.3 which is a weak correlation meaning that other factors affect agricultural production. The study concludes that there is no relationship between number of

farm lands and crop yield and that land fragmentation tends to increase production costs and have negative impact on crop yield.

In Dukagjini region, Zejnullahi (2023) analysed the data of 444 households using SPSS 17 software for data processing and used cluster model to calculated productivity of farm. The analysis concluded influence of various factors as: biophysical factors (climate, soil fertility etc.) and socio-economic (preferences, prices, production objectives, etc.) related to the treatment of farms and labour investments, structure, fragmentation, infrastructure and markets, and management practices. The results showed the strong correlations between fragmentation and productivity.

Sundqvist (2006) collected data from the Vietnam Household Living Standard Survey 2004 and data on the land consolidation process was used for the regression analysis. The results show weak correlations between fragmentation and productivity. Land fragmentation seems to be positively correlated to productivity due to more use of fertilizers and labour input.

Findings:

The impact of land fragmentation on agricultural productivity in Nepal is multifaceted, with both negative and positive implications. Fragmentation often leads to decreased productivity due to increased labour input and challenges in utilizing modern agricultural techniques. However, smaller plots can sometimes yield higher productivity per unit area due to intensive input application. The following sections elaborate on these dynamics.

Niroula & Thapa (2007) conducted a study that focused on two staple crops, namely, maize and paddy. It revealed an increasing trend in the number of land parcels and a decreasing trend in the size of land parcels, primarily due to the heredity tradition of equal division of land among the inheritors. Other factors such as land purchase have also contributed to land fragmentation. Yield analysis revealed that small parcels are more productive than large parcels, because of higher applications of inputs. Consistent with this, small parcels also appeared to have a higher production efficiency than large parcels considering both benefit and cost of purchased inputs indicating a positive impact of land fragmentation on farmers' income. However, an analysis considering also the cost of inputs produced on the farm revealed an opposite trend, that is, on large land parcels, production is more efficient than on small parcels. In view of the need to also recover the cost of the inputs produced on-farm, it is concluded that land fragmentation leading to small plots has a negative impact on production efficiency, thereby constraining agricultural development.

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Land fragmentation in Nepal decreases agricultural productivity by increasing labour input time, limiting the use of modern fertilizers and machinery, and causing inefficiencies in farm management, ultimately leading to lower output and net returns from agricultural crops (Dhakal & Khanal, 2018).

Land fragmentation in Nepal negatively impacts agricultural productivity by reducing parcel sizes, leading to lower input use efficiency and production efficiency. While small parcels show higher yields due to increased input application, overall production efficiency declines when considering on-farm input costs (Niroula & Thapa, 2007).

Parcel fragmentation in Nepal leads to irregularly shaped and smaller land parcels, which negatively impacts agricultural productivity. This fragmentation creates challenges for effective land use planning, resulting in disputes and hindering efficient agricultural practices within the affected areas (Singh Air, 2022).

Land fragmentation in Nepal negatively impacts agricultural productivity by reducing farm size, complicating management, and increasing costs. This fragmentation, coupled with the conversion of agricultural land, poses significant challenges to food security and effective land use in the country (Poudel, 2013).

Small and fragmented plots prevent farmers from benefiting from economies of scale, where larger, contiguous plots can be farmed more cost-effectively. This leads to higher per-unit production costs (Zejnullahi et al., 2023).

Komushaago (2023) focuses on land fragmentation's impact on agricultural productivity specifically in Rukiri Sub-County, Ibanda District. It highlights issues like soil exhaustion and reduced production efficiency due to fragmentation.

Smaller land parcels often lead to higher input application rates, as farmers tend to invest more in their limited plots to maximize yields. Studies indicate that small parcels can yield more per unit area compared to larger ones, primarily due to intensive management practices (Niroula & Thapa, 2007).

Fragmentation allows for the cultivation of diverse crops across different plots, which can improve resilience against pests and diseases. This diversity can lead to better soil health and increased overall productivity, as different crops contribute various nutrients to the soil (Dhakal & Khanal, 2018).

Land consolidation is a strategy to address the inefficiencies caused by small, fragmented plots by merging them into larger, more manageable units. In Nepal, land consolidation could involve voluntary programs where farmers are encouraged to combine their scattered plots through incentives like tax breaks, financial aid, or infrastructure support (Singh Air, 2022). Land exchange systems can facilitate plot swaps between farmers to create more contiguous land parcels. Cooperative farming models allow farmers to pool their land and resources,

enhancing productivity and access to technology. These efforts, coupled with government-supported land reforms, can promote sustainable agricultural development by improving farm efficiency and fostering long-term investments in land (Poudel, 2013).

Conclusion:

In conclusion, land fragmentation is a significant challenge for agricultural productivity in Nepal, particularly in rural and mountainous regions where smallholder farming is prevalent. The study highlights that fragmented landholdings lead to inefficiencies in farm management, higher input costs, and reduced economies of scale, all of which contribute to lower productivity. Farmers are often unable to implement modern agricultural practices or invest in long-term land improvements due to the scattered nature of their plots. The adverse impacts of fragmentation are most apparent in the increased operational costs, difficulty in mechanization, and challenges in effective irrigation.

Furthermore, land fragmentation discourages innovation and the adoption of sustainable farming techniques, exacerbating issues of soil erosion, declining fertility, and reduced agricultural biodiversity. Despite these challenges, efforts to consolidate land or promote cooperative farming models could provide viable solutions to enhance productivity. Land consolidation policies, combined with improved access to agricultural technology and infrastructure, could enable smallholders to overcome the negative impacts of fragmentation. Addressing land fragmentation is therefore critical for enhancing agricultural productivity in Nepal, reducing rural poverty, and ensuring food security. Future policies should focus on creating an enabling environment that promotes land consolidation, resource optimization, and the adoption of modern, sustainable farming practices.

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