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RESEARCH ARTICLE



## Land consolidation and rural aging: challenges and implications in the Red River Delta, Vietnam

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### ABSTRACT

Land fragmentation and rural aging present significant challenges to sustainable agriculture in Vietnam's Red River Delta (RRD). This study examines how demographic shifts, especially an aging population, interact with land consolidation to shape farming practices and labor dynamics. Using a mixed-methods approach, we surveyed 600 households and conducted 60 in-depth interviews across 13 communes from 2020 to 2022. Using the Kruskal–Wallis test, our study highlights the declining youth interest in agricultural pursuits. A Mann–Whitney U test revealed that farmers in their early forties to early fifties expressed the high level of confidence in adopting sustainable practices. Despite consolidation efforts, average farm size remains just 0.22 ha, constraining economies of scale and accelerating youth outmigration. Based on these findings, we recommend targeted policies that increase access to consolidated land for younger farmers, including participatory land exchanges, subsidized mechanization, credit for high-value crop ventures, and tailored extension services. For older farmers, support should focus on reducing physical labor demands and improving profitability through cooperative services and simplified mechanization. Thus, addressing age-specific needs can help retain youth and enhance the long-term sustainability of smallholder agriculture in Vietnam.

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Land consolidation; rural aging; agricultural land; Red River Delta; Vietnam

## 1. Introduction

In Vietnam, agricultural land is often divided into small, scattered plots, leading to labour inefficiencies that hinder irrigation, mechanisation, and productivity, and contributing to declines in product quality, food security, and household income (Gomes et al., 2019; Tran & Vu, 2019; Tran et al., 2022). To counteract this, the government has prioritised land consolidation, rearranging fragmented plots into coherent holdings and adjusting use rights, to boost productivity and sustainable development (Do et al., 2023; Nguyen & Warr, 2020). Studies show that consolidation reduces on-farm labour, increases machinery use, raises farm income, and enables labour to shift off-farm (Do et al., 2023; Nguyen & Warr, 2020; Tran et al., 2022).

Meanwhile, Vietnam's rural population is aging rapidly (Giang et al., 2019), with agricultural employment falling from 37.6 percent in 2018 to 29.1 percent in 2021 (General Statistics Office, 2022). Young adults ( $\leq 30$  years) often migrate to cities for better opportunities, driven by limited farm jobs and credit constraints, which intensifies rural aging and erodes off-farm income for those who remain (Meraner & Finger, 2019; Tran et al., 2021; VanWey et al., 2012). At the same time, industrialisation and scale agriculture reshape livelihoods (Duan et al., 2021; Niroula & Thapa, 2005; Simelton et al., 2021).

Most research has addressed either age's impact on tenure and innovation (Meraner & Finger, 2019; Rigg et al., 2020; Tran et al., 2021) or land consolidation itself (Nguyen & Warr, 2020; Do et al., 2023; Tran et al., 2022). Few studies examine how an aging workforce affects consolidation policies and how those policies, in turn, reshape demographics.

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In Vietnam, rural aging and land fragmentation are interlinked through a reinforcing structural cycle that shapes agricultural sustainability. Highly fragmented plots constrain mechanisation, reduce economies of scale, and limit profitability, making farming less attractive to younger generations. As youth migrate to non-agricultural employment, the farming population becomes increasingly concentrated among older farmers, who often prioritise low-risk, labour-saving strategies over diversification or capital-intensive innovation. Land consolidation is intended to address fragmentation by increasing plot size and improving production efficiency. While consolidation can raise earnings and reduce manual labour, potentially making agriculture more attractive to younger farmers (Tran et al., 2022), it can also lower labour demand and facilitate off-farm migration (Bhandari & Ghimire, 2016). Access to larger holdings may deter migration for some youth who view farming as viable (Kosec et al., 2018), yet mechanised production systems may simultaneously reduce employment opportunities despite higher profitability (Nguyen & Warr, 2020; Tran et al., 2022). These dynamics illustrate a bidirectional relationship as fragmentation contributes to youth exit and aging, while aging constrains the transformative potential of consolidation. Understanding this interaction is critical for designing policies that enhance long-term agricultural sustainability and inter-generational resilience.

Recognising this gap in the literature, this study examines how rural aging influences the outcomes of land consolidation policies, and conversely, how land consolidation practices shape farming behaviours and labour structures among aging rural populations. Specifically, we aim to address the central research question: How do demographic shifts, particularly rural aging, interact with land consolidation efforts to affect farming practices, land-use decisions, and labour structures in Vietnam's Red River Delta (RRD)? To achieve this, we conducted a large-scale, comprehensive survey along with extensive qualitative fieldwork in rural communities across the RRD from June 2020 to December 2022, using a mixed-methods approach that integrates quantitative data with qualitative insights from in-depth interviews and focus group discussions.

By gaining a nuanced understanding of the drivers and complexities of land consolidation in the context of an aging rural population, policymakers can provide a more effective course toward sustainable agricultural development, poverty alleviation, and ecosystem preservation in Vietnam. Through these insights, this study contributes to the broader discourse on addressing agricultural land fragmentation and underscores the potential for innovative policy measures to bring about positive changes in the Vietnamese agricultural landscape.

## 2. Materials & methods

### 2.1. Land policy and agricultural land allocation in Vietnam

In Vietnam, all land is collectively owned by 'the entire population' and managed by the state through local governments at the commune, district, and provincial levels. Following decollectivization in the late 1980s, farmland was allocated to households and other entities with use rights rather than ownership. The 1993 Land Law expanded these rights, allowing holders to sell produce, mortgage, exchange, inherit, and transfer use rights. To promote equitable distribution, landholding limits were set: up to 3 hectares for rice and short-season crops, 10 hectares in lowland regions, and 30 hectares in upland areas.<sup>1</sup> However, the land that farmers typically received in their allocations was fragmented, scattered across the commune, and often varied in quality. The driving factor for each household having such fragmented pieces of farmland is the inherent heterogeneity of good and bad land quality, and the approach attempted to provide each farmer with roughly equal amounts of good and bad land. In this period (the late 1980s and the early 1990s), governments at all levels considered equity and fairness as the key principles for land allocation activities.

Over time, land fragmentation became a major barrier to agricultural efficiency, mechanisation, and economies of scale (Nguyen & Warr, 2020; Tran & Vu, 2019). To address this, policies promoting land consolidation emerged in the 2000s and 2010s (Do et al., 2023), with local governments establishing land allocation committees to manage voluntary or lottery-based consolidation efforts, still applying fairness principles (Do et al., 2023).

Motivations for consolidation remain complex, shaped by individual needs, work preferences, and demographic changes like rural aging and youth outmigration (Nguyen et al., 2020). Vietnam's rural-to-urban migration, driven by economic opportunities and industrial estate development (Fox et al., 2018; General Statistics Office, 2022), has further strained agricultural labour and left land underutilized, deepening the challenges of fragmentation.

In response to underutilized farmland and persistent land fragmentation, national and provincial governments have promoted land consolidation as part of rural development strategies. Consolidation efforts address labour shortages and land abandonment while supporting broader policies such as the Ministry of Agriculture and Rural Development's 'New Rural Development' programme, which seeks to enhance rural livelihoods and promote agricultural mechanisation (Petersen, 2017). Additionally, policies like Decision No. 1064/QĐ-TTg and Decision No. 69/2007/QĐ-TTg encourage farm expansion and specialisation to align agricultural development with industrialisation and modernisation goals (Petersen, 2017). This consolidation efforts seek to optimise land use, address labour shortages, and enhance farming's viability amid an aging rural population (Nguyen & Warr, 2020).

## 2.2. Study sites

The empirical basis for this study draws on fieldwork undertaken in 13 communes across three provinces in the RRD of Vietnam from October 2020 to December 2022. The communes included Hong Chau, Dong Cuong, Dai Dong, Dinh Trung, and Phu Xuan in Vinh Phuc Province (VPP); Nhat Quang, Tong Tran, Nguyen Hoa, and Dinh Cao in Hung Yen Province (HYP); and Nam Hai, Tay Tien, Dong Xa, and An Chau in Thai Binh Province (TBP) (see Figure 1).

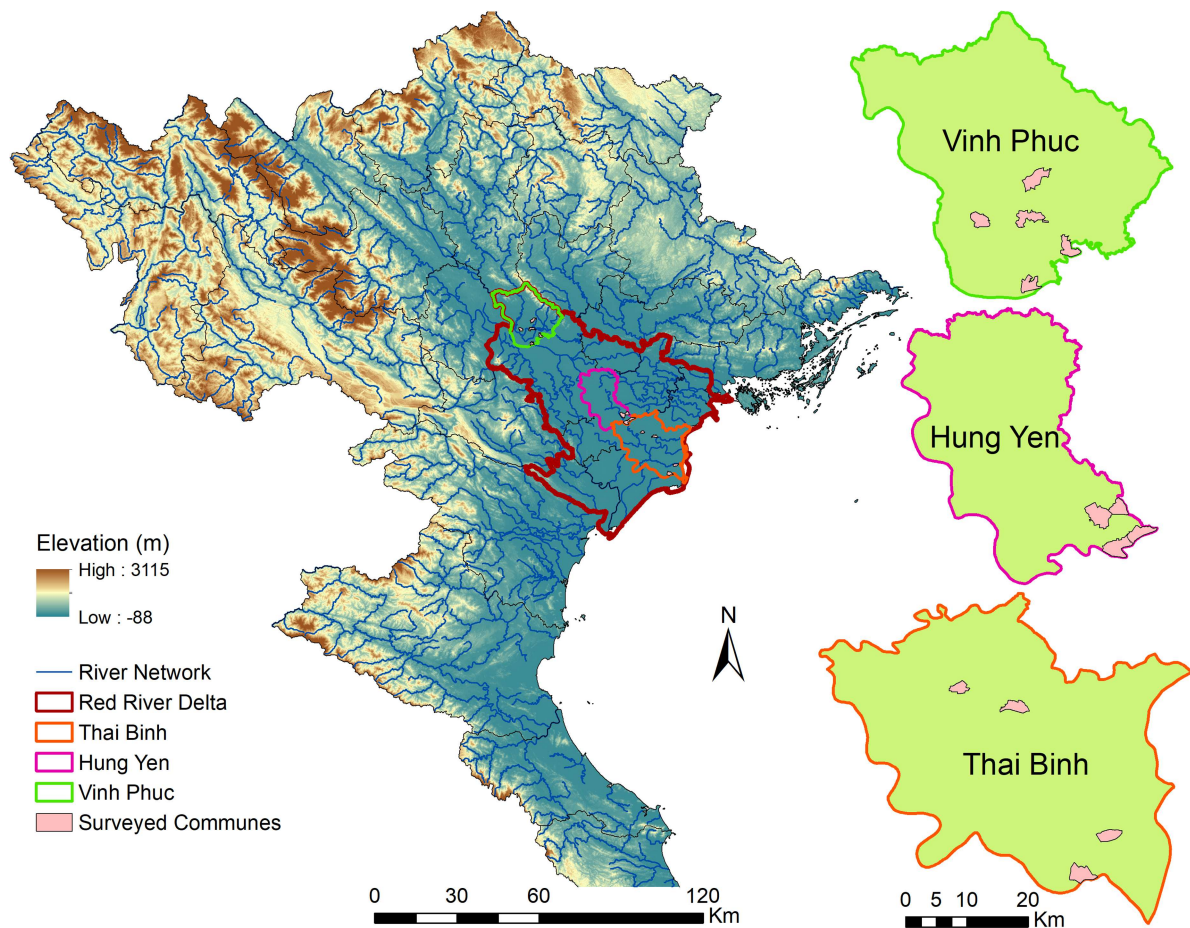


**Figure 1.** Study area location: The Red River Delta and surveyed provinces in Northern Vietnam.

While the study was geographically focused on the RRD, the selected provinces, VPP, HYP, and TBP, represent a diverse mix of peri-urban and rural coastal estuary communities that embody the broader socio-economic dynamics of densely populated, smallholder-based agricultural systems common across Southeast Asia (Kelley et al., 2020; Otsuka et al., 2016). The RRD is among Vietnam's most agriculturally intensive and demographically complex regions, with a long history of state-led land reforms and a high incidence of aging rural populations, making it a relevant setting for exploring the interconnections between demographic change and land policy.

We selected these provinces for several reasons: First, they represent diverse agricultural regions within the RRD and embody different geographical features and farming practices. VPP includes semi-mountainous areas with varied topography, in contrast to the low and flat delta terrain of HYP, which is ideal for rice cultivation. The TBP is renowned for its rich agricultural heritage and traditional farming methods, adding further diversity to our study. Second, the governments of these provinces are proactive in promoting land consolidation. They initiated campaigns and programmes to encourage farmers' participation, making these regions pertinent for studying the effects of such policies. Finally, each province exhibits unique conditions and priorities for economic development, providing a varied context to examine how land consolidation interacts with rural aging and labour structures.

Aging in agriculture is a common phenomenon across all localities. Communes are agrarian communities where villagers typically engage in a combination of crop cultivation, livestock husbandry, and off-farm work, a practice prevalent throughout Vietnam (Sikor, 2012). The three provinces studied also represent distinct trends in land consolidation, further justifying their selection.

In VPP, land consolidation has achieved limited success despite clear policies, hindered by individualised land allocation and lack of transparency. Most households grow rice primarily for subsistence, preferring geographically concentrated plots for convenience, though land size does not directly impact efficiency. In HYP, consolidation through lotteries and mutual agreements successfully reduced household land parcels from 5–12 to 1–2, decreasing fragmentation. Although large contiguous rice fields did not materialise, the process is considered a local success, with farmers often expanding holdings by leasing or purchasing adjacent plots. In TBP, a new model promotes cooperation among neighbouring farmers, who maintain individual boundaries but collaborate on sowing, fertilising, and harvesting, reducing production costs and strengthening mutual support.

In each province, the aim of our fieldwork was to capture the wide range of conditions under which households adapt to changes in labour, land size, and agricultural structure. By studying these diverse contexts, we sought to understand the interplay between land consolidation policies and the ageing rural population in the RRD. This comprehensive approach allows us to analyse how different implementation strategies and local conditions affect the success of land consolidation efforts and their impact on rural communities.

### 2.3. *Mixed-methods theoretical framework*

To systematically investigate the interrelation between rural aging and land consolidation, we employed a mixed-methods research framework. Mixed-methods research integrates quantitative and qualitative approaches to provide a more comprehensive understanding of research problems than could be achieved by using either method alone (McKim, 2017; Tashakkori & Creswell, 2007). This methodology allows researchers to leverage the strengths of both approaches, providing robust, triangulated results that enhance validity and reliability.

As highlighted by Migiro and Magangi (2011), mixed-methods research is particularly effective in addressing complex social phenomena, where neither quantitative nor qualitative methods alone can fully capture the intricacies involved. By combining numerical data with contextual insights, this approach facilitates a more nuanced analysis and interpretation of research findings.

Our study emphasises the interaction between demographic trends, asset management (including land), and livelihood strategies in rural communities. The demographic factor (aging rural populations) influences decisions on land utilisation, consolidation practices, and investment in farming technologies. Simultaneously, land consolidation as a policy measure shapes the viability of livelihoods, affecting both individual and collective community outcomes.

### 2.3.1. Data collection

We implemented a two-stage interview and survey process to explore rural dynamics in Vietnam's RRD. The specific survey and interview questions can be found in the Supplementary Material Section. In the first stage (October 2020–January 2021), during the winter crop cycle, we collected 60 narratives from farmers on farming, migration, non-farm activities, and livelihoods, and conducted in-depth interviews with 35 local authorities and agency representatives: 14 in VPP, 9 in TBP, and 12 in HYP. Interviews addressed economic development, rice farming, and land consolidation strategies. Informed consent was obtained in writing, participants remain anonymous, and data is securely stored.

For the second stage, we developed surveys based on community input, covering housing, demography, gender relations, farming activities, land consolidation, sustainable practices, and household economics. Between October–November 2021 and November–December 2022, to coincide with the transition from the summer-autumn rice harvest to winter crop preparation, we surveyed 600 households across the three provinces, selecting 30–50 households per community at random. Conducting fieldwork during these labour periods allowed for a direct observation of how household labour availability and age-related physical constraints influence land-use decisions, such as the choice between traditional two-season rice cycles and intensive three-season vegetable rotations.

Ethical considerations were strictly observed throughout the data collection process. Prior to each interview or survey, participants received a brief explanation of the study purpose, what participation involved, and how the data would be used. Participants were assured of their right to anonymity and informed that their data would be stored securely and used exclusively for research purposes. This process was designed to ensure transparency, voluntary participation, and compliance with ethical standards for field-based social research.

As sustainable agriculture is increasingly promoted as a policy direction in the RRD and beyond due to its potential to address both environmental and economic challenges in rural areas. As land fragmentation, labour shortages, and soil degradation intensify, sustainable practices offer pathways to maintain productivity while reducing input dependency and environmental harm (Morton, 2020; Ngo et al., 2021). In the second survey round, we posed a key attitudinal question to 300 households: 'Do you think it is feasible or not to switch to sustainable farming in the near future?' and 'Do you think switching to sustainable agriculture will bring you economic benefits?'. Both items were rated on a five-point Likert scale (1 = not feasible/no benefit, 5 = highly feasible/strong benefit). These questions were designed to capture farmers' perceptions of the practicality and profitability of transitioning to sustainable agriculture, factors that are closely tied to land use and labour availability. Understanding these perceptions helps contextualise how demographic shifts, particularly rural aging and youth outmigration, influence not only the willingness to engage in long-term land use changes but also the perceived viability of modern, labour-efficient farming systems.

Using insights from this study, we aimed to investigate how the aging rural population affects the adoption and effectiveness of land consolidation policies, considering that older farmers might be more resistant to changes in land tenure or lack the resources to invest in consolidated landholdings. Additionally, we explored how land consolidation influences the rural labour structure by enabling more efficient use of limited labour resources and facilitating the adoption of labour-saving technologies, which could significantly impact the livelihoods of aging farmers.

### 2.3.2. Quantitative approach

Quantitative analysis combined descriptive statistics with inferential tests, specifically the Kruskal–Wallis and Mann–Whitney U tests. Participants were grouped by occupation (unemployed, farming, non-farming) and age: younger (under 40) and older (40 and above). We chose 40 years as the cutoff, reflecting a key demographic shift in rural Vietnam as Paris et al. (2009) found that men tend to migrate before 40, while women typically remain on farms beyond this age. Because the key outcome variables were measured using ordinal Likert-scale responses and preliminary diagnostics indicated non-normal distributions and unequal group sizes, we employed non-parametric tests rather than parametric alternatives. The Kruskal–Wallis and Mann–Whitney U tests do not assume normality and are therefore more appropriate for ordinal or skewed data.

To examine age versus occupation, we used the Kruskal–Wallis test, a non-parametric method for comparing three or more independent groups when the continuous variable is non-normally distributed (Kruskal & Wallis, 1952). The null hypothesis ( $H_0$ ) was that age distributions were the same across occupations, tested at a significance level of 0.01. Analyses were conducted using SPSS version 29.0.

We also used the Mann–Whitney U test, a rank-based non-parametric method (Mann & Whitney, 1947), to assess age-related differences in two attitudinal items: perceptions of the feasibility and economic benefits of switching to sustainable farming. Both were measured on a five-point Likert scale. Instead of using a fixed age split, we systematically tested every cutoff between 36 and 55 years to identify when younger and older groups diverged in their responses. This threshold analysis revealed the earliest age at which confidence and perceived economic benefits began to shift, offering valuable insight for designing targeted extension programmes and policies for Vietnam’s aging rural workforce.

### 2.3.3. Qualitative approach

Qualitative data were collected through semi-structured, in-depth interviews designed to capture the diverse experiences, perceptions, and decision-making processes of participants in relation to land consolidation and agricultural change. We conducted 60 interviews with farmers, officials, and agency representatives, focusing on land fragmentation, farming challenges, generational roles, and policy perceptions.

All interviews were recorded with participants' consent, transcribed verbatim, and translated where necessary. Thematic analysis enabled the identification of recurring narratives as well as divergent viewpoints, helping us understand how land consolidation is interpreted and experienced by different actors across locations. Themes were then compared across age groups, gender, and provinces to highlight regional and demographic variation in the perception and experience of land policies. Analytical categories were explicitly aligned with constructs from our mixed-methods framework, including agency, structure, livelihood, and generational change. This approach ensured that our qualitative analysis was not only descriptive but also theoretically grounded, offering deeper insight into the complex interactions between aging, land policy, and rural transformation in the RRD.

### 2.3.4. Data integration

Integration of quantitative and qualitative datasets occurred during interpretation to validate and contextualise findings. This triangulation process provided a robust analysis, enabling a nuanced understanding of how rural aging directly and indirectly interacts with land consolidation policies and practices. Our approach combined empirical observations with theoretical perspectives to inform policy recommendations and future research directions, thereby contributing significantly to the broader academic discourse on demographic transitions and rural land management.

## 3. Results

### 3.1. Demographics

Table 1 presents the demographic characteristics of the 600 respondents surveyed across 13 communes in the RRD. A significant majority of the respondents (83%) were over the age of 50, highlighting an ageing

**Table 1.** Profiles of respondents.

|            |                   | Age |       |       |       |     | Total |
|------------|-------------------|-----|-------|-------|-------|-----|-------|
|            |                   | ≤40 | 41–50 | 51–60 | 61–70 | ≥71 |       |
| Gender     | Man               | 14  | 42    | 95    | 104   | 33  | 288   |
|            | Woman             | 9   | 34    | 119   | 117   | 33  | 312   |
| Occupation | Agriculture       | 10  | 58    | 191   | 187   | 54  | 500   |
|            | Non-Agriculture   | 13  | 13    | 11    | 7     | 1   | 45    |
| Education  | Unemployed        | 0   | 5     | 12    | 27    | 11  | 55    |
|            | None              | 1   | 6     | 4     | 4     | 3   | 18    |
|            | Primary school    | 0   | 9     | 14    | 15    | 9   | 47    |
|            | Secondary school  | 6   | 40    | 121   | 137   | 39  | 343   |
|            | High school       | 15  | 19    | 71    | 65    | 13  | 183   |
|            | Vocational degree | 1   | 0     | 2     | 0     | 1   | 4     |
|            | Bachelor's degree | 0   | 2     | 2     | 0     | 1   | 5     |

trend in the agricultural sector. The gender distribution was relatively balanced, with males constituting 48% and females constituting 52% of the sample.

The respondents were categorised into two age groups: those aged 40 and below (younger group) and those aged over 40 (older group). This division aligns with the observed generational shifts in rural Vietnam, where younger individuals increasingly seek non-farming opportunities, often migrating to urban areas, while older individuals remain engaged in agriculture. This categorisation allowed for a comparative analysis of occupational preferences and engagement with land consolidation initiatives between the two generations.

Regarding education, the majority of respondents across all age groups completed secondary education (57%), and approximately 30% had graduated from high school. A small proportion (approximately 2%) held vocational or bachelor's degree.

### 3.2. Occupational preferences across age groups

To delve deeper into occupational preferences, we analysed the occupations of all household members aged 18 years and above, totalling 1,729 individuals (Figures 2 and 3). The division into younger ( $\leq 40$  years old) and older ( $>40$  years old) groups enabled us to examine generational differences in employment within the rural context. Understanding the occupational choices of different age cohorts is crucial for tailoring land consolidation policies and addressing labour shortages in the agricultural sector.

Figure 2 shows a significant contrast between the two age groups regarding their engagement in farming occupations. The older group had a greater percentage of those engaged in farming jobs (79%) than the younger group (15%). Conversely, for non-farming occupations, the statistics reveal a substantial disparity, with 69% of the younger group opting for such jobs, in contrast to a modest 10% of the older group. This result indicates a generational shift away from farming as the primary occupation.

Figure 3 presents a boxplot of age distribution within each occupation category. The mean age (31.5) and median age (32) of the younger group engaged in non-farming occupations were also lower than the mean age (35.1) and median age (36) of the younger group involved in farming. This observation further demonstrates that younger individuals generally lean toward non-farming occupations, and older individuals toward farming jobs.

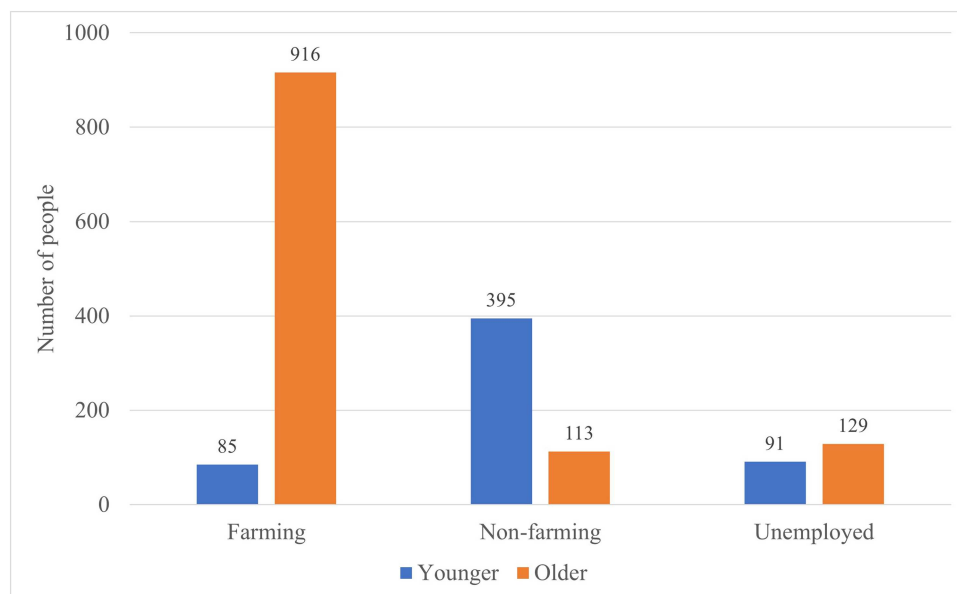


**Figure 2.** The paired bar graph shows the number of members in the younger group and older group in farming, non-farming and unemployed occupation categories.

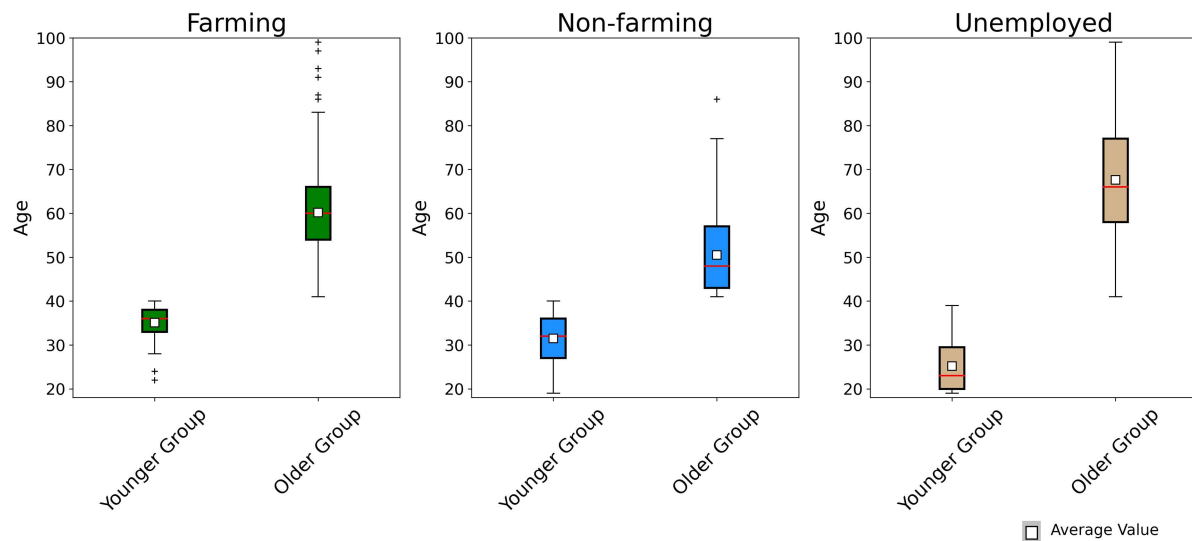


**Figure 3.** Boxplot showing the age distribution of the younger group and older group for various occupation categories, including farming, non-farming and unemployed.

### 3.3. Statistical analysis

To investigate the relationship between age and occupation within our dataset of 1,729 individuals, we performed a Kruskal–Wallis H test (Table 2). This non-parametric test is appropriate for comparing more than two independent groups when the assumption of normality does not hold. Our goal was to determine whether there were statistically significant differences in age distribution across different job categories: farming, non-farming, and unemployed.

The test statistic of 738.424 indicates the strength and magnitude of the differences observed in the age distributions among job categories. A larger test statistic generally indicates a more pronounced difference. The result of the significance level (two-sided test) is reported as  $<0.001$ , which indicates that the  $p$ -value associated with the test is very small and well below the 0.01 threshold of significance.

All pairwise comparisons in Table 3 show adjusted significance levels of less than 0.001, confirming that the age distributions between each pair of job categories differed significantly. When comparing the non-farming and unemployed groups, the statistical analysis indicates that individuals in non-farming occupations tend to be younger than those who are unemployed. A high Z-score and extremely low adjusted  $p$ -value ( $<0.001$ ) confirmed that this difference was statistically significant. Therefore, the age distribution of the non-farming group was significantly different from that of the unemployed group, with non-farming individuals being younger on average.

Similarly, a comparison between non-farming and farming groups shows that individuals in non-farming occupations are generally younger than those in farming occupations. The positive test statistic and significant adjusted  $p$ -value ( $<0.001$ ) confirm that this difference is statistically significant, reinforcing that the non-farming group is younger on average than the farming group.

In the case of unemployed versus farming groups, statistical analysis indicated that the unemployed group tended to be older than the farming group. The negative test statistic, along with a significant Z-score and adjusted  $p$ -value ( $<0.001$ ), confirmed that this difference was statistically significant. Therefore, the age distribution of the unemployed group was significantly different from that of the farming group, with unemployed individuals being older on average.

**Table 2.** Kruskal–Wallis test summary.

| Null hypothesis                                                                    | Number of samples | Test statistic | Signification level | Decision                    |
|------------------------------------------------------------------------------------|-------------------|----------------|---------------------|-----------------------------|
| The distribution of age groups is the same across categories of occupation groups. | 1,729             | 738.424        | $<0.001$            | Reject the null hypothesis. |

**Table 3.** Pairwise comparisons of job categories.

| Sample 1-Sample 2          | Test statistic | Standard error | Standard test statistic | Signification level | Adjusted signification level |
|----------------------------|----------------|----------------|-------------------------|---------------------|------------------------------|
| Non-farming and Unemployed | 314.611        | 32.824         | 9.585                   | <.001               | 0                            |
| Non-farming and Farming    | 598.791        | 22.155         | 27.028                  | <.001               | 0                            |
| Unemployed and Farming     | -284.18        | 30.283         | -9.384                  | <.001               | 0                            |

These findings reinforce the earlier conclusion that age-related variations exist among individuals engaged in different types of occupation within the dataset. Specifically, non-farming individuals are the youngest on average, followed by farming individuals, whereas the unemployed are the oldest. This underscores generational differences in occupational choices within the rural population and highlights potential challenges for the agricultural sector due to the aging farming workforce.

The division into two age groups is crucial for understanding the dynamics between rural ageing and land consolidation. The younger group's low participation in farming poses challenges to the sustainability of agricultural practices. Their inclination toward non-farming occupations suggests that land consolidation policies may need to address barriers preventing youth engagement in agriculture.

Conversely, the older group's greater involvement in farming indicates that they are the primary stakeholders in these initiatives. However, their advanced age may limit their ability to adopt new technologies or practices that could further enhance farm efficiency.

Our series of one-sided Mann Whitney U tests (Table 4) reveals a clear, age-specific shift in farmers' perceptions of sustainable agriculture feasibility. No cutoff below 42 years yielded a  $p$ -value below the conventional 0.05 threshold, indicating that respondents younger than 42 did not differ significantly from their older counterparts at those earlier splits. However, at the 42-year cutoff we observe  $U = 2943.0$  with  $p = 0.0347$ , formally rejecting the null hypothesis of identical rating distributions and demonstrating that farmers aged 42 and under assign systematically higher feasibility scores than those older than 42. Furthermore, when we extend our scan to subsequent cutoffs, the strength of this age-related divergence intensifies: age splits of 43–51 years all produce  $p \leq 0.023$ , peaking at age 48 with  $p = 0.010$ , before the effect begins to wane by age 52 ( $p = 0.047$ ) and becomes non-significant again at ages 53 and above. This pattern suggests not only that early forties represent the first demographic boundary at which confidence in adopting sustainable practices significantly increases, but also that this heightened optimism persists throughout the later forties before gradually converging back toward older farmers' attitudes.

The result enriches our understanding of the interplay between rural aging and land-use innovation in several ways. First, it refines the broad strokes painted by our Kruskal–Wallis H test, where we saw general age-related differences in occupational engagement, by revealing the age when farmers' optimism shifts. Second, it offers actionable guidance for extension agents and policymakers: interventions such as practical

**Table 4.** Mann–Whitney U test results for feasibility of adopting sustainable agriculture across age cutoffs.

| Age cutoff | U statistic | $p$ -value |
|------------|-------------|------------|
| 36         | 153         | 0.446      |
| 37         | 755         | 0.375      |
| 38         | 1050        | 0.352      |
| 39         | 1310        | 0.161      |
| 40         | 1713        | 0.066      |
| 41         | 1856        | 0.069      |
| 42         | 2943        | 0.035      |
| 43         | 3591        | 0.016      |
| 44         | 3705.5      | 0.047      |
| 45         | 4076.5      | 0.022      |
| 46         | 4203.5      | 0.023      |
| 47         | 4329.5      | 0.023      |
| 48         | 4692.5      | 0.010      |
| 49         | 5058.5      | 0.011      |
| 50         | 5297.5      | 0.011      |
| 51         | 5877.5      | 0.011      |
| 52         | 6578        | 0.047      |
| 53         | 6804        | 0.237      |
| 54         | 7414        | 0.105      |
| 55         | 8334        | 0.054      |

demonstration plots, crop-diversification subsidies, or conservation agriculture training are likely to gain the greatest traction among those in their early forties and younger, who have been empirically shown to be most receptive. Third, this threshold analysis allows planners to anticipate how demographic changes (as the rural workforce ages further) may influence the overall adoption curve for sustainable methods. By aligning programme design with this granular, age-specific insight, Vietnam's land consolidation initiatives can remain both effective and equitable, supporting the younger farmers with capacity-building, while developing parallel strategies to address the reservations of older farmers.

Across every age cut-off from 36 through 55, none of the one-sided Mann Whitney U tests reaches statistical significance at the 0.05 level (Table 5). The smallest  $p$  value occurs at age 36 ( $p = 0.4502$ ), but even this is far above the threshold for rejecting the null hypothesis of equal rating distributions. In other words, farmers both younger and older express similar confidence that switching to sustainable farming will bring economic benefit.

This uniformity contrasts sharply with the feasibility question, where a clear age boundary emerged at 42 years. Here, however, perceived economic benefit does not diverge by age cohort. From a policy standpoint, this suggests that while optimism about feasibility must be fostered among older farmers, belief in economic upside extends broadly across the rural population.

The Mann–Whitney U test results reveal no statistically significant gender differences in attitudes toward sustainable agriculture for the two evaluated questions (Table 6). For the question 'Do you think switching to sustainable agriculture will bring you economic benefits?', the  $p$ -value is 0.506, indicating that male and female respondents provided similar responses regarding perceived economic returns from sustainable practices. Likewise, the question 'Do you think it is feasible or not to switch to sustainable farming in the near future?' yielded a  $p$ -value of 0.632, further confirming that gender does not significantly influence perceptions of feasibility. In both cases, the high  $p$ -values, well above the conventional threshold of 0.05, suggest that men and women in this sample share comparable views. These findings imply that gender is not a strong predictor of farmers' attitudes toward sustainable agriculture in this context, supporting the use of gender-neutral strategies in designing outreach and support programmes aimed at promoting sustainable agricultural practices. In RRD, as women take on a growing role in agriculture, their influence over decision-making has also expanded, contributing to a more balanced distribution of farm-related decisions between men and women.

Overall, the statistical analyses highlighted the importance of considering demographic factors, particularly age, when implementing land consolidation policies. They suggested that the nature of employment is associated with distinct age distributions, indicating potential generational differences in job choices within the studied population. This information can be valuable for policymakers, researchers, and organisations that aim to address age-related challenges in the agricultural sector.

**Table 5.** Mann–Whitney U test results for economic-benefit perception ratings across age cut-offs.

| Age cutoff | U statistic | $p$ -value |
|------------|-------------|------------|
| 36         | 151         | 0.450      |
| 37         | 623         | 0.696      |
| 38         | 670         | 0.956      |
| 39         | 814         | 0.940      |
| 40         | 1099        | 0.905      |
| 41         | 1355        | 0.755      |
| 42         | 2058        | 0.791      |
| 43         | 2457        | 0.745      |
| 44         | 2596        | 0.834      |
| 45         | 2980        | 0.797      |
| 46         | 2984        | 0.877      |
| 47         | 3109        | 0.867      |
| 48         | 3234        | 0.916      |
| 49         | 3475        | 0.943      |
| 50         | 3712        | 0.932      |
| 51         | 4517        | 0.761      |
| 52         | 5351        | 0.715      |
| 53         | 5953        | 0.669      |
| 54         | 6514        | 0.560      |
| 55         | 7545        | 0.310      |

**Table 6.** Mann–Whitney U test results comparing gender responses on sustainable agriculture.

| Question                                                                                | U statistic | p-value |
|-----------------------------------------------------------------------------------------|-------------|---------|
| Do you think switching to sustainable agriculture will bring you economic benefits?     | 6904        | 0.506   |
| Do you think it is feasible or not to switch to sustainable farming in the near future? | 7129.5      | 0.632   |

### 3.4. Farm size and land holdings

In contrast to other nations, such as Germany and the Netherlands, where expanding active farms through additional land allocation is a primary goal of land consolidation (Vitikainen, 2004), the Vietnamese government has a different approach. In 1998, the government introduced a policy aimed at incentivizing the exchange of land plots to address farmland fragmentation without necessarily increasing individual farm sizes (Pham et al., 2007). However, farm size in the RRD remains relatively modest.

Our survey revealed that farm sizes in the RRD remain relatively modest, even after land consolidation efforts. The average farm size for a household in the surveyed communes is approximately 0.22 hectares (Table 7), consistent with previous studies in the region (Nguyen et al., 2017). The data showed a negligible correlation between household and farm sizes. Households with four or fewer members, accounting for 64% of the survey respondents, have an average farm size ranging from 0.20 to 0.21 hectares. Even among households with more than seven members (10% of participants), the average farm size increased only slightly to 0.25 hectares.

Since 1993, the local government has refrained from reassigning agricultural land-use rights to farmers. In practice, this means that all individuals born in a rural area of Vietnam after 1993 did not receive agricultural land use rights, and the land of those who died since 1993 becomes the property of their family posthumously (Pham et al., 2020). This policy has implications for farm size and land distribution among households as it limits the expansion of individual landholdings and perpetuates the fragmentation of agricultural land.

To provide a broader perspective on the significance of farm size in RRD, it is pertinent to compare the average farm size in surveyed communes with that of high-income countries, which is approximately 35 hectares, and with lower- and middle-income countries, where it is around 1.4 hectares (Ren et al., 2019). The average farm size, that is, the total amount of agricultural land owned by a family, in our surveyed communes is approximately six times smaller than that in other lower- and middle-income countries. This disparity underscores the unique challenges faced by smallholder farmers, particularly in terms of productivity, resource management, and access to modern agricultural practices.

The limited increase in farm size after consolidation suggests that the primary benefit of land consolidation in RRD is the reduction in land fragmentation rather than the expansion of farm size. This approach aligns with the government's policy focus on encouraging the exchange of land plots to create more manageable and contiguous land parcels, thus improving efficiency without necessarily increasing the total area farmed by each household.

The negligible correlation between household size and farm size further emphasises that landholding patterns are not significantly influenced by the number of household members. This situation is partly due to land inheritance and allocation policies that limit land redistribution based on family size. The static nature of farm size poses challenges for productivity improvements and the adoption of modern agricultural practices that often require larger land areas to be economically viable.

It is important to note that most rural communes in the RRD already operate within some form of cooperative or collective framework, particularly in relation to irrigation management, input supply, mechanisation services, and marketing coordination. These cooperatives, when well-managed, can help smallholders partially overcome the constraints of limited farm size by facilitating shared machinery use, synchronised cropping calendars, and collective bargaining in input and output markets. However, the

**Table 7.** Household sizes and average farm sizes.

| Household size | Count | Average farm size (ha) |
|----------------|-------|------------------------|
| 1–2            | 192   | 0.21                   |
| 3–4            | 193   | 0.2                    |
| 5–6            | 154   | 0.23                   |
| 7+             | 58    | 0.25                   |

effectiveness of cooperatives varies considerably across communes. Some are active and function as genuine service providers that enhance efficiency and reduce transaction costs, while others exist largely in name, with limited coordination capacity or member engagement.

## 4. Discussion

### 4.1. *The aging of farmers in the RRD*

Agricultural census data confirm a marked ageing of Vietnam's farm workforce: between 2006 and 2011 the share of farmers over 55 years rose by 3.6 percentage points, nearly double the increase in the general population of that age bracket (Heide-Ottosen, 2014). In our own sample, half of respondents (502 of 1004) were aged 60 or older, underscoring the growing predominance of senior farmers and the attendant challenges it poses.

The migration of rural youth in the RRD is driven by a combination of systemic economic pressures and structural land constraints. Our qualitative interviews reveal that migration is rarely a simple lifestyle choice; rather, it is a response to the diminishing economic viability of small-scale farming. The primary factor is the lack of land access for those born after the 1993 land allocation, which effectively excludes younger generations from independent farm ownership. Furthermore, the pull of urban industrial centres is intensified by the volatility of agricultural earnings and the rising costs of inputs, which contrast sharply with the stable wages offered in non-farm sectors. Consequently, youth outmigration is a rational economic strategy in a landscape where fragmented, small-scale plots cannot support the modern, high-income aspirations of the next generation.

Older farmers frequently cite labour and physical capacity constraints as reasons for maintaining traditional two-season rice systems and avoiding additional winter crops. Many respondents over 60 reported declining a third vegetable season due to health and workload concerns, consistent with findings that ageing farmers tend to favour established practices and avoid perceived risks (Phung & Dao, 2024). This reliance on rice monoculture carries economic consequences. Although rice remains central to food security and rural livelihoods (Nguyen et al., 2017; Torbick et al., 2017), returns are substantially lower than those from high-value vegetables, which account for up to 83 percent of crop income in peri-urban and 89 percent in rural areas (Pham et al., 2013). Nevertheless, rice policy remains nationally significant, involving approximately two-thirds of rural households (Pham et al., 2015; Phan et al., 2022), with 7.2–7.3 million hectares cultivated in 2022 (Ministry of Agriculture and Rural Development, 2022).

By contrast, younger farmers, (aged 30–50) demonstrate both the capacity and the willingness to intensify and diversify. Many have added a third winter vegetable season, transforming the traditional two-crop calendar into a three-crop rotation, thereby optimising land use and rapidly boosting net income (Tran et al., 2022). This willingness to innovate reflects not only their greater physical resilience, but also a proactive drive to improve economic resilience through advanced techniques and market-oriented crops.

Interviews confirm this pattern. While traditional farming in the RRD typically involves two annual rice seasons (spring and summer–autumn), younger farmers increasingly add a winter vegetable crop, maximising year-round land use. Vegetables generally command higher prices and offer quicker returns than rice, thereby supplementing household income and enhancing profitability. This intensification illustrates the younger generation's willingness to innovate and adapt in pursuit of greater economic returns.

Statistical analysis further reinforces this generational divergence. Although no significant age differences were found in perceived economic benefits of sustainable farming (all  $p > 0.05$ ), age significantly influenced perceived feasibility. A Mann–Whitney U test identified age 42 as a threshold: farmers  $\leq 42$  rated the personal feasibility of adopting sustainable agriculture significantly higher than older farmers. Thus, while both cohorts recognise the economic value of sustainable practices, younger farmers feel more capable of implementing them.

Several factors help explain this gap. Physical capacity and labour availability likely play important roles. Older farmers often report reduced stamina and smaller household labour pools due to youth migration, limiting their ability to experiment with new practices. Risk attitudes also differ. Farmers closer to retirement tend to be more cautious about altering established systems, fearing income instability, whereas younger farmers typically display greater risk tolerance and openness to innovation. As reflected in our findings,

despite shared recognition of sustainable farming's benefits, older farmers' concerns about effort and uncertainty reduce their confidence in adoption, while younger farmers appear more prepared to act on these opportunities.

This finding raises concerns about physical capacity in farming: it highlights that without measures to ease the labour and health burdens on older farmers, even well-regarded innovations might fail to gain traction among a significant portion of landholders. The result also connects to patterns of land consolidation. If older farmers feel unable to implement sustainable practices on their own, they might be more inclined to rent out or sell land to younger, more ambitious farmers, or at least not oppose initiatives that lead to larger, more efficiently managed farms. In this way, younger farmers, who consistently rated sustainable farming as more feasible, could become the main drivers of sustainability transitions, potentially accelerating the consolidation of land into the hands of those willing to innovate. Finally, the evident age-related divide in our results highlights the need for generationally targeted policies. Policies promoting sustainable agriculture should account for the distinct capacities and constraints faced by different age groups. Older farmers often confront physical limitations, labour shortages, and greater risk aversion; therefore, support mechanisms such as access to shared mechanisation services, labour-saving technologies, and time-bound financial risk guarantees can help lower practical barriers to adopting sustainable practices. Importantly, such support should be structured in financially sustainable ways, for example, through cooperative machinery services, cost-sharing arrangements, or gradually declining vouchers, rather than permanent subsidies. At the same time, younger farmers demonstrated greater confidence in adopting diversified and sustainable practices, suggesting that targeted training programmes, improved access to credit, market linkages, and startup incentives could empower them to lead innovation in the sector. By aligning institutional support with the differentiated needs of each cohort, policy can leverage the enthusiasm and adaptability of younger farmers while alleviating the constraints faced by older producers. Such tailored but inclusive approaches increase the likelihood that land consolidation and sustainable intensification efforts remain both economically viable and socially equitable across generations.

#### 4.2. Land allocation and consolidation policy and practice

The VPP was among the first provinces to initiate land consolidation in the late 1990s, issuing its first policy in 1996, though implementation began in the early 2000s due to fragmented, uneven land (Nguyen, 2021). In HYP and TBP, the first land consolidation occurred between 2003 and 2004 (Ministry of Natural Resources and Environment, 2017). In 2015, the national government approved 3.81 million hectares of protected rice land,<sup>2</sup> restricting land conversion and making farmers reluctant to consolidate via lottery. As a result, early consolidation efforts largely failed in most provinces during the initial phase (2003–2004).

Recognising this obstacle, the government at all levels began to allow conversion of low production or inefficient areas to other types of crops with higher economic values. In November 2021, the National Assembly approved the Decision on National Land Use Period 2021–2030 and Land Use Planning 2021–2025, which aimed to reduce the total area of land for rice production to 3.5 million ha<sup>3</sup>. Farmers then had more incentives to consolidate land, as they could use the lowland for fishponds or fruit orchards. This restructuring saw rice land converted into orchards of orange, longan, litchi, and fishponds (in HYP), as well as cash crops and vegetables (in VPP). Land Law 2013 and Decree 43.2014/ND-CP enabled successful land exchange and consolidation in HYP and TBP in 2013 and 2014, respectively. However, crop diversification in the RRD is not a straightforward process. It involved multiple actors with tangled and unequal power relations, as witnessed at our different study sites.

In all provinces, land consolidation required households to surrender a portion of their land for irrigation systems and roads. Each commune's policy dictated land deductions, which ranged from 15 m<sup>2</sup> to 30 m<sup>2</sup> per tonkin yard (360 m<sup>2</sup>). In general, farmers in the surveyed sites strongly supported land consolidation, and the process offered them larger, more versatile plots that positively impacted their livelihoods.

The followings are steps toward farmland division in most RRD provinces:

- Old-style cooperatives dissolved in 1988, and a process to share farmland with individuals was initiated.

- Communes' People's Committees completely reallocated farmland in 1993. Everyone, even those who died between 1988 and May 1993, received a share of one tonkin yard and eight thước (equal to 552 m<sup>2</sup>, as 1 tonkin yard is 360 m<sup>2</sup>, 1 thước = 24 m<sup>2</sup>). Babies born in May 1993 are not eligible to receive a share.
- Those with unpaid agricultural output taxes had to wait until the funds were paid in full. These individuals received low-quality rice fields located farther away or in flooded areas. This has led to differences in living standards among farmers in the same community.

Although VPP was among the first provinces to promote land consolidation and issued several supporting policies, implementation has not been uniformly smooth, particularly in Binh Xuyen district. To address these challenges, the province introduced Decision 256/KH-UBND in 2018, emphasising fairness and transparency. Nevertheless, interviews and group discussions revealed ongoing tensions between local authorities and villagers, especially in Phu Xuan commune. Commune authorities proceeded without securing full community agreement, resulting in 342 out of 652 households refusing to accept reassigned land and leaving it idle since 2019. One interviewee noted that only 20 households were informed of the implementation meeting, no official minutes were recorded, and the purpose of land deductions remained unclear.

The dissolution of agricultural cooperatives in 1988 marked a critical phase in land redistribution, aiming to allocate plots more equitably. However, later phases introduced disparities, with latecomers receiving smaller or less fertile land. Similar concerns resurfaced during consolidation in the late 2010s, as interviewees expressed ongoing doubts about fairness and equity in farmland allocation.

In contrast, HYP's Phu Cu district implement land consolidation under Directive 21-CT/TW, providing financial incentives (VND 1 million/ha) and support through sustainable agriculture, crop diversification, and branding initiatives (e.g. Phu Cu litchi). Through a phased approach, beginning with the dissolution of old-style cooperatives and farmland reallocation, and supported by a series of programmes offering financial incentives and agricultural development initiatives, the district successfully consolidated 4,675.86 hectares, benefiting 24,109 households by 2020.

Initial efforts in 2002–2003 linked land exchange with the VAC model (garden–pond–livestock), encouraging farmers to trade fragmented rice plots for larger wetland parcels. However, high investment costs and limited reversibility led to disappointing outcomes. A second phase (2013–2014) in Nhat Quang commune proved more successful. Previously managing five to seven scattered plots, most households shifted to a single larger parcel. Participation was central: elected representatives classified land quality, facilitated voluntary exchanges, and organised lotteries only when necessary (Ministry of Natural Resources and Environment, 2017).

Post-consolidation, farmers increasingly diversified into fruit orchards and cash crops, initially informally supported and later formalised by local authorities. Although diversification improved incomes, isolated rice plots faced higher pest pressures. Consolidation also enabled broader mechanisation of tilling, fertilising, and harvesting, with standardised labour costs per sào (360 m<sup>2</sup>) enhancing productivity and enabling older farmers to remain active.

In TBP, consolidation policies under 214/QĐ-UBND (2011) and New Rural Plan 20/KH-UBND followed earlier reallocations in 1993 and subsequent consolidation phases (2003–2004; 2012–2013) aligned with revisions to the Land Law. The later phase was more effective. Agricultural land is projected to decrease by 9,104.11 ha by 2030 ('Thai Binh Provincial socio-economic report,' 2022). In Tien Hai district, parcel numbers declined from 5.5 to 1.7 per household after consolidation. While rice production still accounts for 40–50% of provincial food security, authorities plan to convert substantial areas to cash crops and industrial zones. The traditional '4 together' labour exchange model persists, though consolidation sometimes complicates boundary-based cooperation.

The TBP's progress in land consolidation stands as a testament to the province's dedication to sustainable agricultural practices, community cohesion, and strategic alignment with evolving national land policies. The province's focus on preserving its agricultural vitality while strategically integrating the non-agricultural sectors into its overall economic landscape and development paints a picture of a region poised for balanced and sustainable development.

Incorporating insights from interviews with local authorities and community members, our findings also reflect how institutional arrangements and governance capacity, particularly in terms of transparency,

procedural fairness, and responsiveness to community concerns, influenced the outcomes of land consolidation across provinces. For instance, HYP's relatively successful implementation benefited from participatory planning mechanisms that included elected village representatives and collaborative land classification processes. These measures helped foster community buy-in and perceptions of fairness. Conversely, VPP experienced significant tensions and resistance, particularly in areas like Binh Xuyen district, where top-down decisions excluded villagers from meaningful consultation. Our interviews in Phu Xuan commune revealed that hundreds of households refused to reclaim redistributed land due to a lack of transparency and unclear communication. These contrasting outcomes highlight the critical role of commune-level leadership and policy adaptation in shaping public reception and the practical efficacy of land consolidation programmes.

Consistent with Nguyen et al. (2020), our findings suggest that land consolidation must extend beyond administrative plot enlargement to address equity, market access, and long-term livelihoods. Without meaningful farmer participation, consolidation risks stagnation or conflict.

Overall, the experiences in the VPP, HYP, and TBP illuminate the complex dynamics of land consolidation in Vietnam. Initially, inflexible land-use regulations and suboptimal economic strategies hindered consolidation efforts. The situation in VPP illustrates that failure is unavoidable without the participation of farmers. A pivotal shift occurred when policymakers sought direct input from farmers, as seen in HYP and TBP, and acknowledged the necessity for crop diversification on less fertile lands. Aligning consolidation efforts with the practical needs and aspirations of farming communities has led to positive outcomes. These cases exemplify how nuanced local conditions and adaptive policies can result in markedly different outcomes, offering invaluable insight into the evolution of land consolidation in the region.

#### **4.3. Farm size, land consolidation and aging farmers**

This study has proven the significant role of land consolidation in addressing land fragmentation within rural communities in the RRD, helping with the implementation of modern technologies and machinery, and enhancing the efficiency and productivity of agricultural practices. Furthermore, there is a perception that the ability to fully exploit the economies of scale associated with farm innovation is commonly associated with the large-scale use of land and often a consolidated approach to farm design (Nguyen & Warr, 2020). This tendency to a larger scale can be a significant driver of land grabs, as documented in global transitions globally (Goldman, 2020; Jin et al., 2016; Luo & Andreas, 2020). However, it is essential to acknowledge that the average farm size in the RRD, including the studied communes, remains relatively small, which may be a key factor in preventing land-grabbing. The persistence of small-scale farming operations also reflects a complex interplay of factors, including population density, land availability, and cultural preferences. Farm size remains a critical obstacle, as rising production costs, limited market access, and pricing pressures further compounded the financial constraints faced by smallholder farmers. As there is a negative correlation between parents' farm size and youth migration (Bezu & Holden, 2014), agricultural land size can potentially influence young individuals' decisions to migrate. The combination of small farm sizes and lack of profitable opportunities deters young people from pursuing careers in agriculture, leading to an aging farming population and a potential decline in agricultural productivity in the long run. When we inquired about whether their children helped them with farming, less than half (48%) of our respondents answered positively, and only 39% of the respondents' children were still involved in farming. Furthermore, many respondents noted that their children provided limited assistance on the farm because of priorities other than farming. Indeed, when asked whether they wished for their children to continue or return to help with farming, 83% of respondents said that they did not want their children to pursue a career in agriculture. The reasons include lower income compared to other professions, the volatility of agricultural earnings linked to market dynamics and input investments, and limited access to land due to the absence of farmland allocation for those born after 1993. This disinterest not only impacts the continuity of family legacies, but also has far-reaching consequences as it can impact food security, sustainable agriculture, and rural communities' resilience.

As part of the second survey, we asked 300 participants about their intentions regarding their farms over the next decade. The majority (79%) of 275 respondents expressed a preference for maintaining the status quo, indicating no inclination toward expanding their current farm operations or selling their land.

However, a notable trend emerged when examining the different age groups. Farmers under the age of 40 exhibit a significantly greater propensity (36%) to pursue expansion. In contrast, those within the 41–50, 51–60, and 61–70 age brackets demonstrate similar inclinations toward expansion, ranging from 13% to 15%. Additionally, 9% of farmers between the ages of 51 and 70 expressed an interest in either passing down their farm to a family member or considering selling it. When asked if they think that their farm's scale is large enough for cultivation to be economically effective, 42% of younger farmers disagree with this statement, while this number in other age groups ranges from 19% to 25%. These data indicate that younger farmers, especially those under the age of 40, exhibit a heightened sense of agency, particularly in relation to land consolidation initiatives. This suggests that policies aimed at consolidating landholdings may be more readily embraced by the younger farming demographic, and their increased willingness to expand their farms indicates a proactive stance toward embracing modern agricultural trends, including larger and more consolidated farming operations. This implies that younger demographics are more amenable to agricultural reforms and innovations that could enhance productivity, sustainability, and the overall economic prospects in the sector.

The intention of older farmers to expand their farms in terms of both size and crop diversity is influenced by the perceived financial risk associated with altering their current farming management practices. In the second survey, 292 out of 300 participants responded to the question of whether changing their farming practices toward more sustainable agriculture would negatively impact their income. The responses revealed a significant disparity between the age groups. Only 25% of farmers under the age of 40 agreed with this statement, indicating that younger farmers were more willing to embrace change. Conversely, for those above 40 years, around 65% expressed concerns about potential income reduction, reflecting a greater aversion to risk. Ullah et al. (2015) also found that younger farmers exhibit a higher propensity for risk-taking than their older counterparts. This hesitancy could stem from the uncertainty associated with additional financial investments, especially considering the fluctuating prices of agricultural products and rising costs of agricultural inputs. For instance, only 50% of respondents under the age of 40 considered financial constraints to be the main challenge in adopting sustainable agriculture. In contrast, 85–91% of farmers (41–50, 51–60, and 61–70 age groups) saw financial constraints as the primary obstacle. Beyond financial constraints, the physical health of aging farmers serves as a biological limit to agricultural intensification. Our qualitative interviews indicate that senior farmers often prioritise a manageable workload over higher profitability to safeguard their well-being. Many reported declining a third winter crop specifically due to chronic health challenges and declining stamina. Consequently, even when older farmers recognise the economic benefit of sustainable practices, they may perceive them as not feasible because the labour demands exceed their physical thresholds. This suggests that policy support must look beyond finance to provide labour-saving mechanisation that specifically addresses the health-induced constraints of the aging workforce.

Nguyen et al. (2020) similarly cautions that the effectiveness of consolidation efforts depends not only on the physical enlargement of plots but also on how these policies interact with structural constraints such as out-migration, aging labour, and non-agricultural employment. Without adequate support services, local flexibility, and diversified income opportunities, consolidation risks deepening rural inequalities rather than alleviating them. Our fieldwork in VPP and TBP supports this insight: rigid top-down implementation often faced resistance and stagnation, while participatory and flexible processes, as seen in Nhat Quang, resulted in higher community acceptance and sustained productivity improvements.

When viewed in the broader context of Asian countries, the challenges observed in Vietnam's RRD are far from unique. Land consolidation and rural demographic change are interlinked issues across the region, such as the Vietnam's Mekong Delta, Thailand, and the Philippines (Jansuwan & Zander, 2021; Kurnia et al., 2022; Nguyen et al., 2021; Rigg et al., 2018; World Bank Group, 2016). Shared patterns include small and fragmented farm sizes, rapid rural youth migration, aging farming populations, and growing labour shortages that drive demand for mechanisation. Yet regional differences emerge based on historical and policy contexts. While the RRD exemplifies state-led land consolidation, Thailand has relied more on market-based mechanisms and social safety nets. In parts of Indonesia, extreme land fragmentation persists, largely driven by inheritance customs.

In the Mekong Delta, Vietnam, rural demographics are shifting even more rapidly with highest out-migration rate in Vietnam (Nguyen et al., 2021). This exodus has left many villages with aging populations

and dwindling working-age labour. While less formal than in the RRD, local authorities and development projects in the Mekong Delta have encouraged farm aggregation through voluntary parcel swaps, cooperative-based large field models, and a functional land rental market that allows consolidation via leasing (World Bank Group, 2016). According to World Bank assessments, the delta's core rice-producing zones are undergoing steady processes of consolidation and mechanisation, trends that are set to continue.

Recent findings by Zhang et al. (2025) further reinforce the pivotal role of farm size in shaping agricultural viability and demographic transitions. Drawing on longitudinal data from 29 provinces in China, the study reveals how rural population aging accelerates cropland abandonment, especially in regions with dense elderly populations. This has critical implications for food security and long-term sustainability. To counteract these trends, the authors advocate targeted policies to rejuvenate rural economies, incentivize youth engagement in agriculture, and promote thoughtful land consolidation.

The results of this study point to several practical considerations for improving the implementation of land consolidation and crop diversification policies, particularly demographic and structural constraints. Participatory land exchange can be structured as a commune-level process with clearly defined roles and procedural safeguards. Commune People's Committees, in coordination with district land offices, should first complete and publicly disclose detailed plot inventories, including land size, quality, irrigation access, and flood risk. Farmers can then elect representative land exchange committees, including smallholders, older farmers, and women, to facilitate communication, collect preferences, and document agreements. Exchanges may proceed through voluntary matching of plots, followed, if necessary, by transparent allocation mechanisms using predefined equivalence criteria that account for land quality, not merely area. Establishing a formal grievance period and ensuring public documentation can strengthen procedural fairness and community trust. Post-exchange measures should include streamlined land title updates and coordinated access to shared machinery and irrigation services to ensure that consolidation translates into productivity gains.

Beyond institutional design, demographic differences require differentiated but inclusive support. Younger farmers demonstrated greater willingness to expand and diversify, suggesting the value of targeted training in high-value crops, improved market access, and credit or risk-mitigation instruments. Older farmers, by contrast, may benefit more from labour-saving mechanisation services and low-intensity diversification options. Flexible land-use planning, particularly permitting shifts away from low-productivity rice mono-culture, emerges as a critical enabling condition. At the same time, gender-based statistical analysis revealed no significant differences in attitudes toward sustainable agriculture, indicating that policy interventions can remain broadly gender-neutral while still being responsive to generational differences. However, engaging younger generations in agriculture requires more than land access and mechanisation alone. Survey responses and interviews indicate that youth decisions are strongly shaped by income expectations, market opportunities, and perceived career mobility. Therefore, consolidation policies should be complemented by entrepreneurship training, improved access to credit, value-chain integration, digital market platforms, and crop insurance schemes that reduce income volatility. Framing agriculture as a viable business pathway rather than a subsistence occupation may be essential for reversing youth disengagement trends. Together, these measures align institutional reform with the varied capacities and incentives of rural households, strengthening the long-term sustainability of land consolidation efforts.

#### 4.4. Limitations and further research

While this study provides valuable insights into factors shaping farming involvement across age groups, several limitations should be noted. The relatively small sample size may limit generalisability across the broader RRD, and the older skew of respondents may underrepresent younger farmers' perspectives.

Because our analysis relies on cross-sectional survey data, it captures generational differences at a specific point in time rather than longitudinal changes. Future research using panel data would allow for a more rigorous examination of how land consolidation and demographic transitions evolve over time.

While this study primarily focuses on age-based differences in farming practices and perceptions of land consolidation, youth engagement in agriculture is shaped by a broader set of socioeconomic factors. Education level, household income, asset ownership, and access to financial and social capital may significantly influence whether young people perceive agriculture as a viable livelihood. Higher education

can increase access to non-farm employment and raise the opportunity cost of remaining in agriculture, while households with greater wealth or diversified income sources may be better positioned to invest in mechanisation, land rental, or high-value crops. These socioeconomic conditions therefore mediate generational responses to land consolidation and agricultural change. Although these variables were not the central focus of the present analysis, future research should examine young farmers' motivations, constraints, and responses to policy incentives, land access, and training programmes more explicitly. Investigating how different consolidation strategies affect land use and ownership patterns, while remaining attentive to risks such as land concentration or land grabbing (Huggins, 2014), would further strengthen youth engagement strategies. Developing panel-style datasets that track farmers over time would enable the application of econometric models to identify causal relationships between age, land policies, resource access, and adoption of sustainable practices. Integrating such quantitative approaches with qualitative enquiry would provide a stronger empirical foundation for inclusive and evidence-based policy design.

Finally, future studies should integrate additional socioeconomic factors, such as education, income, land tenure security, and access to extension services (Bui & Nguyen, 2022; Keovilignavong & Suhardiman, 2020; Salaisook et al., 2020), to build a more nuanced understanding of land consolidation behaviour and rural agricultural transformation in the RRD.

## 5. Conclusion

While the findings are context-specific for the RRD, structural patterns such as labour constraints from aging, youth out-migration, limited farm size, and challenges in equitable land consolidation mirror trends across Southeast Asia. As such, the insights drawn from this case study can serve as a basis for comparative analysis, while also informing context-sensitive policy design in similarly structured agrarian regions beyond Vietnam.

Land consolidation in the RRD has reduced fragmentation and enabled mechanisation, boosting productivity but reducing labour demand and youth participation. At the same time, consolidation does not necessarily expand total farm size, and mechanisation can reduce labour demand, potentially reinforcing the shift of younger workers toward non-farm employment. A Kruskal–Wallis test ( $p < 0.001$ ) showed significant age differences across employment types, while Mann–Whitney U tests revealed that confidence in sustainable farming peaks for farmers in their forties before declining for those in their fifties, marking an age-related threshold in openness to innovation.

This generational divide reflects deeper concerns over declining knowledge transfer and youth enthusiasm for farming, driven by economic uncertainty and limited land access. Younger farmers tend toward diversification and sustainable practices, while older farmers remain tied to traditional methods, constrained by labour shortages and risk aversion.

These contrasts highlight the need for age-sensitive policies that make farming more viable for younger generations. Land consolidation must be paired with formal land rights, access to capital, mechanisation services, and training in high-value crops. Flexible crop planning can help both younger and older farmers transition sustainably.

Gender-disaggregated analysis found no significant differences in views on sustainable agriculture. This suggests that future strategies can adopt a gender-neutral approach, allowing policymakers to focus resources on age- and occupation-related factors without compromising inclusivity.

Overall, the study underscores the urgent need for multifaceted policies that address demographic challenges, promote sustainability, and sustain the vitality of farming communities amid socioeconomic change.

## Endnotes

1. Vietnam 2013 Land Law No. 45/2013/QH13.
2. Nghị định số 35/2015/NĐ-CP của Chính phủ ngày 13/4/2015 về việc quỹ đất trồng lúa phải đảm bảo 3.8 triệu ha.
3. Nghị quyết về Quy hoạch sử dụng đất quốc gia thời kỳ 2021–2030, tầm nhìn đến năm 2050 và kế hoạch sử dụng đất quốc gia 5 năm 2021–2025.

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## Author contributions

CRedit: **Quang Phung:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing; **Nga Dao:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing; **Julian Williams:** Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft; **Ngoc Thi Hong Nguyen:** Investigation; **Quan Anh Tran:** Investigation.

## Disclosure statement

The authors declare the following financial interests and personal relationships that may be considered potential competing interests.

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## Data availability statement

This study was approved by the York University Office of Research Ethics (ORE) under approval certificate number e2019-377. All research procedures were conducted in accordance with the ethical guidelines established by the ORE. Due to ethical, privacy, and security considerations, data containing sensitive information about research participants is restricted and cannot be publicly shared. Requests for access to the available data should be directed to the corresponding author and will be considered in accordance with the ethical guidelines established by the York University Office of Research Ethics.

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