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On Repeat? The Logic of Agricultural Modernization, the Choices of Tanzanian Small-Scale Farmers, and Implications for the Second Green Revolution

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ABSTRACT

The Alliance for a Green Revolution in Africa (AGRA) is the latest in a series of initiatives aimed at modernizing small-scale farming to address food insecurity and poverty, yet AGRA has fallen short of its goals. This study explores whether these shortcomings might stem from flawed assumptions in AGRA's theory of change—assumptions long embedded in top-down agricultural modernization efforts. We situate AGRA within broader debates on the agrarian question, especially the Chayanov–Lenin debate, and draw historical parallels with United States agricultural industrialization, the Green Revolution, and Soviet collectivization, as well as Tanzania's villagization program. Tanzania is an instructive case, having undergone both collectivist and market-based modernization. Using Chayanov's theory of peasant household decision-making, we analyze panel survey data from the Tanzania National Panel Survey (TNPS), part of the World Bank Living Standards Measurement Study—Integrated Surveys on Agriculture (LSMS-ISA) program, to examine how household demographic factors relate to labor and land use decisions. Our findings show that household composition is significantly associated with agricultural labor allocation choices and land use. We also address Chayanov's gender blind spot, finding that men and women plot managers and men- and women-headed households often pursue different labor allocation and land use strategies. These results suggest that AGRA's model may make questionable assumptions about the decision-making of small-scale farmers. We conclude by considering the implications of this modernization logic and argue that a pragmatic approach to agricultural development, one rooted in the actual priorities and preferences of small-scale farmers, offers an alternative.

1 | Introduction

Small-scale farming is the most common form of agricultural production worldwide (Samberg et al. 2016). Yet small-scale farmers encounter structural barriers including limited access to inputs, reliance on family labor, distance from markets, and insufficient public support that limit their ability to enhance resilience (Ola and Menapace 2020; Roop et al. 2023; Touch et al. 2024). Many development proponents therefore argue that strengthening food access for a growing population will require interventions in which "smallholders, believed to be poor and struggling for a decent future, are envisioned to disappear, progressively replaced by modern, larger farms, strongly engaged in global markets" (High Level Panel of Experts on Food Security and Nutrition [HLPE] 2013: 20).

This approach to agricultural development is not new. As Shanin (1974) noted, the post-World War II march toward modernization encouraged agricultural industrialization and urbanization, eroding the peasant[1] way of life. During the Cold War, the debate was not whether small-scale farmers should be modernized but how: through class differentiation (capitalism) or collectivization (Soviet communism) (Friedmann 2019). These competing visions shaped major development initiatives. The Green Revolution followed the United States (US) model, promoting high-input, efficiency-driven systems that consolidated land into large commercial farms (Harwood 2019). Meanwhile, collectivization was pursued in the Soviet Union, China, Ethiopia, Tanzania, and Eastern Europe (Scott 1998). Although there are important differences, both paradigms reflect a high modernist ideology that views science and technology as solutions to social problems to be implemented through a powerful state (Scott 1998).

Despite the failures of collectivization and ongoing debate regarding the Green Revolution's benefits and tradeoffs (Evenson and Gollin 2003; Harwood 2019; Shiva 2016), high modernist assumptions persist in contemporary initiatives such as the Alliance for a Green Revolution in Africa (AGRA), a prominent example of the so-called Second Green Revolution. Like its predecessor, the Second Green Revolution centers on scientific and technological interventions but aims to correct earlier shortcomings, particularly neglect of Africa and inadequate integration of principles of resilience, sustainability, and equity (Conway 2012). Critical perspectives note that the idea of a Second Green Revolution presumes the success of the first, but key political economic differences distinguish them: whereas the earlier Green Revolution featured direct state intervention, the contemporary model positions the state as a facilitator of private investment and market development (Patel 2012).

Established by the Rockefeller Foundation and the Bill and Melinda Gates Foundation, AGRA aims to address high rates of food insecurity and poverty through enhanced access to technologies and markets, especially among small-scale farmers (AGRA 2017; Toenniessen et al. 2008). The initiative seeks to transform "agriculture from a solitary struggle to survive into farming as a business that thrives" (AGRA 2020: 14). As Scoones and Thompson (2011) contend, the AGRA model assumes that small-scale farmers are rational profit maximizers who will adopt new technologies to become more competitive. Yet, despite the ~$1 billion invested in AGRA as of 2020 (Wise 2020), a recent independent evaluation found that "AGRA did not meet its headline goal of increased incomes and food security for 9 million smallholders, despite reaching over 10 million smallholders through its systems development work" (Blair et al. 2021: 2). Similarly, Wise (2020) found no evidence that AGRA has been effective in its intentions of doubling yields on priority food crops, alleviating poverty, or enhancing food security. Blair et al. (2021) and others (Pasgaard et al. 2022) further suggest that the benefits of AGRA programs tend to favor younger, male, and wealthier farmers.

AGRA's limited success suggests its foundational assumptions may be flawed (Herrero et al. 2010), leading to a top-down approach that homogenizes and potentially mischaracterizes the decisions and behavior of small-scale farmers (Gengenbach et al. 2018). We argue these flaws are symptomatic of agricultural modernization efforts historically, both collectivist and capitalist. This study investigates such assumptions, drawing from debates in agrarian political economy. We highlight the Chayanov-Lenin debate over how to transform the peasantry in early 20th century Russia (Bernstein 2009; Friedmann 2019), with Chayanov (1925/1986) arguing that the collectivization efforts to modernize the peasantry failed to recognize peasant households as distinct economic units pursuing the balance between wellbeing and self-drudgery rather than capital accumulation. We also examine lessons from the US industrialization model in the early 20th century and its later expression in the Green Revolution, alongside the failures of collectivization in the Soviet Union and Tanzania. We then contrast these cases with German efforts around the turn of the 20th century to enhance peasant productivity through breeding and extension responsive to local realities. With the exception of the German example, the historical cases parallel the assumptions embedded in AGRA that small-scale farmers are primarily motivated by economic competitiveness (Scoones and Thompson 2011). In addition, we identify limitations in Chayanov's theorization, particularly the absence of gender (Waltz 2016), prompting us to integrate gender considerations into our analyses.

We use data from the Tanzania National Panel Survey (TNPS), part of the World Bank Living Standards Measurement Study—Integrated Surveys on Agriculture (LSMS-ISA) program, to examine the association between household demographic factors and labor allocation and land management in farming households. Specifically, our study is guided by the following research questions, examined through a gender lens at both the plot manager and household head levels: (1) how do demographic characteristics relate to agricultural labor allocations? (2) how do demographic characteristics relate to agricultural land use? (3) how do demographic characteristics relate to agricultural labor intensity? and (4) how do these associations change over time? We focus our analysis on the case of Tanzania, which has experienced multiple, contrasting phases of agricultural development: from the socialist villagization policies of the 1960s and 1970s to neoliberal structural adjustment and, more recently, the site of heavy AGRA investment (AGRA 2017; Meertens 2000; Scott 1998). At the same time, it shares key features with many countries in sub-Saharan Africa: an agricultural landscape dominated by small-scale farmers, high rates of food insecurity and poverty, and limited infrastructure (Arce and Caballero 2015; Rashid et al. 2024; Wineman et al. 2020).

1.1 | Past and Present Efforts to Modernize Farm Production

Between 1910 and 1930, the assumption that industrializing agriculture would fuel economic modernization undergirded enthusiasm for nation-building in both the US and Soviet Union (Scott 1998). Despite their different approaches, the US and the Soviet Union agreed that "the small farmer or peasant is a drag on progress" (Scott 1998: 199). The US used a market-based approach facilitated by state action to convert some small-scale farmers into larger-scale industrialized producers, steadily increasing productivity while reducing farm numbers. Over the course of the 20th century, the farm labor force in the US fell from 41% to under 2%, with many former farmers becoming industrial wage workers (Dimitri et al. 2005). By contrast, beginning in the 1920s, the Soviet Union pursued top-down agricultural industrialization through forced collectivization. Lenin (1899) argued that capitalism was already transforming the Russian countryside through processes of class differentiation and market expansion, an argument that Soviet leaders later used to justify collectivization. Based on years of study of Russian peasants, Chayanov (1925/1986) disagreed with Lenin, explaining that peasant households organized their labor and land use according to a balance between household wellbeing and self-drudgery rather than the pursuit of profit. Social differentiation shifted according to where families were in their life cycles as labor expenditures and land use varied with the ratio of household consumers to workers (Cook and Binford 1986; Roberts and Mutersbaugh 1996; Schulman et al. 1989).

Bernstein (2009) notes that although Chayanov, like Lenin, supported modernization to increase agricultural productivity, Chayanov disagreed with coercive approaches that ignored peasant decision-making (Shanin 2009). For Chayanov (1925/1986), peasant households were rational utility maximizers, but their utility was defined by household wellbeing and subsistence needs, not capital accumulation.[2] He viewed cooperatives as a means to pool resources, overcome production limitations, and maintain decision-making autonomy (Shanin 2009). His critique challenged Marxist orthodoxy and Stalin's central planning, contributing to his execution in 1937. Ignoring Chayanov's insights, the Soviet Union coercively collectivized the peasantry yet still suffered severe famine in the early 1930s as production declined, leading Scott (1998: 202) to conclude that collectivization "failed to deliver on any of the specifically socialist goals envisioned…".

The US model seemed more effective, but its global export through the Green Revolution beginning in the 1940s brought complications. Combined with complementary packages of inputs, high-yielding varieties of staple grains boosted yields in parts of Latin America and Asia (Pingali 2012), but they also exacerbated inequality, degraded environments, displaced small farmers, and largely bypassed Africa (Evenson and Gollin 2003; Zeigler and Mohanty 2010). Echoing Chayanov's concern that the Soviet approach to agricultural industrialization overlooked the lived realities of the peasantry, Harwood (2019) concludes that many Green Revolution advocates shared an enduring contempt for small farmers and pushed for consolidation of landholdings into larger commercial farms.

Despite their ideological differences, US and Soviet agricultural modernization efforts converged in practice, both pursuing high modernist, top-down interventions with a significant state role. The Ujamaa villagization project in Tanzania, initiated in the mid-1960s and becoming increasingly coercive after its formalization in 1973, exemplifies this convergence. Framed as a collectivist, anticolonial initiative rooted in African socialism, villagization was in part informed by capitalist models of agricultural modernization from the US (Scott 1998). While the project initially gained legitimacy for its rhetorical rejection of colonialism, its implementation increasingly favored administrative control and bureaucratic order in the effort to relocate rural populations into centralized villages (Schneider 2004). Ultimately a failed experiment, villagization overlooked the established livelihoods of rural Tanzanians that suited their specific contexts, which planners dismissed as backward and inefficient (Scott 1998).

An important question remains whether these negative outcomes of agricultural modernization could have been avoided had Chayanov's (Chayanov 1925/1986) insights been taken seriously. Shivji (1998) shows that state-imposed land tenure policies under colonialism, villagization, and the subsequent period of market liberalization in Tanzania assumed that customary land tenure lacked logic and coherence, despite productivity gains under traditional land tenure arrangements. More broadly, many scholars have critiqued the postcolonial state across Africa, arguing that its governance is often judged through Western frameworks, which portray domestic institutions as dysfunctional (Ferguson 1990; Mbembe 2001). Such narratives tend to obscure historically grounded analyses that highlight the uneven but deliberate efforts of African governments to pursue development within their own contexts (Mkandawire 2001). These critiques align with Chayanov's core argument: rural transformation is unlikely to succeed if it ignores the actual social and economic organization of rural livelihoods.

Contemporary scholars have revised Chayanov's theory by emphasizing diverse, context-specific household decision-making rather than uniform household logic (Long 2001). Empirical studies show livelihood strategies are shaped by both structural constraints and household preferences. For example, Ebanyat et al. (2010) found that in eastern Uganda, factors such as political context, market opportunities, labor availability, and soil quality shape crop production decisions. Loison (2015) highlights how household socioeconomic status influences livelihood diversification across small-scale farmers in sub-Saharan Africa. At the same time, Rao et al. (2020) stress that understanding household strategies is essential alongside structural conditions, and Aring et al. (2021) show that both individual and collective aspirations inform the pursuit of particular strategies.

These empirical examples point to the need for less deterministic development models than capitalist and collectivist modernization. One such example is Germany's public breeding program at the turn of the 20th century (Harwood 2012). Facing rural unrest in the 1890s, German politicians sought to make resources more accessible to farmers to enhance production and wellbeing. Chambers of agriculture operated like cooperatives, providing their members with technical assistance and access to credit, fertilizer, education, and other resources. They also hired agricultural scientists to conduct locally relevant research on regional experiment stations, resulting in "peasant-friendly plant breeding" (Harwood 2012: 34). Although this model was later undercut by political shifts, including the rise of the National Socialist Party and Germany's eventual embrace of a modernization agenda, Harwood (2012) nonetheless concludes that public-sector breeding and extension programs could enhance small-scale farmer productivity and wellbeing without displacing them or accelerating land consolidation. If agricultural development aims to achieve humanitarian—and, we would add, sustainable environmental (McKay et al. 2025)—outcomes, Harwood (2012) argues that the German model offers a valuable, historically grounded alternative to dominant modernization approaches.

1.2 | A Gendered Chayanovian Approach in Tanzania

After being sidelined for much of the 20th century, Chayanov's work gained renewed attention with the rise of peasant studies in the 1960s (Friedmann 2019; Shanin 1973, 2009). While some have argued that the behavior of small-scale farmers reflects capitalist preferences (Cook and Binford 1986; Deere and de Janvry 1981), others extended Chayanov's view of a more complex, noncapitalist logic of small-scale producers (Shanin 1972; Tomita et al. 2015). Other authors have highlighted the simplicity of Chayanov's model, whose focus on the nuclear family led to a static portrait of the peasant family pursuing a distinct yet singular logic (Bernstein 2009; Hammel 2005; Leinbach and Smith 1994). For his part, de Janvry (1981) argued that Chayanov offered a faulty explanation for why households might not produce surpluses: it was not based on an alternative logic of decision-making but rather the inability of these households to increase output under the structural constraints of capitalism.

Most significantly for this study, Chayanov's framework lacked a gender perspective. Treating the household as the decision-making unit obscures the intra-household inequalities and gendered divisions of labor that shape agricultural production and land use (Quisumbing et al. 2014; Waltz 2016). Incorporating a gender lens to Chayanov's framework allows for a more nuanced analysis of contemporary agricultural development initiatives, like AGRA, that often presume uniform preferences for yield maximization and income generation (Gengenbach et al. 2018). As Sachs et al. (2021: 7) argue, "There needs to be deeper engagements with capitalist agrarian transition and the kinds of politics and struggles it generates for different groups of rural people."

We respond to this need by integrating a gender perspective with Chayanovian theory in Tanzania, where contrasting efforts to transform agriculture have occurred. Its socialist phase of villagization was followed by a structural adjustment program in the 1980s as part of the World Bank's neoliberalization campaign across Africa (Meertens 2000). Viewed as a neoliberal success case (Treichel 2005), Tanzania provided a ripe context for investment from AGRA and its market-based approach (Moseley et al. 2015). As of 2016, Tanzania had received the second highest percentage of grant money provided by AGRA and the most grants since 2007 (AGRA 2017). However, recent evaluations suggest neither yields of maize (a target crop) nor the adoption of improved seed and synthetic fertilizers meaningfully increased (Blair et al. 2021).

While Tanzania stands out for its early and sustained involvement with AGRA, it also exemplifies broader rural challenges across sub-Saharan Africa. Food and nutrition insecurity and poverty remain high among a predominantly small-scale farming population (Arce and Caballero 2015; Rashid et al. 2024; Wineman et al. 2020).[3] Women contribute the majority of agricultural labor (Food and Agriculture Organization of the United Nations (FAO) et al. 2010), yet face systemic inequalities in access to land, credit, and inputs (FAO 2023). Household-level studies reveal how land use and labor decisions are influenced by both household demographics and structural constraints, with better-off households more likely to diversify livelihoods (Dimova et al. 2021) and household gender composition influencing its labor allocation (Palacios-Lopez et al. 2017). Land access remains uneven: while some regions report relative abundance, others face scarcity (Beegle et al. 2011; Jayne et al. 2014). These constraints are especially salient from a gender perspective, as women own less land and smaller plots than men (Doss et al. 2015). Collectively, these dynamics underscore the need to interpret agricultural labor allocation and land use within the ecological and institutional contexts in which decisions are made (de Janvry 1981). Chayanov's framework can thus serve as a valuable heuristic, illuminating household dynamics, but it must be situated within broader political, economic, and gendered conditions that shape what is possible.

2 | Data and Methods

This study draws on data from the Tanzania National Panel Survey (TNPS) implemented by Tanzania's National Bureau of Statistics in collaboration with the World Bank as part of the LSMS-ISA program, with microdata made publicly available through the World Bank website. We primarily used data from 2014/15 (Wave 4) but also integrated data from 2020–2022 (Wave 5) to examine changes in plot manager and household labor allocation over time. Both waves are nationally representative panel surveys capturing agricultural production, nonfarm income generating activities, consumption, and other farm, household, and individual plot manager characteristics.

TNPS data collection was based on a stratified, multistage cluster sample design, which recognizes four analytical regions in Tanzania: Dar es Salaam, other urban areas (mainland), rural areas (mainland), and Zanzibar. Across both waves, 3352 households were interviewed, with 545 households added as a booster sample in Wave 5. For this study, we restrict our analysis to households farming ≤ 40 acres to maintain focus on small-scale farms (capturing the 99th percentile of the sample). Evidence suggests that the majority of farming households in Tanzania operate on less than five hectares, while medium-scale farms (5–100 ha), though fewer in number, control a substantial share of agricultural land (Jayne et al. 2014, 2016). We further limit the sample to plot managers and households that both cultivated land and allocated labor to agriculture, resulting in a total of 4481 plot managers and 1841 households for analysis. Trained enumerators collected the data which are based on self-reports, with interviews conducted separately with men and women.

All data processing and analyses were conducted using Stata SE version 18. Guided by Chayanov (1925/1986), we focus on agricultural labor as a primary outcome, measured as the total number of household days spent on agricultural activities during the most recent completed long rainy season. We also assess labor intensity, defined as labor days per acre. Conceptually, the difference between total days of agricultural labor versus total days of labor per acre parallels the difference between production (total output) and productivity (total output per unit of land). Labor variables aggregate days dedicated to land preparation, weeding, and harvest. In line with Chayanov's framework, we also examine land use (total acres under production at both the plot manager and household levels), which we logarithmically transformed for analysis.

Applying a Chayanovian perspective, we account for household demographics in several ways. We include the number of household members and dependency ratio, defined as the total number of youth (< 13 years) and elders (≥ 60 years) by the total number of household members. To apply a gender lens, we also include the variables of men- or women-managed plots, women-managed plots in men-headed households, women-managed plots in women-headed households, and men-headed or women-headed households.[4] We also include the age of the plot manager for plot manager-level analyses and average age of all plot managers, total number of plot managers in the household, and proportion of women plot managers for household-level analyses. Acknowledging another oversight by Chayanov in addition to gender, we also incorporate off-farm wage labor (Leinbach and Smith 1994), represented by the proportion of working-age adults in the household engaged in off-farm wage work (as indicated by reporting any time dedicated to off-farm paid labor over the previous 7 days). We also include a series of control variables that characterize agricultural production. These include the proportion of cultivated land dedicated to maize, the most common staple grain in Tanzania; whether a plot manager or household purchased improved seed in the last production season and whether a plot manager or household head applied inorganic fertilizer in the last production season, both of which proxy for access to modern inputs[5]; and household livestock holdings as measured by Tropical Livestock Units (TLU), a widely used proxy for livestock and for overall wealth (Ducrotoy et al. 2017; Raholiarimanana et al. 2023; Tache and Sjaastad 2010).

Though robust, LSMS-ISA data have certain limitations. Despite our efforts to account for gender at multiple levels (household and plot), the data remain limited in capturing intra-household power dynamics, care work, and decision-making roles. To reduce ambiguity, we restricted the sample to individuals identified as primary plot managers, excluding cases of joint plot management. In addition, the datasets do not include information on key structural factors such as local land availability and quality, labor market conditions, or the role of informal labor, limiting our ability to analyze how household decisions are shaped by broader environmental and institutional contexts. Nevertheless, LSMS-ISA data provide rich information for multidimensional and temporal examinations of rural livelihoods.

For analysis, we estimated a series of multiple regressions examining the total number of days worked on agricultural activities, land area under production, and labor intensity (total days worked per acre), each modeled as a function of plot manager characteristics, farm characteristics, and household demographics. Several variables in our dataset exhibit signs of skew, producing standard deviations that sometimes exceed mean values (Table 1), which is not unusual in right-skewed data or in binary variables (e.g., seed and fertilizer adoption). To reduce the influence of extreme values, we applied winsorization rules: total

TABLE 1 | Household and plot manager summary sample statistics for base year (2014/15).

	Plot managers			Households		
Variables	**All M (SD) $n = 4481$**	**Men $n = 2217$**	**Women $n = 2264$**	**All M (SD) $n = 1841$**	**Men-headed $n = 1355$**	**Women-headed $n = 486$**
Total days worked	51.8 (46.8)	49.4 (45.0)	54.2 (48.4)	126.2 (140.0)	134.5 (144.4)	102.9 (124.2)
Land area worked (acres)	4.9 (5.1)	5.1 (5.4)	4.6 (4.9)	11.9 (18.0)	13.5 (19.3)	7.5 (12.9)
Days worked per acre	21.0 (23.8)	18.8 (22.1)	23.2 (25.2)	25.4 (26.2)	23.1 (24.7)	32.0 (29.4)
Age	33.5 (17.4)	32.4 (17.8)	34.4 (17.0)	33.3 (14.0)	32.7 (13.3)	34.8 (15.7)
Purchased improved seed	0.27	0.28	0.27	0.25	0.27	0.20
Used organic fertilizer	0.14	0.14	0.14	0.15	0.15	0.14
Proportion of land in maize production	0.60 (0.43)	0.59 (0.43)	0.60 (0.43)	0.58 (0.44)	0.57 (0.44)	0.59 (0.45)
Household members	—	—	—	5.4 (2.9)	5.7 (3.0)	4.4 (2.6)
Dependency ratio	—	—	—	0.45 (0.24)	0.44 (0.22)	0.48 (0.27)
Proportion of household members: off-farm wage	—	—	—	0.35 (0.39)	0.33 (0.37)	0.39 (0.43)
TLU	—	—	—	1.5 (3.5)	1.7 (3.7)	1.0 (2.7)

Note: For binary variables (e.g., access to improved seed and inorganic fertilizer), values are bounded at 0 and 1. Their standard deviations therefore reflect this limited scale and are not directly comparable to those of continuous measures, so they are not reported.

labor days were capped at 200, labor intensity at 100 days/acre, land area at 40 acres, and livestock holdings at 20 TLU (99th percentile). We also tested alternative thresholds (e.g., labor days capped at 365 and land area at 20 acres) and regression results did not substantively change. Analyses were conducted at both the plot manager and household levels. At the plot manager level, we first considered all plot managers, before disaggregating by women plot managers, men plot managers, women plot managers in men-headed households, and women plot managers in women-headed households. These models take the general form:

$$\text{Agricultural labor (days)}_{ij} = \beta_{0ij} + X_{1ij}\,\beta_1 + X_{2ij}\,\beta_2 + X_{3ij}\,\beta_3 + X_{4ij}\,\beta_4 + X_{5ij}\,\beta_5 + X_{6ij}\,\beta_6 + X_{7j}\,\beta_7 + X_{8j}\,\beta_8 + X_{9j}\,\beta_9 + X_{10j}\,\beta_{10} + e_{ij} \quad (1)$$

where X_{1ij} is the gender of plot manager i in household j, X_{2ij} is the age of the plot manager, X_{3ij} is the natural log of the land area cultivated by the plot manager, X_{4ij} is a binary variable indicating whether or not the plot manager purchased improved seed, X_{5ij} is a binary variable for whether or not the plot manager used inorganic fertilizer, X_{6ij} is the proportion of land managed by the plot manager for maize, X_{7j} is the total number of household members, X_{8j} is the dependency ratio in the household, X_{9j} is the proportion of household members engaged in off-farm wage labor, and X_{10j} is household livestock holdings (TLU).

At the household level, we likewise present models for all households together followed by analyses disaggregated by gender, following the general form:

$$\text{Agricultural labor (days)}_{j} = \beta_{0j} + X_{1j}\,\beta_1 + X_{2j}\,\beta_2 + X_{3j}\,\beta_3 + X_{4j}\,\beta_4 + X_{5j}\,\beta_5 + X_{6j}\,\beta_6 + X_{7j}\,\beta_7 + X_{8j}\,\beta_8 + X_{9j}\,\beta_9 + X_{10j}\,\beta_{10} + X_{11j}\,\beta_{11} + e_{j} \quad (2)$$

where X_{1j} is the proportion of women plot managers in household j, X_{2j} is the average age of the plot managers in the household, X_{3j} is the total number of plot managers in the household, X_{4j} is the household land area worked, X_{5j} is a binary variable indicating whether or not a household member purchased improved seed, X_{6j} is a binary variable indicating whether or not a household member applied inorganic fertilizer, X_{7j} is the proportion of the land area cultivated by the household for maize, X_{8j} is the total number of members in the household, X_{9j} is the household dependency ratio, X_{10j} is the proportion of plot managers engaged in off-farm wage labor, and X_{11j} is the household TLU.

We then examine the total land area worked by households, again at both the household- and plot manager levels:

$$\text{Land area (ln) worked}_{ij} = \beta_{0ij} + X_{1ij}\,\beta_1 + X_{2ij}\,\beta_2 + X_{3ij}\,\beta_3 + X_{4ij}\,\beta_4 + X_{5ij}\,\beta_5 + X_{6j}\,\beta_6 + X_{7j}\,\beta_7 + X_{8j}\,\beta_8 + X_{9j}\,\beta_9 + e_{ij} \quad (3)$$

where X_{1ij} is the gender of plot manager i in household j, X_{2ij} is the age of the plot manager, X_{3ij} is a binary variable indicating whether or not the plot manager purchased improved seed, X_{4ij} is a binary variable indicating whether or not the plot manager used inorganic fertilizer, X_{5ij} is the proportion of land managed by the plot manager for maize, X_{6j} is the total number of household members, X_{7j} is the household dependency ratio, X_{8j} is the proportion of household members engaged in off-farm wage labor, and X_{9j} is the household TLU.

$$\text{Land area (ln) worked}_{j} = \beta_{0j} + X_{1j}\,\beta_1 + X_{2j}\,\beta_2 + X_{3j}\,\beta_3 + X_{4j}\,\beta_4 + X_{5j}\,\beta_5 + X_{6j}\,\beta_6 + X_{7j}\,\beta_7 + X_{8j}\,\beta_8 + X_{9j}\,\beta_9 + X_{10j}\,\beta_{10} + e_{j} \quad (4)$$

where X_{1j} is the proportion of women plot managers in the household, X_{2j} is the average age of the plot managers in the household, X_{3j} is the total number of plot managers in the household, X_{4j} is a binary variable whether or not a household member purchased improved seed, X_{5j} is a binary variable whether or not a household member applied inorganic fertilizer, X_{6j} is the proportion of the land area cultivated by the household for maize, X_{7j} is the total number of members in the household, X_{8j} is the household dependency ratio, X_{9j} is the proportion of plot managers engaged in off-farm wage labor, and X_{10j} is the household TLU.

The next set of models takes the same form as the first set of multiple regression models for labor time at the plot manager level (Equation 1) and household level (Equation 2), but we replace the outcome variable with total days worked per acre. This measure is calculated by the total number of days worked divided by the total number of acres managed by the plot manager or by the household overall.

We conclude our analysis with a series of models examining changes in labor allocation and land use over time at the plot manager level between Wave 4 (2014/15) and Wave 5 (2020–22) as a function of changes in household composition over the same period.[6] We base our analyses on the same dependent variables as the above analyses—total days worked, total land area worked, and total days per acre worked—but convert them to reflect changes in each variable between Wave 4 and Wave 5. We similarly convert time-variant independent variables (number of household members, dependency ratio, access to off-farm wage labor, proportion of land dedicated to maize, TLU) into change variables while maintaining the values from the base year (Wave 4) for all other variables (gender, age of plot manager, purchased improved seed, and use of inorganic fertilizer). We note that the change in labor intensity model has an even smaller sample size because computation of this dependent variable required that plot managers had some land and labor in both waves. The model examining changes in the total number of days worked as a function of changing household demographics between Wave 4 and Wave 5 (days 2020–22—days 2014/15) takes the form:

$$\Delta\,\text{Agricultural labor (days)}_{ij} = \beta_{0ij} + X_{1ij}\,\beta_1 + X_{2ij}\,\beta_2 + \Delta X_{3ij}\,\beta_3 + X_{4ij}\,\beta_4 + X_{5ij}\,\beta_5 + \Delta X_{6ij}\,\beta_6 + \Delta X_{7j}\,\beta_7 + \Delta X_{8j}\,\beta_8 + \Delta X_{9j}\,\beta_9 + \Delta X_{10j}\,\beta_{10+}\,e_{ij} \quad (5)$$

where X_{1ij} is the gender of plot manager i in household j, X_{2ij} is the age of the plot manager, ΔX_{3ij} is the change in the natural log of land area cultivated by the plot manager, X_{4ij} is whether or not the plot manager purchased improved seed, X_{5ij} is whether or not the plot manager applied inorganic fertilizer, ΔX_{6ij} is the change in proportion of land for maize, ΔX_{7j} is the change in total number of household members, ΔX_{8j} is the change in the household dependency ratio, ΔX_{9j} indicates the change in the proportion of plot managers accessing off-farm wage, and ΔX_{10j} is the change in household TLU.

We then conduct a similar analysis for the change in land area cultivated:

$$\Delta \text{ Land area (ln) worked}_{ij} = \beta_{0ij} + X_{1ij}\,\beta_1 + X_{2ij}\,\beta_2 + X_{3ij}\,\beta_3 + X_{4ij}\,\beta_4 + \Delta X_{5ij}\,\beta_5 + \Delta X_{6ij}\,\beta_6 + \Delta X_{7j}\,\beta_7 + \Delta X_{8j}\,\beta_8 + \Delta X_{9j}\,\beta_9 + e_{ij} \quad (6)$$

where X_{1ij} is the gender of plot manager i in household j, X_{2ij} is the age of the plot manager, X_{3ij} is whether or not the plot manager purchased improved seed, X_{4ij} is whether or not the plot manager applied inorganic fertilizer, ΔX_{5ij} is the change in proportion of land for maize, ΔX_{6j} is the change in total number of household members, ΔX_{7j} is the change in the household dependency ratio, ΔX_{8j} indicates the change in the proportion of plot managers accessing off-farm wage, and ΔX_{9j} is the change in household TLU.

The final model takes the same form as the model for change in total days of agricultural labor (Equation 5), but we replace the outcome variable with change in total days worked per acre as a measure of variation in labor intensity over time.

3 | Results

We organize our analysis around our four research questions, examining how characteristics of plot managers, households, and farm-level factors relate to: (1) agricultural labor, (2) agricultural land use, (3) labor intensity, and (4) changes in these outcomes over time at the plot manager level.

3.1 | How Do Demographic Characteristics Relate to Agricultural Labor Allocation?

We first examine how plot manager characteristics, household demographics, and farm-level factors relate to total days worked at both the plot manager level (Table 2) and the household level (Table 3). Among plot managers, women work significantly more days than men. At the household level, labor days vary with household size in women-headed households, while the number of plot managers in a household is most strongly correlated with labor days in men-headed household (though the relationship is also significant in women-headed households). For women plot managers, and especially those in women-headed households, the results suggest that greater household labor availability, as indicated by total household size, is strongly associated with more on-farm labor. Older plot managers work significantly more days across all plot manager types; however, at the household level, age is a significant factor only for women-headed households, underscoring the idea that demographic characteristics intersect in varying ways that produce heterogeneous experiences and outcomes (Quisumbing et al. 2014). We also observe that across plot managers, the amount of land under cultivation is significantly and positively associated with total days worked, while the amount of land under maize production is negatively associated with total days worked (for all plot managers but only in men-headed households). This negative association may reflect that maize requires relatively less labor than other common staple crops in Tanzania, such as cassava and rice (Zaal et al. 2014).

At the household level, the strong positive association between total land cultivated and days worked is consistent with findings at the plot manager level (Table 3). At the plot manager level, only men show a significant reduction in on-farm work days when household members participate in off-farm wage labor, though this association becomes insignificant at the household level, suggesting that household access to off-farm employment is more likely to affect men managers.

3.2 | How Do Demographic Characteristics Relate to Agricultural Land Use?

As Table 4 shows, men plot managers cultivate significantly more land than women, consistent with evidence that men have greater access to land in Tanzania (Food and Agriculture Organization of the United Nations (FAO) 2023). Across all plot managers, household size has a positive association with land area worked, while at the household level, the number of plot managers (but not the household size) is significantly associated with land area worked (Table 5). In addition, only men-headed households have a positive association between dependency ratio and land area worked. Across all plot managers and households, TLU has a significant positive association with land area worked, indicating that livestock ownership correlates with land availability. Similarly, for all types of plot managers, land area increases with the share of land allocated to maize production, which stays consistent at the household level. By contrast, fertilizer use is negatively associated with land area, but only for men plot managers and women in men-headed households (and not at the household level), indicating that the effects of access to improved inputs are mediated by gender. In addition, managers in households with greater engagement in off-farm wage labor cultivate significantly less land, with the exception of women managers in women-headed households, likely reflecting the more limited access these particular households have to off-farm employment opportunities (Van den Broeck and Kilic 2019).

3.3 | How Do Demographic Characteristics Relate to Agricultural Labor Intensity?

Our third set of analyses focuses on labor intensity, measured as days worked per acre (Table 6). Women plot managers exhibit significantly higher labor intensity than men. While household size is positively associated with labor intensity across all types of households (Table 7), this relationship is statistically significant at the plot manager level only for women managers in women-headed households. This may reflect that the most resource-constrained managers rely more heavily on intensifying on-farm labor. Both total land area worked and the proportion of land devoted to maize are negatively correlated with labor intensity at both the plot manager and household levels, with women managers in women-headed households experiencing

TABLE 2 | Multiple regressions on total days worked on agricultural plots by gender of plot manager in 2014/15.

Total days worked—Plot managers					
Variables	**All managers**	**Men managers**	**Women managers**	**Women managers in men-headed households**	**Women managers in women-headed households**
Plot manager characteristics					
Gender (1 = woman)	**6.088*** (1.273)**	—	—	—	—
Age of plot manager	**0.434*** (0.037)**	**0.423*** (0.049)**	**0.448*** (0.055)**	**0.507*** (0.073)**	**0.356*** (0.091)**
Land area (ln) worked	**23.780*** (0.932)**	**23.456*** (1.254)**	**24.062*** (1.384)**	**26.024*** (1.626)**	**21.126*** (2.721)**
Purchased improved seed (1 = yes)	1.961 (1.510)	3.237 (2.056)	0.724 (2.213)	1.353 (2.569)	−0.037 (4.397)
Used inorganic fertilizer (1 = yes)	**4.935*** (1.879)**	4.162 (2.549)	**5.905** (2.765)**	**7.830** (3.260)**	2.008 (5.267)
Proportion of maize production	**−10.643*** (1.546)**	**−8.513*** (2.106)**	**−12.832*** (2.261)**	**−15.586*** (2.740)**	**−8.656** (4.056)**
Household characteristics					
Household members	0.127 (0.241)	−0.372 (0.330)	**0.643* (0.354)**	0.071 (0.419)	**1.920*** (0.695)**
Dependency ratio	3.529 (3.152)	2.043 (4.408)	5.472 (4.523)	3.569 (5.913)	8.252 (7.216)
Proportion of members: off-farm wage	**−3.284* (1.765)**	**−5.061** (2.439)**	−1.938 (2.555)	−0.080 (3.241)	−4.851 (4.200)
TLU	0.096 (0.185)	0.139 (0.242)	0.054 (0.283)	0.416 (0.309)	−1.112 (0.695)
Constant	−3.207 (3.295)	**6.585* (3.633)**	5.176 (4.121)	4.016 (5.054)	6.694 (7.254)
Observations	4481	2217	2264	1546	718
R-squared	0.184	0.195	0.175	0.210	0.119

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

TABLE 3 | Multiple regressions on total days worked on agricultural plots by gender of household head in 2014/15.

Total days worked—Household level			
Variables	**All households**	**Men-headed households**	**Women-headed households**
Farm management characteristics			
Proportion of women plot managers in household	**17.168* (9.408)**	5.742 (13.312)	18.458 (20.108)
Average age plot managers	**0.522** (0.207)**	0.398 (0.253)	**0.686* (0.384)**
Number of plot managers	**29.540*** (2.891)**	**30.924*** (3.383)**	**22.900*** (5.713)**
Land area (ln) worked	**31.522*** (2.299)**	**34.557*** (2.764)**	**24.796*** (4.246)**
Purchased improved seed (1 = yes)	7.889 (6.411)	6.799 (7.543)	14.861 (12.606)
Applied inorganic fertilizer (1 = yes)	6.271 (7.551)	8.256 (9.006)	1.177 (13.974)
Proportion of maize production	**−26.387*** (6.351)**	**−31.534*** (7.660)**	−13.160 (11.382)
Household characteristics			
Household members	**3.217** (1.228)**	2.219 (1.432)	**7.418*** (2.562)**
Dependency ratio	−5.771 (12.013)	−6.012 (15.206)	−13.262 (19.594)
Proportion of plot managers: off-farm wage	−6.035 (7.121)	−5.617 (8.822)	−4.731 (11.957)
TLU	**2.487*** (0.864)**	**2.821*** (0.971)**	0.278 (2.021)
Constant	**−25.138* (13.141)**	−17.262 (15.608)	−30.906 (27.000)
Observations	1841	1355	486
R-squared	0.365	0.383	0.289

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

the strongest negative associations. These results suggest that while expanding land under cultivation is often accompanied by increased maize production (Table 4), labor intensity tends to be concentrated on crops other than maize, except for women managers who may depend more on maize for home consumption or market sales. As households access off-farm employment, both men managers and men-headed households reduce their on-farm labor intensity, but the relationship does not hold for women managers or women-headed households, suggesting that the effects of livelihood diversification vary according to gender dynamics in the household.

3.4 | How Do Associations Between Demographic Characteristics and Days Worked, Land Area Worked, and Days Worked Per Acre Change Over Time?

We test the Chayanovian assertion that households adjust labor and land cultivation in response to demographic changes by examining how changes in household characteristics relate to labor expenditures, land area worked, and labor intensity between Wave 4 (2014/2015) and Wave 5 (2020–2022). Starting with labor expenditures (total days worked), we find that women plot managers, who worked more days in the base period, experience larger reductions in labor days worked over time (Table 8). Differences across men and women plot managers also appear with respect to input access: days worked declined among men who had access to improved seed and for all managers who had access to fertilizer, except for women in women-headed households. Increases in land area correspond to more on-farm labor across plot managers, but as the proportion of maize rises, most managers reduce labor, except women in women-headed households who significantly increase their labor. Likewise, all managers increase labor effort as TLU rises except for women in women-headed households. Together, these results likely point to resource constraints limiting the ability for women managers in women-headed households to adjust their labor in similar ways as other managers. These women managers in women-headed households also work significantly more days as household size increases, while the relationship is negative for men managers. This suggests that in women-headed households, larger household size likely intensifies labor demands, perhaps because these households already face greater resource constraints and limited flexibility to reallocate labor. In contrast, the households of men managers may be able to redirect additional labor toward other livelihood activities, although all managers decrease on-farm labor as household access to off-farm wage opportunities increases.

In terms of land use, both greater household labor availability (except for women managers in women-headed households)

TABLE 4 | Multiple regressions on land area worked by gender of plot manager in 2014/15.

Land area (ln) worked—Plot managers					
Variables	**All managers**	**Men managers**	**Women managers**	**Women managers in men-headed households**	**Women managers in women-headed households**
Plot manager characteristics					
Gender (1 = woman)	**−0.056*** (0.020)**	—	—	—	—
Age of plot manager	**0.001** (0.001)**	**0.003*** (0.001)**	−0.000 (0.001)	0.001 (0.001)	0.000 (0.001)
Purchased improved seed (1 = yes)	−0.002 (0.024)	0.001 (0.035)	−0.006 (0.034)	−0.012 (0.040)	−0.052 (0.061)
Used inorganic fertilizer (1 = yes)	**−0.095*** (0.030)**	**−0.120*** (0.043)**	−0.069 (0.042)	**−0.093* (0.051)**	−0.054 (0.073)
Proportion of maize production	**0.248*** (0.025)**	**0.273*** (0.035)**	**0.223*** (0.034)**	**0.273*** (0.042)**	**0.152*** (0.056)**
Household characteristics					
Household members	**0.049*** (0.004)**	**0.048*** (0.006)**	**0.049*** (0.005)**	**0.045*** (0.006)**	**0.038*** (0.009)**
Dependency ratio	0.032 (0.051)	0.069 (0.075)	0.003 (0.069)	0.070 (0.093)	−0.057 (0.100)
Proportion of members: off-farm wage	**−0.161*** (0.028)**	**−0.154*** (0.041)**	**−0.161*** (0.039)**	**−0.188*** (0.051)**	−0.082 (0.058)
TLU	**0.053*** (0.003)**	**0.049*** (0.004)**	**0.058*** (0.004)**	**0.051*** (0.005)**	**0.082*** (0.009)**
Constant	**0.998*** (0.051)**	**0.881*** (0.059)**	**0.956*** (0.059)**	**0.966*** (0.075)**	**0.879*** (0.095)**
Observations	4481	2217	2264	1546	718
R-squared	0.216	0.210	0.222	0.215	0.176

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

TABLE 5 | Multiple regressions on land area worked by gender of household head in 2014/15.

Land area (ln) worked—Household Level			
Variables	**All households**	**Men-headed households**	**Women-headed households**
Farm management characteristics			
Proportion of women plot manager in household	**−0.292*** (0.095)**	0.040 (0.131)	−0.072 (0.217)
Average age plot managers	−0.003 (0.002)	−0.002 (0.002)	−0.005 (0.004)
Number of plot managers	**0.609*** (0.026)**	**0.611*** (0.029)**	**0.589*** (0.056)**
Purchased improved seed (1 = yes)	−0.076 (0.065)	−0.097 (0.074)	−0.146 (0.136)
Applied inorganic fertilizer (1 = yes)	−0.024 (0.077)	−0.025 (0.089)	−0.038 (0.151)
Proportion of maize production	**0.483*** (0.064)**	**0.508*** (0.074)**	**0.429*** (0.121)**
Household characteristics			
Household members	0.008 (0.012)	−0.008 (0.014)	0.013 (0.028)
Dependency ratio	**0.441*** (0.122)**	**0.618*** (0.149)**	0.145 (0.212)
Proportion of plot managers: off-farm wage	**−0.286*** (0.072)**	**−0.303*** (0.087)**	−0.185 (0.129)
TLU	**0.078***** (0.009)	**0.071*** (0.009)**	**0.122*** (0.021)**
Constant	−0.205 (0.134)	**−0.287* (0.154)**	−0.341 (0.291)
Observations	1841	1355	486
R-squared	0.446	0.441	0.433

Note: Standard errors in parentheses.
*$p < 0.1$.
***$p < 0.01$.

and increases in livestock ownership (TLU) positively associate with increased land under cultivation, pointing to plot managers mobilizing internal resources to support agricultural production (Table 9). In contrast, greater household engagement in off-farm wage labor consistently relates to reductions in land area worked, highlighting potential tradeoffs between on-farm and off-farm opportunities. Although changes in the amount of land used for maize production correlate with increased land area worked for all plot managers, overall, household-level characteristics appear to exert a stronger influence on changes in land use than individual plot manager characteristics.

For changes in labor intensity, individual plot manager characteristics explain more variation than household characteristics (Table 10). Women managers experienced a relatively larger decrease in labor intensity than men, again potentially due to competing household responsibilities limiting their ability to intensify labor. As with changes in land area worked (Table 9), a gendered pattern emerges when considering that only men managers experienced reduced labor intensity when accessing improved seed. This suggests that men may be better able to adjust labor allocations in response to access to improved seed, whereas women managers face constraints that limit such flexibility. However, for all plot managers, days worked per acre declined with increased fertilizer use, highlighting that the effects of fertilizer are similar for men and women. This finding occurs against the backdrop of gender inequalities in access to inputs among farmers in Tanzania (FAO 2023).

4 | Discussion

This study applies alternative theories of small-scale farmers' land and labor decisions that challenge the assumptions underlying large-scale development initiatives like AGRA. Building on other critiques (Gengenbach et al. 2018; Scoones and Thompson 2011), we argue that dominant models of international agricultural development continue to reflect an overly simplistic model of individual behavior emblematic of high modernist ideology (Scott 1998). Given AGRA's recently documented shortcomings (Blair et al. 2021; Wise 2020), we examine small-scale farmers in Tanzania, a key focus country of AGRA, through a Chayanovian lens, while incorporating critiques of Chayanov's theory regarding its simplicity (Bernstein 2009), gender blindness (Waltz 2016), and neglect of off-farm labor (Leinbach and Smith 1994).

Overall, our findings simultaneously provide some evidence for Chayanovian theory while also demonstrating its limitations. Consistent with Chayanov (1925/1986), labor allocation and land under production appear to relate strongly to household characteristics. While household size is positively associated with on-farm labor and land area worked, these relationships often vary by gender (with women managers appearing to experience a higher effect for labor allocation than

TABLE 6 | Multiple regressions on days worked per acre by gender of plot manager in 2014/15.

Total days worked per acre—Plot managers					
Variables	**All managers**	**Men managers**	**Women managers**	**Women managers in men-headed households**	**Women managers in women-headed households**
Plot manager characteristics					
Gender (1 = woman)	**2.478*** (0.564)**	—	—	—	—
Age of plot manager	**0.231*** (0.016)**	**0.201*** (0.022)**	**0.259*** (0.025)**	**0.202*** (0.031)**	**0.315*** (0.044)**
Land area (ln) worked	**−17.851*** (0.413)**	**−16.168*** (0.550)**	**−19.522*** (0.616)**	**−17.257*** (0.680)**	**−24.185*** (1.316)**
Purchased improved seed (1 = yes)	0.302 (0.669)	0.954 (0.902)	−0.260 (0.984)	−0.401 (1.075)	0.431 (2.126)
Used inorganic fertilizer (1 = yes)	0.832 (0.832)	0.020 (1.118)	1.712 (1.230)	1.543 (1.364)	3.499 (2.546)
Proportion of maize production	**−5.269*** (0.685)**	**−4.842*** (0.924)**	**−5.775*** (1.006)**	**−5.188*** (1.146)**	**−8.132*** (1.961)**
Household characteristics					
Household members	0.026 (0.107)	−0.109 (0.145)	0.192 (0.157)	0.111 (0.175)	**0.606* (0.336)**
Dependency ratio	0.204 (1.396)	−0.913 (1.934)	0.982 (2.012)	0.760 (2.474)	−0.762 (3.489)
Proportion of members: off-farm wage	**−1.463* (0.782)**	**−2.127** (1.070)**	−0.986 (1.136)	−1.113 (1.356)	−0.427 (2.031)
TLU	**0.161** (0.082)**	0.134 (0.106)	0.171 (0.126)	**0.213* (0.129)**	−0.241 (0.336)
Constant	**38.650*** (1.459)**	**40.886*** (1.594)**	**43.816*** (1.833)**	**41.896*** (2.115)**	**48.319*** (3.507)**
Observations	4481	2217	2264	1546	718
R-squared	0.382	0.360	0.396	0.366	0.418

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

TABLE 7 | Multiple regressions on total days worked per acre by gender of household head in 2014/15.

Total days worked per acre—Household level			
Variables	**All households**	**Men-headed households**	**Women-headed households**
Farm management characteristics			
Proportion of women plot managers in household	**3.993** (1.555)**	2.308 (2.058)	1.252 (3.937)
Average age plot managers	**0.132*** (0.034)**	**0.087** (0.039)**	**0.245*** (0.075)**
Number of plot managers	**3.448*** (0.478)**	**3.075*** (0.523)**	**4.055*** (1.119)**
Land area (ln) worked	**−13.490*** (0.380)**	**−13.002*** (0.427)**	**−14.673*** (0.831)**
Purchased improved seed (1 = yes)	−0.840 (1.060)	−0.895 (1.166)	−0.822 (2.468)
Applied inorganic fertilizer (1 = yes)	1.347 (1.248)	1.064 (1.392)	2.982 (2.736)
Proportion of maize production	**−5.200*** (1.050)**	**−4.636*** (1.184)**	**−7.044*** (2.229)**
Household characteristics			
Household members	**0.534*** (0.203)**	**0.402* (0.221)**	**1.169** (0.502)**
Dependency ratio	2.550 (1.986)	**5.403** (2.351)**	−3.398 (3.837)
Proportion of plot managers: off-farm wage	**−2.465** (1.177)**	**−3.532*** (1.364)**	−0.638 (2.341)
TLU	0.076 (0.143)	0.104 (0.150)	−0.190 (0.396)
Constant	**31.432*** (2.173)**	**33.007*** (2.413)**	**30.402*** (5.287)**
Observations	1841	1355	486
R-squared	0.507	0.496	0.512

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

men managers) and analytical scale (with effects appearing more clearly at the manager level than at the household level). Household composition likewise exerts influence on land area cultivated but in different ways than labor allocation. While a relationship exists for all plot managers between household size and land area cultivated—and is present for all plot managers except for women managers in women-managed households in models considering changes over time (Table 9)—the relationship does not hold at the household level, suggesting that land adjustments are negotiated by individual managers. Contrary to Chayanovian theory, dependency ratio did not consistently emerge as significant throughout our analyses, yet household demographics clearly influence labor and land decisions. These findings affirm key elements of Chayanov's framework while also highlighting its blind spots regarding gender (Waltz 2016) and intra-household dynamics (Quisumbing et al. 2014).

By considering household access to off-farm labor, our findings reveal further complexity unaccounted for by Chayanov (Leinbach and Smith 1994). Cross-sectional analyses (Tables 2–6) reveal a strong gender effect: for men managers and men-headed households, greater household access to off-farm employment is significantly associated with reduced labor expenditures, land area worked, and labor intensity, whereas over time all plot managers reduce labor expenditures and land area worked but not labor intensity (Tables 8–10). This pattern likely reflects the structural advantages that men farmers enjoy in Tanzania, including greater access to land, capital, and decision-making power, which enhance their ability to reallocate labor and modulate land use (FAO 2023), though this requires further confirmation given this study's limitations in robustly capturing off-farm wage labor including the amount of time dedicated to on-farm or off-farm labor and whether such off-farm labor is seasonal. Still, these findings highlight the importance of considering how opportunities and resources are distributed within households (Quisumbing et al. 2014), the societal positions that different households occupy and the opportunities and constraints shaping their livelihoods (de Janvry 1981), and ways that individuals exercise their agency within these contexts (Long 2001). They further suggest that addressing the structural barriers women face in accessing off-farm opportunities may help ease labor constraints and expand households' options for adjusting cultivation strategies, though an important question remains as to whether observed livelihood patterns among women farmers stem primarily from structural limitations or reflect distinct livelihood preferences (Curtin et al. 2024).

As with off-farm labor opportunities, several patterns emerge in the relationships between labor, land, and on-farm management,

TABLE 8 | Change in total days worked by gender of plot manager over time (2020–22—2014/15).

Change in total days worked—Plot managers					
Variables	**All managers**	**Men managers**	**Women managers**	**Women managers in men-headed households**	**Women managers in women-headed households**
Plot manager characteristics					
Gender (1 = woman)	**−5.491*** (1.425)**	—	—	—	—
Age of plot manager (2014/2015)	**−0.257*** (0.041)**	**−0.267*** (0.057)**	**−0.244*** (0.060)**	**−0.261*** (0.082)**	**−0.223** (0.093)**
Δ land area (log) worked	**23.360*** (0.933)**	**23.509*** (1.295)**	**23.238*** (1.345)**	**24.317*** (1.574)**	**22.596*** (2.630)**
Purchased improved seed (1 = yes) (2014/2015)	**−3.395** (1.656)**	**−5.344** (2.328)**	−1.390 (2.361)	−3.380 (2.787)	3.450 (4.503)
Used inorganic fertilizer (1 = yes) (2014/2015)	**−7.293*** (2.079)**	**−7.326** (2.920)**	**−7.421** (2.965)**	**−9.365*** (3.566)**	−3.320 (5.341)
Δ proportion of maize production (2014/2015)	**−3.708** (1.503)**	**−4.301** (2.094)**	−3.086 (2.158)	**−9.240*** (2.621)**	**8.298** (3.819)**
Household characteristics					
Δ household members	0.108 (0.293)	**−0.738* (0.416)**	**0.926** (0.415)**	−0.069 (0.498)	**2.754*** (0.754)**
Δ dependency ratio	4.875 (3.034)	5.104 (4.312)	4.809 (4.278)	6.675 (5.675)	3.034 (6.522)
Δ proportion of members: off-farm wage	**−8.667*** (1.472)**	**−9.350*** (2.084)**	**−8.116*** (2.082)**	**−7.915*** (2.617)**	**−8.252** (3.408)**
Δ TLU	**0.898*** (0.220)**	**0.949*** (0.302)**	**0.870*** (0.322)**	**1.123*** (0.359)**	0.000 (0.717)
Constant	**10.167*** (2.723)**	**5.917** (2.380)**	−2.106 (2.626)	−0.402 (3.271)	−4.035 (4.609)
Observations	4481	2217	2264	1546	718
R-squared	0.198	0.205	0.191	0.204	0.197

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

TABLE 9 | Change in land area worked by gender of plot manager over time (2020–22—2014/15).

Change in land area worked—Plot managers					
Variables	**All managers**	**Men managers**	**Women managers**	**Women managers in men-headed households**	**Women managers in women-headed households**
Plot manager characteristics					
Gender (1 = woman)	0.022 (0.023)	—	—	—	—
Age of plot manager (2014/2015)	**0.001*** (0.001)**	0.001 (0.001)	**0.002*** (0.001)**	**0.002** (0.001)**	0.001 (0.001)
Purchased improved seed (1 = yes) (2014/2015)	0.022 (0.027)	0.021 (0.038)	0.024 (0.037)	0.008 (0.045)	0.104 (0.064)
Used inorganic fertilizer (1 = yes) (2014/2015)	0.038 (0.033)	0.040 (0.048)	0.037 (0.046)	0.016 (0.058)	0.114 (0.076)
Δ proportion of maize production (2014/2015)	**0.417*** (0.023)**	**0.421*** (0.033)**	**0.412*** (0.033)**	**0.464*** (0.041)**	**0.331*** (0.053)**
Household characteristics					
Δ household members	**0.045*** (0.005)**	**0.047*** (0.007)**	**0.043*** (0.006)**	**0.055*** (0.008)**	0.016 (0.011)
Δ dependency ratio	0.038 (0.049)	0.027 (0.071)	0.049 (0.067)	0.111 (0.092)	−0.078 (0.093)
Δ proportion of members: off-farm wage	**−0.479*** (0.022)**	**−0.496*** (0.033)**	**−0.463*** (0.031)**	**−0.519*** (0.040)**	**−0.347*** (0.047)**
Δ TLU	**0.027*** (0.004)**	**0.029*** (0.005)**	**0.025*** (0.005)**	**0.025*** (0.006)**	**0.026** (0.010)**
Constant	**−0.513*** (0.043)**	**−0.464*** (0.038)**	**−0.500*** (0.040)**	**−0.505*** (0.051)**	**−0.469*** (0.063)**
Observations	4481	2217	2264	1546	718
R-squared	0.257	0.260	0.255	0.285	0.204

Note: Standard errors in parentheses.
**$p < 0.05$.
***$p < 0.01$.

TABLE 10 | Change in total days worked per acre by gender of plot manager over time (2020–22—2014/15).

Change in total days worked per acre—Plot managers					
Variables	**All managers**	**Men managers**	**Women managers**	**Women managers in men-headed households**	**Women managers in women-headed households**
Plot manager characteristics					
Gender (1 = woman)	**−1.502** (0.663)**	—	—	—	—
Age of plot manager (2014/2015)	−0.022 (0.020)	−0.007 (0.026)	−0.037 (0.031)	0.012 (0.040)	−0.072 (0.056)
Δ land area (log) worked	**−12.512*** (0.520)**	**−10.898*** (0.706)**	**−14.110*** (0.762)**	**−13.003*** (0.871)**	**−16.853*** (1.527)**
Purchased improved seed (1 = yes) (2014/2015)	**−2.260*** (0.753)**	**−3.115*** (1.009)**	−1.396 (1.119)	−2.020 (1.233)	0.242 (2.507)
Used inorganic fertilizer (1 = yes) (2014/2015)	**−3.785*** (0.945)**	**−2.562** (1.284)**	**−5.003*** (1.383)**	**−4.235*** (1.565)**	**−6.105** (2.837)**
Δ proportion of maize production (2014/2015)	−1.057 (0.737)	−0.671 (0.970)	−1.491 (1.114)	−1.394 (1.230)	−1.327 (2.437)
Household characteristics					
Δ household members	−0.132 (0.147)	−0.318 (0.196)	0.064 (0.219)	0.281 (0.249)	−0.447 (0.453)
Δ dependency ratio	1.373 (1.478)	0.222 (2.018)	2.339 (2.155)	4.288 (2.613)	−0.324 (3.879)
Δ proportion of members: off-farm wage	**−1.346* (0.742)**	−1.648 (1.004)	−1.213 (1.092)	−0.513 (1.286)	−2.779 (2.067)
Δ TLU	**0.220** (0.103)**	0.182 (0.134)	**0.268* (0.157)**	0.252 (0.168)	0.447 (0.378)
Constant	**2.401* (1.265)**	0.814 (1.076)	−0.461 (1.319)	−1.263 (1.554)	−1.163 (2.669)
Observations	2936	1454	1482	1040	442
R-squared	0.174	0.154	0.195	0.186	0.229

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

reflecting the interplay among household composition, resource access, and livelihood strategies emphasized in Chayanovian theory. Larger land areas correspond with more total days worked but lower labor intensity, perhaps reflecting a labor ceiling that seems to push households toward extensification rather than intensification. In cross-sectional analyses, inputs show little consistent effect on labor or land use, but in longitudinal models, improved seed and fertilizer use are associated with reductions in labor intensity, particularly for men managers, indicating that inputs can substitute for labor over time. While maize cultivation negatively associates with labor intensity at the household level, household size positively correlates, highlighting how labor allocation reflects both demographic pressures and crop choices. Livestock ownership (TLU), meanwhile, appears to reflect a wealth effect (as well as potentially a direct productive input in the form of animal traction and fertilizer), enabling households to expand land under cultivation over time. Together, these patterns suggest that households leverage inputs, crops, and livestock to ease labor constraints and expand cultivation rather than intensifying it. These small-scale farmers, particularly women, appear to lack excess labor to intensify production, contrasting with AGRA's emphasis on sustainable intensification (Conway et al. 2019) and underscoring the need for development models that account for real labor limits and resource constraints.

By integrating variables that address Chayanovian theory's blind spots, our findings add nuance beyond what a strict Chayanovian model could offer, supporting its use as a heuristic framework rather than a fully explanatory model. This heuristic approach also provides empirical support for critiques of AGRA's theory of change, which assumes farmers will respond uniformly to increased access to technology and markets (Gengenbach et al. 2018; Scoones and Thompson 2011). Our results show that plot managers with different characteristics, in households of varying compositions and social position, make decisions about their labor and land in diverse ways, seemingly partly driven by internal household dynamics (à la Chayanov) and partly by structural conditions (de Janvry 1981). Women managers in women-headed households appear to have the least flexibility in labor allocation and land use, reflecting structural disadvantage among the most resource-constrained, while the consistent influence of labor availability across households suggests decision-making rationales that extend beyond purely capitalist logics of profit maximization. Further research is needed to deepen understanding of the multiple factors shaping household choices, including motivations for agricultural choices, the processes and consequences of intra-household power dynamics, and how different households respond in varying contexts where structural factors—from the local to the global level—enable or constrain opportunities alongside the diverse preferences individuals bring to those decisions. Such inquiry would not only advance understanding of rural livelihoods but also refine theoretical frameworks like Chayanov's, ensuring they better capture the interplay of gender, household composition, structural inequality, and individual agency in agricultural decision-making.

Nonetheless, our findings add important insight into the empirical findings that AGRA has fallen short of its goals (Blair et al. 2021; Wise 2020). By demonstrating the influence of factors like household composition and gender on labor allocation and land use, our results support critiques that AGRA and similar approaches may be overlooking complexity for the sake of simplicity and predictability (Gengenbach et al. 2018). Rather than a simplistic Chayanovian explanation, we instead find support for neo-Chayanovian interpretations of development, which emphasize a "multiplicity of rationalities, desires, capacities and practices, including of course those also associated with various modes of instrumentalism" (Long 2001: 5). This suggests that future research should build upon the analysis presented here by more fully accounting for structural conditions and expanding geographic scope. Consideration of structural factors must be complemented by a deeper understanding of the diverse motivations, priorities, and decision-making criteria that guide households and individuals in pursuing particular livelihoods. Future research therefore must directly engage farmers to understand why they act as they do to ground development initiatives in agrarian realities rather than ideological assumptions, for these are what we contend have historically impeded agricultural modernization efforts, both capitalistic and collectivist. For agricultural development to achieve humanitarian and sustainable environmental outcomes (Harwood 2012; McKay et al. 2025), it must be grounded in the preferences, choices, and rationales of farmers, an insight central to Chayanov's vision.

5 | Conclusion

This study challenges the high modernist assumptions behind initiatives like AGRA, which presume that top-down transfers of technology and market creation will produce a uniform development trajectory. Similarly, transformational movements such as agroecology and food sovereignty must grapple with the diversity of small-scale farmers' priorities and farming practices, including those that diverge from their normative goals, rather than dismissing farmers' interest in market access and modern inputs as false consciousness (McKay et al. 2025; Soper 2020). We propose an alternative, pragmatic approach: development initiatives should reflect farmers' own rationalities and preferences, creating opportunities that increase options and allow for change, but without preordaining how farmers (should) make decisions.

Historical precedent suggests such an approach is possible. As Harwood (2012) documents, policies in Central Europe at the turn of the 20th century supported peasant farmers through locally responsive breeding and extension programs. While our findings cannot determine whether modern development should adopt similar "peasant-friendly" programs, they underscore the importance of taking farmers' realities and preferences seriously. Important empirical work already exists to guide such research for development efforts: for example, the persistence of informal seed systems that provide characteristics typically unavailable in formal seed systems (Mastretta-Yanes et al. 2024), relationships between crop choices and food and nutrition security (Jones 2017), and differences in agricultural management across demographic groups, such as gendered patterns of resource allocation and decision-making (Quisumbing et al. 2014). Understanding farmers' motivations and rationales on these issues, including their interest in commercialization and technology, could enable development policies and programs that account for how farmers actually (want to) operate rather than prescribing their goals or decisions.

Perhaps the current geopolitical moment offers an opening. The dismantling of the United States Agency for International Development, however troubling, may create space for new models of engagement—models sorely needed given the persistent shortcomings of agricultural modernization. The ideological battle over small-scale farming—between collectivization and class differentiation—was a defining feature of the Cold War (Friedmann 2019). The Cold War has ended, but the agrarian question persists. What remains to be seen is whether development efforts will finally take small-scale farmers on their own terms or continue to plan for a future that presumes their disappearance.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in the National Panel Survey 2014–2015 Wave 4—Extended Panel at https://microdata.worldbank.org/index.php/catalog/3455, reference number TZA_2014_NPS-R4_v03_M_v03_A_EXT.

Endnotes

[1] The definitions of peasant and small-scale farmer are myriad and not always congruent, with some questioning whether peasants even continue to exist due to the ubiquitous penetration of capital (Bernstein 2014). One reason to perhaps retire the peasant label is that it most accurately refers to a class of agrarian producers in feudal Europe, and its definition and social context have since been altered to allow its application in other spatial and temporal contexts. We do not engage in the debate of whether "peasant" remains a relevant category and instead use the term "small-scale farmer" to denote agricultural livelihoods that primarily rely on household labor, are resource-scarce, and are oriented, at least in part, toward subsistence (HLPE 2013). We only use the term peasant in specific cases when we refer to authors writing about Russian or German peasants. We recognize that our definition of small-scale farmers masks important variations in types of farmers, but this broad definition serves the purposes of our discussion.

[2] This distinction—that farmers can be utility maximizers with diverse preferences—has been elaborated by scholars who observe that farmers often make rational choices to manage risk, fulfill taste preferences, and pursue food security, even if these choices do not reflect the capitalist assumption that individuals always opt to maximize profit (e.g., Brush 2004; Smale 2006). Others, like Escobar (1995), argue that rationalities are diverse, reflective of different social and cultural contexts. While we recognize the validity of both perspectives, we adopt the former standpoint for this paper, consistent with our argument that Chayanov understood peasants as rational utility maximizers with preferences distinct from capitalist models.

[3] As HLPE (2013) indicates, no standardized definition of a smallholder or small-scale farmer exists globally. In Tanzania, a small-scale farm or smallholder household is generally defined as having "between 25 sq. metres and 20 ha of land under production, and/or between 1 to 50 head of cattle, and/or between 5 and 100 head of goats/sheep/pigs, and/or between 50 and 1000 chickens/ducks/turkeys/rabbits" (HLPE 2013: 25).

[4] We do not include men-managed plots in women-headed households due to insufficient representation in the sample.

[5] In the sample, less than 12% of plot managers used inorganic fertilizer and less than 11% of plot managers used purchased seed. We therefore opted to treat these data as binary variables.

[6] We do not conduct these analyses at the household level due to data limitations: namely the number of women-headed households with sufficient data across both waves is too small to support robust findings.

References

AGRA. 2017. "*AGRA Annual Progress Report 2007–2016*." Alliance for a Green Revolution in Africa. https://agra.org/wp-content/uploads/2021/05/AGRA-2016-Progress-Report.pdf.

AGRA. 2020. "*2019 Annual Report: Integration and Scale*." Alliance for a Green Revolution in Africa. https://agra.org/wp-content/uploads/2021/03/AGRA-Annual-Report-Web-2019-26-06-20.pdf.

Arce, C. E., and J. Caballero. 2015. "Tanzania Agricultural Sector Risk Assessment." World Bank Group Report Number 94883-TZ. https://documents1.worldbank.org/curated/en/248961468001158010/pdf/94883-REVISED-Box393201B-PUBLIC-Tanzania-Ag-Risk-Assessment-web-6-29-15-JK-jtc.pdf.

Aring, M., O. Reichardt, E. Menjono Katjizeu, B. Luyand, and C. Hulke. 2021. "Collective Capacity to Aspire? Aspriations and Liveilhood Strategies in the Zambezi Region, Namibia." *European Journal of Development Research* 33: 933–950.

Beegle, K., J. De Weedrdt, and S. Dercon. 2011. "Migration and Economic Mobility in Tanzania: Evidence From a Tracking Survey." *Review of Economics and Statistics* 93, no. 3: 1010–1033.

Bernstein, H. 2009. "V.I. Lenin and A.V. Chayanov: Looking Back, Looking Forward." *Journal of Peasant Studies* 36, no. 1: 55–81.

Bernstein, H. 2014. "Food Sovereignty via the 'Peasant Way': A View." *Journal of Peasant Studies* 41, no. 6: 1031–1063.

Blair, R., K. Kimbugwe, A. Koleros, M. Mangheni, T. Narayan, and F. Usmani. 2021. "Partnership for Inclusive Agricultural Transformation in Africa, Final Evaluation. Volume I—Final Evaluation Report." Mathematica. https://agra.org/wp-content/uploads/2023/08/PIATA-Final-Evaluation-Report-Volume-I.pdf.

Brush, S. 2004. *Farmers' Bounty: Locating Crop Diversity in the Contemporary World*. Yale University Press.

Chayanov, A. V. 1925/1986. *The Theory of Peasant Economy*. University of Wisconsin Press.

Conway, G. 2012. *One Billion Hungry: Can we Feed the World?* Cornell University Press.

Conway, G., O. Badiane, and K. Glatzel. 2019. *Food for All in Africa: Sustainable Intensification for African Farmers*. Cornell University Press.

Cook, S., and L. Binford. 1986. "Petty Commodity Production, Capital Accumulation, and Peasant Differentiation: Lenin vs. Chayanov in Rural Mexico." *Review of Radical Political Economics* 18, no. 4: 1–31.

Curtin, H. M., T. Reynolds, and D. Tobin. 2024. "Gender, Access to Agricultural Extension, and Seed Sourcing Among Small-Scale Farmers in Uganda." *Journal of International Agricultural and Extension Education* 31, no. 1: 109–126.

de Janvry, A. 1981. *The Agrarian Question and Reformism in Latin America*. Johns Hopkins University Press.

Deere, C. D., and A. de Janvry. 1981. "Demographic and Social Differentiation Among Northern Peruvian Peasants." *Journal of Peasant Studies* 8, no. 3: 335–366.

Dimitri, C., A. Effland, and N. Conklin. 2005. "The 20th Century Transformation of U.S. Agriculture and Farm Policy." The United States Department of Agriculture Economic Information Bulletin Number 3. https://www.ers.usda.gov/publications/pub-details?pubid=44198#download.

Dimova, R., S. K. Halvorsen, M. Nyyssölä, and K. Sen. 2021. "Long-Run Rural Livelihood Diversification in Kagera, Tanzania." Wider Working Paper 2021/9. Helsinki UNU-WIDER https://www.wider.unu.edu/publication/long-run-rural-livelihood-diversification-kagera-tanzania.

Doss, C., C. Kovarik, A. Peterman, A. Quisumbing, and M. van den Bold. 2015. "Gender Inequalities in Ownership and Control of Land in Africa: Myth and Reality." *Agricultural Economics* 46, no. 3: 403–434.

Ducrotoy, M. J., C. W. Revie, A. P. Shaw, et al. 2017. "Wealth, Household Heterogeneity and Livelihood Diversification of Fulani Pastoralists in the Kachia Grazing Reserve, Northern Nigeria, During a Period of Social Transition." *PLoS One* 12, no. 3: e0172866.

Ebanyat, P., N. de Ridder, A. de Jager, R. J. Delve, M. A. Bekunda, and K. E. Giller. 2010. "Drivers of Land Use Change and Household Determinants of Sustainability in Smallholder Farming Systems in Eastern Uganda." *Population and Environment* 31: 474–506.

Escobar, A. 1995. *Encountering Development: The Making and Unmaking of the Third World*. Princeton University Press.

Evenson, R. E., and D. Gollin. 2003. "Assessing the Impact of the Green Revolution." *Science* 300, no. 5260: 758–762.

Ferguson, J. 1990. *The Anti-Politics Machine: "Development," Depoliticization, and Bureaucratic Power in Lesotho*. University of Minnesota Press.

Food and Agriculture Organization of the United Nations (FAO). 2023. "National Gender Profile of Agriculture and Rural Livelihoods—United Republic of Tanzania." Dodoma. https://openknowledge.fao.org/server/api/core/bitstreams/1a244b21-a98e-4445-a1de-d5c4040ca87d/content.

Food and Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD), & International Labour Office (ILO). 2010. *Gender Dimensions of Agricultural and Rural Employment: Differentiated Pathways Out of Poverty*. FAO. https://www.fao.org/4/i1638e/i1638e00.htm.

Friedmann, H. 2019. "The Awkward Class: A Foundation for Peasant Studies." *Journal of Peasant Studies* 46, no. 5: 1096–1105.

Gengenbach, H., R. Schurman, T. Bassett, W. A. Munro, and W. G. Moseley. 2018. "Limits of the New Green Revolution for Africa: Reconceptualising Gendered Agricultural Value Chains." *Geographical Journal* 184, no. 2: 208–214.

Hammel, E. A. 2005. "Chayanov Revisited: A Model for the Economics of Complex Kin Units." *Proceedings of the National Academy of Sciences of the United States of America* 102, no. 19: 7043–7046.

Harwood, J. 2012. *Europe's Green Revolution and Others Since: The Rise and Fall of Peasant-Friendly Plant Breeding*. Routledge.

Harwood, J. 2019. "Was the Green Revolution Intended to Maximise Food Production?" *International Journal of Agricultural Sustainability* 17, no. 4: 1–14.

Herrero, M., P. K. Thornton, A. M. Notenbaert, et al. 2010. "Smart Investments in Sustainable Food Production: Revisiting Mixed Crop-Livestock Systems." *Science* 327, no. 5967: 822–825.

HLPE (High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security). 2013. *Investing in Smallholder Agriculture for Food Security*. Food and Agriculture Organization. https://www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE_Reports/HLPE-Report-6_Investing_in_smallholder_agriculture.pdf.

Jayne, T. S., J. Chamberlin, and D. D. Headey. 2014. "Land Pressures, the Evolution of Farming Systems, and Development Strategies in Africa: A Synthesis." *Food Policy* 48: 1–17.

Jayne, T. S., J. Chamberlin, L. Traub, et al. 2016. "Africa's Changing Farm Distribution Patterns: The Rise of Medium-Scale Farms." *Agricultural Economics* 47, no. S1: 197–214.

Jones, A. D. 2017. "Critical Review of the Emerging Research Evidence on Agricultural Biodiversity, Diet Diversity, and Nutritional Status in Low- and Middle-Income Countries." *Nutrition Reviews* 75, no. 10: 769–782.

Leinbach, T. R., and A. Smith. 1994. "Off-Farm Employment, Land, and Life Cycle: Transmigrant Households in South Sumatra, Indonesia." *Economic Geography* 70, no. 3: 273–296.

Lenin, V. I. 1899. "*The Development of Capitalism in Russia: The Process of the Formation of a Home Market for Large-scale Industry*."

Loison, S. A. 2015. "Rural Livelihood Diversification in Sub-Saharan Africa: A Literature Review." *Journal of Development Studies* 51, no. 9: 1125–1138.

Long, N. 2001. *Development Sociology: Actor Perspectives*. Routledge.

Mastretta-Yanes, A., D. Tobin, M. R. Bellon, et al. 2024. "Human Management of Ongoing Evolutionary Processes in Agroecosystems." *Plants, People, Planet* 6, no. 6: 1190–1206.

Mbembe, A. 2001. *On the Postcolony*. University of California Press.

McKay, B. M., G. Catacora-Vargas, A. Castellanos-Navarrete, R. Bezner Kerr, and J. K. Luna. 2025. "Challenging Agroecology—Promise and Pitfalls for Agrarian Studies." *Journal of Agrarian Change* 25: e70019.

Meertens, B. 2000. "Agricultural Performance in Tanzania Under Structural Adjustment Programs: Is It Really So Positive?" *Agriculture and Human Values* 17: 333–346.

Mkandawire, T. 2001. "Thinking About Developmental States in Africa." *Cambridge Journal of Economics* 25, no. 3: 289–313.

Moseley, W., M. Schnurr, and R. Bezner-Kerr. 2015. "Interrogating the Technocratic (Neoliberal) Agenda for Agricultural Development and Hunger Alleviation in Africa." *African Geographical Review* 31, no. 1: 1–7.

Ola, O., and L. Menapace. 2020. "Revisiting Constraints to Smallholder Participation in High-Value Markets: A Best-Worse Scaling Approach." *Agricultural Economics* 51, no. 4: 595–608.

Palacios-Lopez, A., L. Christiaensen, and T. Kilic. 2017. "How Much of the Labor in African Agriculture Is Provided by Women?" *Food Policy* 67: 52–63.

Pasgaard, M., S. K. Kim, N. Dawson, and N. Fold. 2022. "Agrarian Modernization Through 'Ideal Agricultural Subjects': A Lost Cause for Smallholders in Rwanda?" *Journal of Political Ecology* 29, no. 1: 100–122.

Patel, R. 2012. "The Long Green Revolution." *Journal of Peasant Studies* 40, no. 1: 1–63.

Pingali, P. L. 2012. "Green Revolution: Impacts, Limits, and the Path Ahead." *Proceedings of the National Academy of Sciences of the United States of America* 109, no. 31: 12302–12308.

Quisumbing, A., R. Meinzen-Dick, T. L. Raney, A. Croppenstedt, J. A. Behrman, and A. Peterman. 2014. *Gender in Agriculture: Closing the Knowledge Gap*. Springer.

Raholiarimanana, F., H. Rakotomanana, and A. Ishida. 2023. "Does Raising Livestock Improve Household Food and Child Dietary Diversity in a Rural Region of Madagascar?" *Children* 10, no. 5: 765.

Rao, N., C. Singh, D. Solomon, et al. 2020. "Managing Risk, Changing Aspirations and Household Dynamics: Implications for Wellbeing and Adaptation in Semi-Arid Africa and India." *World Development* 125: 104667.

Rashid, F. N., J. K. Sesabo, R. M. Lihawa, and E. Mkuna. 2024. "Determinants of Household Food Expenditure in Tanzania: Implications on Food Security." *Agriculture & Food Security* 13: 13.

Roberts, R., and T. Mutersbaugh. 1996. "On Rereading Chayanov: Understanding Agrarian Transitions in the Industrialized World." *Environment and Planning A* 28, no. 6: 951–956.

Roop, R., M. Weaver, A. P. Fonseca, and M. Matouq. 2023. "Innovative Approaches in Smallholder Farming Systems to Implement the Sustainable Development Goals." In *SDGS in the Americas and Caribbean Region*, edited by W. L. Filho, N. Aguilar-Rivera, B. Borsari, P. R. B. de Brito, and B. A. Guerra, 971–988. Springer International Publishing.

Sachs, C. E., L. Jensen, P. Castellanos, and K. Sexmith. 2021. "Introduction." In *Routledge Handbook of Gender and Agriculture*, edited by C. E. Sachs, L. Jensen, P. Castellanos, and K. Sexsmith, 1–12. Routledge.

Samberg, L. H., J. S. Gerber, N. Ramankutty, M. Herrero, and P. C. West. 2016. "Subnational Distribution of Average Farm Size and Smallholder Contributions to Global Food Production." *Environmental Research Letters* 11, no. 12: 124010.

Schneider, L. 2004. "Freedom and Unfreedom in Rural Development: Julius Nyerere, Ujamaa Vijijini, and Villagization." *Canadian Journal of African Studies* 38, no. 2: 344–392.

Schulman, M. D., P. M. Garrett, and B. A. Newman. 1989. "Differentiation and Survival Among North Carolina Smallholders: An Empirical Perspective on the Lenin-Chayanov Debate." *Journal of Peasant Studies* 16, no. 4: 523–541.

Scoones, I., and J. Thompson. 2011. "The Politics of Seed in Africa's Green Revolution: Alternative Narratives and Competing Pathways." *IDS Bulletin* 42, no. 4: 1–23.

Scott, J. C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press.

Shanin, T. 1972. *The Awkward Class: Political Sociology of Peasantry in a Developing Society: Russia 1910–1925*. Clarendon Press.

Shanin, T. 1973. "The Nature and Logic of the Peasant Economy 1: A Generalisation." *Journal of Peasant Studies* 1, no. 1: 63–80.

Shanin, T. 1974. "The Nature and Logic of the Peasant Economy-II: Diverse and Change: III. Policy and Intervention." *Journal of Peasant Studies* 1, no. 2: 186–206.

Shanin, T. 2009. "Chayanov's Treble Death and Tenuous Resurrection: An Essay About Understanding, About Roots of Plausibility and About Rural Russia." *Journal of Peasant Studies* 36, no. 1: 83–101.

Shiva, V. 2016. *The Violence of the Green Revolution: Third World Agriculture, Ecology and Politics*. University Press of Kentucky.

Shivji, I. G. 1998. *Not Yet Democracy: Reforming Land Tenure in Tanzania*. University of Dar es Salaam.

Smale, M. 2006. *Valuing Crop Biodiversity: On-Farm Genetic Resources and Economic Change*. CABI Publishing.

Soper, R. 2020. "From Protecting Peasant Livelihoods to Essentializing Peasant Agriculture: Problematic Trends in Food Sovereignty Discourse." *Journal of Peasant Studies* 47, no. 2: 265–285.

Tache, B., and E. Sjaastad. 2010. "Pastoralists' Conceptions of Poverty: An Analysis of Traditional and Conventional Indicators From Borana, Ethiopia." *World Development* 38, no. 8: 1168–1178.

Toenniessen, G., A. Adesina, and J. DeVries. 2008. "Building an Alliance for a Green Revolution in Africa." *Annals of the New York Academy of Sciences* 1136, no. 1: 233–242.

Tomita, S., D. M. Parker, J. A. Jennings, and J. Wood. 2015. "Household Demography and Early Childhood Mortality in a Rice-Farming Village in Northern Laos." *PLoS One* 10, no. 3: e0119191.

Touch, V., D. K. Y. Tan, B. R. Cook, et al. 2024. "Smallholder Farmers' Challenges and Opportunities: Implications for Agricultural Production, Environment and Food Security." *Journal of Environmental Management* 370: 122536.

Treichel, V. 2005. "Tanzania's Growth Process and Success in Reducing Poverty." IMF Working Paper WP/05/35. International Monetary Fund.

Van den Broeck, G., and T. Kilic. 2019. "Dynamics of Off-Farm Employment in Sub-Saharan Africa: A Gender Perspective." *World Development* 119: 81–99.

Waltz, A. 2016. "The Women Who Feed Us: Gender Empowerment (Or Lack Thereof) in Rural Southern Brazil." *Journal of Rural Studies* 47, no. A: 31–40.

Wineman, A., T. S. Jayne, E. I. Modamba, and H. Kray. 2020. "The Changing Face of Agriculture in Tanzania: Indicators of Transformation." *Development and Policy Review* 38: 695–709.

Wise, T. A. 2020. "Failing Africa's Farmers: An Impact Assessment of the Alliance for a Green Revolution in Africa." Working Paper No. 20–01. Global Development and Environment Institute, Tufts University. https://sites.tufts.edu/gdae/files/2020/07/20-01_Wise_FailureToYield.pdf.

Zaal, F., R. Bymolt, and M. Tyszler. 2014. "Ariadne's Thread Navigating Crop Choices in Tanzania's Lake Zone and Their Implications for Cotton." Royal Tropical Institute (KIT). https://www.kit.nl/wp-content/uploads/2018/08/553f8ea1cb10e_CTDP-alternative-crop-study-COMPILED.pdf.

Zeigler, R., and S. Mohanty. 2010. "Support for International Agricultural Research: Current Status and Future Challenges." *New Biotechnology* 27, no. 5: 565–572.