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Market Liberalization, Labour Relations and Maize Production Efficiency in Trans-Nzoia County, Kenya

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Abstract: *Market liberalization has reshaped agricultural production by transforming farming practices, labour relations, and institutional arrangements that influence smallholder productivity. However, empirical evidence on how these interconnected transformations affect maize production efficiency remains limited, particularly in Kenya. This study examined the influence of changing farming practices and labour relations on maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya. A convergent mixed-methods design was employed involving 385 randomly selected maize farmers, complemented by focus group discussions and key informant interviews. Quantitative data were analysed using descriptive and inferential statistics, while qualitative data were analysed thematically. The findings reveal a selective modernization process characterized by relatively high adoption of certified seed (63%) but limited uptake of mechanization (42%), agrochemicals (33%), agricultural credit (26%), and irrigation (18%). Labour relations have shifted from traditional reciprocal arrangements towards hired labour, with high labour costs (82%), inadequate labour skills (72%), and labour shortages (69%) emerging as major production constraints. Drawing on these findings, the study proposes Fragmented Agrarian Modernization (FAM), an empirically grounded framework describing an asynchronous process in which technological innovation outpaces institutional, financial, and labour systems. The study concludes that maize production efficiency depends on synchronized technological and institutional transformation rather than technology adoption alone. It recommends strengthening rural finance, mechanization services, irrigation, agricultural extension, labour skills development, and farmer organizations to promote efficient, resilient, and sustainable smallholder agricultural systems under market liberalization.*

Keywords: *Market liberalization; maize production efficiency; labour relations; farming practices; smallholder farmers; Trans-Nzoia County; Kenya.*

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1. Introduction

Agriculture remains one of the most important sectors for economic development, poverty reduction, and food security, particularly in developing countries where the majority of rural households depend directly on farming for their livelihoods. Globally, agriculture employs approximately 27% of the workforce and supports the livelihoods of over 2.5 billion people, while smallholder farmers produce nearly one-third of the world's food despite operating under increasingly constrained production environments (FAO, 2024; World Bank, 2024). Beyond its economic contribution, agriculture underpins social stability, nutritional security, and environmental sustainability. However, sustaining agricultural

productivity has become increasingly difficult as farmers confront climate variability, shrinking farm sizes, rising production costs, labour shortages, and rapidly changing market conditions (IFAD, 2023; IPCC, 2023).

Since the late 1980s, market liberalization has been one of the most influential policy reforms shaping agricultural development across Africa, Asia, and Latin America. The reforms, implemented through Structural Adjustment Programmes, promoted deregulation of agricultural markets, privatization of state-owned enterprises, withdrawal of government subsidies, and greater participation of private actors in agricultural production and marketing (World Bank, 2022). These reforms were intended to improve efficiency by allowing market forces to determine prices, stimulate competition, encourage technological innovation, and increase private investment within the agricultural sector. While liberalization has undoubtedly expanded access to improved seed varieties, fertilizers, mechanization services, and output markets in many countries, evidence increasingly suggests that the expected productivity gains have been uneven because they depend on the strength of supporting institutions, infrastructure, and rural financial systems (Jayne et al., 2019; Dorward & Kydd, 2021).

The effects of market liberalization extend beyond agricultural markets into the social organization of farming itself. Agricultural production has historically been embedded within social institutions that regulate access to labour, knowledge, land, and collective resources. In many rural communities across the Global South, farming activities were traditionally organized through reciprocal labour-sharing arrangements, communal harvesting, collective land preparation, and kinship-based cooperation. These indigenous institutions enabled households to overcome seasonal labour shortages, reduce production costs, and strengthen social cohesion while enhancing agricultural productivity (Ostrom, 1990; Pretty, 2003). Labour therefore functioned not only as an economic input but also as a social institution that reinforced trust, reciprocity, and mutual support among farming households.

Commercialization and liberalization have gradually transformed these traditional arrangements. Increasing reliance on hired labour, contract services, mechanization, and market-oriented production has weakened reciprocal labour systems that historically supported smallholder agriculture. Although these changes have improved access to specialized agricultural services and modern production technologies, they have also increased farmers' exposure to labour shortages, rising wage costs, unreliable labour markets, and widening inequalities in access to productive resources (Barrett et al., 2022). Consequently, the transition from communal to market-based labour systems represents not merely an economic adjustment but a broader transformation of rural institutions that shape agricultural production and household livelihoods.

Experiences from different regions demonstrate that the outcomes of market liberalization are far from uniform. In Southeast Asia, mechanization has significantly reduced dependence on manual labour while improving labour productivity; however, it has also displaced rural workers and accelerated migration to urban areas (Hernandez & Prado, 2018; Maria et al., 2020). In Latin America, particularly Mexico, commercialization of maize production following the North American Free Trade Agreement contributed to the gradual decline of communal labour systems, increasing dependence on wage labour and weakening traditional institutions of reciprocity (Arellano & de Janvry, 2014; Mendoza & Salcedo, 2017). Similarly, studies from Sub-Saharan Africa indicate that while improved agricultural technologies have enhanced productivity among adopters, their successful implementation often depends on access to labour, credit, extension services, and functioning input markets, resources that remain unevenly distributed among smallholder farmers (Liverpool-Tasie et al., 2017; Micheni et al., 2020; Jumpah et al., 2022).

Kenya presents an important context for understanding these transformations. Agriculture contributes approximately 33% of the national Gross Domestic Product directly and indirectly and provides livelihoods for more than 70% of the rural population (KNBS, 2024). Maize is the country's principal staple crop, occupying nearly two million hectares annually and contributing significantly to national food security. Despite numerous policy interventions aimed at modernizing agriculture, maize productivity remains below its potential because many smallholder farmers continue to experience limited access to affordable credit, mechanization, irrigation, extension services, and reliable labour (Ministry of Agriculture, 2023). These constraints have become increasingly evident under liberalized markets, where production decisions and risks are largely borne by individual farmers.

Trans-Nzoia County, widely regarded as Kenya's "grain basket," illustrates both the opportunities and challenges associated with market liberalization. The county has experienced considerable agricultural transformation through increased adoption of certified seed, private agro-dealer networks, mechanization services, and commercial maize marketing. At the same time, farmers have reported rising labour costs, declining communal labour arrangements, limited access to production credit, and increasing uncertainty associated with agricultural production. These changes suggest that technological modernization has not always been accompanied by corresponding institutional development, creating conditions in which productivity gains remain uneven

across farming households. This pattern is consistent with the evidence presented in this study, which shows selective adoption of modern technologies alongside persistent labour and institutional constraints.

Although previous studies have examined agricultural commercialization, technology adoption, and labour markets independently, relatively few have investigated how changes in farming practices and labour relations interact to influence maize production efficiency within liberalized agricultural systems. Existing research has largely emphasized economic indicators of productivity while paying limited attention to the social and institutional transformations that shape farmers' capacity to adopt and effectively utilize modern agricultural technologies. Furthermore, evidence from Kenya remains fragmented, with limited empirical studies integrating quantitative measures of production efficiency with qualitative insights into farmers' lived experiences of agrarian change. This gap limits understanding of the mechanisms through which market liberalization reshapes agricultural production beyond conventional measures of technology adoption and output.

This study addresses this gap by examining how the transformation of traditional farming practices and labour relations under market liberalization influences maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya. By integrating quantitative household survey data with qualitative evidence from focus group discussions and key informant interviews, the study provides a comprehensive understanding of how technological, institutional, and social transformations jointly shape agricultural productivity. It further advances the concept of Fragmented Agrarian Modernization, which describes a situation where technological change progresses more rapidly than the institutional systems required to support it. Under such conditions, productivity gains remain constrained because farmers adopt modern technologies within environments characterized by weak labour markets, limited rural finance, inadequate extension services, and declining social capital. Understanding these interactions is essential for designing agricultural policies that promote not only technological innovation but also the institutional resilience necessary for sustainable and inclusive agricultural transformation.

1.1 Statement of the Problem

Market liberalization has fundamentally reshaped agricultural production systems by promoting private sector participation, competitive input and output markets, and the adoption of modern farming technologies. In Kenya, these reforms have expanded access to certified seeds, mechanization services, and commercial agricultural markets, with the expectation of improving productivity and production efficiency among smallholder farmers. Despite these policy interventions, maize productivity remains below its potential, with national average yields continuing to fall far short of attainable yields under recommended agronomic practices. This persistent productivity gap suggests that technological modernization alone has not translated into sustained efficiency gains because many farmers continue to face structural constraints, including limited access to affordable credit, weak extension services, high production costs, and increasingly constrained labour markets. More importantly, liberalization has transformed traditional farming systems by replacing reciprocal labour-sharing arrangements with market-based labour relations, yet the implications of these changes for maize production efficiency remain inadequately understood (Jayne et al., 2019; Liverpool-Tasie et al., 2017; Ministry of Agriculture and Livestock Development, 2023).

The situation is particularly evident in Trans-Nzoia County, Kenya's leading maize-producing region, where modernization has progressed unevenly. Although previous studies have examined agricultural commercialization, technology adoption, labour markets, and productivity separately, limited empirical evidence explains how the transformation of farming practices and labour relations jointly influences maize production efficiency within a liberalized agricultural system, particularly in Kenya. This study addresses this gap by examining the interaction between changing farming practices, labour relations, and maize production efficiency among smallholder farmers in Trans-Nzoia County, thereby providing evidence to inform policies that strengthen technological innovation alongside labour institutions, rural finance, and agricultural support systems.

1.2 Objective of the Study

This study aimed to analyse how changes in traditional farming practices and labour relations associated with market liberalization shape maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya.

2. Literature Review

2.1 Market Liberalization and the Transformation of Farming Practices

Agricultural transformation has remained at the centre of development discourse because of its direct relationship with food security, rural livelihoods, and economic growth. Across much of the developing world, agriculture continues to support millions of households whose livelihoods depend largely on smallholder farming. Yet the way agriculture is organized today differs considerably from the production systems that characterized rural communities only a few decades ago. The transition from

state-regulated agriculture to market-oriented production has altered not only the economic environment in which farmers operate but also the social and institutional structures that shape agricultural decision-making. Market liberalization therefore represents more than a policy reform; it is a process that has fundamentally redefined relationships among farmers, markets, governments, and rural institutions.

The implementation of market liberalization across many developing countries during the 1980s and 1990s marked a significant departure from earlier models of agricultural governance. Governments progressively withdrew from direct involvement in input supply, commodity marketing, extension delivery, and price regulation, while encouraging private-sector participation in agricultural production and trade. These reforms were largely informed by Structural Adjustment Programmes promoted by international financial institutions, which argued that competitive markets would allocate productive resources more efficiently than state-controlled systems (World Bank, 2022). Liberalization was expected to stimulate investment, improve farmers' access to agricultural inputs, strengthen market incentives, and enhance production efficiency by allowing producers to respond to demand and price signals. Although these objectives appeared economically rational, the practical outcomes varied considerably across countries because market reforms interacted with institutional, political, and socio-economic conditions that differed widely between regions.

The uneven performance of liberalization has generated extensive debate within agricultural development literature. Early proponents viewed liberalization as a necessary catalyst for agricultural modernization because removing state monopolies would create competitive markets capable of improving efficiency, reducing production costs, and encouraging innovation. Subsequent empirical evidence, however, suggests that markets alone cannot guarantee agricultural transformation. Rural economies frequently operate under conditions that differ substantially from the assumptions of perfectly competitive markets. Smallholder farmers often encounter poor infrastructure, limited access to credit, weak extension systems, fluctuating commodity prices, and significant information asymmetries that constrain their ability to make optimal production decisions (Dorward & Kydd, 2021). These realities have shifted scholarly attention from evaluating whether liberalization is inherently beneficial to understanding the institutional conditions under which market-oriented reforms contribute to sustainable agricultural development.

One of the most visible consequences of market liberalization has been the transformation of farming practices. Agricultural production has progressively shifted from subsistence-oriented systems towards commercially driven production characterized by increased use of certified seeds, mineral fertilizers, mechanization, agrochemicals, irrigation technologies, and digital agricultural services. Advances in biotechnology, precision agriculture, and climate-smart farming have further accelerated this transition, enabling farmers to improve crop management, optimize resource utilization, and increase productivity under increasingly variable climatic conditions (FAO, 2024). These technological developments have contributed significantly to agricultural growth in regions where farmers have adequate access to financial resources, extension support, and functioning markets.

Despite these advances, the transition has been neither uniform nor complete. Evidence from Sub-Saharan Africa consistently demonstrates that technology adoption occurs selectively rather than comprehensively. Many smallholder farmers adopt improved seed varieties because they are relatively accessible and produce visible yield advantages, yet considerably fewer invest in mechanization, irrigation systems, agricultural insurance, precision farming technologies, or integrated soil fertility management. This selective adoption reflects the financial realities facing rural households rather than a reluctance to innovate. Technologies that require substantial capital investment or depend upon complementary infrastructure remain beyond the reach of many resource-constrained farmers. Consequently, modern agricultural practices often coexist with traditional production methods, producing hybrid farming systems in which technological advancement remains incomplete (AGRA, 2023).

The literature increasingly emphasizes that agricultural technologies rarely function independently. Instead, productivity gains emerge from combinations of complementary innovations operating within supportive institutional environments. Improved seed varieties, for example, achieve their full production potential only when farmers also have access to appropriate fertilizer application, pest and disease management, irrigation where necessary, extension advice, and reliable markets. Where one or more of these complementary factors are absent, expected productivity gains are substantially reduced. This principle explains why farmers who adopt improved technologies frequently experience lower returns than anticipated despite significant investment in agricultural inputs. The productivity of modern farming practices therefore depends not only on technological characteristics but also on institutional arrangements that facilitate effective implementation.

Recent studies further demonstrate that agricultural modernization should be understood as a multidimensional process rather than simply increased technology adoption. Technological innovations inevitably reshape farm management practices, labour allocation, production risks,

household decision-making, and relationships between farmers and markets. Mechanization reduces dependence on manual labour while simultaneously increasing demand for technical skills and capital investment. Improved seed varieties require changes in planting calendars, fertilizer management, and post-harvest handling. Conservation agriculture demands different approaches to land preparation and residue management, while digital agricultural technologies increasingly require farmers to access information through mobile platforms and online advisory systems. These changes illustrate that modernization affects the organization of agricultural production as much as the technologies themselves.

Experiences from Asia provide valuable insights into the opportunities and challenges associated with these transformations. Countries such as China and Vietnam have achieved substantial increases in agricultural productivity through coordinated investments in mechanization, irrigation, extension services, rural infrastructure, and market development. Importantly, these technological advances were supported by strong public institutions that reduced transaction costs and improved farmers' access to complementary services. By contrast, several low-income countries introduced liberalization without comparable institutional investment, leaving private markets to fill gaps previously occupied by government agencies. In many cases, these institutional gaps persisted, limiting farmers' ability to benefit fully from market reforms despite increased availability of commercial agricultural technologies.

A similar pattern has emerged across Sub-Saharan Africa. Although access to improved agricultural inputs has expanded considerably over the past two decades, productivity growth has remained relatively modest compared with other regions. Researchers increasingly attribute this outcome to institutional constraints rather than technological limitations. Weak rural financial systems continue to restrict investment in productivity-enhancing technologies, while inadequate extension services limit farmers' capacity to implement improved agronomic practices effectively. Poor road infrastructure increases marketing costs, and volatile commodity prices reduce incentives for long-term investment. Under these conditions, technology adoption alone cannot generate sustained improvements in agricultural productivity because farmers continue operating within institutional environments that constrain production efficiency.

Kenya reflects many of these broader continental trends. Since the liberalization of agricultural markets, the country has experienced rapid expansion of private agro-dealer networks, commercial seed companies, fertilizer distributors, and mechanization service providers. These developments have improved farmers' physical access to agricultural technologies while increasing competition within input markets. Nevertheless, national maize productivity remains substantially below attainable levels, particularly among smallholder producers. Studies attribute this gap to limited access to affordable credit, declining soil fertility, climate variability, inadequate extension support, and rising production costs. These findings suggest that although market liberalization has improved access to technologies, complementary investments necessary to sustain productivity growth remain insufficiently developed.

The situation in Trans-Nzoia County illustrates this complexity particularly well. As Kenya's principal maize-producing region, the county has experienced considerable agricultural commercialization following liberalization. Farmers increasingly purchase certified seed, utilize commercial input suppliers, hire mechanized land preparation services, and participate in organized maize markets. At the same time, production costs have increased steadily, access to affordable agricultural finance remains limited, and institutional support services have become increasingly uneven. The coexistence of modern production technologies with persistent institutional constraints demonstrates that agricultural transformation is not a linear progression from traditional to modern farming systems. Instead, modernization unfolds unevenly as farmers adapt available innovations to local economic realities, household resources, and institutional opportunities.

Viewed collectively, the literature indicates that market liberalization has undoubtedly accelerated technological change within smallholder agriculture. However, modernization has occurred unevenly because technological innovation has frequently outpaced the development of complementary institutions required to sustain production efficiency. Existing scholarship has generated considerable knowledge regarding technology adoption and agricultural commercialization, yet relatively little attention has been devoted to understanding how these transformations interact with changing labour relations to influence maize production efficiency. Most studies continue to evaluate technological adoption independently of the broader institutional changes accompanying market liberalization. This omission limits understanding of agricultural transformation as a socially embedded process in which farming practices, labour organization, and institutional development evolve simultaneously. Addressing this gap is essential for explaining why productivity improvements remain uneven among smallholder maize farmers despite decades of agricultural modernization.

2.2 Theoretical Framework

2.2.1 Political Economy of Agrarian Change

This study is principally anchored in the Political Economy of Agrarian Change, which provides a comprehensive lens for understanding how macroeconomic policies, institutional reforms, and market forces reshape agricultural production systems and rural livelihoods. Rooted in the works of Bernstein (2010), Byres (1996), Long (2001), and De Janvry and Sadoulet (2002), the theory argues that agrarian transformation is not merely a consequence of technological progress but is fundamentally shaped by the interaction between markets, institutions, state policies, and social relations. Agricultural change therefore reflects broader political and economic processes that determine access to productive resources, labour organization, capital accumulation, and market participation.

The theory emerged as a critique of conventional modernization perspectives that viewed agricultural development as a linear transition from traditional to modern production systems. Political economy scholars contend that such perspectives overlook the unequal distribution of resources and opportunities that characterizes rural societies. Market-oriented reforms may create opportunities for some producers while simultaneously exposing others to new forms of vulnerability arising from unequal access to land, credit, technology, labour, and information (Bernstein, 2010). Consequently, agricultural modernization is understood as an uneven and contested process in which the benefits of market liberalization are mediated by existing institutional structures and socio-economic inequalities rather than being distributed uniformly across farming populations.

Within liberalized agricultural systems, farmers are increasingly expected to respond to market signals by adopting improved technologies, investing in commercial production, and integrating into competitive value chains. However, these decisions occur within institutional environments that frequently constrain farmers' capacity to respond effectively. Limited access to agricultural finance, declining public extension services, imperfect input markets, fluctuating commodity prices, and inadequate rural infrastructure reduce the ability of smallholder farmers to translate market opportunities into improved production efficiency. From a political economy perspective, these constraints are not isolated technical problems but manifestations of broader institutional arrangements that influence the distribution of resources and opportunities within rural economies.

The theory is particularly relevant to understanding the transformation of farming practices under market liberalization. Commercialization encourages farmers to adopt improved seed varieties, mechanization, fertilizers, and other productivity-enhancing technologies. Yet adoption remains highly differentiated because households possess unequal economic resources, institutional support, and market access. Wealthier farmers generally have greater capacity to invest in modern technologies and manage production risks, whereas resource-constrained households often adopt technologies selectively or continue relying on traditional production methods. Consequently, modernization does not replace traditional agriculture uniformly but produces hybrid production systems characterized by varying combinations of traditional and modern practices.

A central contribution of the Political Economy of Agrarian Change is its recognition that labour is socially organized rather than merely purchased within competitive markets. Labour relations evolve in response to broader institutional and economic transformations affecting rural livelihoods. Historically, agricultural labour among smallholder communities was organized through reciprocal exchange, communal work groups, and kinship networks that reduced production costs while strengthening social cohesion. Liberalization has gradually replaced many of these arrangements with wage labour, contractual employment, and commercial service provision. Although these changes may improve specialization and labour mobility, they also increase production costs and expose farmers to labour shortages, wage fluctuations, and declining social support systems. The transformation of labour relations therefore represents an institutional consequence of market liberalization with direct implications for agricultural productivity.

This perspective closely aligns with the present study because it explains why similar policy reforms produce different outcomes among smallholder farmers. The theory suggests that agricultural productivity cannot be understood solely through technological adoption because farmers operate within institutional environments characterized by unequal access to labour, financial capital, extension services, and markets. Consequently, variations in maize production efficiency reflect not only differences in farm management but also differences in the institutional conditions shaping production decisions.

The empirical findings of this study strongly resonate with these propositions. Although many farmers have adopted certified seed varieties, the uptake of mechanization, irrigation, formal agricultural credit, and other complementary technologies remains comparatively low. Simultaneously, farmers continue to experience increasing labour costs, labour shortages, and declining communal labour-sharing arrangements. These findings indicate that market liberalization has accelerated technological change without generating corresponding improvements in the institutional systems required to sustain efficient agricultural production. The Political Economy of Agrarian Change therefore provides an appropriate framework for interpreting these uneven patterns of agrarian transformation.

The theory also provides the conceptual basis for the study's central proposition of Fragmented Agrarian Modernization. Rather than viewing agricultural modernization as a complete transition from traditional to commercial farming, the study argues that market liberalization has produced partial and uneven modernization in which technological innovations coexist with weak labour institutions, limited financial services, and declining forms of social capital. These structural imbalances help explain why improvements in technology adoption have not consistently translated into corresponding gains in maize production efficiency among smallholder farmers.

2.2.2 Sustainable Livelihoods Framework

To complement the macro-level perspective offered by the Political Economy of Agrarian Change, this study also draws on the Sustainable Livelihoods Framework (SLF) developed by the UK Department for International Development (DFID, 1999) and subsequently refined by Scoones (1998) and Ellis (2000). Whereas the Political Economy perspective explains how policy reforms and institutional changes shape agricultural systems, the Sustainable Livelihoods Framework explains how individual households mobilize available assets and capabilities to respond to these changing conditions. The Sustainable Livelihoods Framework conceptualizes livelihoods as the outcome of interactions among five forms of capital: human capital (knowledge, education, health, and labour), natural capital (land, water, and environmental resources), financial capital (credit, savings, and income), physical capital (farm equipment, infrastructure, and technology), and social capital (networks, trust, collective action, and reciprocal relationships). These livelihood assets operate within broader institutional and policy environments that either facilitate or constrain household livelihood strategies.

Within the context of this study, the framework is particularly relevant because market liberalization affects each of these livelihood assets simultaneously. Improved agricultural technologies enhance physical capital, while commercialization creates opportunities for income generation and financial accumulation. However, rising production costs, declining communal labour arrangements, and limited access to affordable credit may weaken financial and social capital, thereby reducing farmers' capacity to sustain productive agricultural enterprises. Labour itself is conceptualized as an element of human capital whose effectiveness depends not only on its availability but also on education, technical skills, health status, and institutional support.

The Sustainable Livelihoods Framework further recognizes that households continuously adjust their livelihood strategies in response to changing economic, environmental, and institutional conditions. Smallholder farmers therefore make production decisions based on the resources available to them rather than purely on market incentives. Farmers with stronger livelihood assets are generally better positioned to adopt improved technologies, manage production risks, and respond to market opportunities, whereas households with weaker asset portfolios remain vulnerable to production shocks despite operating within the same policy environment. This perspective complements the Political Economy of Agrarian Change by shifting analytical attention from macro-level institutional reforms to household-level decision-making. Together, the two theories provide a multi-level explanation of agricultural transformation. The Political Economy perspective explains how liberalization restructures markets, institutions, and labour relations, while the Sustainable Livelihoods Framework explains how farmers respond to these structural changes through their livelihood strategies and resource mobilization.

3. Methodology

This study adopted a convergent mixed-methods research design to examine how changes in farming practices and labour relations under market liberalization influence maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya. The design was appropriate because it enabled quantitative evidence on production efficiency to be complemented with qualitative insights into farmers' experiences, perceptions, and institutional realities, thereby providing a more comprehensive understanding of the phenomenon (Creswell & Plano Clark, 2018). The study was conducted in Trans-Nzoia County, Kenya's principal maize-producing region, selected because of its strategic contribution to national food security and its long-standing experience with agricultural commercialization following market liberalization. The target population comprised smallholder maize farmers in the major maize-producing sub-counties. A sample of 385 farmers was determined using Cochran's (1977) sample size formula, of whom 380 completed the survey and provided valid responses for analysis. A multistage sampling procedure was employed in which maize-producing sub-counties were purposively selected based on production intensity, followed by stratified sampling of wards and simple random sampling of villages and farming households to ensure broad geographical representation. For the qualitative component, participants were purposively selected on the basis of their knowledge and experience of maize production and agricultural commercialization. Data were collected using interviewer-administered structured questionnaires, Focus Group Discussion (FGD) guides, and Key Informant Interview (KII) schedules involving agricultural extension officers, county agricultural

officials, cooperative leaders, local administrators, and representatives of farmer organizations. The research instruments were pre-tested in a neighbouring area with similar socio-economic and farming characteristics, and minor revisions were made to improve the clarity and consistency of the instruments before the main field survey.

Data collection commenced after obtaining ethical approval from the relevant institutional ethics review committee and research authorization from the National Commission for Science, Technology and Innovation (NACOSTI), as well as permission from county and local administrative authorities. Participation was voluntary, informed consent was obtained from all respondents before data collection, and confidentiality and anonymity were maintained throughout the study. Quantitative data were coded and analysed using SPSS software. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' characteristics and key study variables, while chi-square tests, Pearson correlation analysis, and multiple regression analysis were employed to examine the influence of changing farming practices and labour relations on maize production efficiency at the 5% level of significance. Qualitative data from the FGDs and KIIs were audio-recorded with participants' consent, transcribed verbatim, and analysed thematically to identify recurring patterns and contextual explanations. Finally, the quantitative and qualitative findings were integrated through triangulation during interpretation, allowing areas of convergence and divergence to be examined and providing a richer understanding of how market liberalization has reshaped farming practices, labour relations, and maize production efficiency among smallholder farmers in Trans-Nzoia County.

4. Results and Discussion

This study examined how market liberalization has transformed farming practices and labour relations and how these interrelated changes influence maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya. The findings indicate that liberalization has expanded farmers' access to commercial technologies and private agricultural markets, thereby stimulating a gradual transition from traditional to market-oriented production systems. However, this transition has not occurred uniformly across the agricultural production system. While farmers have increasingly adopted selected technologies, particularly certified seed varieties, investments in complementary production inputs including mechanization, irrigation, agricultural credit, and skilled labour remain substantially constrained. Consequently, technological progress has outpaced institutional transformation, creating important gaps between innovation and production efficiency.

The findings further reveal that changes in farming practices cannot be understood independently of changes in labour relations. As market liberalization restructured agricultural production, labour organization also shifted from reciprocal community-based arrangements towards commercial labour markets characterized by rising labour costs, declining labour availability, increasing skill deficits, and weakening social capital. Rather than representing separate dimensions of agricultural change, farming practices and labour relations evolved simultaneously, each shaping the effectiveness of the other. Farmers adopting improved technologies frequently lacked the labour, financial resources, or institutional support required to utilize those technologies efficiently, while labour shortages often discouraged investments in complementary production innovations. The study therefore demonstrates that maize production efficiency is determined by the interaction between technological modernization and institutional transformation rather than by technology adoption alone.

4.1 Transformation of Farming Practices under Market Liberalization

Table 1: Adoption of Modern Farming Practices (n = 385)

Practice	Yes (%)	No (%)
Certified seeds	63	37
Mechanization	42	58
Agrochemicals	33	67
Credit access	26	74
Irrigation	18	82
Retained traditional practices	13	87

The adoption profile presented in Table 1 reveals that agricultural modernization under market liberalization has progressed unevenly across farming systems. Certified seed varieties were adopted by 63% of respondents, making them the most widely diffused agricultural innovation within the study area. Adoption declined substantially for technologies and services requiring higher levels of capital investment or institutional support. Mechanization was reported by only 42% of respondents, agrochemical use by 33%, formal agricultural credit by 26%, and irrigation by just 18%. Conversely, only 13% of respondents indicated that they continued relying predominantly on traditional farming practices. These findings demonstrate that market liberalization has stimulated technological change, but modernization remains selective rather than systemic.

Operationally, these findings indicate that farmers have entered the modernization process but have not progressed to a stage where complementary technologies function as integrated production systems. Certified seed adoption reflects relatively low barriers to market entry because improved seed is increasingly available through agro-dealers, farmer cooperatives, and public distribution programmes. However, technologies requiring larger financial investments such as mechanization, irrigation, and formal credit remain inaccessible to a considerable proportion of households. This uneven adoption trajectory results in hybrid farming systems where modern technologies coexist with traditional production methods, limiting the efficiency gains expected from agricultural commercialization.

The implications for maize production efficiency are significant. Improved seed varieties are designed to perform optimally when combined with adequate soil fertility management, reliable moisture, timely planting, effective weed control, mechanized land preparation, and efficient harvesting. Where these complementary inputs are absent, farmers cannot fully realize the yield advantages associated with improved genetic material. Consequently, productivity losses arise not because the technologies themselves are ineffective but because they are implemented within incomplete production systems. Market liberalization has therefore expanded access to individual technologies without simultaneously strengthening the institutional and financial conditions required for integrated agricultural production. The experiences shared by farmers reinforce these quantitative patterns. During the focus group discussions, participants consistently described modernization as a gradual process constrained by financial realities rather than a reluctance to innovate.

One farmer observed: *"We use certified seed because we know it produces better yields, but improved seed alone is not enough. Without fertilizer, irrigation and timely labour, the harvest does not match our expectations."* (FGD 2, Male Farmer, Kiminini Sub-County). Another participant explained: *"Each season we have to choose which technology we can afford. Sometimes we hire a tractor but reduce fertilizer. Other times we buy fertilizer but plant late because we cannot pay for land preparation. We cannot afford everything at once."* (FGD 3, Female Farmer, Saboti Sub-County) A County Agricultural Officer provided a broader institutional perspective: *"Farmers have embraced modern agriculture, but the supporting systems have not kept pace. Credit remains expensive, irrigation infrastructure is limited, and mechanization services are still inaccessible for many smallholders."* (KII 4, County Department of Agriculture)**.** These accounts illustrate that adoption decisions are shaped less by farmers' willingness to modernize than by the institutional environment within which production occurs. Knowledge of improved farming practices is widespread, yet implementation remains constrained by limited financial capital, weak rural credit systems, inadequate infrastructure, and fluctuating input prices.

These findings corroborate earlier work by Feder, Just and Zilberman (1985), who argue that agricultural innovations are complementary rather than independent. Similar observations have been reported by Doss (2006), Liverpool-Tasie et al. (2017), AGRA (2023), and recent FAO assessments, which show that technology adoption among African smallholders is frequently constrained by incomplete input markets and weak institutional support. The present findings extend this literature by demonstrating that selective technology adoption is not merely a household-level decision but a manifestation of broader institutional asymmetries created during market liberalization. From the perspective of the Political Economy of Agrarian Change, these findings demonstrate that market incentives alone are insufficient to produce broad-based agricultural modernization. Instead, access to technology remains mediated by institutional arrangements, financial capacity, and unequal access to productive resources. Similarly, the Sustainable Livelihoods Framework explains that adoption decisions depend upon the interaction of financial, physical, human, and social capital. Households possessing stronger livelihood assets are able to combine complementary technologies more effectively than resource-constrained households, thereby achieving higher levels of production efficiency.

5.2 Transformation of Labour Relations and Maize Production Efficiency

The transformation of labour relations represents one of the most significant consequences of market liberalization observed in this study. The findings indicate that labour has shifted from being primarily coordinated through

reciprocal community institutions to being increasingly organized through commercial labour markets. Although commercialization has expanded farmers' flexibility in sourcing labour, it has simultaneously increased production costs and introduced new forms of uncertainty that directly influence maize production efficiency. This is shown in Table 2 below.

Table 2: Labour Constraints (n = 385)

Labour Constraint	Frequency	Percentage (%)
High labour costs	306	82
Poor labour skills	267	72
Labour shortages	256	69
Unreliable labour	221	60

Results in table 2 above indicate that over (82%) of respondents identified labour costs as their greatest production constraint, while 72% cited inadequate technical skills among hired workers. Labour shortages affected 69% of respondents, and 60% reported difficulties associated with unreliable labour supply. Collectively, these findings demonstrate that labour constraints are multidimensional, affecting affordability, quality, availability, and timeliness simultaneously.

Operationally, these labour constraints have direct implications for production efficiency. High labour costs increase the overall cost of production and reduce farmers' capacity to invest in complementary inputs such as fertilizer, mechanization, and pest management. Labour shortages delay time-sensitive agricultural operations, including land preparation, planting, fertilizer application, weeding, and harvesting. Such delays reduce crop establishment, increase weed competition, expose maize to climatic variability, and ultimately diminish yields. Poor labour skills further reduce labour productivity because incorrectly applied fertilizer, poor planting practices, or ineffective weed management compromise the performance of improved technologies. Thus, labour transformation affects maize production efficiency through both economic mechanisms (increased production costs) and technical mechanisms (reduced quality and timeliness of farm operations).

Farmers consistently emphasized these interconnected challenges during the qualitative interviews. One respondent explained: *"Nowadays labour is available only if you have enough money. Even then, experienced workers are difficult to find because many young people prefer other jobs."*(FGD 5, Male Farmer, Cherangany Sub-County). Another participant added: *"Sometimes we postpone planting because we cannot raise enough money to hire workers. When the rains come early, delayed planting means we already lose part of the harvest."* (FGD 6, Female Farmer, Kwanza Sub-County).

An elderly village leader reflected on the institutional changes that have accompanied commercialization: "In the past, neighbours worked together during planting and harvesting. Today everyone asks for payment first. Community cooperation has reduced, and farming has become an individual struggle." (KII 3, Village Elder, Endebess Sub-County). Similarly, an extension officer observed: "Modern farming requires skilled labour, yet most casual workers have never received practical agricultural training. Farmers therefore spend more time supervising work or correcting mistakes, increasing production costs."(KII 7, Agricultural Extension Officer).

These narratives reveal that labour transformation extends beyond wage increases to encompass broader institutional changes within rural society. Commercialization has gradually replaced reciprocal labour-sharing arrangements that historically reduced production costs, strengthened collective action, and facilitated the transfer of agricultural knowledge. While market-based labour systems improve labour mobility, they also weaken the social institutions that once enhanced resilience during periods of labour scarcity. Consequently, labour markets have become increasingly dependent on financial capital while becoming less embedded in community reciprocity.

These findings are consistent with Barrett et al. (2010), Jayne et al. (2014), and more recent evidence from FAO (2024), IFPRI (2024), and AGRA (2023), which identify labour shortages, rural out-migration, rising wage costs, and declining participation in collective farming arrangements as major constraints to agricultural productivity across Sub-Saharan Africa. However, the present study advances this literature by demonstrating that labour transformation should not be interpreted solely as a labour market phenomenon. Instead, it reflects broader institutional changes affecting social capital, collective action, knowledge transmission, and household production strategies.

From a theoretical perspective, the findings strongly support the Political Economy of Agrarian Change, which views labour as a socially embedded institution whose organization changes alongside market reforms. Simultaneously, the Sustainable Livelihoods Framework explains that labour productivity depends upon interactions among human, financial, physical, and social capital. The weakening of social capital alongside persistent financial constraints reduces households' ability to mobilize labour efficiently, even where improved agricultural technologies are available.

Taken together, the findings from Sections 4.1 and 4.2 demonstrate that market liberalization has produced neither complete traditional agriculture nor complete commercial agriculture. Instead, the evidence supports what this study conceptualizes as Fragmented Agrarian Modernization (FAM) a transitional agrarian condition in which technological innovation advances more rapidly than the institutional, financial, labour, and governance systems required to support efficient agricultural production. Under FAM, farmers increasingly adopt improved technologies while remaining constrained by weak rural credit systems, incomplete mechanization, labour market imperfections, declining social capital, and limited institutional support. These interacting constraints reduce the efficiency with which productive resources are combined, resulting in lower yields, delayed agricultural operations, higher production costs, and uneven modernization outcomes.

The conceptual contribution of Fragmented Agrarian Modernization extends beyond the empirical case of Trans-Nzoia County. It offers an analytical lens for understanding why productivity gains under market liberalization remain inconsistent across many smallholder farming systems in Sub-Saharan Africa. The findings suggest that future agricultural policies should move beyond promoting individual technologies towards strengthening the complementary institutional systems that enable those technologies to generate sustained improvements in production efficiency. Investments in affordable rural finance, labour skills development, mechanization services, irrigation infrastructure, extension systems, and farmer organizations are therefore likely to produce greater productivity gains than technology diffusion alone.

5. Conclusion and Recommendations

5.1 Conclusion

This study examined how the transformation of traditional farming practices and labour relations under market liberalization influences maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya. The findings demonstrate that market liberalization has accelerated the transition from subsistence-oriented farming to increasingly commercial agricultural systems by expanding access to improved seed varieties, private input markets, and market-based labour arrangements. However, this transformation has remained incomplete and uneven. While farmers have progressively adopted selected modern farming technologies, access to complementary production resources including mechanization, irrigation, agricultural credit, skilled labour, and institutional support remains constrained. Consequently, the anticipated productivity gains associated with market liberalization have not been fully realized because technological innovation has advanced more rapidly than the institutional systems required to sustain efficient agricultural production.

The study further demonstrates that labour relations constitute a critical yet often overlooked determinant of maize production efficiency. The gradual replacement of reciprocal labour-sharing arrangements with commercial labour markets has increased production costs, reduced labour reliability, weakened social capital, and constrained the timely execution of essential farm operations. Rather than functioning independently, farming practices and labour relations interact dynamically to shape production efficiency. Farmers' ability to benefit from modern technologies depends not only on technology adoption but also on access to affordable, skilled, and reliable labour, as well as supportive financial and institutional environments. The findings therefore suggest that productivity constraints in liberalized agricultural systems arise from the fragmented evolution of complementary production systems rather than from farmers' unwillingness to modernize.

A major contribution of this study is the development of the concept of Fragmented Agrarian Modernization (FAM). The study defines Fragmented Agrarian Modernization as a transitional agrarian condition in which technological innovation advances more rapidly than the institutional, financial, labour, and governance systems necessary to convert innovation into sustained production efficiency. This conceptualization extends existing theories of agricultural commercialization by demonstrating that market liberalization does not automatically generate comprehensive agricultural modernization. Instead, modernization occurs unevenly as farmers selectively adopt technologies while remaining constrained by weak labour markets, inadequate rural finance, declining social capital, and incomplete institutional support. The concept provides a useful analytical framework for explaining why productivity improvements remain inconsistent across many smallholder farming systems in Sub-Saharan Africa despite increasing access to modern agricultural technologies.

Collectively, these findings underscore the need to rethink agricultural transformation beyond technology-centred

interventions. Sustainable improvements in maize production efficiency require integrated policy approaches that simultaneously strengthen technological innovation, labour systems, rural financial markets, extension services, farmer organizations, and institutional coordination. Agricultural modernization should therefore be understood not simply as the diffusion of improved technologies but as the coordinated transformation of the interconnected systems that enable farmers to translate innovation into higher productivity, resilience, and sustainable livelihoods.

5.2 Policy Recommendations

The findings indicate that improving maize production efficiency requires policy interventions that move beyond promoting isolated technologies toward strengthening the institutional ecosystem that supports agricultural production:

1. National and county governments should expand access to affordable agricultural finance through farmer-friendly credit facilities, guarantee schemes, and low-interest lending programmes tailored to smallholder producers. Improved access to finance would enable farmers to adopt complementary technology packages including mechanization, irrigation, quality inputs, and labour-saving innovations rather than relying on partial modernization strategies that limit productivity gains.

2. Investment in mechanization services and rural infrastructure should be prioritized. Expanding community-based machinery hiring centres, improving irrigation infrastructure, and strengthening rural transport networks would reduce labour bottlenecks, lower production costs, and improve the timeliness of agricultural operations. These investments are particularly important in major maize-producing regions where seasonal labour shortages continue to constrain production efficiency.

3. Agricultural extension systems should shift from technology dissemination alone toward integrated capacity development. Extension programmes should strengthen farmers' technical competencies while simultaneously supporting labour management, farm business planning, financial literacy, climate-smart agriculture, and efficient resource allocation. Capacity-building initiatives should also target casual agricultural workers to improve labour quality and enhance the effective implementation of modern farming practices.

4. Policymakers should strengthen collective institutions that rebuild social capital within rural communities. Supporting farmer cooperatives, producer organizations, labour-sharing associations, and community-based mechanization groups can reduce transaction costs, improve access to agricultural services, facilitate knowledge exchange, and enhance farmers' bargaining power within liberalized markets. Such institutions provide important mechanisms for overcoming the coordination failures identified in this study.

5. Agricultural policy should adopt a systems-based approach to modernization. Rather than evaluating success solely through technology adoption rates, policy frameworks should assess whether complementary institutional conditions such as labour availability, financial inclusion, extension support, market access, and governance capacity are evolving alongside technological innovation. Such an integrated approach would address the structural fragmentation identified in this study and improve the long-term efficiency and resilience of smallholder maize production systems.

5.3. Contribution to Knowledge

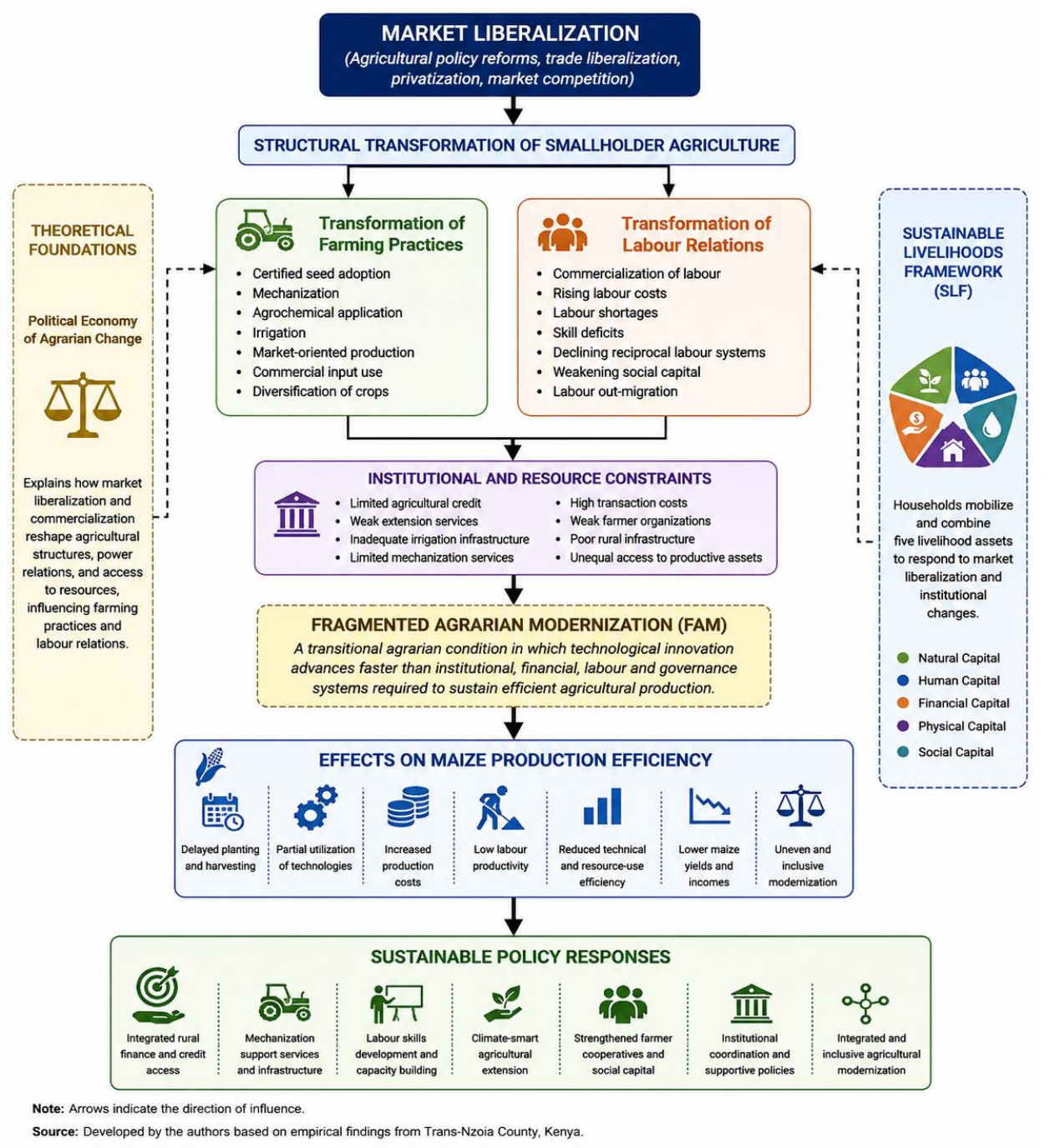

Figure 1. Fragmented Agrarian Modernization (FAM) Model
Source: (Wafula et al. 2026)

Figure 1 presents the Conceptual Model of Fragmented Agrarian Modernization (FAM), developed inductively from the empirical findings of this study and interpreted through the Political Economy of Agrarian Change and the Sustainable Livelihoods Framework. The model explains the pathways through which market liberalization reshapes agricultural production systems and labour organization, ultimately influencing maize production efficiency among smallholder farmers in Trans-Nzoia County, Kenya. It provides an integrated geographical perspective that links policy reforms, production systems, institutional environments, and livelihood resources within a liberalized agricultural economy.

The model identifies market liberalization as the principal driver of agricultural transformation. Liberalization has altered the organization of agricultural production by increasing farmers' access to private input markets, improved seed varieties, mechanization services, agrochemicals, and commercial marketing channels. At the same time, it has transformed rural labour systems by replacing traditional reciprocal labour arrangements with increasingly market-oriented employment relationships characterized by rising labour costs, labour shortages, skill deficits, and weakening community-based support systems. These changes demonstrate that agricultural transformation extends beyond technological adoption to include broader reorganization of rural production systems, labour institutions, and resource allocation.

The Political Economy of Agrarian Change provides the macro-level explanation for these transformations by illustrating how market reforms restructure access to productive resources, alter labour relations, and reshape patterns of agricultural commercialization. In contrast, the Sustainable Livelihoods Framework explains how differences in farmers' access to financial, human, physical, natural, and social capital influence their capacity to respond to these structural changes. From a geographical perspective, these livelihood assets are unevenly distributed across rural landscapes, creating spatial differences in farmers' ability to adopt modern technologies, organize labour, and sustain productive farming systems.

The model further demonstrates that technological transformation occurs within a context of persistent institutional and resource constraints, including inadequate access to agricultural credit, weak extension services, limited mechanization facilities, insufficient irrigation infrastructure, high transaction costs, and weak farmer organizations. These constraints interrupt the integration of complementary production resources required for efficient maize production. Consequently, farmers frequently adopt individual technologies without simultaneously acquiring the institutional and financial support necessary to maximize their productive potential.

This interaction gives rise to what this study conceptualizes as Fragmented Agrarian Modernization (FAM). Fragmented Agrarian Modernization refers to an asynchronous process of agricultural transformation in which technological innovation advances more rapidly than the institutional, financial, labour, and governance systems required to convert innovation into sustained production efficiency. Rather than representing complete agricultural modernization, FAM describes a transitional condition where technological progress coexists with persistent structural weaknesses. The concept therefore shifts attention from technology adoption alone to the broader geographical organization of agricultural systems and the institutional conditions that shape production outcomes.

The model further illustrates that fragmentation influences maize production efficiency through multiple interconnected pathways. Because agricultural production depends on the coordinated interaction of complementary inputs including technology, labour, finance, infrastructure, and institutional support any imbalance within these systems reduces production efficiency. Incomplete modernization contributes to delayed planting and harvesting, inefficient utilization of improved technologies, increased production costs, lower labour productivity, reduced technical and resource-use efficiency, and ultimately lower maize yields. The findings therefore demonstrate that productivity is determined not simply by access to technology but by the degree of integration among the various components of the agricultural production system.

The model concludes by identifying integrated policy responses necessary for sustainable agricultural transformation. These include strengthening rural financial systems, expanding mechanization services, improving irrigation infrastructure, enhancing agricultural extension, developing labour skills, supporting farmer cooperatives, and improving institutional coordination across agricultural value chains. Such interventions address the systemic constraints identified in the study and promote more efficient, resilient, and geographically inclusive agricultural development.

The principal contribution of the model is the introduction of Fragmented Agrarian Modernization (FAM) for explaining uneven agricultural transformation under market liberalization. Unlike conventional modernization perspectives, which frequently assume that technological diffusion naturally translates into higher agricultural productivity, the FAM model demonstrates that productivity gains depend on the synchronized evolution of technological, institutional, financial, labour, and governance systems operating within specific geographical contexts. By highlighting the consequences of asynchronous transformation, the model extends existing theories of agricultural commercialization and contributes to agricultural geography by providing a spatially informed explanation of why productivity improvements remain uneven across smallholder farming systems in Kenya and other parts of Sub-Saharan Africa.

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