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SUSTAINABILITY OF THE RURAL LAND REGISTRATION INFORMATION SYSTEM: IMPLICATIONS FOR CREDIT AND INVESTMENT IN SUSTAINABLE LAND MANAGEMENT IN ETHIOPIA

PhD Dissertation

Shewakena Aytenfisu Abab

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Sustainability of the Rural Land Registration Information System: Implications for Credit and Investment in Sustainable Land Management in Ethiopia

By

Shewakena Aytenfisu

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Supervisors

Feyera Senbeta (Ph.D.), Professor, Addis Ababa University, Ethiopia

Tamirat Tefera (Ph.D.), Associate Professor, Addis Ababa University, Ethiopia

Addis Ababa, Ethiopia

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DECLARATION

Declaration by candidate

I, Shewakena Aytenfisu Abab, declare that this dissertation is my own original work with the guidance and close direction of my supervisors, and it has never presented for degree in any other institution.

Signed_____ Date

_____

Declaration by supervisors

This dissertation has submitted for examination with my approval.

Signature_____ Date_____

Main supervisor's name: Feyera Senbeta (Ph.D., Professor)

Center for Environment and Development

STATEMENT OF AUTHOR

I have learned the deep-rooted inequality and insecurity of land tenure rights among the rural communities in Ethiopia which inspired me and charted my career in the field of land administration at an early stage of my career. My eye-breaking job was my engagement as junior statistician in the ever and first of its kind Ethiopian Agricultural Sample Enumeration (EASE) conducted between 2001 and 2002 under the auspices of the Ethiopian Agricultural Census Commission and implemented by the then Central Statistical Authority (CSA). This engagement provided me an opportunity to understand the deep-rooted land tenure insecurity and inequality among rural farmers in Ethiopia that limited their development capacity and trapped them in poverty. It was in that moment that I decided to join a land administration institution to contribute my own part to eliminate this binding constraint and disincentive for farmers' long-term and sustainable investment in their ultimate means of livelihoods, land and protect their environment sustainably. After completing my junior statistician contract with CSA in 2002, I joined the newly established Amhara Regional State Environmental Protection Land Administration and Use Authority as land administration expert in 2003 which cemented my ambition to become a land administration professional.

Between 2005 and 2007, I studied for my master's degree in Sweden with a major in the built environment specializing land management, and acquired new skills and world view that helped me hugely to become an enthusiastic and result-oriented land administration professional. Since then, I navigated through an exciting and challenging job career both in public, private and non-government development organizations. At the proper time, I have seen inspiring and touching stories of communities and individuals, particularly women and vulnerable groups, whose land tenure rights secured, and their lives and livelihoods improved significantly due to the development interventions that I have been involved with.

However, since 2016, working for the World Bank as a short-term consultant helped me to apply my technical skills and knowledge in land administration into broader development agenda including environment and natural resources management, forested landscape and watershed management, poverty reduction and social cohesion and inclusions, urban development and management, agriculture and food systems, and climate change and development supporting programs. But what I realized is that I should pursue my Ph.D. study that would help me develop critical thinking and analytical skills to serve my country and communities of development professionals at a higher-level of responsibility. That is why I applied and joined the Ph.D. program

in Addis Ababa University, College of Development Studies in October 2018. I hope the skills and knowledge that I have acquired during my Ph.D. study will help me serve the world's poorest people, not only in Ethiopia, but also at the global scale in the field of land administration and environment and development nexus. Going forward, I will try my level best to help communities, people, business firms, and their governments to make land tenure and resource rights secure and fungible to all and bring about sustainable environment and development outcomes in the ever-changing climate and world order.

DEDICATION

For all those who sacrifice their life for peace, human dignity, and environmental justice.

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ABBREVIATIONS

BoL	Bureau of Land
ELAP	Ethiopia Land Administration Program
ELTAP	Ethiopia Land Tenure Administration Program
ESIF	Ethiopia Strategic Investment Framework for Sustainable Land Management
FLLC	First Level Landholding Certification
LAS	Land Administration System
LIS	Land Information System
LTIFs	Land Tenure Institutional Factors
LRIS	Land Registration Information System
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
NRLAIS	National Rural Land Administration Information System
SLLC	Second Level Landholding Certification
SLM	Sustainable Land Management
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
UTAM	Unified Technological Acceptance Model

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GENERAL ABSTRACT

Land is one of the fundamental natural capitals and means of livelihoods for most of Ethiopian population in the rural landscapes. However, centuries of dependencies and unsustainable exploitations of this critical natural capital for sustaining livelihoods led to severe environmental degradation and disruption of ecosystems functions. To avert this situation Ethiopia has been implementing different interventions since early 2000s in the land administration front including policy and legal reforms, institutional restructuring, business processes reengineering, mass systematic land registration, and digitizing of land registers. While the available literature shows that these interventions improve tenure security and land administration service delivery, little has researched on the sustainability of the digital land registers called the National Rural Land Administration Information System (NRLAIS) and its implications for credit and investment in sustainable land management (SLM).

By exploring the driving factors of the acceptance and actual use of the system in delivering land administration services, the study explores whether the NRLAIS is sustainable and assesses its implications for credit and investment in an on-farm SLM. To help generate new insights and fill this evidence gap, primary and secondary data were collected using surveys (from smallholder households and woreda land experts), key informant interviews with regional and federal land administration officials as well as micro finance officers, focus group discussions with Kebele administration officials and land administration committee members, literature review and policy analysis. A probit regression and structural equation models used as well as descriptive and inferential statistics substantiated by qualitative explanations were employed to analyze the data collected.

The results indicated that several factors influence the acceptance and actual use of NRLAIS among land experts as a good proxy predictor of its sustainability. These factors include system quality, information quality, service quality, perceived ease of use, and perceived usefulness of the system. Landholders' formalization of subsequent land rights transactions after first-time land registration also significantly influenced by attitude, subjective norms, and intentions with implication for the up-to-datedness of the information in the NRLAIS. The results also indicate that access to information from the NRLAIS increases the creditworthiness of small landholders and reduces transaction costs and risks. Policy and legislative reforms in collateralizing land use rights incentivizes financial institutions to develop and provide a new loan product tailored to smallholders using land certificates as collateral. These reforms represent unique opportunities and

allow smallholder households to access the capital required to move from subsistence farming to more productive, market-oriented, and sustainable land use management practices. This has multiple policy and practice implications including a) land administration reforms need long-term and programmatic approaches, particularly land-IT system adoption should be context specific and fit-for-purpose, follow incremental approach including business process reengineering and data quality enhancement, b) maintenance and timely updating of the information in the land registers is critical which should also be given due consideration supported by reforming secure transaction law and expanding digitalizing of the land registers, raising awareness of land rights holders on the need to formalizing subsequent land transactions, creating user's incentives such as making service centers closer to landholders, and valuing land resource for higher land rights tradability such as credit market, c) consideration of land tenure institutional factors along the categories of security of tenure and bundle of rights for possible tradeoffs and synergies in the context of effective SLM policy that help to incentivizes small landholders' on-farm SLM investment.

Key words: land administration, land registration, land information system, tenure security, credit, investment, sustainability, Ethiopia

1. CHAPTER ONE. GENERAL INTRODUCTION

This chapter provides an introductory background of the study. It also highlights what is known in the existing body of knowledge and the motivation why the researcher draws attention to this research topic. It also briefly discusses the problem statement, the key research questions, and overall and specific objectives of the research. The closing section of this chapter features the significance and scope of the study and highlights the structure of the dissertation.

1.1 Background and Justification for the Study

Land is a key natural resource, means of livelihood, and development asset for many societies in the world. With increasing pressure and competition for land resources, the need for clear and secure tenure rights for all men and women, youth, communities, and business firms are an essential development issue. In recent years, there has been increasing awareness of the importance of land administration and governance globally in the face of multiple development challenges. Scholars and development practitioners argue that efficient land administration and natural resources governance practices and their spatial enablement are essential to achieve numerous global, regional, and national development goals and commitments including the UN land degradation neutrality and Decade on Ecosystem Restoration, the New Urban Agenda, the COP21 Paris climate change agreement, and Sustainable Development Goals (SDGs) [1–3]. Achieving these goals requires understanding how land-to-societies relationships are defined, recognized, organized, and governed. Governing such resources in turn requires appropriate policy, legal framework, organizational structures, financing mechanisms, knowledge and power that targeted at societal changes. Besides, governing these relationships need accurate, complete, and accessible information emanating from a functional land and property rights registration system [2].

To help this societal development agenda meet their objective, countries have established land administration systems which created to record and disseminate information about people's relationships to land including rights, responsibilities, restrictions, location and boundaries, and other attributes of land and real properties [4]. Depending on the context, the strengthening of land rights can take a variety of forms, from documenting customary uses to formalizing individual and communal rights [5]. Central to securing tenure rights is the existence of an efficient and well-functioning land registration system though not sufficient on its own [6]. While in other instances, existing customary land tenure systems may be sufficient to ensure land tenure security [7]. In the

developing world, land registration and administration programs and procedures to implement these programs are among the major reasons of failure or success to achieve strong tenure security. While comparative studies encouraged previously [8], context-specific studies on land registration systems organizations and their effectiveness or success as well as channels of impact promoted recently [9].

Over the past two decades, while attention accorded to the initial establishment of land administration systems, less attention given to their sustainability and maintenance [10]. In fact, now when land registered initially, records in the land register are open to changes due to subsequent land rights transactions. These records change either during full transfer (entailing textual records change), or during partial transfer of rights due to property formation (entails both textual and cadastral map changes) [11]. The changes can also occur due to change in the processes of recording or change in laws and poorly thought through design or inadequately resourced land administration programs [10]. This requires a genuine willingness, participation, and cooperation of land rights holders to report changes. Otherwise, the land register can quickly lose its functionality and sustainability since outdated records in the land register contradict the realities on the ground.

While scholars differ in their views on the exact factors that influence the reporting and non-reporting of land transactions, what they have in common is that they all relate this challenge with administrative challenges [12]. Although the formal administrative system influences, also influenced by the socio-cultural context and behavioral attitudes of landholders towards the value of land registration [13]. Likewise, land rights holders might not be incentivized to report and formalize changes in their land rights after first-time land registration and certification, if land laws lack provisions that encourage or force them to do so. This slowly but surely influences the overall functionality and sustainability of the land administration information system of the country.

The other issue related to sustainable land administration information systems is related to technological innovation. To help the acquisition, organization, storage, management, and dissemination of information in a land register in an efficient and effective manner, countries have been digitizing their land administration systems. The digital transformation is about responsibly moving the entire sector from a paper-based, manual service mode, towards one that fully delivered by a digital technology [14]. This brings about increased availability and accessibility of land information for more efficient operations and decision making. This increases service delivery and

promotes land market efficiency, improves land revenue generation for local governments, and stimulates economic growth through current information products and services [15]. Digitization also enhances accountability, transparency, equality, and investment prioritization [2]. Hence, to sustainably maintain land administration systems demand systematic, unified, and durable digital solutions. However, it is impossible for any land administration information system to become sustainable without significant acceptance and actual use among its users. Hence, investment decisions in this area need to consider the demand for services and the incentives for participation in the land administration systems.

Since the 1950s, land reforms in Ethiopia have continuously been one of the top development agendas of the successive governments that ruled the country. Over the same period, Ethiopia has undergone through various socio-economic, political, and environmental challenges. Land tenure and its governance has been one of the makers and breakers of political power relations, determinants of economic growth, and environmental sustainability. For instance, with the aim to establish legally binding land tenure system in Ethiopia, the government of Emperor Haile Selassie I implemented the *qalad* system vigorously after the 1942 decree [16]. However, little was achieved until the downfall of his government in 1974 due to various challenges. *Qalad* system is a land measurement and registration system that evolved since the 19 centuries in Ethiopia [16].

With the aim of improving land tenure security and incentivizing land-based investment, Ethiopia has successfully undertaken the world's most cost-effective and largest land certification program since late 1990s [17, 18]. The program was implemented in the Amhara, Oromia, Tigray, and the former South Nations Nationalities and Peoples regional states. Scholars documented the positive economic, social, and environmental outcomes of this massive program in the highland regions of Ethiopia [19–22]. However, the First Level Landholding Certification (FLLC) program was not without shortcomings including lack of spatial reference of parcels and incompleteness of tenure information, among others [18, 21, 22]. Besides, since land rights continuously change through transfers of rights, the land registers need sustained maintenance [23]. Since 2013, Ethiopia continues deploying more resources upgrading the FLLC into the Second Landholding Certification (SLLC) and addressing the gaps in the registers that incentivizes landholders more to invest in sustainable land use management and increase productivity.

At the heart of the recent land administration reform is expanding the SLLC coverage and digitization of the manual land registers. Between 2015 and 2017, the Ministry of Agriculture (MoA) has developed and piloted a digital land information system called National Rural Land Administration Information System (NRLAIS) that helps to convert data in the land register into digital form [24]. NRLAIS is a web-based, nationwide, and decentralized system developed separately from, but in coordination with, the manual registry system. The NRLAIS focuses on the process of maintenance of the land register for continuous updating of land records [25]. Under this context, NRLAIS forms the framework and defines the role of stakeholders and their relationship among personnel, data, hardware, software, standard operating procedures, and infrastructure requirements [26]. It also manages and serves as a legitimate bearer of land registration information including the socio-spatial aspects of landholdings and users' rights to land. Supported by different development partners including the World Bank, UK-DFID, Finland, Norway, and Canada, NRLAIS implemented into over three hundred Woredas with twenty-two million plus parcels of landholdings digitized since 2018 [26].

However, little is known about what factors influence the acceptance and actual use of NRLAIS among land experts at the woreda level as a proxy predictor of its operational success and sustainability. Besides, while updating the land register considered as a concern from sustainability point of view [18, 23], little is known whether landholders' behavior drive lack of updating and what factors influence their lack of formalization of subsequent land transaction is unclear. While researchers also argue that the theory that land certification would increase opportunities to access credit [27, 28], this argument does not differentiate access to information from NRLAIS increases small landholders' creditworthiness in Ethiopia. Hence, there is no rigorous research about the implication of the land administration information system underpinned by policy and regulatory reforms and technological innovations to creditworthiness of small landholders in Ethiopia. Moreover, while the positive effects of land certification on tenure security and investment have been documented [28–30] little is known about the effect of land tenure institutional factors on smallholders' on-farm SLM investment through the lens of tenure security categories (de jure, de facto, and perceived) along bundle of rights in the pertinent land administration laws. Therefore, this research designed to examine the sustainability of the national rural land administration information system with implications to credit and investment in SLM in Ethiopia.

1.2 Literature Review

Starting with a discussion on the land tenure theory, this section briefly discusses key concepts and theories that frame the research topic. It also analyses related empirical studies in the field and demonstrates why and how the selected theories applied in this research undertaking. The final parts of this section outline the research purpose statement which summarizes the conclusion reached about the major trends and development in the topic under discussion.

1.2.1 Theories of Land Tenure and Development

The available literature on land tenure theory has evolved over time and contains conflicting statements and arguments both on the causes and consequence of land tenure security and its effect on development outcomes. However, different orientation of land tenure theory can take diverse conceptualization discourses. These diverse conceptions affect the design and implementation of ranges of policy options including the legalization or formalization of land tenure and the causal link to ranges of development outcomes [31, 32]. Particularly, the meaning of land tenure security is eclipsed by uncertainty in developing countries context, hence impeding the growing discourse focused on land tenure security [33–35] and its causal effect on environment and development outcomes. This is because the concept of land tenure and its security are complex matters and so are its drivers, effects, and remedies of insecurity of tenure.

Hence, any attempts of land tenure discussion need to recognize the importance of cultural, historical, and political influences, as well as those of technical and legal systems that shapes land tenure and property rights institutions [9, 36]. Institutions, here, can take as rules, norms, and principles that shape human interactions [37, 38]. In a land reform program, defining institutions in this way directs the analysis how the reform process eliminates or minimizes constraints (high transaction costs) and enhance incentives to access credit and investment in sustainable land management [39]. Besides, it also contributes to the understanding of how property rights in land can organized to prevent externalities to resources owners and the society at large [40].

Therefore, from the outset, it is critical to define the concepts of land tenure and property rights and distinguish their difference and similarity. According to UN-Habitat [41] land tenure defined as the way land held or owned by individuals and groups, or the set of relationships legally or customarily defined amongst people with respect to land. A more nuanced land tenure definition given by Payne et al [36] as recognized interests in land or a property vested in an individual or group and can apply

separately to land or development on it such as house, buildings, or trees. On the other hand, the term property right refers to a bundle of rights to use, control, and transfer assets, including land [36, 42]. Others refer to an owner's right as a private property to use a good or asset for consumption and/or income generation (referred to as "use rights") [39]. This property right can also include the right to transfer to another party in the form of sale, gift, or bequest (referred to as "transfer rights") and convoys the right to contract with others in the form of renting, pledging, or mortgaging a good or asset or by allowing other parties to use it [36, 39, 43]. Therefore, the common attributes for the term land tenure and property rights are that both can used to refer to the rights held in land and its fixture including water, forest, wildlife and, in cases, mineral resources [44]. These relations as institutions may established by the state or custom, and these rights may accrue to individuals, families, communities, or organizations [5, 43].

Likewise, depending on the school of thought, scholars try to define the term secure land tenure. Overall, three schools of thoughts are identified including economic or market oriented, legal based, and adaptation paradigms [31, 34]. Marie et al [33] in their recent work systematically review the available literature and conclude that a fragmented set of reductionist approaches that result in narrow definition of land tenure security [32]. These narrow conceptions impede more complete analysis and discourse of land tenure security including policy formulation, implementation, and evaluation of its development outcomes. However, regardless of all forms of land tenure, whether private, community, state, or communal, are prone to insecurity [5], insecurity of tenure depends on the composition of their bundles of rights [45] in a particular context including how it is defined and enforced [43]. Hence, any land tenure regime sees the issue in perspective and approached as a system in its totality and considered as part of a complex structure regulating the social relationships among citizens in each society [46]. Therefore, to capture the broader spectrum of secure tenure and its effect on development and environment, a triple dimension of legality, legitimacy, and certainty [33, 43] are especially important to consider in the analysis. This is essential realizing the benefits within the bundles of rights, mediating investment, safeguarding incentives, securing inclusion in governance, and guaranteeing the safety of property over land [5]. However, it is also worth noting the spatial dimension of secure tenure as well and implication to divergent development paths.

The other important concepts that come to mind is the significant heterogeneity in the duration, quality, divisibility, flexibility, exclusivity, and transferability of these rights called characteristics

of property rights [47, 48]. Some refer this as a bundle of property rights which commonly include access, withdrawal, management, exclusion, alienation, transferability [5, 43], and the rights to compensation in an event of expropriation [36]. Property rights systems include mechanisms to resolve disputes, defend rights, and administer or manage land-based resources through tenure institutions in the form of a statutory structure or customary arrangement [42].

Security of tenure is another important concept in land tenure and property rights study. This is the perception by right holder that rights to land recognized by others and protected in the event of specific challenges [49]. Broadly speaking, a property right is secure when a person perceives it to be stable and predictable over reasonable period and legally protected from expropriation or arbitrary change, with claims that backed up by a type of authority [50]. However, the quality of security of tenure depends on how it measured. Scholars [9, 45, 51] distinguish the categories of secure tenure rights into three, namely de jure/legal, de facto/context, and perceived/socio-psychological tenure security.

Nonetheless, multifaceted, and multi-level appearances of land tenure and its recognition in the form of land registration systems around the world should always clearly see this in perspective as simplifications obscure its complex nature. Hence, a land registration system also approached as a system in its totality and considered as part of the complex structure of property rights institutions [11, 33, 36]. This is because most accepted central theories of land tenure and property rights are related to land titling and cadaster or system of land registration-based, primarily on economic determinism and modernization theory, and various alternatives to this theory [6, 36, 52]. The economic case for secure land and property rights is that growth depends on investment [50]. As economic determinism, the structure of incentives created by a society's property rights regime will determine the degree of specialization in productive activities and hence the overall productivity of an economy [7, 39, 53]. If property rights improperly defined or left ambiguous and unenforced, resources wasted as people try to capture or defend their claims to resources [47, 54–56]. Security typically implies the ability to appropriate benefits arising from a particular property right [50].

As with any other development issue, land tenure and property rights are central to sustainable natural resource management. In recent years, land tenure security has increasingly been recognized as a foundational element of advancing the sustainable development goals, the Paris Agreement, and Aichi Targets [8, 23]. Across the world, the natural resources that are highly degraded and the people who are highly vulnerable interconnected [5, 36, 56]. This clearly shows "the poverty-natural

resource degradation and vulnerability nexus" [57]. This paradigm is the development motive of the government of Ethiopia in its policy document called the Ethiopia Strategic Investment Framework (ESIF) for promoting Sustainable Land Management.

Hence, the discussion focuses on selected investment channels that this research is interested in. In sum, research continually highlights the critical role of tenure security in reducing poverty [47, 50], protecting biodiversity [45, 58], increasing agricultural production gains [7], incentivizing sustainable use of natural resources [59], mitigating and adapting climate change for resilience [60, 61], enhancing women's empowerment [62, 63] and many more. These are all crucial elements to consider in view of the challenges faced by humanity today. Hence, modernizing land administration system looked at in this perspective and as a response to complex shocks that human beings are facing today.

1.2.2 Information System Theory and land administration

Economic growth in most African countries is largely driven by land-based activities. Land administration systems are striving to adapt to the prevailing knowledge economy by using technology advancement to better manage information about land to achieve efficient, sustainable, and integrated management of land resources. According to the existing literature, the digital transformation of land administration systems is about responsibly moving the entire system from a paper-based, manual service mode, towards one that fully delivered by digital technology [14]. Information systems related to land administration are, thus, developed using Information Technology to enhance the performance of individuals and organizations indirectly and influenced by people, organization, and other environmental factors [64].

However, measurement of information system success and its sustainability is both complex and illusive [65–67] due to lack of diversity in theory that explains or predicts phenomena relating to information systems (IS) dealing with land tenure and property rights [68]. The existing theory in related research areas have not been articulated in a manner which lends it to rigorous testing either. For instance, after more than a decade of modeling and building international consensus, the Land Administration Domain Model (LADM) was only a formal international standard: ISO 19152 in 2012 [1]. Bennett et al. [8] also highlighted the role of spatial information technology and sustainability theory implications on future land cadaster. Moreover. Bennett et al. [10] also provided a review of the persistent problem and emerging fit-for-purpose solutions in land

administration maintenance. Biraro et al. [12] , on the other hand, documented good practices in updating land information systems that used unconventional approaches in systematic land registration. Nevertheless, in the broader IS domain, scholars categorized theories into five types depending on different conception of epistemology including causality, explanation, prediction, and generalization that underlie and understanding of theory [69]. According to Gregor [69] these five diverse types of theory distinguished as: (i) theory for analyzing, (ii) theory for explaining, (iii) theory for predicting, (iv) theory for explaining and predicting, and (v) theory for design and action.

In recent years, a variety of theoretical perspectives for explaining and predicting have been advanced, particularly to provide an understanding of the determinants of IS acceptance and usage. One important line of research has employed intention-based models which use behavioral intention to predict usage and, in turn, focus on the identification of the determinants of intention, such as attitudes, social influences, and facilitating conditions [70]. To fulfill the objective of this research, the researcher employed three of the prominent IS theories that underpin the conceptual and theoretical foundations to the research topic under investigation. These are the DeLone and McLean's IS success model, the Technological Acceptance Model (TAM), and the Theories of Planned Behavior (TPB). All these theories have strong behavioral elements, which assume that when someone forms an intention to act, they will be free to act without limitation. In practice, constraints such as limited ability, time, environment or organizational limits, and unconscious habits will limit the freedom to act [64]. Details of these theories are presented in chapter 2 and chapter 3. This helps the researcher to identify and explain influencing factors and extends its applicability to the current research model and empirically evaluate it in the Ethiopian context.

1.2.3 Success and Sustainability of Information System

Another important aspect of an information system is its operational success and sustainability. Technology-based improvement of doing business has been common since the invention of information technology. In today's uncertain world, the existence of IS, as well as their establishment and operational use, can have manifold effects towards sustainable development goals. Scholars documented the information technology related issues including its maturity of technology usage and their adoption in different industries [71]. Myrach [72] identified three streams of research that are relevant at the intersection of IS research including sustainability by IS, sustainability in IS and Sustainability of IS. The latter stream explores the maintenance and use of the IS which is an area of interest for this research topic.

In the same token, a sustainable land administration system is one that meets the needs of society today and that incrementally improved over time [73]. Sustainability being one of the nine principles of good land governance, a land administration system should be sustainable in the long-term [54]. Land records can quickly become out of date without systems for maintenance of the land register. Thus, once land registration and certification completed it is vital to ensure that the land administration system properly equipped at all levels with operational IS that can register land transactions and help to maintain and update the register efficiently and effectively [22].

While understanding implementation success factors is one side of the coin, a more particular challenge is to sustain IS function over medium to longer periods of time [74, 75]. First, users need to adopt the IS [76], but acceptance alone is not sufficient for continued use that needs system maintenance such that they constantly used to optimize their impact [72]. Likewise, understanding factors that influence successful operationalization of a land registration information system within the land administration organization routines is necessary. Normally, sustainability in land administration understood as occurring between land information system establishment and maintenance phases [73]. It argued that a project team should be created with a fixed number of resources in setting up a land information system and managing the process until project life completion. However, system maintenance is less amenable - ongoing resources, impetus and skills needed [72, 73].

For these reasons, various establishment efforts are an initial success [67], yet countless attempts fail in the end as they do not adequately consider the issues of sustainability after the project accomplished [77]. This takes hold when the diffusion of the target functionalities among a user community performing organizational business rules accomplished [78]. The same holds true when most land administration organizations move towards automation of their land registration system that depends on information system. This implies a program like this should ensure developing capacity for sustainability. Unfortunately, when programs are forced to shut down, hard won improvements in tenure security can be degraded and rolled back into informal service outcomes and fall into insecurity. Considering the rapid growing demand for land information, continuous land information updating is extremely essential to keep conformity with reality for land-related service provision [73] .

For this study, the sustainability of the LRIS is, therefore, about the effective maintenance of the data in the rural Land Register by capturing and processing land transactions on a continuous basis

and the effective and efficient provision of land administration services. Its performance could depend on the extent to which the quality of land information in the LRIS meets the needs of different end users and quality of services in the land administration institutions.

1.3 Conceptual Framework

Theoretically, a relationship between a rights holder and a subject parcel of landholding depends on the characteristics of land tenure rights that qualify its usefulness in economic exchange and influence economic behavior on investments [6, 39, 79, 80] and the financing of these investments [81]. What is equally important is that innovations in institutional constellation of the land administration information system in terms of people, organization, and technology [37, 56]. Land governance institutions shape human interactions in relation to their property rights in land. Traditionally, cadastral information systems have been paper-based. The global trend in the last half a century has been to migrate from paper-based information systems to digital information systems to improve efficiency, transparency, and accessibility of information [15, 82, 83]. Adopting a digital land information system in land administration is both a solution and a problem in itself [84]. Particularly, the acceptance and actual use of the system by concerned experts and the behavior of land rights holders towards compliance with established rules influences NRLAIS operations and usage. In principle, success of a land administration system understood as occurring between land registration information system establishment and maintenance phases by which its sustainability is ensured [73].

Because land administration information systems are complex and multidimensional, they affect expect return through various distinct but interrelated channels. The resultant outcomes can be measured in terms of livelihoods and/or environmental outcomes at temporal and spatial scale. The conceptual framework has also a feedback loop that affects the structure and function of each rearrangement. Hence, this research focuses on only three selected channels of investment and factors influencing attitudes, behavioral intention, and actual use of: i) the operational success of NRLAIS, ii) its effect on access to credit, and iii) access to credit effect on investment in sustainable land management. The researcher suggests an extended form of conceptual framework and analytical pathway shown in Figure 1 below.

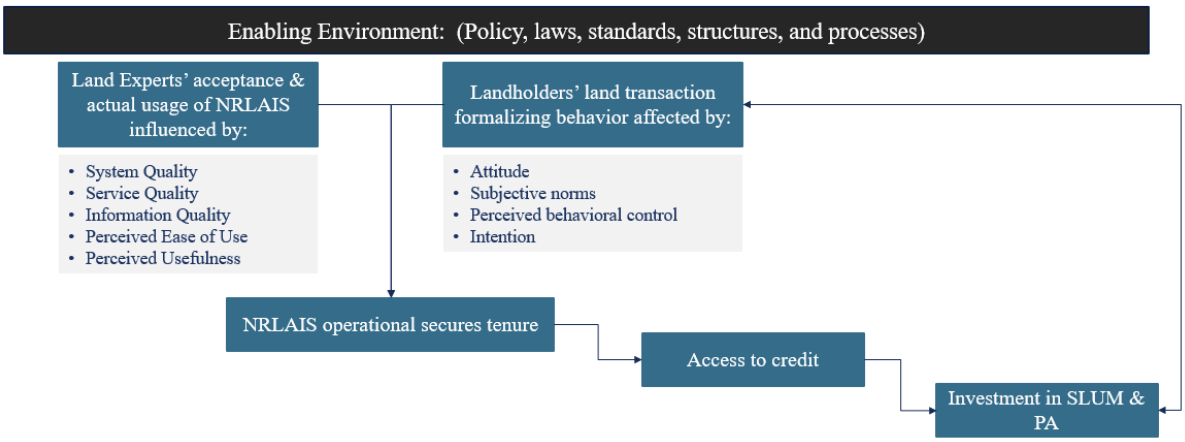

Figure 1. Conceptual framework showing the relationship between factors influencing the acceptance and actual usage of NRLAIS (users' intentions and incentives) as a proxy predictor to its operational sustainability that secure land tenure, access to credit, and investment in sustainable land management. Source: author's construction based on literature and own understanding, 2020.

Based on this conceptual framework, details of the research methods have been designed and employed for each research question. It includes a brief description of motivation on the selection of research philosophy on worldwide-views, the research designs or strategy of inquiry including the study areas for field work, sources and type of data, data collection tools and approaches, model(s) identifications and specifications and methods of data analysis to conduct the research. It also shows a workflow that provides a sequential overview of the whole research plan from initial research question to results and conclusions. However, in terms of methodological design, the research combines the use of quantitative & qualitative or mixed approaches that unfold relations that neither method does in its own at different unit of analysis (households, land experts, organizations) levels.

On the other hand, in terms of philosophical orientation, the researcher stands a pragmatic knowledge claim. This is because, in the lens of modernization and globalization development theories and discourses, the concepts and principles of land administration have evolved and continues to evolve as part of a wider land management paradigm or worldviews. Fundamental to this are the key functions, processes, and approaches of a specific land administration system and its development implication. While theories and principles of land tenure and property rights are universal, the scopes, processes, and approaches of a particular reform are context specific. Central

to this research inquiry is the identification of determining factors for the sustainability of the NRLAIS with implications to credit and investment in SLM in Ethiopia. Addressing such theoretical constructs arises a) out of action, b) context or situation specific, and c) consequences rather than antecedent conditions. Hence, from philosophical orientations point of view, these elements better match with pragmatism knowledge claim by which the researcher presented the research problem and employed appropriate research methods to understand the problems under each specific objective of the research agenda under discussion. Hence, following the pragmatism philosophical orientation, the research proposed hypothetical variables and empirically evaluate and analyses them by constructing models. Interpretation and validation of findings evaluated in a convergent approach in which results further followed-up with qualitative triangulation. Henceforth, the design of the research method contributes to the theoretical discussion, to methodological designs, and the analysis and comparisons of empirical cases in Ethiopia.

1.4 Statement of the Problem

Scientifically human behavior and activities are believed to be the main causes of environmental and natural resources degradation. Tackling these challenges requires understanding the relation between humans' behaviors and their environmental resources. For most Ethiopians, land is central to life: 'to be landless is to be sub-human' runs the popular proverb. Ethiopia has one of the world's most complex systems of land tenure and resources rights. In rural Ethiopia, widespread tenure insecurity due to frequent land redistribution [85–87] thought to be one of the drivers in that most smallholders to have exploitative behaviors leading to unsustainable natural resource use [88]. This behavior resulted in unprecedented environmental degradation, biodiversity loss, and ecosystem destruction [89]. The land certification program claimed to be the Government of Ethiopia's (GoE's) policy response to revers these severe environmental degradation challenges [90]. Since late 1990s, Ethiopia continues investing in one of the biggest land certification programs in Africa, digitalizing the land register, and making institutional reforms including laws, regulations, standards, and structures. However, scholars yet claim that there is post-certification tenure insecurity in highland parts of Ethiopia [91]. Similarly, others claim land use and tenure insecurity exist in pastoral and semi pastoral dominated parts of the country where dichotomy of customary and formal administrative rules and institutions converge [92] that affects access to and control over land, pasture, and water resources.

Firstly, using households as a unit of analysis, the available studies explore the immediate effect of the land certification program related to broader environment and development outcomes. However, the literature assumes that land registration and certification increase tenure security [20–22, 29, 93–95] without exploring whether, at what category of security of tenure along the bundles of rights increase beneficiaries' tenure rights and its implications on investment in SLM and access credit. These efforts are only partial to empirically investigating the dividend of the broader tenure security across the bundles of rights, making it difficult to understand the potential tradeoffs or synergies. Also, the available studies often lacked the time scales necessary to estimate its long-term effects on environmental outcomes that enduring positive outcomes on biodiversity and ecosystem services.

Secondly, in the existing literature, there is a lack of diversity in theory that explains or predicts phenomena regarding information systems dealing with land tenure in the lens of users' behavior. It is quite evident that there is a limitation in the application of information systems and behavioral theories explaining or predicting better the behavior of land experts and smallholder households towards the acceptance and actual use of NRLAIS. Although the transition to the digitization of the land registries is a recent phenomenon in Ethiopia, as far as the researcher's knowledge concerned, the operational success and sustainability of the national land administration information system has never scientifically researched based on an explanation and prediction theories. It is little known how and why land experts would decide to accept and use the rural land administration information system at the woreda level where it implemented. Additionally, there is a knowledge gap on the factors that influence land experts' behavior in doing so or not doing so. This research argues the lack of consideration afforded to factors for the operational success of the system from the outset places huge threats on its sustainability in the medium to long term. Hence, unless influencing factors measured scientifically and known in advance, the durability of the accrued benefits so far and the expected investment returns in the future from the system remain uncertain.

Thirdly, after over 20 years of implementation of such a massive land registration and certification programs, there is a critical concern about the maintenance and updating of the land records in the registries and their longer-term sustainability. Land rights can change hands due to subsequent land transactions made after the first-time land registration. Therefore, making the information in the system up to date in a continuous manner is one of the key challenges for its sustainability. Establishing a land registration system for the first time is essential but maintaining the system is

even more important. Without a continuous registration or formalization of subsequent land transactions, be it in a manual or digital system, the information in the land registers could quickly be outdated; and the system tends to face a rollback tendency into informality and tenure insecurity. This can jeopardize the primary objective of the programs, i.e., improving landholders' tenure security to incentivize long-term land-based investment that reverses land and environmental degradation. In this regard, despite few qualitative existing studies, such as by Cochrane and Hadis [23], there is a critical evidence gap on what factors influence landholders' intentions to formalize subsequent land transactions.

Scholars in the field of land administration or social science rarely study formalization of subsequent land transactions through the lens of landholders' intentions. Yet, studying these intentions is important for at least two reasons. Firstly, the analysis of landholders' intentions helps to predict the formalization rate. Secondly, it helps to improve our understanding of the factors that are responsible for the realization, or not, of these intentions. Knowing this information can help inform targeted interventions for diverse types of landholders facing various constraints in putting their good intentions into action. If applied properly the action ensures functioning and sustaining of the land registration information system for generations to come.

Fourthly, desired research findings do not exist in the available research particularly how availability and accessibility of land tenure information signal creditworthiness in rural Ethiopia. Recent exploratory research has investigated whether formal and customary land documentation (land certificates and non-land certificates), potentially improve access to informal credit in rural Ethiopia [27]. However, this study was conducted when the existing land law did not recognize the use of land certificates as collateral to access credit from financial institutions. In recent years, there have been changes in technological innovations and policy and regulatory reforms related to collateralization of movable properties including land use rights. These changes coupled with the existence of land certificates stimulate the financial institutions and small landholders to behave differently than ever before. While there is a mixed result about the effect of land certification or titling on access to credit in different parts of the world [7, 96], little has been known whether availability and accessibility of information on land tenure from NRLAIS signals creditworthiness of smallholder households, to what degree it reduces transaction costs and risks, and whether policy and legislative reforms towards the collateralization of land use rights increases the willingness of financial institutions to develop and provide small landholders tailored loan product.

In sum, there is a critical implementation-success-oriented knowledge gap that combines processes and impacts of the NRLAIS operational sustainability with implication to credit and investment in SLM in Ethiopia. To help generate new insights and fill this knowledge gap, the research examines the operational sustainability of the NRLAIS with implications to credit and investment in SLM in Ethiopia.

1.5 Research Questions

This sub-section highlights the overall and specific research questions under discussion.

1.5.1 Overall Research Question

Is the national rural land administration information system sustainable with implications to credit and investment in an on-farm SLM in rural Ethiopia?

1.5.2 Specific Research Question

Specifically, the study aimed to answer the following specific research questions:

1) What factors influence the acceptance and actual use of the national rural land administration information system (NRLAIS) among woreda land experts?
2) What factors determine landholders' intentions formalizing subsequent land transactions?
3) How do policy and technological innovations affect creditworthiness of small landholders, increase willingness of financial institutions, and reduce transaction costs and risks?
4) How do land tenure institutional factors influence landholders' on-farm investment in SLM?

1.6 Research Objective

The overall objective of the research is to examine the operational sustainability of the NRLAIS with implication to credit and investment in SLM.

The specific objective of the research is to:

- explore factors that influence the acceptance and actual use of the rural land administration information system as a proxy predictor for its operational success and sustainability.
- investigate factors that influence landholders' intentions to formalize subsequent land transactions as another proxy measure of the information system sustainability.
- assess whether availability and accessibility of the NRLAIS underpinned by policy reform and technological innovations increases creditworthiness of smallholder households,

incentivize financial institutions to provide individual loans to smallholders, and reduce transaction costs and risks.

- understand the effect of land tenure institutional factors on small landholders' on-farm investment in SLM practice.

1.7 Significance of the Study

The land administration modernization program in Ethiopia is a recent phenomenon which aims to improve land tenure security and incentivize long-term investments in land that reduces environmental degradation and increase ecosystem functions. While there have been studies in the country concerning the effect of land registration and certification to perceive security of tenure, rental market, land dispute resolution, gender empowerment, and investment but those themes usually addressed separately.

Taking the geographic expansion of the SLLC and digitization of the land register at the heart of the land administration reform in rural Ethiopia, this research generates new data on the digitization (acceptance and use of the digital land information system) and formalization practices of subsequent land rights transactions; and contributes to bridge policy implementation-success-oriented knowledge gaps which combines effects at the household, individual land expert, and organizational levels. Besides, the research can provide new insights on the link between categories of tenure security along bundles of rights, as land tenure institutional factors, on investment in an on-farm SLM. This evidence base helps to inform policymakers on what policy and regulatory reforms are needed and prioritize investment of scares resources to strengthen the NRLAIS in meeting broader environment and development outcomes at the national level. The research also generates new data, documents evidence, and informs development practitioners on the factors and measures required that influence the operational success of the NRLAIS, on one hand, and the translation of the good intentions of small landholders formalizing land transactions on the other hand, which both influence the sustainability of the land administration information system.

For the scientific world, the study contributes to the extension of theoretical insights and empirical methodological approaches. In this regard, inspired by the 2003 Information System (IS) success modified model of DeLone & McLean, the 1985 Ajzen invented Theory of Planned Behavior (TPB), and Technology Acceptance Model (TAM), the research extends and integrates these theories with the land tenure theory and land registration system discourse. By extension and

integration, the research developed and empirically evaluated a new research model which proved the soundness of the set out conceptual framework of the research design. In sum, the research contributes both to theories and practices about the role of land administration information system to environment and development research agenda and further informs required policy actions to greater environment and development outcomes.

1.8 Scope of the Study

This study explores the operational sustainability of the NRLAIS, by using land experts' perceptions (supply side) and landholders' intensions (demand side) of the system in formalizing subsequent land transaction, with implications to credit and investment in SLM in rural Ethiopia. With an attempt to exploring the operational success of NRLAIS at organizational level, the research covers 201 land experts as a unit of analysis from fifty randomly selected woredas from Amhara, Oromia and SNNP regional states. Besides, the Ministry of Agriculture at federal level and regional land administration bureaus of Amhara, Oromia, and SNNPR covered to understand policy, strategic, and programmatic issues related to the establishment and functionality of the NRLAIS. Using landholders' intentions as a lens, the study also conducted a deep dive investigation in Basona Worena woreda of Amhara region which helps to explore the operational sustainability of the NRLAIS, which is one of the early adopters of the NRLAIS as a pilot site. Moreover, to explore the long-term implications of the system to credit and investment in SLM, the study covers 2,296 smallholder households who reside in 183 rural kebeles in three regional states (Amhara, Oromia, and SNNP). These three regional states hold over 80 percent of the total population and close to half of the country's landmass.

1.9 Limitation of the Study

The research geographically limited to Amhara, Oromia, and SNNP regional states of Ethiopia. While the rural land administration reforms and its development and environmental outcomes are broader in scope, this study limited to the sustainability of the rural land administration information system, and its implication for credit and investment in SLM only.

1.10 Structure of the Dissertation

The dissertation is divided into six main chapters. Chapter one dedicated to general introductory including background of the study and literature review that justifies the relevance of the research, statement of the problem, the central research questions, general and specific research objectives, significance, scope, and limitations of the research. Chapter two discusses the determining factors

of the rural land administration information system as operational sustainability measures of the system. Chapter three focuses on factors influencing the formalization of subsequent land transactions behavior of landholders in rural Ethiopia. Whereas chapter four discusses the implication of the NRLAIS to small landholders' creditworthiness underpinned by policy and technological innovations. Similarly, chapter five elaborates the land tenure institutional factors that influence investment in SLM across categories of land tenure security and along bundle of land rights. Finally, chapter six summarizes general discussions, conclusions, and recommendations as well as implications to policy and future research. The readers should note that, as part of this dissertation, the researcher published four articles in internationally known journals, which presented here from chapter two through five. For further reading you can find them in the following links.

- Chapter two: Land 2021, 10, 1394. https://doi.org/10.3390/land10121394
- Chapter three: Land 2022, 11, 633. https://doi.org/10.3390/land11050633
- Chapter four: Land 2023, 12, 1055. https://doi.org/10.3390/land12051055
- Chapter five: Sustainability 2023, 15, 9150. https://doi.org/10.3390/su15129150

2. CHAPTER TWO: DETERMINANTS OF THE LAND REGISTRATION INFORMATION SYSTEM OPERATIONAL SUCCESS: EMPIRICAL EVIDENCE FROM ETHIOPIA

Abstract

Ethiopia has embarked on one of the largest digitalization programs for rural land registration in Africa. The program is called the national rural land administration information system (NRLAIS). Over the past couple of years, NRLAIS was rolled-out and made operational in over 180 woredas (districts). There is, however, limited empirical evidence on whether and to what extent NRLAIS has been operationally successful. This study explores the factors that influence the acceptance and actual use of NRLAIS to gauge its operational success in Ethiopia. Data collected both from primary and secondary sources using surveys, key informant interviews, and a literature review. Survey data collected from 201 staff of fifty woreda land administration offices in three regional states (Amhara, Oromia, and SNNP) and analyzed using a structural equation model. The results revealed that system quality, information quality, service quality, and perceived use-fullness of NRLAIS have positively and significantly influenced the acceptance and actual use of the system. However, perceived ease of use has an insignificant influence. The predictive relevance of the research model is significant and indicates substantial operational success of NRLAIS. The quick acceptance and use of NRLAIS will improve service delivery, promote data integration, and strengthen informed decision-making. The study recommends strengthening behavioral changes of the land administration experts through two enhanced service quality measures - technical and operational capacity to a robust and sustainable digitalization. Policymakers could leverage operational success to upgrade the NRLAIS into a unified national land registration information system that bridges the urban–rural land governance divide.

Keywords: land register; digitalization; standardization; tenure security; service delivery; governance; structural equation model

2.1 Introduction

Land is a key natural resource, means of livelihood, and development asset for many societies in Ethiopia. The relationship between people and land also transects almost all sustainable development goals (SDGs) [10, 97]. The SDGs and other recent global initiatives have renewed and increased the need to improve land tenure to address a multitude of development challenges [5]. Secure land tenure has regularly prioritized by policymakers to ensure long-term land-based investment, improved agricultural productivity, as well as to address changing climate risks, biodiversity loss, poverty reduction, food security, and spur sustainable growth [5, 79, 98, 99].

Traditionally, land administration systems created to record information about property ownership, rights, and boundaries, and other attributes of real properties [4]. However, depending on the context, the strengthening of land rights can take a variety of forms, from documenting customary uses to formalizing individual rights [5]. In other instances, existing customary land tenure systems may be sufficient to ensure land tenure security [100]. Deficiencies in land registration and information system programs and procedures to implement these programs are among the major reasons for failure or success to achieve stronger tenure security [99]. Thus, land registration and information system organization should be part of studies on land tenure and investment in land and productivity [7].

Land information systems (LIS) in this paper understood as a set of land information technologies (hardware, software, infrastructure, and equipment), personnel, data, rules-based procedures, and organizational structures. The existence of good and well-functioning land information infrastructure is key to answering the fundamental land development and management decision-making questions (i.e., why, who, what, where, when, and how) [101]. The LIS should be complete, dependable, uniform, up to date, and sustainable [47]. Accurate and up-to-date land administration data also understood as occurring between land information system establishment and maintenance phases [73]. Hence, LIS needs to reflect the reality on the ground and transform itself into a dynamic and sustainable innovation hub and meet service expectations [12, 83].

However, it is worth noting that the overall establishment, effectiveness, and maintenance of an integrated geospatial land information system depends on governance, technology, and people factors [1, 102]. The governance factor further decomposes to the establishment of appropriate policy, legal framework, and governance structures, while the technological aspects include the

data, innovation, and standards. The people dimension is concerned with capacity building, education, partnership, communication, and engagement [97]. Particularly, understanding factors influencing the intention of personnel to accept and use the system is important for the digital transformation and effective land administration service deliveries [84].

In the land registration and land tenure discourse, the 1970s and 1980s marked a move from a paper-based and manual type of data management and process to digital and automated systems in developed economies [10]. Various attempts were made to set up titling systems in number of African countries in the same period [103]. However, the efforts have failed to achieve the expected transformation, owing to colonial imported rules and systems that disregard local context, among other reasons [80, 104]. In most cases, land registries failed to provide authoritative records of titles and transactions and quickly became outdated due to poor planning, lack of capacity, and the flouting and manipulation of laws by officials and elites [105].

Despite low coverage of land registration in Africa (only 10%), the surge of land titling programs following the recent reform of land policy and legal framework, such as in Ethiopia and Rwanda, have shown positive trends and outcomes [33, 80]. The reform provides a rapid scale-up across the continent that improves access to land and tenure security [80]. These approaches take different forms, ranging from fit-for-purpose to pro-poor land recording approaches [33, 106, 107]. Advancements in information technology have also facilitated the speedy acquisition, storage, dissemination, and application of data related to tenure, use, value, as well as the development of land and other natural resource governance [108]. Demands for a more customer-oriented focus is also one of the drivers for the automation of land administration systems [1, 10]. In this regard, a first step in introducing a current information technology (IT)-enabled land administration system is the determination of user needs [4]. Hence, if LIS is to be successful, designs should fulfill the requirements of its end-users [83]. Evidence shows that few African countries such as Rwanda and Ethiopia have launched modernization initiatives for their land information systems [12]. These countries accelerate and securely register land titles into a functional land registration information system [23, 109].

In Ethiopia, at the heart of the land administration reform is the digitalization of the manual land register. Recognizing the manual land register shortcomings related to the maintenance, security, accessibility, and integration of land information at different administration levels, the Ministry of Agriculture (MoA) has opted for digitalization. Between 2015 and 2017, the MoA developed and

successfully piloted the national rural land administration information system (NRLAIS) in the highland regions [24]. NRLAIS is a web-based system developed on open-source licensed software and based on the land administration domain model (LADM). Hence, NRLAIS is the programmatic approach of the MoA to address the shortcomings of the semi-manual land register, improve the standardization of service delivery, and promote informed policymaking [24].

While the transition to the NRLAIS is at an initial stage, its operational success has not been researched based on explanation and prediction theories. There is little knowledge about what causes user acceptance and actual use of the NRLAIS in the land administration domain. It is also not known why and how the woreda land administration experts choose to discontinue the use of the semi-manual land register that they are using currently. There are few similar studies in Africa such as Zeng and Cleon [84] on the implementation and development of land information systems (LIS) in Liberia, which adopted the diffusion paradigm. To the best of the authors' knowledge, this is the first attempt in the country. Taking the woreda land administration experts as a unit of analysis, the study seeks to understand the behavior of the woreda land administration experts towards the acceptance and actual use of the NRLAIS and document its operational success. The proposed and empirically tested model of this study reveals a strong construct validity and predictive power. The model captures multiple aspects of each variable, which is a change from much of the measurement of LIS success model constructs that focus on only one aspect of the construct. The study also highlights the needed policy and strategic actions to achieve robust and sustainable digitalization.

2.2 Literature Review

2.2.1. Land Tenure and Registration in Ethiopia

Dominated by the agrarian economy, the available scholarly literature documents that widespread tenure insecurity hinders long-term land-based investment in rural Ethiopia [24]. Land tenure insecurity contributes to unprecedented environmental degradation, ecosystem depletion, biodiversity loss, decrease in productivity, and food insecurity [24, 110]. These development challenges have compounded and amplified by climate change and disaster risks that threaten the sustainability of productive landscapes and livelihood resilience [111]. This section briefly highlights the historical account of land tenure and the land certification program and its implication to NRLAIS development in Ethiopia.

During the last century, the land tenure history of Ethiopia has experienced extensive changes. Ethiopia has a long legacy of state intervention in land tenure relations that influence local tenure regimes throughout different political discourses [22]. Hence, the creation and recording of land rights by the national state has been a development theme since the 1960s in the contemporary land tenure history of Ethiopia [112]. The land tenure registration innovations before 1960 have been swept away by subsequent changes, but they still have relevance as the model of tenure reform. Before the 1974 revolution, the land tenure systems of Ethiopia grounded in historically shaped, local institutions, complex and varied across the regions [86]. The military socialist regime's redistributive land reform of 1975 ensured that rural farming households received access to land through only usufruct rights, while ensuring state ownership. Notably, this reform legacy not only weakened the remaining customary institutions but also swept away the overall imperial land governance systems [113]. The current land registration system is highly influenced by the 1975 radical land reform of the military socialist regime (1974 to 1991).

In post-socialist Ethiopia, tenure insecurity linked to a history of limited empowerment of smallholder farmers and significant control by the state in determining access to and control over land resources [113]. During the Ethiopia Revolutionary Democratic Front (EPRDF)-led government (1991 to 2018), state ownership maintained and enshrined in the 1995 constitution. The 1995 constitution of the federal democratic republic of Ethiopia Article 40 continued the state land ownership and usufruct rights for landholders from the military socialist regime. The governance structure also changed from a centralized socialistic arrangement to market-led decentralization [114]. Article 52 of the 1995 constitution gives the regional governments the right to administer land and other natural resources following the federal laws. As a result, the land tenure system is evolving differently in rural and urban areas [115]. Different federal proclamations govern its development, and reforms have been progressing at different speeds across the country [116, 117]. Moreover, there are two parallel land registration and information system infrastructures - one for rural and one for urban areas. This rural-urban divide costs the country hugely in terms of policy, institutional, technical, operational, and human resource challenges for integrated and transparent land administration and resource governance systems that foster sustain-able development [110].

The Government of Ethiopia (GoE) has been implementing a progressive two-stage land registration and certification program since 1998 [17]. The first-level landholding certification (FLLC) program that started in 1998 has claimed by the GoE as a policy response for improving

tenure security to reverse land degradation, food insecurity, and poverty reduction [20]. Till 2010, the FLLC, which claimed to be cheap and fast, was mainly financed by regional states but without spatial data of parcels [22, 112], whereas the second level landholding certification (SLLC) is being coordinated by the Federal Government in collaboration with the regional states and has attracted strong technical and financial support from international development partners [28]. The latter approach introduced parcel-level cadastral mapping and the transition of the manual registry into a harmonized computerized LIS [118]. Since 2013, Ethiopia has continued investing in the SLLC program to cover over fifty million rural parcels and improve tenure security and land administration service delivery [20, 118]. According to MoA [26], between 2013 and 2021, over twenty-one million rural parcels were demarcated and mapped, of which close to eighteen million parcels were issued with SLLC. The demarcation and mapping cover about 42 percent of the estimated fifty million parcels found in the highland parts of the country. Different scholars have well studied the household-level positive impact of these massive land registration and certification programs [20, 22, 28].

2.2.2. Land Information System in Ethiopia

The land registration information system (LRIS) in Ethiopia follows the rural–urban cadastral divide. NRLAIS developed for rural land and the cadaster and real property registration system (CRPRS) for urban land. Two different agencies are administering the systems. NRLAIS operated by the rural land administration agencies under the guidance of MoA, while CRPRS operated by the Urban Land and Cadaster Chief Executive Officer under the guidance of the Ministry of Urban and Infrastructure (MUI). The focus of this paper is NRLAIS, the rural land administration in formation system.

In 2010, MoA developed its information system/information communication technology (IS/ICT) and software development strategy for the first time [24]. The strategy developed following analysis of the requirements of a harmonized land administration system that is suitable for the adoption and implementation of a unified LIS in Ethiopia. According to MoA [26], this IS/ICT strategy provides a single overarching requisite framework embracing both urban and rural lands for the safe and secure maintenance and updating of land records. However, following legal mandates, MoA revised the IS/ICT and software development and implementation strategy twice, i.e., in 2012 and, later, in 2017, with a focus on rural land.

As part of the standardization of the rural land administration system, the development of NRLAIS was well established based on the analysis and business reengineering of the four existing organizational structures (federal, regional, zonal, and woreda) [24]. NRLAIS is a web-based system developed on open-source licensed software and based on the land administration domain model (LADM). The system utilizes a modular technology stack and meets the functional and legal requirements for registering rural landholding rights in all the non-pastoral and highland regional states of Ethiopia. The definition of technical specifications for the development of NRLAIS considered the requirements of the functional and legal framework at both the federal and regional levels, including inheritance, gift, exchange, divorce, rent, and encumbrances.

Between 2015 and 2017, supported by the Finnish government-financed project Responsible and Innovative Land Administration in Ethiopia (REILA), MoA developed and piloted NRLAIS. A production version delivered with an operational acceptance report (OAR) to the then MoA in March 2018 [119]. Between 2016 and 2017, NRLAIS has undergone due diligence processes through a series of pilot testing and upgrades. Since late 2018, the MoA initiated the rollout of NRLAIS into more regions and woredas. The NRLAIS roll-out is divided into two phases of two years each, starting with a comparative trial of four-to-six months that may reveal necessary improvements and changes, followed by a one-and-a-half-year period for full-scale roll-out at national level. Since 2020, the second phase of the rollout has continued at increasing speed, addressing sustainability factors such as capacity building and up-grading of the software with emerging functionality requirements [24, 26].

According to MoA [24], up to four hundred woredas covering twenty-five million parcels of land records targeted to establish a functional and operational NRLAIS by 2024. NRLAIS is now operational in over 180 woredas of Amhara, Benishangul Gumuz, Oromia, Southern Nations Nationalities and Peoples (SNNP), and Tigray regional states as of November 2021 [26]. By mid-2021, about 113 woredas with NRLAIS have verified by third party or independent verifying agency for the system made operational. Operational means woreda land administration offices started registering subsequent land rights transaction and delivering services using NRLAIS. During the same period, the information of approximately eleven million parcels was migrated into the system, 5 to 13 subsequent land transactions updated per day per woreda, and over 102,000 transactions per year updated in total. NRLAIS is the largest distributed LIS in Ethiopia and currently operates in six regional states, 37 Zones, and over 180 woredas. However, the wider area

network (WAN) that connects woredas to zonal, regional to federal/central servers for an online data replication and information flow is yet to deployed due to underdeveloped digital network infra-structure in the country.

NRLAIS will provide security, transparency, service quality, and continuous maintenance of land records, with enhanced data management functionality and usability at the woreda level in an effective, spatially integrated, and sustainable manner [24]. NRLAIS considered the key strategic component within the land administration modernization effort and an integral part of standardization of land cadaster information in the country. Under this context, NRLAIS forms the framework and defines the role of stakeholders and their relationship among personnel, technology, and standard procedures. It also serves as a legitimate bearer of land information including the socio-spatial aspects of landholdings and users' interests in land and natural resources.

2.3. Theoretical Base

The theoretical base of this study is the DeLone and McLean Information System success model (D&M IS success model) of 2003 and the theory of technology acceptance model (TAM) of Davis and modified by Venkatesh et al. [120–123]. An information system (IS) developed using information technology (IT) to enhance the performance of individuals and organizations. However, the adoption of an IS influenced by people, the organization, and other environmental factors [64]. Measurement of information system success is both complex and elusive [124]. Knowledge advancement in IT and related practices currently verifies that the right practice is the main factor of technology and knowledge success regarding diffusion and assimilation of IT innovations [84, 125]. Researchers have derived various models to explain what makes some IS successful. For instance, Davis adapted the theory of planned behavior (TPB) and developed the technology acceptance model (TAM), which explains why some IS more accepted by users than others [126, 127]. Acceptance, however, is not equivalent to success, although acceptance of an information system is a necessary precondition to success [64]. In recent years, intention-based models were one important lines of re-search that employed behavioral intention to predict usage [121]. In turn, this focuses on the identification of the determinants of intention, such as attitudes, social influences, and facilitating conditions [128].

Since its invention, the D&M IS success model and the TAM model have applied across several IS domain research contexts but are rare in the LRIS context [129, 130]. DeLone and MacLean

reviewed the existing definitions of IS success and their corresponding measures and classified them into six major categories [66]. Thus, they created a multidimensional measuring model with interdependencies between the different success categories [123, 131, 132]. Ten years after the publication of their first model, DeLone and McLean [67] proposed an updated IS success model based on the evaluation of many other contributions to it. The updated D&M IS success models of 2003 consist of six interrelated dimensions that include (1) system quality, (2) information quality, (3) intention to use, (4) user satisfaction, (5) individual impact, and (6) organizational impact [64]. Each of these variables is a composite of numerous and diverse constructs and measures. The practical application of the D&M model is naturally de-pendent on the organizational context [64, 67].

On the other hand, TAM is an adaptation of the TPB to the field of IS. TAM later advanced to TAM 2, which incorporated additional theoretical constructs spanning social influence processes (SIP) and cognitive instrumental processes [133]. TAM posits that perceived usefulness and perceived ease of use determine an individual intention to use an IS, while the intention to use serves as a mediator of the actual use of a system. Perceived usefulness also seen as directly impacted by perceived ease of use [75, 120]. Both TAM and TPB have strong behavioral elements, which assume that when someone forms an intention to act, they will be free to act without limitations. In practice, constraints such as limited ability, time, environmental or organizational limits, and unconscious habits will limit the freedom to act [64].

However, the existing theory in related research areas has not articulated in a manner that lends it to rigorous testing to land tenure IS [68]. For instance, after more than a decade of modeling and building international consensus, the land administration domain model (LADM) only became a formal international standard (ISO 19152) in 2012 [1]. LADM offers a very generic spatial representation model, and it is becoming a common language in establishing geospatial referenced cadastral and land information systems [1, 10, 12, 134]. On the other hand, a recent study by Biraro et al. [12] summarizes parameters and indicators taken to account when updating a LIS in the context of the land administration domain. In addition, Bennett et al. [10] systematically reviewed land administration system maintenance and indicated pathways for future research. Although all these models have different approaches, they have commonality in that they provide variables considered while evaluating or investigating a LIS development, implementation, and maintenance.

This helps the researcher to develop the proposed research model and empirically evaluate it to gauge the acceptance and actual use of NRLAIS and predict its operational success in Ethiopia.

Accordingly, six latent variables identified include system quality, information quality, service quality, perceived ease of use, perceived usefulness, and intention to use as a latent construct to determine acceptance and actual use of NRLAIS. The actual use behavior of the woreda land administration experts considered a proxy predictor of NRLAIS operational success. First, the authors posit that the land administration experts at the woreda level, as internal system end-users/operators, need to accept NRLAIS. However, acceptance alone is not enough for continued use. In addition, as part of the service quality measure, the NRLAIS requires continuous maintenance of the system infrastructure and updating of the land records. In addition, the staff needs continuous competency and skill upgrading as a critical element of the system to operate and render land administration services daily. This explores the identification by land administration staff of the perceived factors that determine the acceptance and actual use of NRLAIS as a proxy predictor to its operational success.

The land administration experts at the Woreda land administration offices were taken as a unit of analysis for this study because they are the key players and responsible for daily business service delivery. NRLAIS is the main and reliable source of information for the land administration experts for decision-making for service delivery per organizational rules and standards. The woreda land administration experts are the most experienced in creating, describing, defining, and altering the human to parcels of land relationship to legal interests (rights, restrictions, and responsibilities). Hence, the acceptance and actual use of NRLAIS at the woreda land administration offices would have the utmost policy and operational relevance for the success and sustainability of the land administration system in the country.

On this basis, this study proposed the definition of the identified variable constructs, their measurement, and their hypothetical relationships to each variable, which presented as follows and presented in Figure 2.

System Quality (SYQU)

System Quality (SYQU) - System quality relies on user needs and overall performance, as perceived by users [64] and as specified in the system technical requirements and development. System quality measures the technical success aspects of NRLAIS. High-level system quality

would serve users with useful perception for doing their daily business effectively and under a secured condition that is easy to use and learn. Hence, the main measurement items identified are ease of use, usefulness, and ease of learning [64]. Thus, the following are hypothesized.

Hypothesis 1. (H1). System quality has a positive and significant influence on actual use of NRLAIS (a) on service quality, (b) on information quality, and (c) on perceived ease of use of NRLAIS.

Information Quality (INQU) - INQU is the desirable characteristics of the system outputs, such as outcome reports [67]. All types of generation of information by application of information technology cannot be used for decision making. The INQU represents the success of a land registration information system (LRIS) as the information aid to make appropriate business decisions. Seven attributes identified, of which five considered in this study, including availability, usability, accuracy, relevance, understandability, format, and ease of access or retrieval [64]. Information quality is often a dimension of end-user satisfaction instruments. INQU measured as a component of user satisfaction since it is often not distinguished as a unique construct. While this holds true, the authors contend and support the 2003 modified D&M success model construct, which embedded information quality as an independent construct. Hence, the following hypothesized.

Hypothesis 2. (H2). Information quality has a positive and significant influence on actual use of NRLAIS (a) on perceived usefulness and (b) on perceived ease of use of NRLAIS.

Service Quality (SRQU) - According to Petter et al. [64], service quality refers to the quality of the institutional support that system users receive from the IS department and support personnel. Hence, service quality is considered an important organizational dimension that determines individual performance. A specific service quality improvement depends on the status of the measurable service quality attributes, which include five dimensions—tangibles, reliability, responsiveness, assurance, and empathy [135, 136]. Similarly, in this study, the SRQU measures are an internal service provider dimension and rendered to the woreda NRLAIS users by regional and federal land institutions. The measurement attributes include reliability, availability or assurance, and empathy of support staff. Reliability includes the ability to perform the promised service dependably and accurately. Assurance includes the knowledge and courtesy of IT (technical) and operational support staff and their ability to inspire trust and confidence in the woreda land

administration experts. Empathy, on the other hand, includes the caring and individualized attention the IT and support staff provides its woreda land administration experts. In addition, SRQU significantly affects information quality, perceived ease of use, perceived usefulness, and intention to use. Hence, the following hypothesized.

Hypothesis 3. (H3). Service quality has a positive and significant influence on actual use of NRALIS (a) on perceived ease of use, (b) on information quality, and (c) on perceived usefulness of NRLAIS.

Perceived Ease of Use (PEOU) - The extent to which individuals believe that using part of a system does not require much effort is known as perceived ease of use [122]. TAM is considered a flexible model, as it includes variables that explain technology acceptance. Perceived ease of use has a direct impact on behavioral intention and on perceived usefulness [120]. Hence, the following hypothesized.

Hypothesis 4. (H4). Perceived ease of use has a positive and significant effect on actual use of NRLAIS (a) on perceived usefulness of NRLAIS.

Perceived Usefulness - Davis [75] proposed that certain factors such as perceived usefulness, attitude, and perceived ease of use can be the components of TAM. TAM defines individual positive or negative reactions towards a certain thing, which are referred to as attitudes. However, the perspectives of individuals of a certain system being useful to them through influencing their performance called perceived usefulness [64]. Innovative technologies' acceptance or adoption can be determined and explained by perceived usefulness. TAM further discovered usefulness as one of the noteworthy perceptions leading to the intention to adopt new systems. TAM contends that actual system use is an indicator of IS success and is associated with the ultimate impact rendered from IS [64, 137]. Hence, in this study, PRUS and PEOU represent the perceived behavior of the woreda land administration experts towards acceptance and actual use of the system for the daily operational success of NRLAIS.

Hence, the following hypothesized.

Hypothesis 5. (H5). Perceived usefulness has a positive and significant effect on actual use of NRLAIS.

System Actual Use (SYAU) - Petter et al. [64] reviewed the updated DeLone and McLean 2003 IS success model and added service quality as a new dimension, grouping all "impact" measures into a single "net benefit" [64]. The construction of "system actual use" and "intent to use" is still considered in this model as an important measure. Hence, the authors considered system actual use (SYAU) in the proposed research model. The research model graphically represented in Figure 2.1 below.

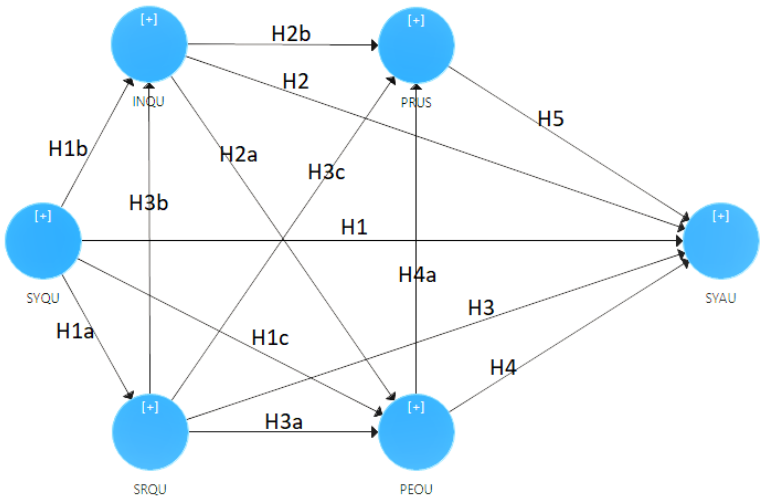

Figure 2. Research model with latent variables and hypotheses construct adapted from information system success model and technology acceptance model.

2.4. Materials and Methods

The paper draws on primary and secondary data. The primary data collected from the woreda land administration experts through surveys and key informant interviews of national-level senior experts. Key informant interviews were also employed to collect information on NRLAIS development, support and maintenance services, and operational deployment at the federal and regional land institutions. In addition, the secondary data collected through a review of scientific literature and policy and program documents.

A partial least square structural equation model (PLS-SEM) is used for the data analysis, which integrates various multivariate techniques into one model-fitting framework. Smart-PLS software version 3.0 used to process the data analysis related to the coefficient of interaction terms. PLS-SEM includes confirmatory factor analysis, path analysis and partial least square to impute relationships between latent variables [138]. SEM used to evaluate the structural relationships

between the fourteen hypotheses and the actual use of NRLAIS. Cronbach Alpha analysis performed to examine the consistency of data, and the value of Cronbach alpha should be greater than 0.7. SEM combines the usage of latent (unobserved) variables that represent the concept of theory and data from measures (indicators or manifest variables). The manifest variables are used as input for statistical analysis that provides evidence about relationships among latent variables. Descriptive statistics are also employed to analyze the results of survey data. Figures, tables, and maps were utilized to present the results and findings of the study.

Questionnaires formulated to collect the professional perceptions and experience of the woreda land administration experts on the technological (SYQU), organizational (INQU and SRQU), and behavioral aspects (PEOU and PRUS) of NRLAIS. The survey consists of three main sections. The first section comprises ten questions on the demographics of the woreda land administration experts. The second section consists of five questions on the NRLAIS use experience of the experts. The third section includes twenty-nine questions related to the measurement variables and their respective indicator items. All the measurement variable indicators are formative and adapted from various earlier related studies [64, 130]. The respondents asked to state their opinions using a seven-point Likert scale from strongly disagree (1) to strongly agree (7).

Five to six items were initially formulated to develop pilot survey questionnaires for direct measures. The formulation of these pilot questionnaires aimed to assess each of the theory's major constructs: system quality, service quality, information quality, perceived ease of use, perceived usefulness, intention to use, and actual use behavior. Seven-point bipolar adjective scales were employed. The pilot questionnaires also included measures of background factors and other variables, including demographic characteristics, professional experience, and system use. The pilot questionnaires distributed to thirty land administration experts convened in a national workshop in February 2021. The experts came from national and regional level land administration institutions that had been supporting the roll-out of NRLAIS at the woreda land ad-ministration offices. The results of the pilot questionnaires also allowed the authors to evaluate the validity and consistency of each item and utility of the background measures. Based on these inputs, necessary adjustments were made, and the standard questionnaires used in the main study produced.

2.4.1. Study Site

The study covers fifty sample woredas of three regional states (Amhara, Oromia, and SNNP) in Ethiopia. These three regional states hold over 80 percent of the total population and close to half of the country's landmass [139]. Geographically, the study areas are in the central highlands of the country and along the south-central parts of the Rift Valley, characterized by high population density and diverse land uses. The male (50.1%) population is slightly higher than the female (49.9%). Over 70% of the population in the study areas is under age 30, which aligns with the overall national age breakdown [139], showing a high density of younger people in the study areas. Agriculture, forestry, and livestock raising contributed directly or indirectly to the livelihoods of the population in the study areas. Climate change is leading to above average temperatures and greater rainfall variability, with a pronounced effect on agricultural productivity and the suitability of major crops in the study areas [111].

According to official figures from the Ethiopian Central Statistics Agency (CSA), the urbanization rate is growing at an average rate of 5.2 percent per year since 2018. If these trends continue, the urban population projected to reach fifty million by 2034 [140]. Natural increase rather than rural-to-urban migration was the main driver of urban population growth up to 2018, with rural-to-urban migration being the main driver since 2018 [141]. As population density increases, combined with continued land fragmentation, large cohorts of young people will increasingly become functionally landless. This fuels intense land use competitions and conversions of rural land to build environments. This is becoming a serious land governance issue, particularly in the urban–rural frontiers of most Ethiopian cities [142]. Currently, access to land continues to be difficult due to increasing land scarcity and the total area of landholding per household diminishing over time in the study areas [143]. The average number of rural land parcels per study woreda is 83,000. The woreda land administration offices had an average annual subsequent land transactions turnover of 1 percent, through inheritance, donation, and land rentals. The average size of parcels involved in these transactions was about a quarter of a hectare [26].

According to the MoA [26], as of November 2021, over 180 woredas had established NRLAIS and made it operational. Woredas with operational NRLAIS found in Amhara (61 woredas), Oromia (68 woredas), and SNNP (56 woredas) regional states (see Figure 3 for a map of the study woredas). The study excluded the inaccessible Tigray regional state due to the ongoing armed

conflict and instability. According to the same source, information of about eleven million parcels has registered in NRLAIS, covering close to six million hectares.

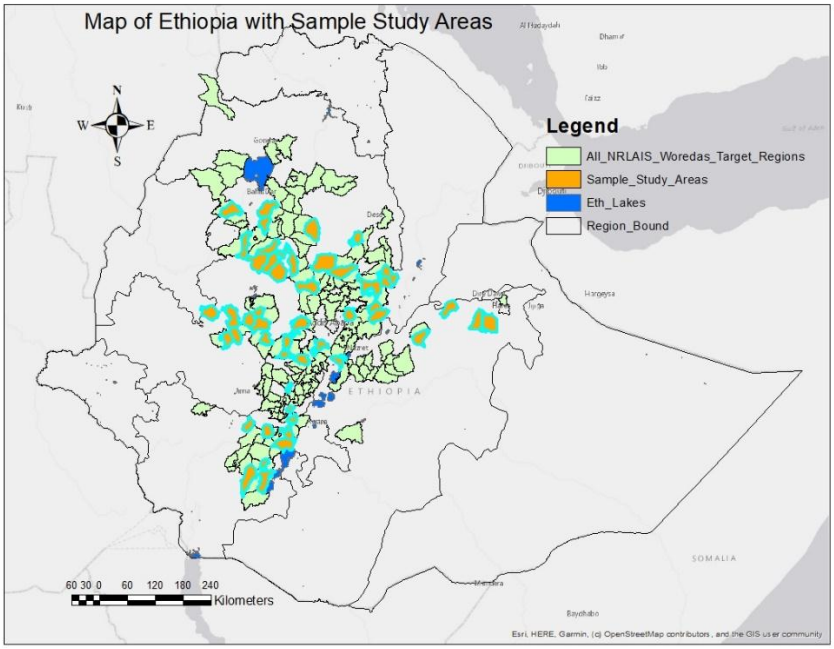

Figure 3. Study Site Map. Data Source: Ministry of Agriculture, November 2021.

2.4.2 Sampling Method

To determine the sample size required for a study that uses a structural equation model (SEM), the authors applied the Soper [144] online free statistic calculator, which calculates prior sample sizes for structural equation models. This sampling calculator considers the number of observed and latent variables in the model, the anticipated effect size, and the desired probability and statistical power levels. Accordingly, the model of this study contains twenty-nine observed variables and six construct latent variables. The model considers the anticipated effect size of medium (0.3), the desired probability level of 0.05, and desired statistical power level of variables of 0.8. Hence, the mini-mum initial sample size to detect effect was determined to be 161, the minimum sample size for the model structure was one hundred, and the recommended minimum sample size was 161. The random selection process stratified by regions in proportion to each region's number of woredas covered with operational NRLAIS.

2.4.3. Sample Size

As a result of these sample size requirements, fifty woredas were selected randomly (seventeen from Amhara, eighteen from Oromia, and fifteen from SNNP). There are four to six land administration experts per woreda on average who operate the NRLAIS, which means about 450 experts in total. In this study, land administration expert used as a common name for people working on land administration matters in the woreda land ad-ministration offices with different titles, including land registration experts, cadastral surveyors, geospatial and land information management experts, land law and compliant management experts, land transaction experts, and team leaders.

From the fifty sampled woredas, about 275 land administration experts targeted and invited to respond to the self-administered quantitative survey questionnaire by email and the Telegram social media platform. The survey data collection was conducted between April and May 2021. This virtual method of data collection preferred due to restrictions on movement to field sites caused by the COVID-19 pandemic outbreak and the state of emergency in the study areas following social instabilities, particularly in the northern parts of the country. Telephone follow-up calls were also employed to clarify question items to respondents and enhance the quality of the survey data. Of the 220 filled in and returned questionnaires, nineteen were in-complete. The result shows a 73% success rate of properly completed questionnaires. Depending on the study design model selected, the sample and effect size of the survey data was found satisfactory.

2.5 Results

2.5.1. Characteristics of Respondents

The sample respondents included 157 (78%) males and 44 (22%) females, Figure 4. Despite their dwindling numbers, the presence of women land administration professionals in the woreda land administration offices would help the policy reform move to-wards gender-sensitive land tenure security. About 188 (87%) of the respondents were between 21 and 40 years of age. In addition, 82% and 18% had completed their bachelor's degrees and diplomas, respectively. This also indicates that the Woreda land ad-ministration offices filled with young and degreed land administration professionals. This would foster innovative technology acceptance in the rural land administration sector and facilitate the establishment of the NRLAIS at woreda level. The range of disciplines the university graduates had studied were extremely broad, including surveying (17%),

ICT and computer science (16%), agriculture (14%), natural resource management (14%), geography (12%), land administration (8%), economics (7%), and others (13%). The diversity of the disciplines would also reflect the multi-disciplinary nature of the land administration domain. However, the number of existing land administration professionals with land law and economics backgrounds appeared low.

In terms of work experience, respondents asked how long they had been working for their respective woreda land administration offices. The experience levels ranged from less than a year (8%), to between one and seven years (70%), to over seven years (22%). The result revealed that about 61% of the respondents had worked for over 5 years, while 25% had worked for between 3 and 5 years. Only 24% of the respondents had worked less than 3 years in their respective woreda land administration offices. During data collection, on average, 83% of the land administration expert positions were filled. Despite frequent staff turnover reported during the key informant interviews as a key challenge for NRLAIS deployment, the survey result revealed a substantial level of staff retention in the woreda land administration offices. However, this does not mean that the reported land administration experts' turnover did not affect NRLAIS roll-out and activation.

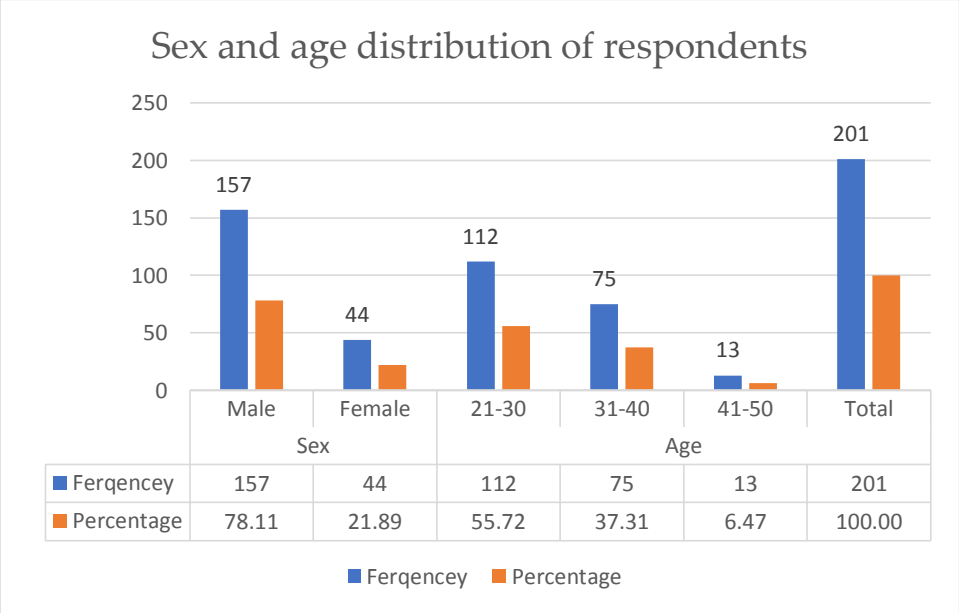

Figure 4. Sex and age distribution of respondents.

In terms of system use, 67.2% of the respondents had NRLAIS use experience between six months and one year. In addition, 26.2% of the respondents had used NRLAIS for over one year and less than two years. Only 1.5% of the respondents had used NRLAIS for over three years, which

indicates respondents from the pilot woreda of NRLAIS, Figure 5. This system use experience revealed that all respondents have had adequate familiarity with NRLAIS functional and operational issues.

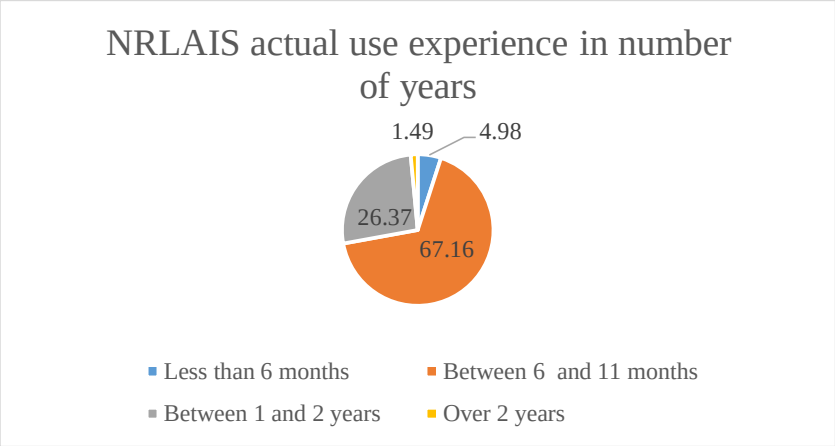

Figure 5. Experience of the respondents' actual usage of the NRLAIS in their daily official business discharge.

Respondents also asked for the minutes or hours per day they spent working on NRLAIS to discharge their service delivery related to land transaction management. As presented in Figure 6, 47% of the respondents spent between six to eight hours. Moreover, 31% of the respondents spent between four to six hours of office hours using NRLAIS to process land transaction management and service delivery. This indicates that about 78% of respondents use NRLAIS for over half of typical office hours. In addition, this shows that NRLAIS is used as a source and maintains land record information at woreda land administration offices.

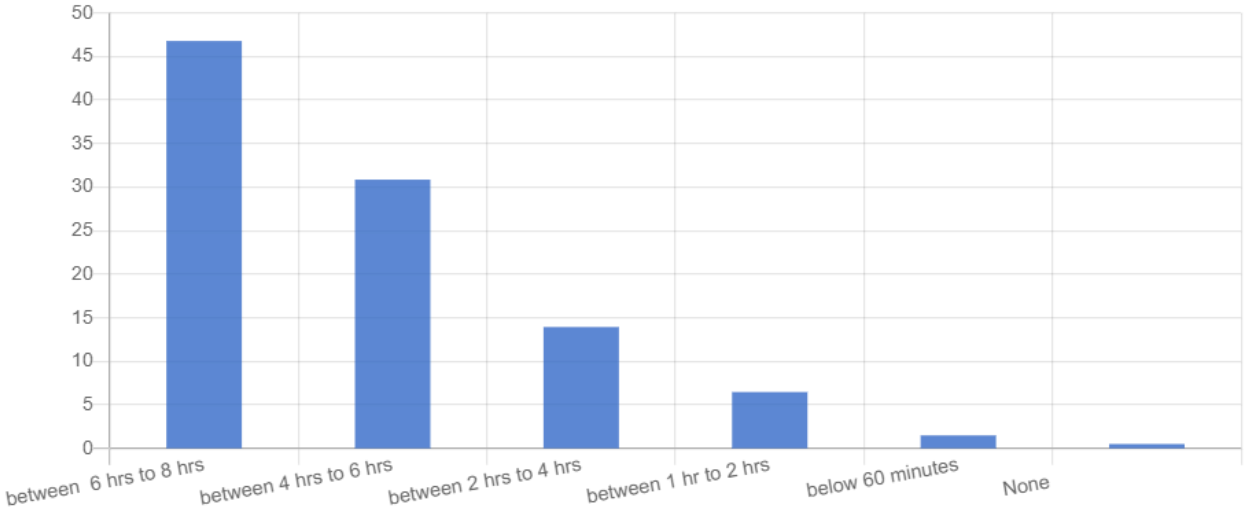

Figure 6. Time spent processing land transaction management and service delivery using NRLAIS.

Similarly, the respondents also asked an average login into the system per day. The question measures the frequency of system login as a proxy indicator of access security awareness and rule compliance. The survey shows that about 45% of respondents answered that they log in over ten times per workday. About 30% of respondents log in between six and ten times per workday. Only 2% of respondents log in once per day and process the land transaction management tasks assigned to them on the system. This result seems congruent with the average number of land transactions processed (5 to 13 per day) at the Woreda land administration offices. This, in turn, implied good compliance with standard producers and rules by the woreda land administration offices. However, the 2% of responses indicating only one log in per day seemed to reflect a misunderstanding of the question, as NRLAIS has a session time-out functionality.

According to the technical specification of NRLAIS, user-specific roles and user administration have been defined through the business processes. NRLAIS also supports user role definition, assignment, auditing, and reporting with separate management trees according to the administrative structure (federal, region, zone, and woreda) and within the same hierarchy of the woreda land administration offices [25]. To this end, respondents asked which access privileges they assigned as internal system users or operators. As presented in Figure 7, the respondents answered that about 44% held an expert role, 31% an officer role, 21% a supervisor role, and 3% a system administrator specific role. However, 3% responses misunderstand the question, since system administration specific roles assigned at federal, regional, and sometimes zonal or mobile IT support teams only.

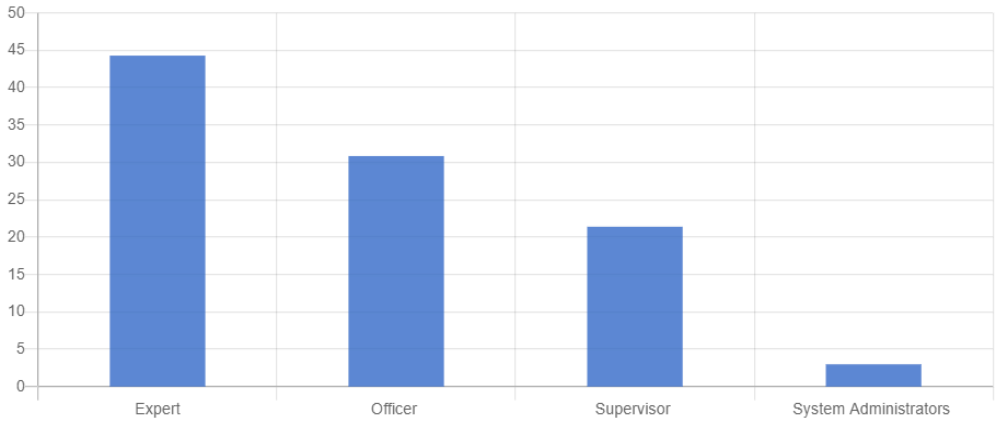

Figure 7. Users' specific assigned role of respondents

Similarly, according to the architecture design of NRLAIS, the woreda is the primary level at which the system functions. The technical requirement also specifies five subsystems at the woreda level,

which affect only parts of the system while processing transactions management, including web information, cadastral maintenance, property registration, document management, and process subsystems [24]. The processing subsystem manages the main operations to register rights, while the cadaster maintenance subsystem oversees the management of spatial features (parcels, maps, points, and boundaries). Both the document management subsystem and the processing sub-system have been customized for specific rural land registration processes. Respondents asked which subsystems they have been using the most while processing land transaction management and service delivery in priority orders. The result revealed that all respondents used the web information subsystem, as this is the user interface to log in to access the other subsystems. This followed by the property registration subsystem (48%), cadastral maintenance subsystem (35%), and process subsystem and document management subsystems (17%).

2.5.2. Validity and Reliability

The first test conducted in this study was evaluating the validity and reliability of the outer model. The outer model testing performed through a process of algorithm iteration, a parameter of measurement model that includes convergence validity, discriminant validity, composite reliability, and Cronbach's alpha. Validity and reliability ensure that the multiple indications of each latent variable in the measurement model converge to measure a single construct and hence develop legitimacy, defined as the level to which things used to measure can calculate the idea, they meant to quantify [145]. All items used to measure the construct should pile to their constructs rather than different builds. As for the component analysis, it ensures that items designated to their constructs, as they express high loading on them that stands out from various constructs [146]. The measurement model assessment of vertical collinearity is presented in Table 1. This shows the subjective independence of every indicator on its latent variable using cross-loading criteria.

The individual item reliability is evaluated by examining the loading and cross-loadings of indicators on their respective construct. According to Fornell and Larcker's criteria [147], a reliability score of Cronbach alpha 0.6 considered minimally acceptable, with 0.70 preferred (50% of the explained variance). The theory also recommends that an indicator loading having a value of less than 0.40 should be removed from the model. Hence, this study found three indicator items with less than or equal to 0.4 outer loading. As per the rules, the indicator items removed from the model include INQU4 (format), PEOU4 (clear and understandable), and SYQU4 (risk of losing data).

Table 1. Indicator item cross loading.

Variables	Code	INQU	PEOU	PRUS	SRQU	SYAU	SYQU
Information Quality	INQU1	0.698	0.507	0.432	0.453	0.458	0.571
	INQU2	0.862	0.569	0.578	0.571	0.654	0.672
	INQU3	0.890	0.716	0.556	0.608	0.602	0.741
	INQU5	0.743	0.599	0.501	0.577	0.568	0.508
Perceived Ease of Use	PEOU1	0.588	0.796	0.462	0.560	0.426	0.560
	PEOU2	0.608	0.863	0.578	0.641	0.507	0.593
	PEOU3	0.512	0.724	0.622	0.588	0.519	0.428
	PEOU5	0.718	0.867	0.507	0.699	0.631	0.626
Perceived Usefulness	PRUS1	0.452	0.402	0.737	0.411	0.424	0.404
	PRUS2	0.412	0.434	0.680	0.472	0.340	0.309
	PRUS3	0.288	0.350	0.591	0.249	0.184	0.302
	PRUS4	0.489	0.483	0.807	0.432	0.451	0.441
	PRUS5	0.469	0.502	0.801	0.489	0.458	0.429
	PRUS6	0.640	0.663	0.773	0.624	0.576	0.484
Service Quality	SRQU1	0.498	0.615	0.433	0.756	0.458	0.405
	SRQU2	0.371	0.455	0.322	0.668	0.266	0.296
	SRQU3	0.570	0.613	0.482	0.806	0.489	0.482
	SRQU4	0.482	0.553	0.509	0.730	0.526	0.422
	SRQU5	0.585	0.570	0.541	0.721	0.570	0.499
System Actual Use	SYAU1	0.648	0.599	0.506	0.696	0.750	0.545
	SYAU2	0.491	0.502	0.431	0.398	0.733	0.465
	SYAU3	0.475	0.391	0.347	0.364	0.718	0.467
	SYAU4	0.417	0.318	0.375	0.315	0.725	0.347
System Quality	SYQU1	0.737	0.643	0.535	0.551	0.626	0.843
	SYQU2	0.462	0.423	0.316	0.327	0.430	0.786
	SYQU3	0.662	0.561	0.449	0.504	0.477	0.819

The composite reliability index and the average variance extracted (AVE) applied to assess the internal consistency and convergent validity [147]. According to the rule, the square root of the AVE of a particular construct should also be greater than its correlation with other constructs. The AVE should be higher than 0.5. Table 2 shows the internal consistency of each construct. In the measurement model, the study used Cronbach's alpha and composite reliability (CR) to evaluate

the reliability of the constructs. The study found that all the CRs were higher than the recommended value of 0.700, ranging from 0.822 to 0.887. The Cronbach's alpha of each construct exceeded the recommended 0.700 threshold, which is 0.720 to 0.831 in the current study. Hence, convergence validity was acceptable because the average variance extracted (AVE) was over 0.500.

Table 2. Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
INQU	0.811	0.827	0.877	0.644
PEOU	0.829	0.837	0.887	0.664
PRUS	0.831	0.856	0.875	0.541
SRQU	0.791	0.799	0.856	0.544
SYAU	0.720	0.730	0.822	0.535
SYQU	0.754	0.776	0.857	0.666

Discriminant validity concerns the uniqueness of a construct, whether the phenomenon captured by a construct is unique and not reflected in the model by the other construct [145]. The subjective independence can help reduce the presence of multicollinearity amongst the latent variables, denoting that the average variance extracted (AVE) of a latent variable should be higher than the squared correlations between the latent variable and all other variables [147]. Discriminant validity assessed by the Fornell–Larcker criterion [147]. Table 3 shows that the square-root of AVE for the construct in the diagonal was greater than the inner-construct correlation, which ranges from 0.732 to 0.816. The test result of the current study may therefore imply the strong reliability of all the items.

Table 3. Fornell–Larcker Criterion. Note: Value in diagonal represent the Square-root of AVE.

	INQU	PEOU	PRUS	SRQU	SYAU	SYQU
INQU	0.802					
PEOU	0.749	0.815				
PRUS	0.648	0.664	0.736			
SRQU	0.692	0.767	0.632	0.737		
SYAU	0.715	0.645	0.581	0.644	0.732	
SYQU	0.782	0.681	0.548	0.582	0.639	0.816

2.5.3. Structural Model (Inner Model) Analysis

The structural model (Figure 8) reflects the path hypothesized in the research framework. Using the bootstrap resampling technique (5000-resamplings), the path coefficient then evaluated to investigate the significance of the hypothesis. The t-value > 1.96 is significant at $p < 0.05$, and t-value > 2.58 is significant at $p < 0.01$ [138]. A structural model also assessed based on the R^2, Q^2, and significance of paths. The goodness of the model is determined by the strength of each structural path, deter-mined by the R^2 value for the dependent variable; the value for R^2 should be equal to or over 0.1 [138]. The values of R^2 in PLS interpreted similarly to those obtained from multiple regression analysis. It considered that R^2 values of 0.75, 0.50, and 0.25 are substantial, moderate, and weak, respectively [138], and evaluated subsequently. Hence, the predictive capability was established.

In this study, information quality accounted for 69.6 percent of the variance in explaining perceived usefulness and perceived ease of use. Meanwhile, service quality accounted for 33.9 percent of the variance explaining perceived usefulness and perceived ease of use. Likewise, perceived ease of use accounted for 69.5 percent, and perceived usefulness accounted for 51.2 percent of the variance explaining SYAU. Finally, the current model explained 57.5 of the variances in acceptance and actual use of NRLAIS, which provided substantial explanatory power and predictive capability (see Figure 8).

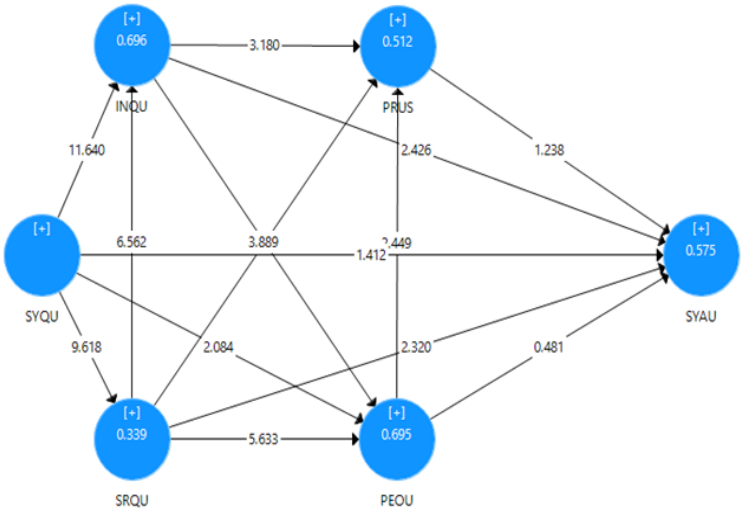

Figure 8. Measurement and structure equation model results of the research model.

Furthermore, the model fit is assessed using SRMR. The value of SRMR was 0.100, equal to the required value of 0.10, indicating acceptable model fit [80]. Further assessment of the goodness of fit hypotheses evaluated to ascertain the significance of the relationship, Table 4.

Table 4. Model fit analysis of the proposed model

	Original Sample (O)	Sample Mean (M)	95%	99%	Original Sample (O)	Sample Mean (M)	95%	99%
Saturated Model	0.100	0.059	0.070	0.074	3.520	1.241	1.727	1.944
Estimated Model	0.100	0.060	0.072	0.075	3.521	1.298	1.808	1.963

The studied 5000 resamples also generate 95% confidence intervals, and hypotheses testing results summarized in Table 5. A confidence interval not equal to zero indicates a significant relationship. Further, Q^2 establishes the predictive relevance of the endogenous constructs. A Q^2 above 0 shows that the model has predictive relevance. The result shows that there is significance in the prediction of the construct in the research model. Therefore, except for H4 and H5, the rest of the hypotheses have positive and significant impact on the acceptance, which is a proxy predictor to NRLAIS operational success.

H1 evaluates whether SYQU has a positive and significant effect on the acceptance and SYAU of NRLAIS. The result revealed that a positive and significant impact on SYAU ($\beta = 0.639$, $t = 10.019$, $p = 0.000$), on the SRQU (H1a: $\beta = 0.583$, $t = 9.879$, $p = 0.000$), on INQU (H1b: $\beta = 0.583$, $t = 9.879$, $p = 0.000$), and on the PEOU (H1c: $\beta = 0.194$, $t = 2.128$, $p = 0.034$). Hence, H1 is fully supported. The result shows (Figure 7 and Table 5) that 63.9% of NRLAIS acceptance and actual usage explained by the system quality variables with indicators including easy to learn (SYQU1: 84.3%), easy to use (SYQU2: 78.6%), and useful for doing daily business effectively under secured conditions (SYQU3: 81.9%).

Secondly, the result shows that (Figure 7 and Table 5) information quality found to have a positive and significant influence on acceptance and actual use of NRLAIS (H2). The result revealed that the relation between INQU and SYAU ($\beta = 0.436$, $t = 3.600$, $p = 0.000$) (2a) on perceived usefulness, i.e., INQU -> PRUS ($\beta = 0.283$, $t = 3.347$, $p = 0.001$), and (2b) on perceived ease of use,

i.e., INQU -> PEOU (β = 0.275, t = 3.818, p = 0.000), has a positive and significant influence. Hence, H2 supported. Respondents admitted that information quality of NRLAIS has a positive and significant influence on acceptance and actual use. When the information generated by NRLAIS is accurate, useable, relevant, dependable, and understandable, the Woreda land administration experts consider the information system useful and valuable. This result revealed that information availability (69.8%) is the main characteristic of NRLAIS to ensure a necessary level of acceptance for land administration to provide seamless services that do not halt business. In addition, information usability (86.2%), information accuracy (89%), information relevance, and understandability (74.3%) are influencing factors that determine information quality.

Thirdly, service quality has a positive and significant influence on acceptance and actual use of NRLAIS (H3) (3a) on the perceived ease of use, (3b) on the information quality, and (3c) on the perceived usefulness of NRLAIS. The result revealed that a positive and significant impact on SYAU (β = 0.208, t = 2.057, p = 0.040); (3a) on the perceived ease of use, i.e., SRQU -> PEOU (β = 0.465, t = 5.537, p = 0.000); (3b) on the information quality, i.e., SRQU -> INQU (β = 0.575, t = 12.019, p = 0.000); and (3c) on the perceived usefulness, i.e., SRQU -> PRUS (β = 0.213, t = 2.222, p = 0.027). Hence, H3 is fully supported. The SRQU construct is one of the most influential service quality measurement instruments and widely used in many applications, and the development of service quality affects IS success factor. The result revealed that the technical support service provided by the federal and regional land institutions is significantly affecting the acceptance and actual usage of NRLAIS at the woreda offices of land administration. The result revealed that 20.8% of the acceptance and actual use of NRLAIS explained by the quality of support services (Figure 7). This includes the knowledge and skill transfer made through classroom training and during data migration, on-the-spot support by a mobile IT team, and remote helpdesk support. Such support services were found relevant to the job performance and awareness regarding compliance with actual system use by the Woreda Land Administration experts.

Conversely, H4 evaluates whether PEOU has a positive and significant effect on SYAU of NRALIS. The result revealed that PEOU has a positive but an insignificant impact on acceptance and SYAU (β = 0.086, t = 0.852, p = 0.395), and (4a) PEOU has a positive and significant effect on perceived usefulness, i.e., PEOU -> PRUS (β = 0.291, t = 2.556, p = 0.011). Hence, H4 is not supported, while H4a fully supported.

Similarly, H5 evaluates whether PRUS has a positive and significant effect on acceptance and SYAU of NRLAIS. The result revealed that PRUS has a positive but insignificant impact on acceptance and SYAU (β = 0.111, t = 1.285, p = 0.199). Hence, H5 is not supported.

Table 5. Mean, STDEV, T-Values, p-Values, R2, and Q2.

	β	STDEV	T Statistics	*p* Values	2.50%	97.50%
INQU -> PEOU	0.275	0.072	3.818	0.000	0.154	0.420
INQU -> PRUS	0.283	0.085	3.347	0.001	0.105	0.427
INQU -> SYAU	0.436	0.121	3.600	0.000	0.182	0.655
PEOU -> PRUS	0.291	0.114	2.556	0.011	0.083	0.508
PEOU -> SYAU	0.086	0.101	0.852	0.395	−0.111	0.294
PRUS -> SYAU	0.111	0.086	1.285	0.199	−0.039	0.290
SRQU -> INQU	0.356	0.053	6.681	0.000	0.246	0.453
SRQU -> PEOU	0.465	0.084	5.537	0.000	0.285	0.615
SRQU -> PRUS	0.213	0.096	2.222	0.027	0.022	0.401
SRQU -> SYAU	0.208	0.101	2.057	0.040	0.027	0.416
SYQU -> INQU	0.575	0.048	12.019	0.000	0.477	0.665
SYQU -> PEOU	0.194	0.091	2.128	0.034	−0.006	0.355
SYQU -> SRQU	0.583	0.059	9.879	0.000	0.475	0.693
SYQU -> SYAU	0.639	0.064	10.019	0.000	0.503	0.752
	R^2	Q^2				
INQU	0.697	0.434				
PEOU	0.695	0.451				
PRUS	0.512	0.252				
SRQU	0.340	0.175				
SYAU	0.567	0.258				
SYQU	0.000					

2.5.4. Mediation Analysis

Mediation analysis was performed to assess the mediating (INQU, SRQU, PEOU and PRUS) role of system actual use outcomes. The results revealed an insignificant (p > 0.05) mediating role of PRUS (H3a: β = 0.024, t = 2.000, p = 0.322) and a partially significant (p = 0.046) mediating role of PEOU (H3c: β = 0.040, t = 2.000, p = 0.046). INQU was found to significantly mediate the relationship between SRQU and SYAU of NRLAIS (see Table 6).

Table 6. Total, specific, and indirect effect between the independent variables and dependent variables.

	Total Effect	T	Sig	Direct Effect	Sig	Specific Indirect Effect	Effect	T	Sig
SR -> SYAU	0.464	7.397	0.000	0.208	0.040	SRQU -> INQU -> SYAU	0.251	3.665	0.000
						SRQU -> PEOU -> SYAU	0.040	2.000	0.046
						SRQU -> PRUS -> SYAU	0.024	2.000	0.322

2.6. Discussion

Land administration governance in Ethiopia is complex and requires the use and integration of an innovative and robust set of land registration information technologies that meet the social, economic, and environmental goals of tenure security and service delivery. Innovative information technologies and systems used to help build a quicker, accessible, affordable, and more reliable LIS. This, in turn, provides landholders, communities, business firms, and the public with a clearer sense of tenure security, particularly to women, by providing evidence of recognized and enforceable land and resource rights. Landholders with secure tenure rights are incentivized to make long-term land-based investment that improve welfare and environmental outcomes.

This study demonstrated that the theoretical application of the research model that integrated selected variables from the IS success and TAM models to explain the acceptance and actual usage of NRLAIS in Ethiopia; acceptance and usage serve as proxy predictors of NRLAIS' operational success. The paper explored the determining factors and their relationships with technical (SYQU), organizational (SRQU and IN-QU), and the behavioral (PEOU and PRUS) aspects of the woreda land administration experts that influence the acceptance and actual usage of NRLAIS in Ethiopia. These constructs, along with measuring the LRIS' operational success, pave the way to scientifically research land administration system digitalization, particularly in developing economies. The research suggests that the IS success model integrated with TAM with selected variables was applicable for explaining LRIS acceptance and actual usage as a proxy predictor for operational success. This study does not include the organizational net benefit in its latent variable constructs measured by productivity, competitiveness, and management improvements. The discussion of the results is presented in detail as follows.

Firstly, based on the structural model, the study examined the relationship between the system quality and acceptance and actual use of NRLAIS. The results indicate that there is a positive and

significant relationship between the system quality and the acceptance and actual use of NRLAIS (H1) on SRQU (1a), on INQU (1b), and on PEOU (1c). Based on that, the researcher inferred that the woreda land administration experts relate this system quality with the acceptance and actual use of NRLAIS. The system quality constructs reflect the technical aspects of NRLAIS to its acceptance and actual use. These are that it is easy to learn, easy to use, and useful to do daily business related to land transaction management and service delivery at the woreda land administration offices. Malik et al. [130] and Hamdan and Al-Hajra [148] observed that a system's level of association had a positive influence on the perceived ease of use and the perceived usefulness of the system under investigation [129, 130]. Moreover, the system quality would also affect the information quality and the service quality of the organization under study, and this, in turn, affects the acceptance and actual usage of the system.

As described in the background section, the technical requirement review provides an understanding of the different components of NRLAIS as an automated and streamlined land registration information system for rural land. The functional and legal aspects of the rural land administration are key requirements of NRLAIS. This includes data capturing, data management, visualization, and workflow management and reporting. The NRLAIS system development process has engaged the regional and federal level land administration professionals in terms of the definition, verification, and approval of the functional and legal requirements as part of its quality assurance system. Hence, the multi-tiered application architecture makes NRLAIS possible to use at the different administrative levels with differentiated functionality and user interface. The login function and session time-out are also suited to secure the user's access to the system and the subsystem before any transaction begins. Furthermore, the classified roles of system users (officer, expert, and supervisor) represent read-only, data entry, and approval and change secure system access as primary actors in the existing administrative roles in the institutions that operate the NRLAIS.

Regarding information quality, the results of this study are consistent with what found by Nugroho and Machdar [123, 149]. NRLAIS also manages information regarding land transaction performance at the woreda level, such as the type and patterns of land transactions made. Updating the land record is one of the key functions of the woreda land administration offices. This affects the efficiency and effectiveness of the land administration system and staff job performance related to all land transactions. Relevant and accurate land information affects operational business decisions

of transactions to the regional governments, to federal ministries, and to the public. Since land relationships change frequently, the information in NRLAIS needs updated and maintained. Timely and accurate management of information ensured through well-maintained cadastral and land use related information should reflect the reality on the ground. Complete and up-to-date land information will support expedited business decisions made by the woreda land administration offices, thereby enhancing legitimacy and trustworthiness of the woreda land administration offices. Further to this, the availability of such geospatial land information lays a foundation for the national spatial data infrastructure to flourish and be accessible to all concerned to inform strategic and policy reform.

Moreover, NRLAIS has a modular design that allows the system deployed at various administrative levels. The modular stack and the web-based server design of NRLAIS enable the transfer of data and information from lower to higher administration levels to include zone, region, and federal levels that facilitate easier deployment. However, this data and information flow is yet to happen due to low and weak telecom network infrastructure coverage in the country for access to strong bandwidth Internet services.

Regarding service quality, the result of the current study is consistent with the findings of Al-Fraihat [150], Nugroho [123], and Malik et al. [130]. These studies found that the effective role or support service of the technical staff, (i.e., service quality) is positively related to the eventual use of the system [150]. Competency of the support staff, vendor support, and availability of training affected acceptance and use of IS [151]. The current study also revealed that the technical support service is significantly affecting the acceptance and actual usage of NRLAIS. However, an IT-enabled LRIS at this decentralized scale needs a solid IT management approach, which is dependable, available, and has good empathy of support staff. NRLAIS with sufficient quality affects the type and intensity of technical support in the transition operation from manual to digital service delivery. The quality of support service, in turn, affects adherence to standardized methods and procedures for service delivery in the acceptance and actual use of NRLAIS.

The transition and service operation are the highest priority for NRLAIS to function and be operational at the woreda level. In the context of the establishment of NRLAIS, it is essential to have a proper knowledge transfer from the developer to an in-house or outsourced local IT company, which conducts the ongoing system maintenance, up grading, and operational support services. The woreda land administration experts' knowledge and skill acquired through training,

experience gained during data migration, self-practice, and helpdesk support are also critical success factors. Therefore, the support service quality should be strong, regular, dependable, and available when needed at the woreda level.

Fourthly, the analysis revealed that perceived ease of use has a positive but insignificant effect on the acceptance and actual use of NRLAIS. However, perceived ease of use has a positive and significant effect on the perceived usefulness of NRLAIS (H4a). Hence, H4 not supported, while H4a supported. Malik et al. and Floropoulos et al. [129, 130, 152] found that perceived usefulness influenced by an understanding of the information quality. The current study analysis also revealed similar findings (H2b). Machdar and Malik et al. [129, 130, 149] found that the quality of information positively affects perceived usefulness and ease of use, and perceived ease of use positively affects perceived usefulness [149]. Studies have found strong relationships between perceived usefulness and self-reported use [153], extent of use [154], or dependence on an information system [155]. Empirical studies in various contexts have confirmed that the post-usage perception of usefulness has a strong association with actual use [156]. This holds true in the current study too since the hypothetical relationships between the perceived ease of use effect on acceptance and actual use found to be significant. This may be because the survey collected post-usage perceptions rather than measuring intention to use prior-actual system use. Therefore, the behavioral antecedences of perceived ease of use and actual use should not underestimate to meet operational success, though perceived ease of use has shown a weak relationship to actual use in the analysis.

The result of this study revealed that 69.5% of the acceptance and actual use of NRLAIS explained by the perceived ease of use construct (Figure 8). The quality of information affects the perceived ease of use (27.5%), as well as the perceived usefulness (28.3%) of the woreda land administration experts. This, in turn, affects the acceptance and actual use of NRLAIS to maintain the land records of subsequent land transactions and to make effective and efficient business decisions in daily service delivery.

2.7. Conclusions and Recommendations

Investigation of the general antecedents of what causes users' acceptance and use of innovative information technology in the land administration domain is critical for digital transformation and improve service delivery. The research has attempted to understand the influencing factors of the

acceptance and actual use of NRLAIS in Ethiopia to gauge and predict its operational success. The research found that, even though the NRLAIS program of Ethiopia is at the initial stage of establishment, the speed and scale of its implementation have implications for its acceptance and actual use. The authors argue that investigating what factors affect this transition is worth studying to document the experience and generate a knowledge base for similar initiatives in other countries.

The research demonstrated that a system must developed that understands the functional, technical, legal, and administrative requirements. These factors significantly affect the acceptance and actual use of the system and better predict its operational success. Similarly, the organizational aspects related to support services and in-formation quality determine the behavioral attributes of staff to accept and use NRLAIS and rely on it to make business decisions and deliver services daily.

Moreover, twelve of the fourteen constructs (hypotheses) in this study found to be significant in terms of affecting the acceptance and actual use of NRLAIS. The findings rendered a theoretical and practical knowledge base about land administration information digitalization and operational success. Practically, the findings of this study help the country to make strategic and policy decisions on the planning, implementation, and use of a land registration information system for sustainable land re-source management and governance systems. Secondly, the study demonstrated that, while the service quality and information quality constructs to the acceptance and actual use of NRLAIS deserve an independent construct, they are also playing a mediating role between system quality and actual use of the system. The proposed model empirically revealed strong construct validity, in that it captures multiple aspects of each variable, which is a change from much of the measurement of LIS success model constructs that focus on only one aspect of the construct.

Historically, the land administration system in Ethiopia has evolved in the urban–rural cadastral and land registration system divide. This costs the country a great deal in terms of economic, social, and environmental management and governance systems. With the depth of functional and legal requirements compliance, NRLAIS is instrumental in strengthening secure tenure rights in rural authorities. It also demonstrates that standardization would pave the way for the development of a unified land administration information system in Ethiopia that embraces both urban and rural land tenure.

Despite the study's contribution to policy, research, and practice, the authors suggest that a similar future research undertaking would be recommendable in other developing countries and should

include other variables that not considered in this study. The method applied in this study adds to the knowledge base and replicability of the proposed model under the land administration information domain. Further, future studies should include the organizational net benefit in their latent variable constructs as measured by productivity, competitiveness, and management improvements. Finally, the research did not consider the success of NRLAIS from the perspective of an external system user, such as financial institutions, courts, businesses, and smallholder farmers, which would be worth studying in a future research undertaking.

3. CHAPTER THREE: FACTORS INFLUENCING THE FORMALIZATION OF RURAL LAND TRANSACTIONS IN ETHIOPIA: A THEORY OF PLANNED BEHAVIOR APPROACH

Abstract

Despite the recent successful establishment of systematic land registration programs in various African countries including Ethiopia, updating the land registers has become a growing concern. However, there limited empirical evidence about whether landholders' behavior is driving the lack of updating land registers in Ethiopia. Using the theory of planned behavior, this study examines the factors that influence landholders' behavior of formalizing rural land transactions in Ethiopia. Primary and secondary data collected using surveys, key informant inter-views, and a literature review. A total of 206 respondents participated in the survey from the Basona Worena district of the Amhara region, central Ethiopia. A structural equation model and descriptive statistics used to analyze the survey data and supplemented by qualitative findings. The study findings revealed that landholders' attitudes and subjective norms have positively and significantly influenced their intentions to formalize land transactions. However, perceived behavioral control has a negative and insignificant influence. The predictive relevance of the re-search model is significant and indicates strong intentions to formalize but less actual behavior. This behavior can influence the currency of the information in the land register soon and degrade the functions and sustainability of the land registration system in Ethiopia. The study findings recommended facilitating the behavioral changes of landholders to transform their strong intentions into actual practice. Policymakers should develop and implement an innovative information value creation strategy including landholder-oriented services that incentivize the formalization of land transactions and helps landholders overcome hurdles created by subjective norms.

Keywords: land register; updating; attitudes; subjective norms; perceived behavioral control; intentions; actual behavior; Ethiopia

3.1 Introduction

Conventionally, land administration systems created to record and disseminate information about people's relationships to land including rights, responsibilities, restrictions, location and boundaries, and other attributes of real properties [4]. The establishment of land information could take place through either systematic or sporadic land registration approaches [11]. The approach depends on the purpose, available technologies, and source of funding [6, 12]. Systematic land registration is commonly compulsory and driven by the state (supply-side), whereas sporadic registration can either be voluntary if initiated by a landholder (demand-side), or compulsory (during a land transfer) [157, 158]. The existence of good and well-functioning land information is key to answering fundamental land development and management decision-making questions (i.e., Who has rights? To what land? Where is the land? When was it acquired? How is it used?) [101]. A land information system (LIS) should be complete, accurate, dependable, uniform, up-to-date, sustainable, and mirror the reality on the ground in real time [47]. Land registration becomes socially more valuable as more parcels registered, because it leads to more investment and more transactions [159]. However, the cost of leaving land that is outside of the registry also becomes higher as more land registered, because investment is lowest for land held under an informal regime [160]. Whether implicit or explicit, the landholder's intention or choices to register one's land and property rights is the result of a reasoned decision [6, 13, 160]. Therefore, the intentions to formalize land transactions after first-time land certifications are central to the discussion of a functional and sustainable land registration system.

Recently, however, keeping the LIS up to date is becoming more challenging than establishing a LIS for the first-time [10, 12]. It has also understood that the maintenance and updating of a LIS depends on factors including governance, technology, and behavioral factors [10, 12, 97, 161]. The latter specifically covers both people working in the system (supply-side capacity) [6, 47], and the intent and behavior of land rights holders (demand-side) [11] of formalizing land transactions after first-time land registration. Understanding the factors influencing landholders' land transactions formalization intentions and actual practice, which affects the functionality and sustainability of a LIS are highly important. Without the full cooperation of land rights holders to formalize land rights transactions, the information in the land register could quickly become outdated, inaccurate, unreliable, and less relevant, and the system may roll-back into informality and insecurity of tenure

[10–12, 73]. That would be like the previous situation, prior to first-time land registration, and even worse [12].

The preceding chapters cover the policy objectives, historical account, implementation procedures, coverage and development outcomes and their limitations of the two-stage land certification program [17, 21, 30]. Though the FLLC was employed through a systematic land registration approach, there were significant numbers of unregistered parcels due to landholders' fear of confiscation, an increase in land taxation, or other socially undesired norms [18, 22]. Other research evidence from parts of Ethiopia suggests that customary property interests often go unregistered [162].

Since 2014, Ethiopia launched and continued investing in the SLLC program that addresses the limitations of the FLLC and maintain tenure security. According to the Ministry of Agriculture (MoA) [163], between 2013 and the end of 2021, over twenty-two million rural parcels have demarcated and mapped, of which close to eighteen million parcels have been issued with SLLC. The SLLC program is still ongoing; it uses ortho-images as a base map for the cadastral surveying produced from aerial photography (25 cm) [164] and high-resolution satellite images (40 and 50 cm) [21, 22]. The SLLC includes information on the parcel map (geographical location, size, shape, and land use), and textual information on the landholder(s) and their landholding rights and encumbrances [22, 165]. It is notable that the FLLC and SLLC only adjudicate and register the existing landholding rights attached to the claimed and demarcated parcels [163]. In areas where the FLLC had conducted, FLLC data used as a legal source of information and verified by the kebele (village) land administration committee elected by the community and field para surveyors in the SLLC process [12, 165]. After no objection obtained from the landholders or necessary correction made at the woreda (district) land offices, parcel based SLLCs were prepared and approved by the pertinent authorities. Then, landholders were issued with the SLLC in hard copy and advised to report and formalize any subsequent land trans-actions. The formalization of land transactions helps to update the land register kept at the district land administration offices [163, 164]. Alongside the SLLC, the Government of Ethiopia introduced complementary land market innovations to improve access to the credit, land rental, and agricultural inputs markets that make the rural land administration system more sustainable [166].

To ensure the functionality and sustainability of the land registration system, rights holders expected to fulfill the legal and administrative requirements of formalizing or registering

subsequent land transactions [164]. How rights holders perceive and respond to the established process of formalizing subsequent land transactions after the first-time land certification is a critical issue. For instance, the formalization of a new land transaction will have a cost associated with it in fees, stamp duty, and other transaction costs including travel to the service center [23]. After the successful implementation of the FLLC and ongoing SLLC programs over the past two decades, there is a growing and valid concern about the sustainability of the land registration system emanating from issues related to updating the land register to reflect continued land transactions in Ethiopia [23, 167].

Recently, few studies in Ethiopia have examined the functionality of updating the land register. For instance, with an exploratory and qualitative approach, Cochrane and Hadis [23] have studied the functionality of the land registration program in three woredas of the South Wollo administrative zones in northeast Ethiopia. They reported that updating the land certificates was functional in some instances but not in all and suggested investigating the causes of non-functionality and viable options addressing the causes thereof at scale. One of the reasons that identified for non-functionality is woreda–kebele non-collaboration, with disconnected processes of updating at these levels. Another study conducted by the Ethiopia Economic Association (EEA), who also reported that the volume of formal land transactions registered is still low [167]. On the other hand, Biraro et al. [12], using a qualitative and comparative approach, have studied good practices in updating the LIS in unconventional ways in nine case study countries, including Ethiopia, which apply similar data collection procedures for initial registration. Despite the existence of good practices in the cases of countries possessing the required infrastructure, they argue that the technical and financial sustainability of land registries in countries without the required infra-structure is uncertain and threatened by long registration procedures and a lack of da-ta sharing among institutions [12]. In Rwanda, Ali and Deininger have also found that 5 years after completing a first-time land registration, 87% of rural transactions remain informal and the cost of registration is the main reason [52].

However, scholars in the field of land administration rarely study the formalization of subsequent land transactions through the lens of landholders' intentions. However, studying these intentions is important for at least two reasons. Firstly, the analysis of landholder's intentions helps to predict formalization rates. Secondly, it helps to improve our understanding of the factors that are responsible for the realization, or not, of these intentions. The focus of the current study is on the

latter research stream. This information can help inform target interventions for different types of landholders facing various constraints in putting their intentions into action and ensure a functional and sustainable LIS.

This study demonstrates that the application of the theory of planned behavior (TPB) can be usefully employed to deepen our understanding of land rights holders' formalization of subsequent land transactions. Through the lens of TPB, among other issues, the authors considered and explored the influencing factors of rural land trans-action formalization and their relationships, including attitudes, subjective norms, and perceived behavioral control as antecedents to the intention and actual behavior of land rights holders. In addition, the authors considered the role of background factors, such as institutional policies and regulations, societal customs and values, and personal characteristics.

3.2 Theoretical Base

The theory of planned behavior (TPB) evolved from the theory of reasoned action (TRA) [168]. TRA developed in 1967 by Fischbein for the first time, in response to the repeated failure of traditional attitude measures to predict a given behavior [169, 170]. The theory begins with the premise that the simplest and most efficient way to predict a given behavior was to ask a person whether he or she was or was not going to per-form that behavior [170]. Thus, according to the theory, performance and non-performance of a given behavior are primarily determined by the strength of a per-son's intention to perform (or not perform) that behavior, where the intention is defined as the subjective likelihood that one will perform (or try to perform) the behavior in question (Attitude - Behavior consistency) [169]. During the early 1970s, the theory revised and explained by Ajzen and Fishbein [170]. By 1980 the theory used to study human behavior and develop appropriate interventions [171]. In 1988, the TPB added to the existing model of reasoned action to address the inadequacies that Ajzen and Fishbein had identified through their research using the TRA [168, 171].

The theory of planned behavior adapted the components of the TRA but added perceived behavioral control as an additional factor predicting both behavioral intentions and actual behavior [172]. Since the TPB proposed by Ajzen in 1985 [173], it has attracted extensive interest and has widely applied worldwide. To date, studies have tried to improve the interpretation ability of the theory by extending variables or integrating other theories into the TPB model [174, 175]. The TPB

has received broad attention in social and behavioral sciences such as health, environment, business and management, educational research, and the political sciences [175]. Investigators continue to explore the intricacies of the structural model such as moderating the effects of perceived behavioral control and proposing additional factors to account for the complexity of human behavior [174].

At the core of the TPB is its concern with the predication of intentions [70]. According to the TPB, human behavior guided by three kinds of considerations: beliefs about the consequence of the behavior, beliefs about the normative expectations of others, and beliefs about the presence of factors that may facilitate or hinder the performance of the behavior [168, 171, 174, 175]. Put it in other ways, the beliefs influenced by behavioral beliefs, normative beliefs, and control beliefs. Behavioral beliefs produce favorable or unfavorable attitudes toward the behavior, whereas normative beliefs result in perceived social pressure or a subjective norm. In addition, control beliefs give rise to perceived behavioral control or self-efficacy [70, 171, 176]. Whether intentions predict a behavior depends in part on factors beyond the individual's control, meaning the strength of the intention to behavior relation moderated by actual control over the behavior [70]. The effects of attitude towards the behavior, and subjective norm on the intention, moderated by the perception of behavioral control [175]. As a rule, the more favorable the attitudes and subjective norms, and the higher the perceived behavioral control, the greater the person's intentions should be to perform the behavior in question [171, 175].

According to the TPB, attitudes towards the behavior defined as the individual's positive and negative feelings about performing a behavior [177]. It is determined through an assessment of one's beliefs regarding the consequences [171]. Likewise, subjective norms defined as an individual's perception of whether people important to the individual think the behavior should perform [176, 177]. The contribution of the opinion of any given referent weighted by the motivation that an individual must comply with the wishes of that referent [178]. In summary, by changing these three 'predicators', i.e., attitudes, subjective norms, and perceived behavioral control, we can increase the chance that the person will intend to do the desired action and thus increase the chance of the person doing it or the actual behavior [168, 171, 175].

Regarding the land registration system, Abubakari, Richter, and Zevenbergen [13], in their recent work, highlighted three general underlying assumptions for the conventional land registration approach and show what such assumptions imply for the emerging fit-for-purpose approaches.

According to these authors, the three underlying assumptions include (a) desirability, (b), registrability, and (c) accessibility [13]. The arguments outlined by Abubakari, Richter, and Zevenbergen are much closer to what is stated in the theory of planned behavior. Likewise, Deininger and Feder also underlined the need to understand the context while introducing a land registration system in each authority [6]. Overall, individuals are located within a social 'culture' that influences the development of values, beliefs, attitudes, and behavior [171]. Socio-cultural factors play an influential role in shaping an individual's early life (and later life) experiences and general beliefs about the world [179]. Hence, access to the land registration system embedded in socio-cultural practices of land allocation, and practices of landholding, as well as the practice of land registration [6, 180, 181].

Similarly, Biraro et al. [12] also identified comprehensive criteria in unconventional contexts of updating land information. Bennett et al. [10] also outline aspects of land administration maintenance including the level of change, method of change, components, and options to change. Zevenbergen in his early work on the system thinking approach to land registration, outlined aspects and conditions of land registration systems including the initial establishment and updating [11]. Magis and Zevenbergen [182] also highlighted long-term value creation mechanisms of land registration for sustainable land administration system design. This major scholarly literature covers what should be considered in establishing, maintaining, upgrading, and updating the function of a land registration information system for sustainability.

Based on this brief theoretical analysis, the authors posit the following theoretical assumption. As the desired outcome of a functional and sustainable land registration system, land rights holders' formalization (registration) of subsequent land transactions is an outcome of their intentions. The authors preferred formalization over registration for subsequent land transactions to minimize confusion of concepts with first-time land registration. According to Ethiopia's land administration legislation, the formalization of subsequent land transactions includes over twenty business cases related to inheritances, gifts, rentals, divorce, parcel mutation or merger, collateral, and encumbrances [23, 166]. Land rights transferred partially or fully for a certain period or perpetually. The formalization of these subsequent land transactions is dependent on the perceived behavioral belief or attitudes of the land rights holders toward the legal consequences of land registration. That is, the decision to formalize a transaction is an output of the value placed by individual landholders

or groups of people on the benefits of formally registering one's land use or holding rights [182]. These benefits include secure tenure, control and/or use, and transfer rights to others [23].

In terms of the enforcement of rights, land registration is a dynamic and complex system between individual titling decisions and social choice [160]. The registration system secures all registered parcels [11, 12] and needs to design to facilitate updates to the land register following transactions [182], which implies a cost. The formalization of subsequent land transactions by the land rights holders is also influenced by beliefs about the normative expectation of others (normative beliefs) or referents such as a spouse, relatives, and extension service providers. Moreover, land rights holders' beliefs about factors that may enable, or hinder land transactions registration (control beliefs) also affect their intentions to formalize subsequent land transactions. The control beliefs can include the accessibility, affordability, simplicity of procedures, speed/time, and incentives (benefits) of formalization, among others [12]. Overcoming such control beliefs would determine the level of self-efficacy [171] that in turn influences the intentions and actions of formalization of the land rights holders.

Landholders' intentions to formalize land transactions and their actual behavior assumed to be of particular interest to policymakers for two reasons. Firstly, knowing the intention to formalize would help to estimate the rate of transactions for planning and resource allocation. Secondly, it would also help to improve understanding about what factors influence land rights holders' intentions to formalize subsequent land transactions. Hence, appropriate interventions to encourage land rights holders to formalize subsequent land transactions could be designed to strengthen the land registration system. Therefore, facilitating landholders' attitudes of formalizing land transactions, will help them to overcome social norms and control beliefs and will increase intentions and actual practice that ensures land registration systems remain up to date and sustainable. Hence, the following hypotheses are constructed and evaluated.

Hypothesis 1 (H1). *Attitudes of land rights holders towards the value of land registration have a significant influence on the intentions of land rights holders to formalize subsequent land transactions.*

Hypothesis 2 (H2). *Attitudes have a significant influence on the overall subjective norms that influence land rights holders' formalizing subsequent land transactions.*

Hypothesis 3 (H3). *Attitudes have a significant influence on the perceived behavioral control towards land rights holders' formalization of subsequent land transactions.*

Hypothesis 4 (H4). *Subjective norms have a significant influence on land rights holders' intentions to formalize subsequent land transactions.*

Hypothesis 5 (H5). *Perceived behavioral control has a significant influence on land rights holders' intentions to formalize subsequent land transactions.*

Hypothesis 6 (H6). *Perceived behavioral control has a significant influence on the formalization of subsequent land transactions by the holders of land rights.*

Hypothesis 7 (H7). *Intentions to formalize subsequent land transactions have a significant influence on land rights holders' formalizing of subsequent land transactions.*

The theory and hypotheses presented in Figure 9.

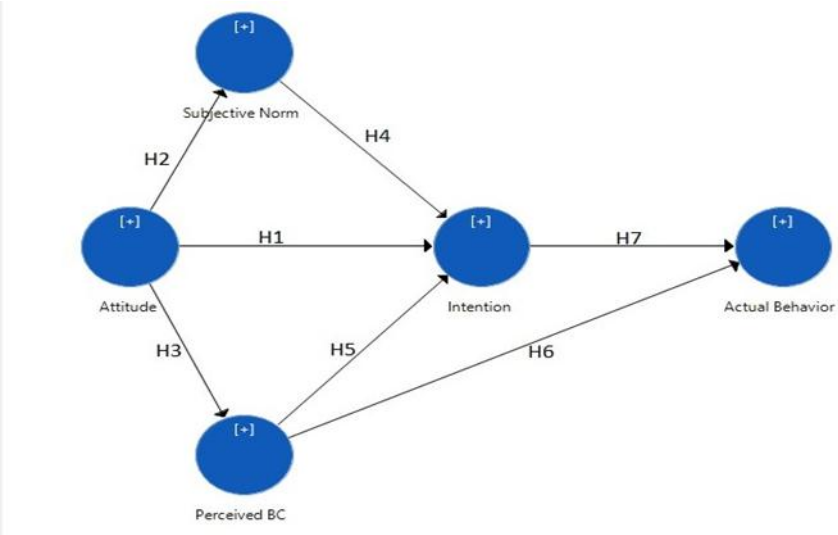

Figure 9. Research model with latent variables and hypotheses adapted from Icek Ajzen theory of planned behavior and applied to the formalization of subsequent land transactions.

3.3 Study Site and Methods

This section presents explanations about the study area contexts and the methods employed for data collection including sampling methods, sample size, data collection instruments, and materials used

to generate the required data for this study. This section also describes the methods of analysis and means to triangulate the results of the quantitative and qualitative data.

3.3.1. Study Site

The Basona Worena woreda is one of the rural woredas selected for the household survey of this study in the Amhara regional state. It is situated surrounding the Debre Birhan town, the North Shewa administrative zone's capital, and is located 130 km from northeast Addis Ababa, Figure 10. Debre Birhan is a historic town located at the very heart of the medieval age history of the country. It is one of the fastest-growing zonal administration towns of the Amhara regional state recently. Debre Birhan is expanding in all directions to its surrounding Basona Worena woreda. It is becoming an industrial investment hub for hundreds of mega, medium, and small-scale industries. This fuels the expansion of new residential neighborhoods to labor households and ex-acerbates horizontal expansion. As a result, Debre Birhan has expanded its urban form and size threefold into the neighboring Basona Worena woreda over the past decade. This fast urban growth leads to a high agricultural land conversion into the built environment. Therefore, the competition of land resources between urban development and agricultural practices is considerable and the Basona Worena woreda land re-source is the podium to this arena. This implies that there would be a high potential for land transactions in the study woreda.

The Basona Worena woreda is composed of thirty rural kebeles with a population of around 135,000 persons and 27,000 households, according to the information received from the woreda land administration office. It covers around 140,000 ha and close to 250,000 land parcels. The Basona Worena woreda represents highland agroecology where mixed farming is the major source of livelihood. It has an altitude range of 1300–3400 m above sea level [183]. According to the woreda land office, the woreda has 42,828 hectares of arable land with 159 hectares of irrigable land, and 6828 hectares of forest plantations. Crops grown in the Basona Worena woreda include teff, barley, wheat, faba bean, field pea, sorghum, lentil, chickpea, onion, potato, temperate fruits, and oil crops [183].

The Second Level Land Certification (SLLC) issuance process was conducted between 2016 and 2019. The SLLC was supported by the UK-funded Land Investment for Transformation (LIFT) program and resulted in the identification of close to 250,000 parcels, where 99.6% of the landholders received the SLLC. The installation of a national rural land administration information

system (NRLAIS), a digital land register and data migration system, has been initiated since September 2019 and has been operational since 2020. According to the key informants, the Basona Worena woreda also undertook the FLLC program between 2005 and 2007. Between 2008 and 2010, the woreda land administration office converted the manual land register into a digital land register called the Information System for Land Administration (ISLA). ISLA is a pioneer computerized land registration software solution designed to operate in the woreda land offices in the Amhara region. ISLA supports the registration of parcels, landholders, and their rights for the transfer of parcels and attached rights including division of parcels, leases, and easements, and it facilitates statistical reporting [184]. According to the key informants, the ISLA data have been instrumental for the implementation of the SLLC program in the Basona Worena woreda.

The Basona Worena woreda has a land office in Debre Birhan, the seat of both the zonal and the woreda administrations. The woreda land office has three business teams; the land administration work process team is one of the three teams and staffed with seven experts. There are also thirty land administration experts - one expert in each rural kebele land office. Besides this, there are elected and voluntary land administration committees that are responsible for the facilitation of the land registration and certification process and land disputes resolution, among others. The Kebele land offices are the windows for landholders to lodge their applications or land services, including registration of subsequent land transactions. Accordingly, survey data collected from land rights holders of seven different rural kebeles (villages) of the Basona Worena woreda (district).

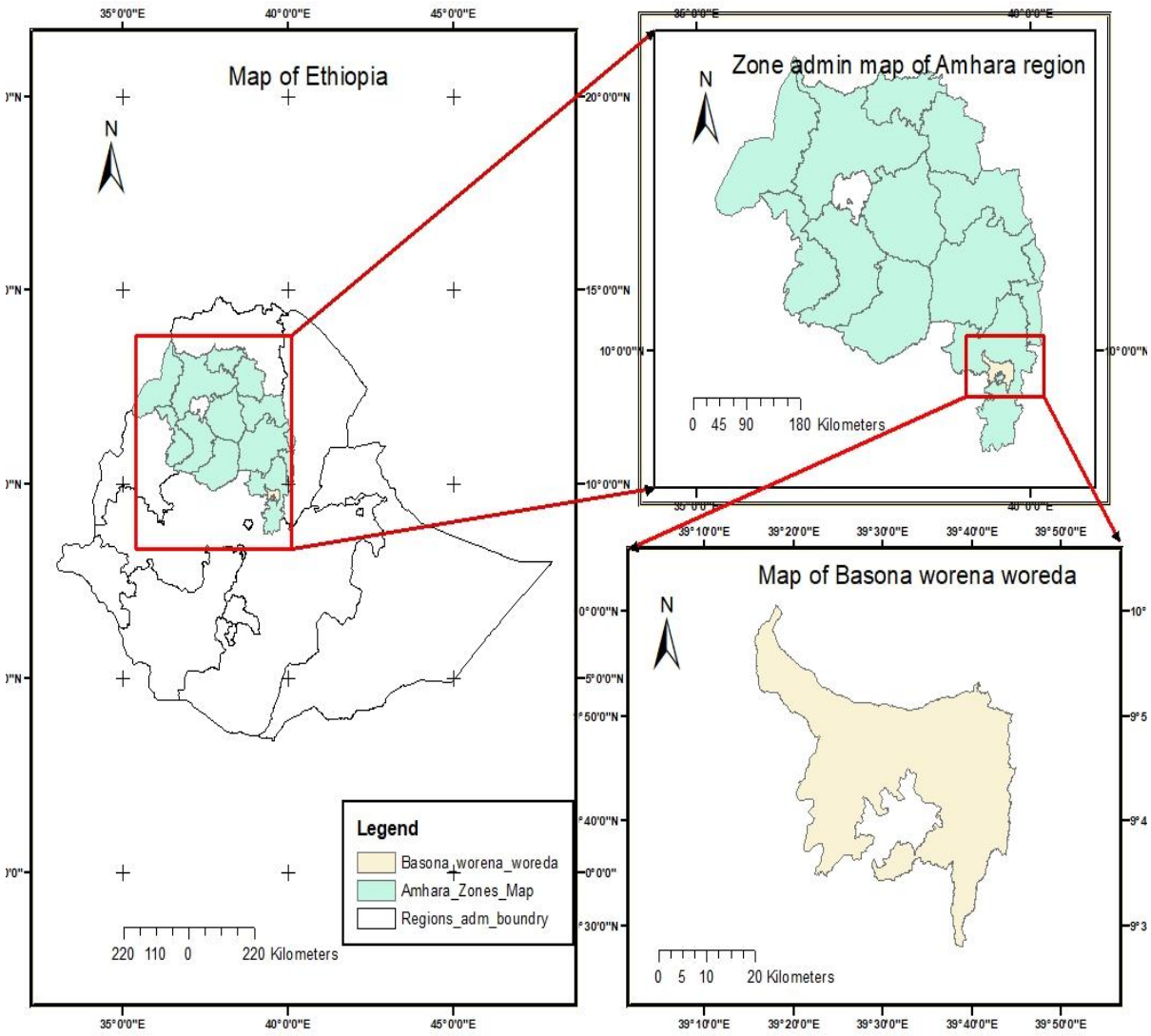

Figure 10. Study Site Map. Map organized by the authors based on the 2018 updated shape file/map of Ethiopia by Central Statistical Agency under the auspices of the Ministry of Finance.

3.3.2. Methods for Data Collection and Analysis

3.3.2.1. Data Types and Collection Methods

The study employs primary and secondary data. The primary data collected from smallholder households through a cross-sectional survey and key informant interviews (KIIs) with woreda and kebele land administration experts. Key informant interviews were employed to collect information on standards, procedures, requirements, trends, types, and magnitudes of subsequent land transaction registrations. The KIIs also intended to learn about the understanding, knowledge, skills, attitudes, experiences, and perception of respondents on subsequent land transaction handling. In addition, the secondary data collected through a review of the scientific literature,

program documents, operational manuals, and data mining from the woreda digital land register, called the national rural land administration information system (NRLAIS).

A pilot survey questionnaire developed for the study based on the guideline for the TPB questionnaire [185]. According to the guideline, before any work begins, the behavior of interest must clearly define in terms of its target, action, context, and time elements [186]. However, to elicit salient beliefs initially, the authors first visited the woreda land administration office of the study area in February 2021, where landholders formalize subsequent land transactions that they have made after first-time land certification. This first stage is conducted individually in a free-response format related to readily accessible behavioral outcomes, normative referents, and control factors. Next, five to six formative items are formulated to develop the pilot survey questionnaire for direct measures. Seven-point bipolar adjective scales were employed. The respondents asked to state their opinions using a seven-point Likert scale, from strongly disagree (1) to strongly agree (7), for behavioral beliefs, referents, and behavioral control measurement-related items. The formulation of the pilot questionnaire aimed to assess each of the theory's major constructs: attitude, subjective norms, perceived behavioral control, intention, and the actual behavior [186, 187] of landholders towards reporting and formalizing subsequent land transactions. The pilot questionnaire also included measures of background factors and other variables, including demographic characteristics and other socioeconomic data.

Using the pilot questionnaire, twenty-eight landholders, twelve of whom were female, interviewed in the second week of February 2021. Most landholders had visited the woreda land administration office to follow up on their earlier application of up-dating land transactions including inheritance, donation, lost certificate replacement, and complaints related to land-related conflicts. The results of the pilot questionnaire allowed the authors to evaluate the validity and consistency of each item and the utility of the background measures, and other socioeconomic indicator items. Based on these inputs, necessary adjustments were made, and the standard questionnaires used in the main study produced.

Tablet-based data collection was employed for the actual survey from April to May 2021. After successful survey questionnaire pilots and adjustment, the questionnaire programmed into a cloud-based Kobo Toolbox server. An Open Data Kit (ODK) data collector application installed and configured on Android tablets to connect, download, fill, and upload the survey questionnaire to and from the cloud server. Before the actual survey, training was provided to eight data collectors

and two supervisors on the use of the tablet-based data collection, management of the tablet, and hardware to limit complications in the field. Moreover, orientation on the meaning of each item, protocols for the tablet-based data collection, procedures on addressing data inconstancies or misreporting, data transmission, validation protocols, contingency plans, and steps, if needed, to revert to a paper-based version were part of the training. The tablet-based data collection was a systematic approach that reduced data entry error as the questionnaires encoded with prepopulated entries based on prior information. The tablet-based data collection also improved the quality of the data and saved time per interviewee. The average time taken to complete a household survey was 40 min.

3.3.2.2. Data Analysis Methods

A partial least square structural equation model (PLS-SEM) and descriptive statistics used for the quantitative survey data analysis. Qualitative data collected through key informant interviews is first organized thematically. Then, the analysis focused on context-specific meanings and explanations for reported practices, and perceptions of land experts on processing subsequent land transactions. Next, a deductive approach that triangulates and explains results from the quantitative survey data applied. A summary of the descriptive and inferential statistics was also employed to analyze the results of the survey data related to socioeconomic and demographic characteristics of the respondents.

PLC-SEM uses proxies of interest, which weighted as composites of indicator variables for a particular construct; in most cases, this considered a novel second-generation multivariate statistical technique [188]. Smart-PLS software version 3.0 used to process the data analysis related to the coefficient of interaction terms [189]. PLS-SEM includes confirmatory factor analysis, path analysis, and partial least squares to impute relationships between latent variables [138]. In PLS-SEM, the model has two parts namely, the outer or measurement model and the inner or structural model. In the measurement model the researcher assessed and evaluated whether the constructs of the latent variables were valid and reliably constructed. The validity and reliability of the measurement model of the research was evaluated using the factor loading analysis of each latent variable. Whereas in the structural model, the authors evaluated the path hypothesized in the research framework.

- Validity

Validity tests attempt to determine how accurately or well an instrument measures a particular concept and designed to measure the underlying construct [188]. This shows the extent to which the items used to measure can calculate the idea that they are meant to quantify [145]. The measurement model shows the subjective independence of every indicator on its latent variable using factor loading or cross-loading criteria [138]. Through factor loadings, the convergent and divergent validity of each item is evaluated against the underlying latent variable construct. The individual item reliability is evaluated by examining the loading and cross-loading of indicators in their respective constructs. Moreover, Composite Reliability (CR) and Average Variance Extracted (AVE) analyses used to evaluate the convergent reliability of the constructs [145], whereas a divergent validity test conducted using the Fornell–Larcker analysis and Heterotrait–Monotrait Ratio (HTMT). The divergent or discriminant validity examines whether that constructs' items correlate with the items of other constructs [147].

- Reliability

A reliability test tries to find the stability and consistency of the measuring instrument. Composite reliability and Cronbach's alpha used to evaluate the reliability of each construct [188]. The composite reliability and Cronbach's alpha examine whether the items are measuring what they are supposed to measure. Put differently, the Cronbach Alpha analysis examines the consistency of data. According to Fornell and Larcker's criteria, a reliability score of Cronbach Alpha 0.6 considered minimally acceptable, with 0.70 preferred (50% of the explained variance) [147]. This theory also recommends that an indicator loading with a value less than 0.4 should remove from the model [188].

In the second part of the research model, a structural model is used to evaluate the structural relationships between the hypotheses. Using the bootstrap resampling technique (5000 resamples), the path coefficient evaluated to examine the significance of the hypothesis. A t-value > 1.96 considered significant at $p < 0.05$, and a t-value > 2.58 is significant at $p < 0.01$ [188]. Most researchers also use p values to assess significance levels. When assuming a significance level of 5%, the p-value must be smaller than 0.05 to conclude that the relationship under consideration is significant at a 5% level [188].

The structural model also assessed based on the R^2, Q^2, and significance of paths. The R^2 indicates the proportion of the variance for the endogenous variable explained by the exogenous variable [188, 190]. The validity of the model was determined by the strength of each structural path, determined by the R^2 value for the dependent variable; the value for R^2 ranges from 0 to 1, with higher levels indicating higher levels of predicting accuracy [138, 188, 190]. According to Hair et al. [145], R^2 values of 0.75, 0.50, and 0.25 can describe as substantial, moderate, and weak, respectively [145] while Chin articulated R^2 values of 0.67, 0.33, and 0.19, considered as substantial, moderate, and weak, and evaluated subsequently. Hence, the predictive capability was established. Moreover, Q^2 establishes the predictive relevance of the endogenous construct. A Q^2 above 0 shows that the model has a predictive relevance [188].

3.3.2.3. Sampling Method

To determine the sample size required for a study that uses a structural equation model (SEM), the authors applied the Soper [144] online free statistic calculator, which calculates priori sample sizes for structural equation models. This sampling calculator considers the number of observed and latent variables in the model, the anticipated effect size, the desired probability, and the statistical power levels, presented in Table 7. The model of this study contains twenty observed variables and six construct latent variables. The model considers the anticipated medium effect size of 0.3, the desired probability level of 0.05, and the desired statistical power level of variables of 0.8. Hence, the minimum initial sample size to detect the effect was determined to be 150, the minimum sample size for the model structure was one hundred, and the recommended minimum sample size was 150.

Table 7. Sampling parameters and values.

Parameter	Values
Anticipated effect size: medium	0.3
Number of latent variables	6
Probability level	0.05
Desired statistical power level	0.8
Number of observed variables	20
Minimum initial sample size to detect an effect size	150
The minimum sample size for the model structure	100
Recommended minimum sample size	150

A systematic random sampling method used to identify the sample kebeles of the study woreda. There are thirty kebeles in the Basona Worena woreda, of which seven kebeles randomly selected including Bakelo, Billila, Birbisa, Debele, Goshebado, Mehal Amba, and Wushawishign. As a result of these sample size requirements, a careful review of the existing land register in the Woreda land office conducted. The total landholder population in these sample kebeles was 11,149. To randomly select a proportional sample of respondents, the authors used the landholding identification numbers in the ISLA computerized land register and ran the sampling model in Microsoft excel. Hence, 320 respondents identified randomly from all sample kebeles including reserve respondents. However, data collected from only 206 respondents, which is above the recommended minimum sample size of 150 respondents for the research model.

3.3.4 Results

3.3.4.1. Characteristics of Respondents

Discussing the demographic features and socioeconomic conditions of respondents would have a significant role in understanding whether such a background affects the intention and decision on the formalization of subsequent land transactions. According to the survey result, the sample respondents included 148 (72%) male and 58 (28%) female smallholder household heads, Figure 11. This indicates that most land-holder households male-headed in the study kebeles. The age of the respondents ranges between 20 and 93 with a mean of 49.31 years. This may affect the socioeconomic aspects of the households with far reaching implications on access to land rights, registration of the subsequent land transaction, and land management practices in the study area.

According to the Ethiopia Statistical Service (ESS), ages between 15 and 65 considered as the working ages of the population. The result indicates that the respondent landholders (about 90%) are within their working ages. In addition, the sample respondents' family size ranges between 1 and 10, with a mean family size of 4.31 and a total of 888 persons, of which 47.75% were females, including household heads. Family labor is one of the most important assets of the respondent households. Hence, the availability of sufficient labor within respondent households would help them to undertake better land use management practices and increase land productivity.

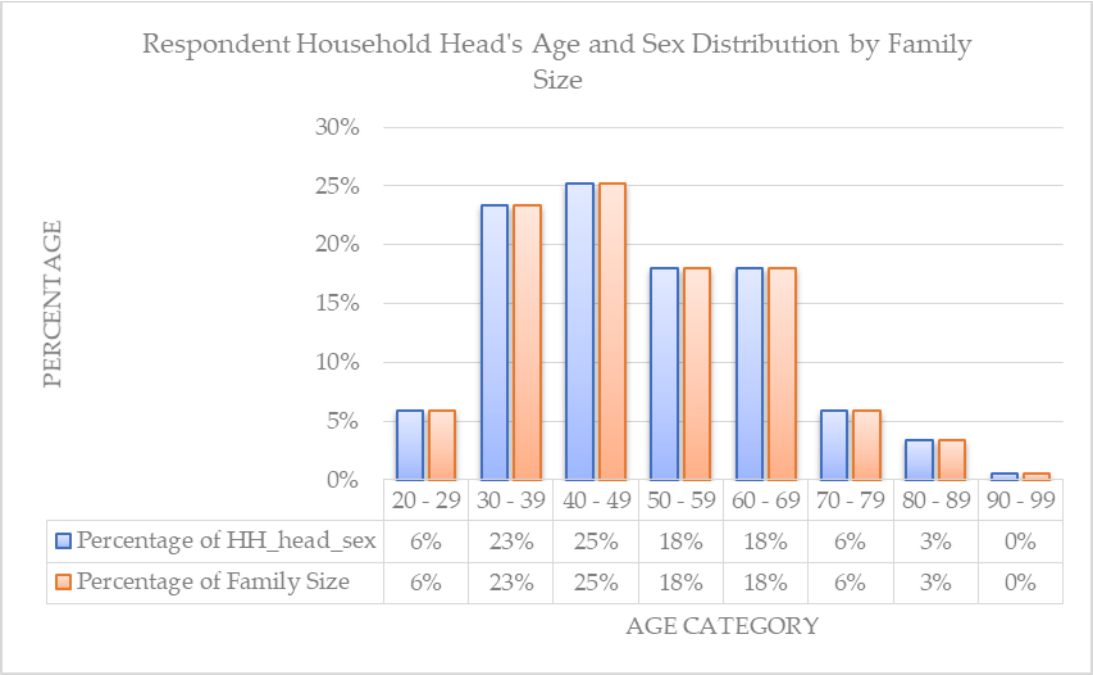

Figure 11. Respondent household's age and sex distribution with family size. Source: authors' compilation from household survey.

Regarding respondents' educational status, about a third of them were illiterate, while 9.17% can read only, another 34.47% can read and write, whereas the remaining quarter (24.27%) completed fourth grade and above, Table 8. The survey results also revealed that two thirds of all illiterate respondents were men. This shows that a third of the respondents require a sort of literacy aid from others who can read them documents related to their landholding rights and registration process. In addition, about 78% of all men (148) and 38 % of all women (58 respondents) were married landholders, Table 2. This implies that there are more married women who enjoy access to land, jointly with their male counterparts, than unmarried women (27) who have access to land use right independently.

Table 8. Respondent's Marital and Educational Status by Sex. Source: Authors' Compilation from the household survey.

Educational Status								
				Female				
Marital Status	>12 Grades Complete	Grade 10–12 Complete	Grade 8 Complete	Grade 4 Complete	Read and write	Read-Only	Illiterate	Female Total
Divorcee	0	0	0	1	0	0	0	1
Married	0	2	1	1	9	1	8	22
Unmarried	0	1	10	3	7	0	6	27
Widower(ed)	0	0	0	0	0	0	8	8
Sub Total	0	3	11	5	16	1	22	58 (28%)
				Male				Male Total
Divorcee	0	0	0	0	0	0	2	2
Married	0	4	4	9	47	17	34	115
Unmarried	1	5	3	5	6	2	6	28
Widower(ed)	0	0	0	0	2	0	1	3
Sub Total	1	9	7	14	55	19	43	148 (72%)
Grand Total	1 (0.5%)	12 (5.8%)	18 (8.7%)	19 (9.2%)	71 (34.5%)	20 (9.7%)	65 (31.5%)	206 (100%)

3.3.4.2. Landholding Assets of Respondents

Land is the primary source of livelihood for all respondent households. Despite differences in the means of acquisitions, the size of a landholding reflects an important productive asset and socioeconomic status of respondents within their own community. This socioeconomic status would affect respondent's intentions and decisions in formalizing subsequent land transactions. In terms of landholding assets, Table 9 shows that the total area of landholding possessed by the

respondents ranges between 0.06 and 7.8 hectares with a mean area of 1.83 hectares in the study area. According to the survey result, the number of parcels per landholding ranges between 1 and 6 with a mean of 4.15 parcels per respondent, which is a bit above the national average, Table 3. This indicates a high fragmentation of landholding in the study area, which may have implications on the cost of subsequent land transactions registration eventually.

Moreover, a sizable number of parcels of landholdings found below the minimum landholding size determined by the Amhara regional state revised rural land administration and use proclamation No. 252/2017 [191] and regulation No. 159/2018 of the same [192], Table 3. The regulation, Article 5.1, determined that the minimum parcel size that rural landholders entitled to obtain in the regional state may not be below 0.25 hectares for rain feed, 0.06 hectares for irrigable parcels, and 0.02 hectares should it to use for the construction of a dwelling. Article 5.2 of the same regulation states that "in any conditions and settings, no parcel (s) of a holding shall subdivide below the limit indicated under Article 5.1." This legal precondition, while encouraging the defragmentation of parcel(s) of a holding, may impede the transfer and registration of transactions and leave it under informal conditions.

Table 9. Summary and descriptive statistics of selected variables.

Variable	Observations	Mean	Std. Dev.	Min	Max
Family size	206	4.31	2.32	1	10
Household head sex (M = 1, F = 0)	206	0.72	0.45	0	1
Household head age	206	49.31	14.36	20	93
Total number of parcels	206	4.15	1.63	1	6
The total area of landholding	206	1.83	1.17	0.06	7.8
SLLC received	206	1.04	0.39	1	6
Amount willingness to pay for SLLC	206	174.85	93.23	0	300

Despite having a similar average family size and number of parcels per landholding to that of the national average, the results show low levels of per capita landholding size (0.42 ha) in the study

area. This characterizes a typical land scarcity in the study area that reflects the scarcity in the highland regions of the country. Since the parcels are below the minimum size, this may affect the land acquisition opportunities among heirs, such as through inheritance and gift, in the study area. Further, this could affect the registration of such land transactions after the first-time land certification. The fragmentation may also increase the cost of sustainable land use management practices of the households in the study area.

The survey results also revealed that 26.7% of all respondent households had been engaged in a subsequent land transaction since 2019. The year 2019 hallmarks the completion of the SLLCs issuance in the study area. These subsequent land transactions consist of inheritance with a will (4%), a gift (2.9%), rent (9.7), and access to cred-it (9.2%). The survey results also notably revealed that all inheritance and access to credit transactions had been registered in the land register. Whereas only 16.7 % of all gifts and 35% of all land rentals registered or formalized in the woreda land register. This shows that most land transactions made through gifts and rentals not found formalized, which affects the up-to-datedness, accuracy, and completeness of information in the land register of the woreda. Respondents also revealed that the reason for lack of registering all rentals and gift transactions was because a land transaction among family members or relatives needed no registration since customs warranty the protection and enforcement of contracts. This information and trend are quite similar with the data generated from the woreda digital land register, explained in Section 4.4 below.

3.4.3. Distance to the Woreda Land Office, Cost of Travel and Registration

Distance to the land registration service center, in this case the woreda land ad-ministration office, assessed with the aim to factor its effect on respondent's intentions to formalize subsequent land transactions. According to the survey result, 98% of landholders have received an SLLC as a first-time certification for at least one of their parcels of landholding by 2019. The average distance to travel to the woreda land office ranges from 9 to 28 kilometers from the respondents' respective resident kebeles, Table 10. This allowed us to compare the likelihood of intentions to formalize subsequent land transactions. The survey results also revealed that the average cost of travel to the woreda land office per round trip, including purchasing a normal lunch, ranges from 190 to 383 Ethiopian Birr (ETB), should they be using a public transport. Though all the sample kebeles have access to public transport, the type of road varies between asphalt and all-weather gravel roads, as do the tariffs of travel cost. It found that land rights holders closer to the woreda land office with

access to public transport with an asphalt road have a much higher intention and practice of formalizing subsequent land transactions.

Another interesting element considered related to cost was the registration and service charges. Land administration service fees have a direct impact on the perceived behavior or willingness to register subsequent land transactions and keep the land register up to date [10, 12]. The survey result also shows that landholders are willing to pay up to three hundred Ethiopian Birr (ETB) per SLLC with a mean value of 175 ETB, Table 3. The average willingness to pay, per kebele, ranges from 153 ETB to 209 ETB, Table 4. In addition, the survey result shows that the average total cost (cost of travel and registration fee) differs from kebele to kebele. It found that, should the registration of a subsequent land transaction be complete in a single round trip, per kebele, the cost ranges from 315 ETB (respondents from Birbisa—the nearest kebele with a gravel road) to 571 ETB (respondents from Goshebado—the second most remote kebele with a gravel road). Likewise, the average total cost of travel and a subsequent land transaction registration for kebeles having access to asphalt public transport ranges from 393 ETB (respondents from Bakelo—the nearest kebele) to 483 ETB (respondents from Billila—the second most remote kebele).

According to the key informants, landholders asked to pay 50 ETB for a trans-action that needs updating, for those landholders who had received a first-time land-holding certificate. Whereas, if the applicant is a new landholder who did not receive a landholding certificate in the first-time registration and certification, she/he asked to pay 150 ETB for the SLLC, plus a 100 ETB service charge. Interestingly, despite this variation, the subsequent land transactions registration fee structures of the woreda are much more consistent with and within the range of what found in the survey results of this study. The result revealed that there are good attitudes towards land registration values and a willingness to pay the indicated registration and service fee, including the cost of travel. With proper interventions, this, in turn, indicates a good potential for a self-financing land registration system.

Table 10. Average distance to woreda land administration office, cost of travel/round trip, and willingness to pay for the registration of a subsequent land transaction. Source: Authors' compilation from household survey, 2021.

Kebele Name (ID)	Average Distance to Woreda Land Office (KM)	Average Traveling Cost (ETB)	Average Willingness to Pay for the Registration of a Subsequent Land Transaction	Total Cost Should the Registration of a Subsequent Land Transaction be Complete in a Single Round Trip
Bakelo (4)	14	190	203	393
Debele (9)	24	282	155	437
Birbisa (12)	9	158	157	315
Goshebado (14)	19	362	209	571
Wushawishign (20)	28	383	146	529
Mehal Amba (27)	15	217	153	370
Billila (30)	17	311	172	483
Grand Total Average	18	272	171	443

3.4.4. Results from Key informant Interviews

Results from the key informant interviews (KII) also revealed that the woreda land office receives applications from clients on Mondays and Fridays. The remaining business days are dedicated to handling and processing the applications internally. According to the KII, the reception days and hours well communicated to, and known by, land rights holders. It mentioned that there are close to twenty business transaction types recognized by the land office. To facilitate these transactions, fifteen types of standard application forms and copies of all these are distributed to the kebele land offices, where applicants initiate their cases. It claimed that all kebele land administration experts and the kebele land administration and use committees (KLAUC) have received proper training and have adequate knowledge to manage the different business case applications.

According to the report generated from the digital land register of the woreda land office, only about 3391 land transaction applications processed and completed in 2021, Figure 12. This includes inheritance without a will (868 cases), ex-officio (882 cases), mortgage (604 cases), simple

correction of tenure documents (458 cases), gift (285 cases), and expropriation and compensation (168 cases). In addition, completed transactions with small numbers of cases include land-to-land exchange (66), divorce (19), replacement of land certificates (17), land rentals (15), land consolidation (5), and inheritance with a will (4 cases). This shows that over half of all transactions were inheritance without a will and ex-officio cases, while inheritance by will and parcel consolidations represented the least number of transactions of all registered transactions.

Key informants also revealed that land rights holders are becoming more interested in formalizing subsequent land transactions now than ever before. This is due to the continued awareness-raising campaigns made to landholders, KLAUC, and kebele land experts. However, they have also admitted that, in some cases, more and continuous awareness campaigns are needed, particularly on the benefits of registering subsequent land transactions and the risks of informal transactions. In addition, the introduction of new benefits of registration, such as SLLC-linked individual loans from micro finance institutions (MFIs) to landholders, incentivizes them to have strong intentions to formalize subsequent land transactions.

However, key informants also revealed that sizable portions of subsequent land transactions remain unregistered and fall under an informal transaction regime. Some of the main reasons outlined for non-registered transactions include incomplete information of transacted parcels, missing supporting documents such as marriage certificates, transactions made of a parcel with no SLLC, fear of land taxation increases, the limit determined on minimum holding size, long administrative procedures, some disabled land rights holders being unable to come to the woreda office, limited awareness, no perceived need to register due to no perceived risk, and remoteness of the woreda office to some of the kebeles.

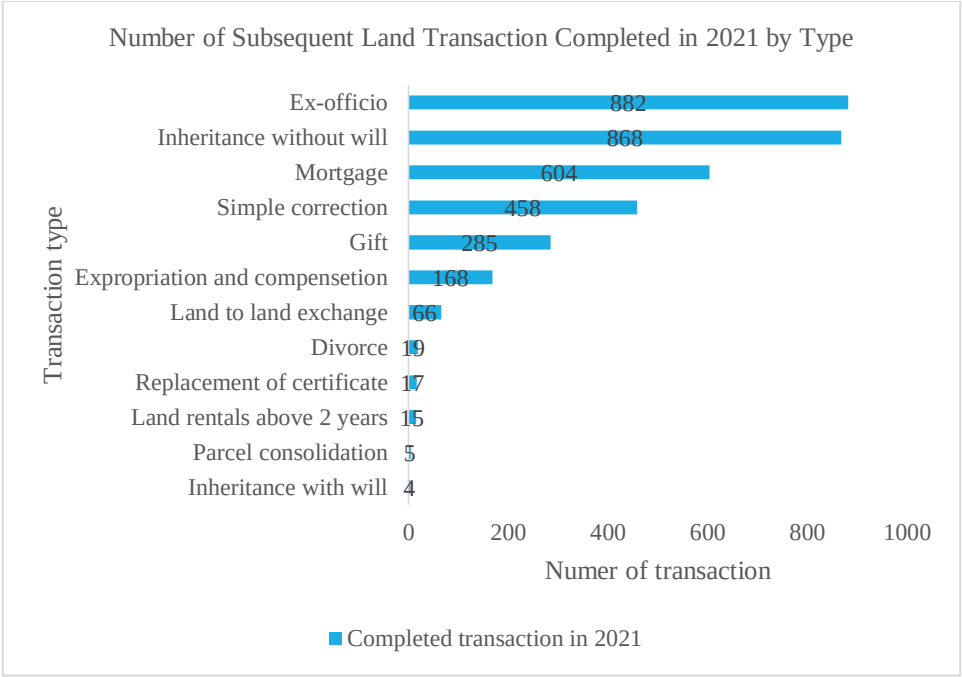

Figure 12. Numbers and types of subsequent land transactions completed in the year 2021. Source: Basona Werena woreda land office digital land register, called NRLAIS.

3.4.5. Validity and Reliability of the Analysis of the Structural Measurement Model

As per the rule outlined in Section 3.2.2., this study found and removed two indicator items with less than or equal to 0.4 outer loadings; these included SN1 - respondents do not believe formalizing subsequent land transactions within six months is important) and PBC3 - respondents always forget to report and formalize subsequent land transactions that were made within six months. These two items failed to reflect the underlying assumptions or constructs about subjective norms and perceived behavioral control, respectively. Otherwise, the result revealed that all construct items have a moderate to strong content validity, Table 11.

Table 11.Indicator item cross-loading. Attitudes (AT), Subjective Norms (SN), Perceived Behavioral Control (PBC), Intentions to Formalize (INTF), and Actual Behavior/formalization (ACB).

Variable	Code	AT	SN	PBC	INTF	ACB
Attitudes	AT1	0.879	0.578	0.281	0.652	0.790
	AT2	0.924	0.627	0.262	0.710	0.804
	AT3	0.869	0.545	0.236	0.621	0.658
	AT4	0.886	0.654	0.245	0.665	0.745
	AT5	0.809	0.582	0.114	0.608	0.639
Subjective Norms	SN2	0.365	0.409	0.476	0.081	0.769
	SN3	0.481	0.472	0.442	0.038	0.712
	SN4	0.202	0.290	0.190	0.208	0.489
	SN5	0.546	0.657	0.577	0.117	0.796
Perceived Behavioral Control	PBC1	−0.101	−0.001	0.062	−0.296	−0.036
	PBC2	0.206	0.206	0.143	0.741	0.086
	PBC4	−0.249	−0.184	−0.177	−0.744	−0.137
	PBC5	0.074	0.073	−0.037	0.096	−0.072
Intention to formalize	INTF1	0.628	0.496	0.284	0.855	0.663
	INTF2	0.610	0.484	0.140	0.842	0.552
	INTF3	0.632	0.617	0.067	0.811	0.597
Actual Behavior/formalization	ACB1	0.781	0.538	0.268	0.635	0.925
	ACB2	0.778	0.583	0.318	0.714	0.942

In the measurement model, Table 12, the study used Cronbach's alpha, composite reliability (CR), and AVE to evaluate the reliability of the constructs. According to the rule, Cronbach's alpha, and CR values of 0.700 and higher preferred, with an AVE above 0.500. As seen from Table 6, except

for the perceived behavioral control (PBC = 0.014), the CRs of all the other variables were higher than the recommended value of 0.700, ranging from 0.791 to 0.942. Similarly, the AVE of the PBC (0.300) was less than the recommended 0.500 and the AVE of the SN (0.493) was nearly 0.500. However, the AVE of AT (0.764), INTF (0.700), and ACB (0.872) were well above the recommended value of 0.500. Hence, the convergent validity was acceptable.

Table 12. Reliability and Validity. The "Rho_A" coefficient was also considered to check the reliability of the la-tent variable construct scores, as defined in Dijkstra and Henseler (2015a).

Variable Code	Cronbach's Alpha	Rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
AT	0.922	0.926	0.942	0.764
SN	0.659	0.711	0.791	0.493
PBC	−0.058	0.250	0.014	0.300
INTF	0.785	0.786	0.875	0.700
ACB	0.854	0.864	0.932	0.872

Discriminant validity also assessed by the Fornell–Larcker criterion [147, 193]. Table 13 shows that the square root of the AVE for the construct in the diagonal was greater than the inner-construct correlation, which ranges from 0.934 to 0.548. The test result of the current study may therefore imply the strong reliability of all items.

Table 13. Fornell–Larcker Criterion. Note: Value in diagonal represents the square-root of AVE.

	ACB	AT	INTF	PBC	SN
ACB	**0.934**				
AT	0.835	**0.874**			
INTF	0.725	0.746	**0.836**		
PBC	0.315	0.263	0.197	**0.548**	
SN	0.601	0.684	0.639	0.138	**0.702**

3.4.6. Structural Model Analysis

The structural or inner model of the research is evaluated with a standard algorithm. The result revealed that there is significance in the prediction of the construct in the research model. According to the 5000-resampling test, except for H3, H5, and H6, i.e., the perceived behavior control constructs, the data demonstrates positive and significant results for the rest of the hypotheses tests (H1, H2, H4, and H7) for the formalization of subsequent land transactions, Table 14.

According to the rule, the t-values of AT-> INTF, AT -> SN, INTF -> ACB, and SN -> INTF are well above 1.96, with p = 0.000 showing significant relationships. Whereas the t-values of AT -> PBC, PBC -> ACB, and PBC -> INTF are all below 1.96, with p > 0.05 indicating insignificant relationships. The results revealed that, except for the perceived behavior control constructs, there is significance in the prediction of the construct in the research model. Therefore, four of the seven hypotheses' tests have a positive and significant influence on the intentions and actions of the formalization of sub-sequent land transactions by the land rights holder. These are H1, H2, H4, and H7. The detailed analysis of these relationships is presented as follows.

Firstly, H1 evaluates whether the attitudes of land rights holders towards the value of land registration have a significant influence on their intentions to formalize sub-sequent land transactions. The result revealed a positive and significant influence on their intentions to formalize subsequent land transactions (β = 0.578, t = 8.257, p = 0.000), Table 8. Hence, H1 is fully supported. The result shows that 83.5% of the actual behavior of land rights holders in terms of formalization explained by attitudinal variables of the landholders towards the value of land registration. The attribute variables of attitudes include secure tenure (AT1: 87.9%), rights to fair compensation (AT2: 92.4%), access to individual credit (AT3: 86.9%), defense of boundary encroachment (AT4: 88.6%), and enforcement of rental contract (AT5: 80.9%), Table 5 and Figure 27.

Secondly, H2 estimates whether attitudes have a significant influence on the subjective norms of land rights holders' formalizing subsequent land transactions. The result revealed that the attitudes of land rights holders towards the value of land registration have a positive and significant impact on subjective norms (β = 0.684, t = 20.182, p = 0.000), Table 8. Hence, H2 is also fully supported. Respondents admitted that 68.4 % of attitudinal variables of the landholders influence the

relationships with subjective norms, Table 7. The individual cross-loading of attitude variables to subjective norms ranges between 54.7 (AT3) and 65.4% (AT4), which shows above moderate relationships, Table 14.

Thirdly, H4 evaluates whether the subjective norms have a significant influence on land rights holders' intentions to formalize subsequent land transactions. The result revealed that subjective norms have a positive and significant impact on land rights holders' intentions to formalize subsequent land transactions (β = 0.240, t = 3.036, p = 0.003), Table 8. Hence, H4 is also fully supported. In Table 7, respondents disclosed that 63.9% of the land rights holders' intentions to formalize subsequent land transactions explained by the subjective norms attributable to the variables, see Figure 5 too. The attributable variables of the subjective norms include SN2—most people who are important to land rights holders approve the formalization of all subsequent land rights transactions that I have made within six months (36.5%), SN3 - spouse encourages the formalization of all subsequent land rights transactions that I made within six months (48.1%), SN4 - few relatives (brother, sister, uncle, aunt, etc.) discourage the formalization of all sub-sequent land rights transactions that I made within six months (20.2%), and SN5 - reporting and formalization made by a land rights holder would encourage other land rights holders to do the same within six months (54.6%), Table 14.

Finally, H7 evaluates whether the intentions to formalize subsequent land transactions have a significant influence on the act of formalizing subsequent land transactions by the holders of the land rights. The result revealed that land rights holders' intentions to formalize have a positive and significant impact on the act of formalizing subsequent land transactions (β = 0.689, t = 16.420, p = 0.000), Table 14. Hence, H7 is also fully supported. Respondents admitted that 72.5% of the actual behavior of land rights holders' formalization explained by intention variables. The attribute variables of intentions include a willingness to formalize subsequent land transaction within six months (INTF1: 66.3%), a willingness to pay for formalizing subsequent transaction costs in the next six months (NTTR2: 55.2%), and a willingness to participate in the private service provision scheme related to formalizing subsequent land transactions in the next six months (INTF3: 59.7%), Table 14 and Figure 13.

Table 14. Mean, STDEV, T-Values, p-Values, R2.

	β	STDEV	T Statistics	*p* Values	2.5%	97.5%
AT-> INTF	0.578	0.070	8.257	0.000	0.440	0.703
AT -> PBC	0.263	0.291	0.903	0.367	−0.382	0.392
AT -> SN	0.684	0.034	20.182	0.000	0.624	0.753
INTF -> ACB	0.689	0.042	16.420	0.000	0.603	0.762
PBC -> ACB	0.179	0.187	0.956	0.340	−0.269	0.268
PBC -> INTF	0.013	0.054	0.237	0.813	−0.108	0.103
SN -> INTF	0.241	0.079	3.036	0.003	0.091	0.399
	R^2					
ACB	0.556					
INTF	0.587					
PBC	0.069					
SN	0.468					
AT	0.000					

In summary, subjective norms accounted for 46.8 percent of the variance in explaining intentions to formalize subsequent land transactions, Figure 13. Whereas, perceived behavioral control accounted for only 6.9 percent of the variance explaining intentions to formalize. On the other hand, intentions to formalize subsequent land transactions accounted for 58.7 percent of the variance explaining the actual behavior. Finally, the current model explained that 55.6 percent of the variance accounted for the act of formalizing subsequent land transactions by the holders of the land rights, which provides a substantial explanatory power and predictive capability of the current model.

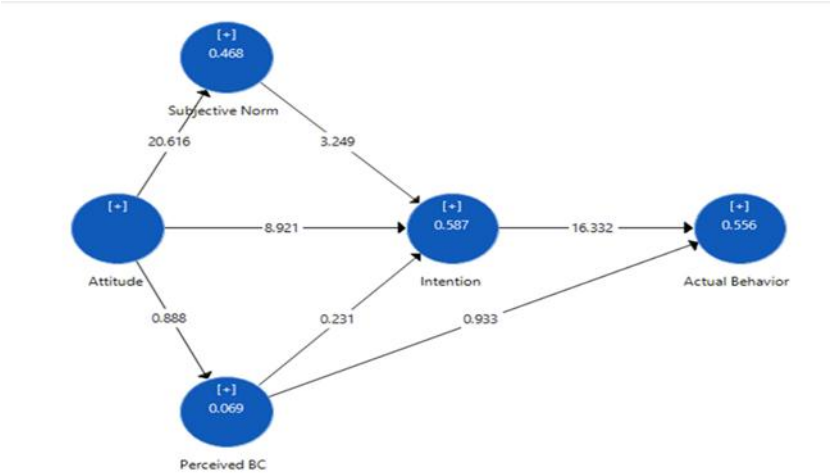

Figure 13. Measurement and structure equation model results of the research model.

Furthermore, the model fit is assessed using SRMR. The value of SRMR was 0.083, this is well below the required value of 0.10, indicating an acceptable model fit [190]. Further assessment of the validity of fit hypothesis evaluated to ascertain the significance of the relationship, Table 15. The studied 5000 resamples also generate a 95% confidence interval, and hypotheses testing results summarized in Table 15. A confidence interval that is not equal to zero indicates a significant relationship. Hence, the current model's 95% interval shows 0.066 and indicates a significant relationship.

Table 15. Model fit analysis of the proposed model.

	Original Sample (O)	Sample Mean (M)	95%	99%	Original Sample (O)	Sample Mean (M)	95%	99%
Saturated Model	0.083	0.057	0.066	0.070	1.184	0.565	0.741	0.847
Estimated Model	0.101	0.061	0.070	0.075	1.729	0.647	0.847	0.973

3.4.7. Mediation Analysis

Mediation analysis was performed to assess the mediating roles of SN, PBC, and INTF on actual behavior outcomes. As seen from Table 16, SN was found to be significantly mediating the relationship between attitudes and intentions to formalize subsequent land transactions (β = 0.165, t = 3.013, and p = 0.003), i.e., specific indirect effect. Similarly, INTF was found to significantly

mediate the relationship between subjective norms and the actual behavior of land rights holders in formalizing subsequent land transactions (β = 0.166, t = 2.888, and p = 0.004). Moreover, INTF was found to be significantly mediating between attitudes and the act of formalizing subsequent land transactions (β = 0.398, t = 7.225, and p = 0.000). On the other hand, the results re-veal an insignificant mediating role of PBC (p > 0.05) between the attitudes and intentions to formalize subsequent land transactions by the holders of the land rights (β = 0.003, t = 0.231, p = 0.818). Similarly, the result revealed that the same insignificant mediating role of INTF between the perceived behavioral control and the act of formalization by the land rights holders (β = 0.009, t = 0.233, p = 0.816), Table 16.

Table 16. Total, specific, and indirect effect between the independent variables and dependent variables. T represents the t-statistics while Sig represents the significance or p value in the research model.

	Total Effect	T	Sig	Total Indirect	Effect	T	Sig	Specific Indirect Effects	Effect	T	Sig
AT -> ACB	0.561	14.007	0.000	AT -> ACB	0.561	14.007	0.000	PBC -> INTF -> ACB	0.009	0.233	0.816
				AT -> INTF	0.168	2.912	0.004	SN -> INTF -> ACB	0.166	2.888	0.004
				PBC -> ACB	0.009	0.233	0.816	AT -> INTF -> ACB	0.398	7.225	0.000
				SN -> ACB	0.166	2.888	0.004	AT -> SN -> INTF	0.165	3.013	0.003
								AT -> PBC -> INTF	0.003	0.231	0.818
								AT -> PBC -> INTF -> ACB	0.002	0.229	0.819
								AT -> SN -> INTF -> ACB	0.114	2.852	0.005
								AT -> PBC -> ACB	0.047	2.084	0.038

3.5. Discussion

Both the FLLC and SLLC land registration programs have been implemented in the study area over the past one and a half decades. This is part of the national land registration process. The policy drive behind this program is to improve the security of land and resource tenure to incentivize landholders to invest in sustainable land use practices that, in turn, would bring about sustainable

livelihoods and environmental out-comes. Despite the two stages of successful large-scale land registration programs, the number of subsequent land transactions registered and updated in the land registers is less than 1% of the total number of parcels [163]. Thus, regardless of the success of first-time registration, the volume of formalizing (registering) subsequent land transactions is still low and threatens the accuracy, currency, and completeness of the information in the land registers across the country.

The current study, therefore, tries to explore whether land rights holders' behavior is driving the lack of updating of the land register. If so, what factors influence land rights holders' intentions and the act of formalizing land transactions? What must be conducted to ensure the functioning and sustainability of the land information system in the country? These are topical and valid research questions that this study addresses.

This study demonstrated that the theory of planned behavior (TPB) can be employed to deepen our understanding of land rights holders' formalization of subsequent land transactions. Among other issues, the authors considered and explored the influencing factors of land transaction formalization and their relationships, including attitudes, subjective norms, and perceived behavioral control, as antecedents to landholders' intentions to the act of formalizing land transactions in Ethiopia. The authors also considered the role of demographic and socioeconomic background factors, such as institutional policies and regulations, societal customs and values, and demographic characteristics. Below is the discussion of the results in detail.

Firstly, based on the structural model (inner model), the paper examined the relationship between land rights holders' attitudes towards the values of land registration and their intentions to formalize subsequent land transactions. The result indicates that there is a positive and significant relationship between attitudes towards, and intentions to formalize, subsequent land transactions. Hence, the research inferred that land rights holders relate their beliefs on the value of land registration with their intentions to formalize land transactions that they have made, after first-time land certificate issuance.

The attitudes constructs reflect whether the land rights holder is in favor of formalizing subsequent land transactions, or the land rights holder's beliefs about the consequences of registering one's land use rights in the formal land register. These values are influenced by the outcomes of land registration, including secure tenure, transferability of rights (inheritance or donation, rights to fair

compensation, access to cred-it, and defense against boundary encroachment). In addition, the perceived benefits of land registration relate to the landholders' perceptions about the impact of land registration on the enforcement of other social contracts including a lease, rent, or joint venture.

The study suggests that the prediction tends to be quite accurate in its aggregate form or the macro level, but not at the individual level, between intentions to, and the actual behavior of, completing the formalization of subsequent land transactions. This means that the correlation between the intentions to get subsequent land transactions formalized, and the actual behavior of the same, in the coming six months, was 93.2 percent at the aggregate level, but ranges from 26.8 percent to 94.2 percent at the individual level, Tables 3 and 5. This result indicates a strong intention to formalize but less actual completed subsequent land transactions at the individual level. This result is also consistent with that of the qualitative findings of this research conducted through KII. The reasons justifying the gap between strong intentions and less actual formalized land transactions may be due to inadequate awareness among land rights holders. Moreover, landholders feel transactions were among families and relatives, so there is no need to register, and did not feel any risk in prior transactions, so there is no need to register. This result is also quite like the results in other fields of study, such as in demography, on the intended and actual family size [194].

Secondly, subjective norms refer to how a land rights holder feels social pressure to formalize the subsequent land transaction. The results of this study are consistent with other studies dealing with different behavior (voting, reducing household waste, and energy consumption), as summarized by Barbera and Ajzen [176]. Most importantly, as found by Edwin [195] and Kingwill [196], social property regimes display characteristics that not easily registered as people to property and relations hinge on localized customs and social networks that defy the formal registration of all transactions. Abubakari et al. [197] also found that the registration of subsequent land transactions also drives from and underpinned by socio-political struggles and strategies, for example, across gender and between hierarchies of those within land governance structures.

The current study also revealed that subjective norms have a positive and significant impact on land rights holders' intentions to formalize subsequent land transactions. Updating the land registers is one of the key functions of the woreda land offices. Depending on the types of land transactions, land rights holders are legally obliged to formalize subsequent land transactions that they have made within a certain period. However, their intentions to formalize subsequent land transactions

influenced by the social customs and values of the communities towards registration. The better the customs and values of the communities towards land registration, the stronger the intentions of landholders to report and formalize subsequent land transactions.

Based on the result of this study, the research concludes that normative beliefs of land rights holders result in perceived social pressure or subjective norms. The subjective norms, in turn, influence the intentions of land rights holders to formalize subsequent land transactions. Therefore, the formalization of subsequent land transactions needs to consider the context of social norms and customs. This finding is similar with what Abubakari et al. found in their recent work in Ghana [180]. They found that the decision to register inherited land is a co-produced agency of different norms and influenced by multiple normative, official, social, and practical frames [180, 197].

Thirdly, regarding perceived behavioral control, landholders' intentions to formalize subsequent land transactions could be determined by their control beliefs about the power of both situational and internal factors to inhibit or facilitate performing the behavior. The results show that perceived behavioral control has a weak predictive relation to intentions to formalize subsequent land transactions. This result is somehow counterintuitive to the individual level formalization behavior. However, information from the key informant interview has strongly supported this finding as to why such weak variance accounted for by perceived behavioral control in the current model. This may be because land rights holders in the study area consider land as the ultimate resource of their livelihoods, and privileges of identity in their community. Hence, landholders are ready to pay any cost, including life scarification to defend their land rights. That is why most respondents invariably responded to the measurement items related to perceived behavioral control. This indicates that we need to be careful when interpreting the coefficients of the model.

Barbera and Ajzen [176] advise that the question of actual control has little bearing on the application of the TPB to predict intentions to attain a behavioral goal. Barry [198] also found that, in volatile situations, investigations should include comparative cases of actual behavior of the cadastral system. In the present study, a behavioral goal could be exclusive enjoyment of one's landholding rights, but the intention here is to formalize subsequent land transactions after a first-time land registration. The study results revealed that regulatory and administrative barriers, such as rules on minimum parcel/holding size, may hinder the registration of subsequent land transactions [191, 192].

Contrarily, health condition, economic, and marital status can define actual control, which, if favorable, will enable land rights holders to act on their intentions to formalize subsequent land transactions or, if unfavorable, will make it difficult for them to get subsequent land transactions formalized, despite their intentions to do so. To illustrate it further, a land rights holder who intends to formalize subsequent land transactions may have a good health condition, emotional status, be able to pay a registration fee, knows the procedure of registration, and feels that registration is accessible, or the procedure is easy and affordable, and thus exhibits control over the required formalization behavior. Yet, he/she may fail to attain his/her goal if his/her spouse is unwilling to do so, or if registration is impossible due to court cases/injunctions or other regulatory and administrative requirements. The recent literature in the field has well documented considerations to overcome land administration maintenance challenges and recommended solutions and specific examples in the context of the overall framework for effective land administration establishment, maintenance, and upgrading [10, 12, 199].

3.6. Conclusions and Recommendations

The purpose of the present study was to examine the factors that influence landholders' intentions and the act of formalizing rural land transactions after a first-time registration. Using the theory of planned behavior (TPB), this study has evaluated the hypotheses that influence land rights holders' intentions to formalize land transactions. The study demonstrated that the application of the TPB can be employed to deepen our understanding of land rights holders' intentions to formalize land transactions. By examining behavioral, normative, and control beliefs about getting subsequent land transactions formalized, the study identified important policy and operational considerations that influence this behavior. The structural equation model (tested hypotheses) findings also substantiated by the descriptive and inferential statistics findings. Further, the findings are also supported by qualitative data analysis and findings obtained through key informant interviews.

Based on the results of this study, the researcher concludes that landholders' attitudes to land registration benefits and their perceived normative beliefs (subjective norms) can influence their intentions and actual practices of formalizing land transactions. An implication of this is the possibility that affects the currency, accuracy, and completeness of information in the land register. Participants in the study admitted that the two stages of the land registration program brought about positive development outcomes, including improved secure tenure, and opened new opportunities such as SLLC-linked individual loans. However, the longer-term functionality and sustainability of

the land registration system is essential if the land register is kept up to date after first-time registration. The land registration system should be able to facilitate subsequent land transaction formalization. Land rights holders need to be aware of, and believe that, land transactions need to be registered in the formal land registration system. Since the SLLC program was completed a couple of years ago in the study area, local government capacity needs to shift gears towards the maintenance and updating of the land register. The attention given to land transaction formalization will have far reached consequences, not only to the land registration system sustainability, but also to the overall land governance system effectiveness in the country.

Therefore, this study underscored that facilitating landholders' attitudes to the formalization of land transactions and helping them to overcome hurdles facing subjective norms are critical issues for the functionality and sustainability of the land registration system in Ethiopia. The study findings recommended facilitating the behavioral changes of landholders to transform their strong intentions into actual practice. Policymakers should develop and implement an innovative information value creation strategy, including landholder-oriented services that incentivize the formalization of land transactions and help landholders overcome hurdles created by subjective norms.

The strategy may include continuing regular awareness-raising campaigns, familiarizing incentive mechanisms such as making service centers closer to the communities for remote and inaccessible kebeles and introducing a private service providers' scheme for selected transactions such as land rentals. Regular monitoring and incentivizing mechanisms for registering land transactions at the woreda and kebele level would also consider improving the formal registration of land transactions. This could establish a system where services and service delivery centers customized to local contexts, and are simple, accessible, affordable, accurate, and quick. Moreover, the regulatory and administrative document requirements should ease, such as removing marriage certificate submission as a supporting document for registering subsequent land transactions. Such requirements disincentive landholders to register land transactions since marriage certificates are not a customary practice among the rural societies in the country.

The findings reported here shed light on the importance of updating the land register through formalizing land transactions and factors influencing landholders' intentions to do so. The present study is one of the few studies that attempted to thoroughly examine factors that influence landholders' intentions of formalizing land transactions after a first-time land registration in Ethiopia. As with any development interventions, land administration programs are a planned

public policy and development intervention. Hence, future research can use intentions that help to predict the performance of desired outcomes in the complex land administration and management public policy reforms. In addition, future research can consider additional predictors such as trust and the legitimacy of the registration system that drive landholder's behavior and evaluate it as mediators between perceived behavioral control and intentions that could increase the explained variance. Moreover, future research can consider the effects of interactions of variables on intentions in the current model. The interactions can be between subjective norms and perceived behavioral control, or other additional predictors suitable to the field, and their effect on intentions and actual behavior.

4. CHAPTER FOUR. THE EFFECT OF POLICY AND TECHNOLOGICAL INNOVATION OF LAND TENURE ON CREDITWORTHINESS OF SMALLHOLDERS: EVIDENCE FROM ETHIOPIA

Abstract

Since early 2000's, Ethiopia has been implementing one of the largest land certification and digitization programs in Africa underpinned by technological and policy innovations. The reform indicates a promising avenue for increasing the collateralization of land use rights for smallholder households who have been credit constrained. However, there is scant evidence to what extent these reforms influence access to credit. To help generate new insights and fill this gap, the study employed administrative data generated from eleven districts digital land registers, survey data from 2,296 households in nineteen districts, key informant interviews and policy and legal frame-work review. Descriptive and inferential statistics complemented by qualitative explanations were employed to analyze the results of the study. The results revealed that accessibility of information from the digital rural land registers increased creditworthiness of small landholders and reduced transaction costs and risks. The reform related to collateralization of land use rights also incentivizes financial institutions to establish new loan products to small landholders. The study concludes, while the two-stage land certification programs allow smallholders to possess documented land rights, their creditworthiness may likely remain negligible without such further technological and policy innovations. This implies two policy issues: the need to reform secured transaction laws and digitizing registries for higher land rights tradability.

Key words: policy reform, digital land registers, access to information, creditworthiness, transaction risks, Ethiopia

4.1. Introduction

In Ethiopia, land is a key natural resource and development asset for most smallholder households whose primary livelihoods depend on agriculture. Agriculture considered as the backbone of the economy which account about 34 percent of the national GDP [200]. About 74 percent of Ethiopian farmers are smallholders who contributed for more than 90 percent of both total cultivated area and total agricultural production [201]. The agriculture dominated by rain-fed, labor intensive and scarcely mechanized production system on extremely fragmented and small land parcels [202, 203]. Official data on holding size in Ethiopia shows that 38 percent of households possess less than 0.5 hectare of land, 23.65 percent held between 0.51 and 1 hectare, 24 percent between 1.1 and 2 hectares, and the remaining 14 percent held above 2 hectares [200]. Besides, only 2 percent of smallholder landholding irrigated, and only 3.7 of smallholders have access to agriculture machineries [202]. However, the agriculture sector continues to provide an opportunity to address Ethiopia's core development challenges including poverty, persistence food insecurity, unemployment, climate vulnerability, and foreign exchange earnings, among others. Yet, the within-sector transformation in agriculture lags because of a weak policy and enabling environment [200, 202].

Researchers argue that the flow of credit from formal financial institutions (FIs) towards the agriculture sector is low. Only 13 percent of the total lending provided by the formal FIs directed to the agriculture sector which significant amount of this credit channeled towards large-scale agricultural enterprises [204]. Another study found that two-thirds of smallholder farmers in Ethiopia are credit constrained, of them (71.9 percent) due to risk factors and transaction costs (14.33 percent) [201]. These include high interest rate, collateral requirement, and substantial risk of losing collateral due to inability to repay loans [201, 205]. Others also found that credit constraint often considered as one of the key barriers to the adoption of modern agricultural technologies and low agricultural productivity [204, 205]. Smallholder households facing capital constraints resort to unsustainable land use practices and production systems. However, it believed that smallholders' efficient and sustainable land use and management is essential for sustainable agricultural growth that positively contributes to the structural transformation of the country.

In this regard, documented land rights are a necessary condition for land markets and reduce the need for owners to spend resources on protecting claims [206, 207]. Scholars often presumed that tenure security via land registration and titling increases access to credit by allowing landowners to

use land as collateral [208–210]. Yet, evidence of credit effects of land registration and certification programs has been rare and at times with mixed results. The ability of land tenure security to make credit access ease is a necessary precursor for the rural world in general, and the agricultural sector, in that it is credit access that can lead to modernization of agricultural economy [211]. In fact, evidence suggests that without other factors put in place such as appropriate policy environment [212], the hypothesized link to credit access fails to materialize [96, 213, 214]. For instance, Deininger and Ali [206], using land registry administrative data in Lesotho, found that land and credit market activation is exclusively due to policy reform rather than systematic urban land titling program alone.

While there is a mixed result about the effect of land registration or titling on access to credit in various parts of the world, there is scanty rigorous evidence on the effects of the digital land registers on access to credit in rural Ethiopia underpinned by technological and policy innovations. Yet, in 2016, Cloudburst conducted an impact evaluation of the USAID funded two successive programs run between 2005 to 2013 and found that the Second Level Landholding Certifications (SLLC) in the program areas led to a slight increase in access to credit compared to control groups [27]. Seven years later a follow-on impact evaluation research of the same programs undertaken by USAID, this time by commissioning another contractor called Landesa [215]. The research team found that negligible impact of SLLC on access to credit effect was negligible although cautious to draw this conclusion due to small sample size. But the study is bold enough to conclude that SLLC may increases the likelihood of households obtaining credit until peaking 5 to 6 years after receiving the SLLC and then decreases [215].

However, these studies did not account the effect of the policy change and regulatory reforms of collateralization of land use rights enacted since 2017 and the technological innovations made since 2018 related to the National Rural Land Administration Information System (NRLAIS), and its effect on credit access to small landholders in rural Ethiopia. NRLAIS is a digital cadaster and land register that securely stores tens of millions of parcels records issued with a SLLC and holds information about the registration of sporadic subsequent land transactions including mortgages. To fill this knowledge gap and generate new insights, this paper tried to assess the effect of access to information from the digital land registers, i.e., NRLAIS on creditworthiness of smallholder households in rural Ethiopia. The study also assessed transaction risks of SLLC-linked credit

market anchored by new policy and regulatory reforms related to collateralization of land use rights.

Since early 2000's, Ethiopia has implemented one of the largest progressive land certification programs in Africa. Despite difference in technology employed for the adjudication of parcel boundaries and data storage, there is no big and substantive legal difference in recognizing the de facto land tenure rights between the First Level Landholding Certification (FLLC) and Second Level Landholding Certification (SLLC) programs. Yet, the SLLC includes value-added information related to the land parcels with geo-referenced maps to the landholding certificates and precise land area measurement. Historically, the FLLC started around the end of 1990s and run through 2010. Whereas the SLLC pilots have started since 2003 and run through 2013 [165]. Since 2014 the SLLC rollout program launched nationwide and continued expanding in the highland parts of the country to date [163]. Existing study shows that, over twenty-five million rural land parcels demarcated, mapped, and issued with a SLLC as of 2022 [165]. Existing studies well documented the effects of this large scale and cost-effective land certification program on tenure security [93], agriculture productivity [7], women empowerment [215], land rental market participation [20, 216], and land disputes [21].

Since 2018, there have been changes in technology innovation of digitalizing the land registers and organizational constellations in the land administration institutions. Besides, there is a change of policy and regulatory reforms related to collateralization of rural land use rights in Ethiopia. Firstly, along with the SLLC program, Ethiopia developed and operationalized a digital cadaster and land registration system called National Rural Land Administration Information System (NRLAIS). Since 2018, this system has been rolled out and made operational into over three hundred woredas (districts) in which over twenty million rural land parcels information securely digitized. Abab et al [163] found that this digital land administration information system makes updating of the land records easy, transparent, less costly, and increase availability and accessibility of land rights information to concerned bodies.

Secondly, in 2019, the federal Government of Ethiopia enacted the movable property security rights Proclamation No. 1147/2019. Prior to this proclamation, the Amhara regional state enacted proclamation no 252/2017 which extended landholders' rights to include the use of land as collateral for up to 30 years. As per this proclamation Article 16 states that in the event of default, the landholder will not evacuate from the land, but rather the financial institution will temporarily

gain the use right to recover the loan amount. The revised draft rural land administration and use proclamation at federal government level also included a provision that enables landholders to access loans from financial institutions after securing a collateral agreement that attested and registered by local land administration offices in NRLAIS. This policy change and regulatory reforms and technological innovations coupled with the land certification programs stimulate the financial institutions and smallholder households to behave differently than ever before. This behavior includes the financial institutions incentivized to develop a new loan product that targets small landholders and the landholders also more interested to access those credit products using their documented land use rights as collateral.

The rest of the chapter is organized as follows. Section 4.2 presents the conceptual framework of the study while section 4.3 presents the methodology employed. Section 4.4 and section 4.5 present results and discussions, respectively. Section 4.6 provides conclusions and recommendations.

4.2 Conceptual Framework

The conceptual framework presented in Figure 14 below shows the causal relationship between service availability and accessibility of information from the NRLAIS anchored by policy and regulatory reform to access credit. This relationship reflects the ability of the land use rights used as collateral once a smallholder household received land certificate for a subject parcel of landholding. What is equally important is that innovations in institutional constellation of the NRLAIS in terms of people, organization, and technology [56, 217]. Deininger and Goyal find digitization of land register reduces transaction cost and increases access to credit in India [214].

Access to credit for smallholder households was much more limited in rural Ethiopia. Microfinance institutions and saving and credit cooperatives and their unions have been the main source of finance, through group-lending arrangements since smallholder households were unable to provide sufficient collateral [218]. Absence of enabling policy and legal framework means smallholder households could not be able to use their usufruct rights of their landholding, which is the main asset held by them, to use as collateral to access individual credit. The group loans did not always meet their needs in terms of loan size and repayment schedule. Form the available literature one can draw the conclusion that, stronger land tenure and property rights founded on right policy and regulatory frameworks and availability and accessibility of a digital land information system can contribute to at least two investment channels related to collaterals [205, 212, 217]. This includes an

increase the supply of credit and reduce the cost of contracting and monitoring enforcement of collateralization [219], i.e., transaction cost.

To demonstrate the relationship, the land tenure literature suggests that land registration and certification programs enhance tenure security of land and resource rights which stimulates collateralization and increase the supply of credit [6, 56, 79, 80]. The effect on the credit supply is an increase in the willingness of lenders to provide credit if borrowers can use secured land as collateral [56, 220]. Besides, the creditworthiness of individual smallholders for collateral is dependent on the absence of uncertainty and asymmetric information [39, 53, 220]. This may be due to the availability of dependable and secure information services delivery from the land administration institutions anchored by sustainable and functional digital land information system [217]. This incurs transaction cost but managed properly can reduce the inefficiencies arising from uncertainty [56, 221, 222]. Hence, credit impacts from land titling or registration would be expected only if such efforts are comprehensive including enabling policy environment [212], registries remain up to date over time [73], and third parties, such as mortgage lenders, can access reliable land registry information at low cost on a routine basis [217].

Moreover, the existing literature suggests that transaction costs consist of the costs of measuring the valuable attributes of a right, the costs of protecting rights, and enforcing contracts [221–223]. This is mostly moderated by the availability and accessibility of reliable information from a functional land register. Enforcement of contract depends on a constellation of supporting arrangements and implementation mechanisms such as the coordination between financial, land administration, and law enforcement institutions [37, 56, 222]. With certified land that secures land rights as a collateral for credit and contract enforcement, creditors can lawfully repossess land, if necessary, arise from a default [39]. Also, the threat of repossession collateral acts as an incentive to the borrowers to repay the loan on time [219].

Keeping this theoretical background in mind, recent policy change and regulatory reforms at the federal and regional state levels in Ethiopia suggests a promising avenue for increasing the collateral capacity of small landholders. Up until recently, it was uncommon practice across the country to pledge land rights as collateral for individual loans from financial institutions. However, the Amhara regional state proclaimed the rural land administration and use proclamation number 252/2017 Article 16 has extended landholders' rights to include the use of land as collateral for up to 30 years.

Guided by this proclamation, the UK Foreign Commonwealth and Development Office (FCDO) funded Land Investment for Transformation (LIFT) program provided technical assistance to the GoE. The Program run between 2014 and 2020 in Amhara, Oromia, SNNP, and Tigray regional states. The program supported the demarcation and issuance of over fourteen million rural parcels with SLLC and included complementary activities such as technical assistance to improve access to credit, agricultural inputs, and formalization of land rental contracts. The aim of the program was to improve the incomes of the rural poor in Ethiopia through improved land tenure security and addressing the constraints faced by the rural poor to access market. The program assisted the federal and regional state governments and selected microfinance institutions to develop and pilot a SLLC-linked loan product, specifically tailored to smallholder households [218]. The loan product disbursed on an individual basis, according to the needs, business plan, and creditworthiness of the individual borrowers that offers greater flexibility than loans offered via group lending [218]. According to document (fact sheets) from the implementation of the LIFT program, this arrangement allows smallholder households to access loans with bigger size and longer repayment period on an individual basis compared to group-based loans.

As the policy changes and legal framework improve at regional level and the digital land administration information system coverage expands at woreda level, the SLLC-linked credit significantly expanded to non-pilot areas of the country. The policy change and regulatory reform made at federal level also reinforce the development gains from this innovative piloting and spearhead the scale-up of SLLC-linked loan product. The federal level policy change and regulatory reform further clarifies the codification, valuation, and registration of land use rights as a lean for collateral. This laydown the legal foundation for operationalization of an electronic registry system of movable collateral registry that receives, stores, and makes information accessible to the public about security of rights and non-consensual rights in movable properties. Hence, as part of this research objective the conceptual framework focuses on three investment channels of the policy change and the role played by the NRLAIS on a) signaling creditworthiness of individual small landholders b) increasing the willingness of financial institutions to provide credit, and c) reducing collateralization related transaction costs.

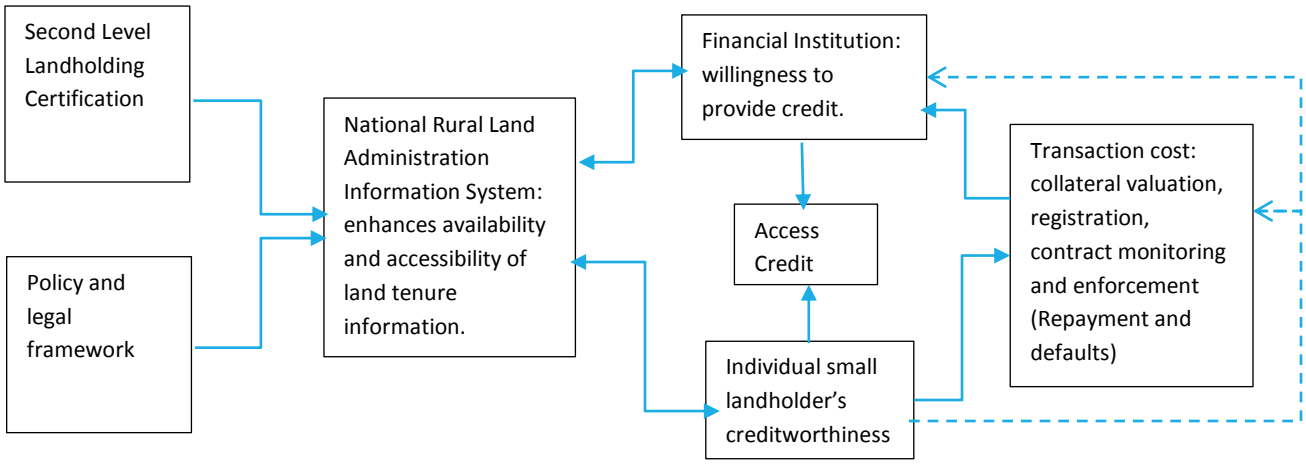

Figure 14. Conceptual framework showing the land administration information system as a broker to access credit by individual small landholders from FI. Also shows the monitoring and enforcement of collateralization contracts including valuation, registration, repayment, and defaults. Source: Authors' construction based on literature & own understanding, April 2023.

Procedurally, the Woreda Land Offices provide each credit applicant small landholder with a "blocking letter." The blocking letter attests that the landholder who possesses a SLLC applies for individual credit is free from third party interest including not already used as collateral for previous credit. The small landholder applies to a FI with supporting documents including a copy of the SLLC and business plan. The FI reviews their application and requests the Woreda Land Office to ensure that the SLLC registered in NRLAIS, only pledged once, and register the mortgage deed on the subject parcel of landholding as collateral once the credit approved to the applicant. The applicants should also pledge their original SLLC upon approval of the credit application to the FI.

Based on the agreed payment schedule the borrower expected to repay the credit. In case of a default, the FI has the right to reclaim the land use rights of the subject parcels as a lien according to the agreed terms in the mortgage contract or until it recovers its credit amount including the principal and interest. This can be done through renting out the subject parcels to the same landholder as agricultural profits or any other potential tenant. Once the FI fully recovered the loan amount and interest, the FI wrote a letter of mortgage cancellation to the district land office. The FI also handed back the SLLC to the borrower. The district land office updates the record in the NRLAIS by cancelling the collateral information registered on the subject parcel.

4.3 Methodology

This section presents the methods applied in the study including the administrative data and key informant interviews, the econometric model and estimation methods as well description of the study sites, data sources, and materials used.

4.3.1. Materials and Data

4.3.1.1 Sample Size and Data

Table 18 presents the summary of sample size, tools and methods employed by the 2021 USAID impact evaluation study and characteristics of the digital land registers administrative data observations. The study conducted in three regional states of Ethiopia (Amhara, Oromia, South Nation Nationalities and People (SNNP)), nineteen districts and 183 kebeles/villages. The study employed administrative data generated from the digital land registers of woredas that established the national rural land administration information system (NRLAIS). Those NRLAIS databases have been used to register all subsequent land transactions including the registration of mortgage and used as a matching approach with the household survey datasets. This digital register administrative data helps to implement an approach using administrative units that allows identifying the effects of policy change and technological innovations separately from those of the two-stage systematic land registration programs.

To help compare the results, the study also used survey data collected for the 2021 follow-on impact evaluation (IE) studies of the USAID funded land administration programs, namely Ethiopia Land Tenure Administration Program (ELTAP, run between 2005 and 2008) and Ethiopia Land Administration Program (ELAP, run between 2008 to 2013). The evaluation examined land certification investments to better understand the impacts and limitations of the land certification programs on rural land users. Data previously collected in three rounds namely, 2008 as baseline, 2015 as end line, and 2021 as follow-on impact evaluation studies. Besides, qualitative data was also collected through key informant interviews from land administration officials and financial institutions.

The administrative data generated from eleven study woredas of Amhara, Oromia, and SNNP regional states, Table 17. The digital registers administrative data after NRLAIS establishment and policy and regulatory reforms suggest that these changes triggered distinct shift in (i) number of

registered, cancelled or amended mortgage transaction including loan size and duration, (ii) the share of registered parcels after subsequent transactions reported by type of land transactions including area in hectare and numbers, and (iii) share of parcels registered in the name of male headed only, female headed only and jointly male and female headed households among others.

For systematic comparison, the authors selected the same woredas covered by the 2021 follow-on USAID's IE study except woredas from Tigray regional state. Woredas from Tigray regional state not covered with the USAID 2021 follow-on IE study due to the war that took place in the country during the household survey data collection. In addition, 12 Kebeles in the Amhara region were excluded due to the security situation in this study areas. Looking at the survey data closely, all study woredas in Amhara regional state, established and made NRLAIS operational in 2019/2020. Contrarily, out of the six study woredas in Oromia regional state only one woreda, i.e., Bora woreda established and made NRLAIS operational. In fact, Bora woreda is a new woreda split up from the parent Dugda woreda. According to the key informants, the other five woredas did not yet establish NRLAIS due to data quality issues with the cadastral index maps. Moreover, out of the six surveyed study woredas of SNNP, five woredas established and made NRLAIS operational starting 2020. However, Wendo Genet woreda has moved to the newly established Sidama regional state and did not yet establish NRLAIS so not considered in this study.

A manual data collection was also employed for those woredas without NRLAIS. While employing manual data collection in non-NRLAIS established study woredas, it is important to note that those woredas have been registering subsequent land transactions sporadically and trying to update their semi-manual land registers. These records are considered objectively secured since they have verified by legal and administrative procedures before the registration of those subsequent land transactions made on the legally protected land registers.

Table 17. Summary of Tools and Methods used for the three rounds of panel data collection. Source Alvarado et al. [221]. and Woreda Rural Land Administration Information System (WoRLAIS).

Data Collection Tools/Sample Size	**Sampling Strategy**
2021 survey: Data collection for all surveys & focus groups took place between April 1 and May 16, 2021	
• Total HH surveys = 2,306 • HHs with no certification = 123 • HHs with FLLC only = 388 • HHs with parcel survey but no SLLC = 394 • HHs issued with SLLC = 1,391	Panel, using heads of HH and wives from 2008 and 2015 with these exceptions: • HHs from Tigray due to security • 12 kebeles from Amhara due to security • ELAP specifically targeted HHs with higher potential for agricultural investment and productivity leads to selection bias
Digital and manual land registers data sources, February to April 2023	
• Total number of woredas … 9 • Total number of observed kebeles with registered mortgage transaction … 366	from the three regions the following woreda are part of the study sites: • Amhara: Achefer, Basona worena, Dangla and Kewot • Oromia: Bora, Chiro, Tiyo, and Walmara • SNNP: Sodo Gurage, Silti, Lemo/Hadya

4.4 Results

4.4.1 Descriptive Statistics

Table 18. presents descriptive statistics of the household survey. Totally, 2,294 household heads participated in the third round of the household survey, which conducted between April 1 and May 16, 2021, of which 78% of the respondents were male while 22% of the respondents were female. The average age of respondents was about 55 years with the minimum and maximum of 19 and 99 years old respectively, shows most household heads found their active and productive ages. Out of the total 2,294 respondents 76.26% (1,749) were married in which 74.14% (1,700) were males and 2.12% (49) females. To understand the literacy level of the respondents, the survey also included the highest grade of schooling completed by the respondents. The data shows that about 51% of the respondents were illiterate while about 46% of the respondents were literate, including 11.75% of them can read and write, 19.43% and 8.24% of them completed grade 4 and grade 8, respectively.

This shows that the respondents need support to read and understand about their legal land use rights, obligations, and responsibilities.

Table 18. Marital status and educational level disaggregated by sex. Source – USAID 2021

Marital status of HH heads		Sex		Highest grade of schooling completed by HH heads and marital status							
		Male	Female	Illiterate	Read only	Read & write	Grade 4	Grade 8	Grade 10	Above grade 12	Total
Unmarried/ Never Married	frq	38	7	4	1	1	10	11	18	1	45
	%	1.65	0.3	0.17	0.04	0.04	0.43	0.48	0.78	0.04	1.95
Married	frq	1716	49	741	54	255	404	174	93	44	1765
	%	74.41	2.12	32.13	2.34	11.06	17.52	7.55	4.03	1.91	76.54
Divorcee	frq	21	59	67	0	5	7	0	1	0	80
	%	0.91	2.56	2.91	0	0.22	0.3	0	0.04	0	3.47
Widower/ed	frq	34	382	367	4	10	27	5	3	0	416
	%	1.47	16.61	15.92	0.17	0.43	1.17	0.22	0.15	0	34.67
Cohabiting	frq	0	1	1	0	0	0	0	0	0	1
	%	0	0.04	0.04	0	0	0	0	0	0	0.04
Total	frq	1809	497	1180	59	271	448	190	115	45	2306
	%	78.45	21.55	51.17	2.56	11.75	19.43	8.24	4.99	1.95	100

About 989 households (26% women) have obtained credit between May 2019 and April 2021 which linked to 3,048 parcels from different lending institutions including Microfinance (60.7%), saving and credit cooperatives (25%), individuals (13.58%), and Commercial Banks (0.72%), Table 19. This shows that most small landholders have obtained credit from microfinance followed by saving and credit cooperatives. Most heads of the survey households in the study areas practiced saving in their saving and credit cooperatives, increased the liquidity of the cooperatives. Households with higher income, livestock, and landholding area per capita, and closer to financial institutions are more likely to practice savings.

Table 19. Number of parcels used for collateral by the respondent HH heads who obtained individual credit in the past 2 years by lending institutions and sex. Source USAID 2021.

Variables	Man	Women	**Total**	
			frequency	%
Households who obtained credit (between March 2019 to April 2021	735 (74%)	254 (26%)	989	100
Number of parcels linked to credit	2,254 (74%)	794 (26%)	3,048	100

Number of parcels used for collateral by the respondent HH heads who obtained individual credit in the past 2 years by lending institutions and sex

Lending institutions	frequency	percentage	Man	Women
Microfinance institutions	1,850	60.70	1,536	314
Saving and Credit Cooperatives	762	25.00	536	226
Commercial Banks	22	0.72	22	0
Individual	414	13.58	160	254
Total	3,048	100	2,254	794

The survey results also revealed that the maximum (19 percent) and the minimum (1 percent) number of credits were obtained in March and October, respectively. Over the years (May 2019 to April 2021), 79 percent of the credit obtained between the months of December and July whereas the remaining 21 percent obtained between the months of August and November, Figure 15. This shows that household heads reported that the credits obtained were in line with the agricultural land preparation calendar.

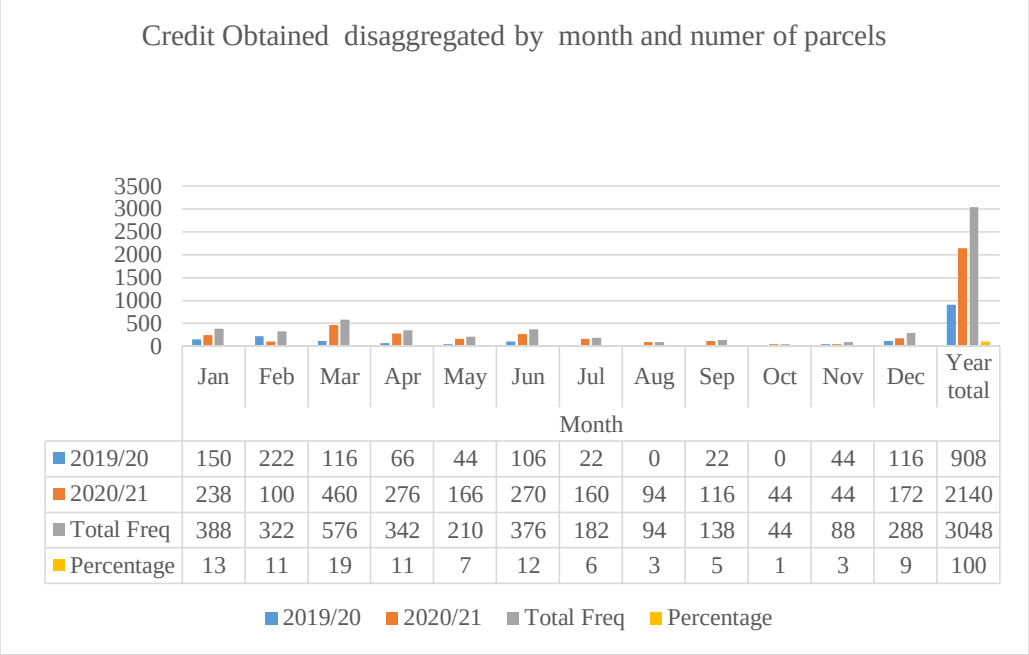

Figure 15. Number of credits obtained by household heads between March 2019 and March 2021.

Respondents also asked about the number and size of credits obtained, length of repayment period, use of land certificate as collateral by type and what will happen if they are unable to repay the loans. About 39 percent of household heads had obtained a credit amount ranging between 500 ET Birr and 10,000 ET Birr whereas only 5.45 percent of household heads obtained more than 50,000 ET Birr, Table 20. The survey results also revealed that only 24 percent of household heads used their land certificate as collateral and of those who used land certificate as collateral 25 and 54 percent used FLLC and SLLC, respectively. This shows that creditors increasingly tended to hold SLLC as collateral as SLLCs issuance coverage increasing over time.

However, about 21 percent who reported that they have been using both FLLC and SLLC appears subject to interpretation of contexts. This could happen when a landholder obtained one or more of the credits using FLLC in the first round before their possession of SLLC and another one after possessions of SLLC. Otherwise, this response generated due to the misunderstanding of the question itself since it is less likely a landholder could have both the FLLC and SLLC to various parcels of landholdings under their possession within the same administrative registration Kebele. On the other hand, the results also revealed that 80 percent of household heads agreed to repay between 6 and 12 months while only less than 1 percent agreed a repayment schedule of 48 months, meaning the loans are short term. Moreover, about 39 percent of the borrowers feel that they will

lose their land certificate if they default on the repayment based on the terms and conditions of the credit agreement.

Table 20. Amount of credit obtained, repayment period, use and type of land certificate as collateral, and default consequence.

Amount of credit obtained	**Freq.**	**Percent**	**Use land certificate as collateral**	**Freq.**	**Percent**
500 – 10,000	1176	38.58	Yes	734	24.08
11,000- 20,000	940	30.84	No	2314	75.92
21,000 – 30,000	556	18.24	Total	3048	100.00
31,000 – 40,000	66	2.17	Type of land certificate Creditor hold		
41,000 – 50,000	144	4.72	First Level	182	24.80
More than 50,000	166	5.45	Second Leve	398	54.22
Total	3048	100	Both	154	20.98
Default consequence	Freq.	Percent	Length of repayment period (months)	Freq.	Percent
I will have to borrow more money from other Bank	366	12.01	Up to 6	464	15.22
I will not be able to access credit at any FIs	720	23.62	6 and 12	2440	80.05
I will lose my land certificate	1182	38.78	13 and 18	50	1.64
Nothing will happen	188	6.17	19 and 24	72	2.36
I do not know	116	3.81	48	22	0.72
Other	476	15.62	Total	3048	100
Total	3048	100.00			

4.4.2. Descriptive statistics of data from the digital land registers

Table 21 presents descriptive statistics of the administrative data generated from the study woredas digital land registers in April 2023 for the period of two years (between January 2021 and December 2022). Although such data lack information on socioeconomic characteristic of households, it includes information on gender of registered landholders, numbers and types of transactions registered after first time land certification, allows to compute the loan size, requested number of mortgage registration and cancellation, and estimates the SLLC-linked transaction risks.

In the current study, the total number of woredas covered by this administrative data was 11 (4 woredas from Amhara and Oromia each and three woredas from SNNP regional states) covers 366

kebeles for the year 2021 and 2022. These woredas are the subset of the nineteen woredas covered with the 2021 USAID impact evaluation study household surveys. According to these digital registers administrative data, the total number of households who received SLLC-linked credits was 10,789 of which 1,621 (15.02%), 1,152 (10.68%), and 8,016 (74.3%) headed by men, women, and dual/jointly headed households, respectively. The mean of households who received SLLC-linked credit per kebele was 4.43, 3.14, and 21.9 headed by men, women, and dual/jointly headed in the year 2021 and 2022, respectively. This indicates that only 3 percent of households in the study kebeles obtained SLLC-linked formal individual credits over the past 2 years.

Likewise, these administrative datasets indicate that about 11,679 parcels with a total area of 5,636.31 hectares collateralized for the total SLLC-linked credits obtained by the households in 366 kebeles. This shows the total number of pledged parcels for the credits obtained is more than the total number of households. Meaning, households were pledging one or more parcels of their landholdings to access those credits. This is a particularly widespread practice among households in Amhara region compared to the other two regions (Oromia and SNNP). This variation may arise due to the average parcel size in the Amhara region are less than that of average parcels size in the Oromia and the SNNP regional states.

According to the digital land registers administrative data, the total value of credit obtained within those two years (2021 and 2022) is 427 million Ethiopian Birr (ETB) which is equivalent to about 8 million US dollars for all study kebeles. One fourth of this loan obtained by the dual/jointly headed households while one tenth of the loan channeled to the women headed households. This shows each household obtained about 40,000 ETB on average as individual credit over the past two years. This indicates a four times loan size increment compared to the household survey loan size that conducted for the preceding couple of years. Meant, there is a clear increase of loan size obtained by the household heads during 2021 and 2022 compared with that of the 2019 and 2021 (survey result) result. This may indicate the effect of the policy change of land use collateralization which was enacted in 2019 at Federal government level and being effective in 2020. In addition, this may be due to the availability and opportunity to access digital land information which is securely registering mortgage transactions and guaranteeing them from third party interests. The key informants revealed that the establishment and operations of the digital land registers at the woreda level help to monitor volumes of transactions including mortgages at risk and take corrective measures.

According to the key informants, the households who obtained those credits have used to procure agricultural productivity enhancement inputs such as fertilizers, improved seeds, and pesticides as well as for animal husbandry (bull and shoats fattening, dairy farms, and poultry) that diversify their livelihoods. The key informant interviews also revealed that the credit interest rate ranges from 8 percent to 15 percent with an average loan repayment period ranging from 12 months to 60 months, meaning the credits are short term like the household survey data.

Table 21. Descriptive statistics on households who obtained credit by pledging their land use rights represented by their second level landholding certificates. Source: Woreda Land Administration Offices digital land register. Compiled by the author.

Data source	Variables	Male headed	Female headed	Dual/Jointly headed	Total for all Kebeles	
					frequency	%
Digital register (WoRLAIS 2023)	Households who obtained credit (between Jan 2021 & Dec 2022)	1,621 (15.02%)	1,152 (10.68%)	8,016 (74.3%)	10,789	100
	Number of parcels linked to credit	1,754	1,217	8,678	11,679	100
	Total parcels area (ha)	846.57	601.96	4,187.78	5,636.31	100
	Total loan amount (ET Birr)	64,164,944 ($1,188,000)	45,624,607 ($845,000)	317,407,146 ($5,878,000)	427,196,697 ($7,911,000)	100
		Minimum (months)	Maximum (months)			
	Loan repayment period	12	60			
	Interest rate	8%	15%			

4.4.3 Estimates of the parameters of the probit regression model

The probit regression model result indicates that among the ten hypothesized explanatory variables 7 variables were found to influence the landholder's creditworthiness significantly. The model result and average marginal effect size estimates are presented in Table 22. From the results, the regression model outperformed by 7.17 percent than the baseline model. The likelihood ratio Chi-square of 162.84 with a p-value of 0.000 indicates that the current study model is statistically significant.

Those independent variables with positive average marginal effects include sex, parcel distance, FLLC, and SLLC whereas age, household type, and perceived credit transaction risk have negatively affected landholder's creditworthiness in the study areas. Education, parcel area, and time travel to the parcels were found to insignificantly affect creditworthiness of the landholders. The average marginal effects of each of the parameters discussed are based on their significance as follows.

Sex - the result revealed that sex of the household head positively and significantly influenced creditworthiness. The survey result revealed that a household headed by a male has a 7 percent increased probability of creditworthiness compared with their counterpart household headed by a female. Meaning female headed households were more credit constrained than their counterpart male headed household. This may have a negative effect on the productivity and livelihood status of female headed households in the study areas.

Age - the age of a household head negatively and significantly affected creditworthiness with an average marginal effect of 0.2 percent, meaning every one-year in-crease in the age of the household head leads to a 0.2 percent decrease in the probability of their creditworthiness. This may indicate households with older ages were less likely to obtain credit.

Household type – The result revealed that household type negatively and significantly affected creditworthiness in the study areas with an average marginal effect of 1.5 percent, meaning a married household heads have a 1.5 percent decreased probability of creditworthiness compared to their counterpart single household heads.

Land certificates – the tow-stage land certification program is one of the mechanisms sought for improving tenure security in Ethiopia. Under the current study, the survey result revealed that possessions of either FLLC or SLLC were found to positively influence creditworthiness of

household heads significantly in the study areas. The results indicated that certification increases the creditworthiness of household heads with an average marginal effect of 7 and 5.4 percent for FLLC and SLLC, respectively. This result is consistent with the lessons of property rights theory, which predict a direct positive effect of land titling as a proxy measure of tenure security on creditworthiness. Moreover, the result is in line with Cheng et al. [223] found households living in counties where the local governments explicitly permitted the use of land as collateral, land titling reform had a positive effect on credit in China. Piza [224] also found land titling increases credit use, decrease reliance on credit borrowed from relative, and increases credit borrowed from commercial banks in Brazil.

Credit transaction risk – the results of the survey indicated that perception of credit transaction risk negatively and significantly affected creditworthiness of household heads with an average marginal effect of 27.8 percent, meaning one-fourth of household heads found risk averse which hinders their creditworthiness.

Contrarily, the survey results revealed that education, parcel area and travel time to a parcel were found to influence on creditworthiness of household heads negatively but in-significantly. This is a complete contradiction to the results found from the key in-formants' interviews of microfinance and credit and saving cooperatives in that level of literacy and land area are part of the key parameters while assessing the creditworthiness of credit applicants.

Table 22. Estimates of the probit regression model and average marginal effects. Source: calculated by the author based on the survey data obtained from USAID, 2022.

Credit	Coefficient (Rubst Std. errors)	dy/dx	z	p>|z|	95% Conf. Interval
Gender	0.5674101 (0.1333088)	0.0688499	4.25	0.000	- .0370893 .1006104
Age	-0.0131511 (0.0018241)	-0.0015228	-7.10	0.000	-.0020362 -.0011554
Education	-0.0239987 (0.0156737)	-0.002912	-1.53	0.126	-.0066413 .0008173
Marital status	0.1669117 0.0525938	0.0378832		0.001	.0149666 .0607998
HH type	-0.1258369 (0.0249824)	-0.0152691	-1.69	0.000	-.0212232 -.009315
Land area	-0.0004115 (0.0002431)	-0.0000499	-2.68	0.091	-.0001078 7.91e-06
Time taken from homestead to parcel	-0.0087632 (0.0032609)	-0.0010633	3.86	0.007	-.0018408 -.0002858
Parcel distance	0.0001311 (0.0000338)	0.0000159	5.07	0.000	. 7.83e-06 .000024
FLLC	0.5447336 (0.1072497)	0.0660983	7.26	0.000	.0405288 .0916678
SLLC	0.4481495 (0.0618987)	0.0543787	7.26	0.000	.0396974 .0690601
Credit transaction risk	-0.2777714 (.0384487)	-0.033705	-6.65	0.000	-.043633 -.0237769
Constant	-1.645595 (0.2118085)				

n = 7,111, Wald Chi2(10) = 126.34, Prob > Chi2 = 0.0000; Pseudo R^2 = 0.0717*; p<0.01, p<0.05; Robust standard errors given in parentheses. Average marginal effect (dy/dx) calculated at the mean for continuous and for a discrete change from 0 to 1 for dummy variables.*

5. Discussion

The key objective of this chapter is to assess the effect of the policy and technological innovations on the creditworthiness of small landholders in the highland parts of three regions (Amhara, Oromia, and SNNP) of Ethiopia. While the quantitative analysis of the household survey helps us to understand the factors influencing access to credit, the descriptive statistics of data from the land registers and qualitative policy and legal framework analysis help us to indicate the differential effect of the policy and technological innovations. The current study also looked at the willingness of financial institutions to provide SLLC-linked individual loan product measured by volume of credit transactions and related monitoring transaction costs or risks. Based on the descriptive statistics and regression model results, this section discusses the key elements of the conceptual framework shown in Figure 1. The figure shows how the rural land administration information system as a service powered by technological innovations is brokering to access credit by individual smallholder households from formal financial institution. Moreover, how the institutional constellation helps to monitor and enforce collateral contracts including valuation, registration, repayment, and defaults.

5.1. Policy innovations lead to legislative reforms.

Access to credit for smallholder households has been much more limited in rural Ethiopia due to absence of enabling policy and legal framework. Meaning, smallholder households could not be able to use their usufruct rights, which is the main asset held by them, to use as collateral to access individual credit. The available option is group loans which did not always meet their needs in terms of loan size and repayment schedule. It is not surprising that even in the most advanced economies where reliable credit information and a wide range of financial products are available, borrowers have to offer collateral. Particularly, financial institutions operating in the developing economies including in Ethiopia prefer to use immovable properties, such as land and real properties, as security interests. This increases the financial market friction with that of rural land market imperfection and negatively impacts the productivity of the smallholder households as entrepreneur in the agricultural sector.

One of the ways to increase access to credit leis improving or reforming secured transaction laws and registries. A sound legal framework and institutional arrangement as well as a well-functioning and secured transaction system enables business firms and individual proprietors to use the best available assets as security to guaranty capital. In this regard, secure land tenure and property rights

founded on sound policy and regulatory frameworks are vital. In addition, availability, and accessibility of functional land registers with streamlined information service standards are the key enablers if the rural credit market should work for most smallholder households.

Recent policy and regulatory reforms at the regional states level in Ethiopia suggests a promising avenue for increasing the collateral capacity of smallholder households. Until 2017 in Amhara region and 2019 at federal government level by implication to other regions, there was no enabling policy and legal framework that promote the collateralization of land rights to access credit. Hence, it was not a widespread practice across the country to pledge land rights as collateral for individual loans from financial institutions. However, the Amhara regional state amended the existing law and pro-claimed new rural land administration and use proclamation number 252/2017. Article 16 of the same proclamation clarified and expanded landholders' rights to include the use of land use rights as collateral for up to 30 years. Under this article, in the event of default, the landholder will not evacuate from the land, but rather the financial institution will temporarily gain the right to use the land until it recovers the loan. The outstanding loan recovered either leasing/renting the subject parcel of landholding to a third party or by another means such as agricultural profits, the landholders shall regain their landholding rights.

The current study results revealed that 60 percent and 25 percent of households obtained credit from microfinance institutions and credit and saving cooperatives, respectively between May 2019 and April 2021. This shows that micro finance and cooperatives of credit and saving have been the main source of finance for the rural small-holder households. This may indicate that those institutions will continue dominating the rural credit market over the coming years. This result is consistent with the Ethiopian Economics Association findings in that the supply of credit by formal and semi-formal financial institutions accounts for 80 percent of the total amount channeled to the agricultural sector in Ethiopia [225]. However, this may make sense where rural financial institutions can and do respond effectively to increased demand on the part of newly collateralized households. Alibhai et al. [204] find in Ethiopia that only 13 percent of the total lending provided by the formal financial institutions directed to the agriculture sector with most channeled towards large-scale agricultural enterprises. Meaning smallholder households are still credit constrained. This finding is consistent with Mukasa et al. [201] who find that two third of smallholder farmer in Ethiopia are credit constrained.

However, according to the key informants, Banks which have operating as microfinance institutions are upgrading to commercial Banks and embraced the SLLC-linked loan product for smallholder households. This includes Sinqii Bank, Tseday Bank, and Omo Bank which upgraded from microfinance institution to commercial Banks in the past couple of years. This shows that the recently enforced policy change and regulatory reform facilitated the financial institutions feeling confident and willing to provide the SLLC-linked loan product for smallholder households at scale. According to the same key informants, this policy innovation removes unnecessary restrictions on creating collateral, leaving lenders uncertain about whether a credit agreement will be enforced by law. This emerging perception is consistent with findings in other countries by Mehnaz et al. [226] in that businesses are not rationed out of the credit market because they lack assets to meet the (unnecessary high) collateral requirements of Banks and other lenders, instead, because the legal framework prevents them from using their assets to secure loans. Using registers data, Ali and Deininger [206] also find comparable results in Lesotho where land and credit market activation is exclusively due to policy reforms.

5.2. Whether possession of land certificate signaling creditworthiness.

The land tenure literature suggests that land registration and certification pro-grams enhance tenure security of land and resource rights which stimulates collateralization and increase the supply of credit [6, 56]. Land registration becomes socially more valuable as more parcels registered in the system, because it leads to more investment and more transaction [159, 227]. However, recent reviews of the evidence do not show a clear link between land certification and access to formal credit in developing economies [7, 96]. Sanjak et al. [228] suggests that the expectation that land formalization will in-crease farmers access to credit fails to consider other significant factors including the farmer's income levels, the availability of credit in the market and borrowers' business plans.

Up until the early 2000s a large share of land in Ethiopia is undocumented and often insecure and hence cannot use as collateral. However, Ignacio [218] find that the second level landholding certificate (SLLC)-linked individual loan product is increased overtime compared to the group-lending arrangements. However, the findings of the current study results indicated that only 24 percent of households who obtained any credit used their land certificate as collateral, and them from the informal credit market. Despite the critical mass of smallholder households received land certificate in the highland Ethiopia, this finding is unsurprising given that there was no sound legal

framework that allows the use of land as collateral before 2017. This is consistent with the findings of Cloudburst in 2016 [27] in that SLLC may facilitate credit access by indicating that the loan will use for agricultural purpose, validating livelihood and creditworthiness, especially through alternative financing such as community-based lending and microfinancing in Ethiopia. Implies the need to have sound legal framework and institutional infrastructures including secured transaction systems such as collateral registries for movable assists and functional land registers. This leads us to the discussion on the role played by the digital land registers increasing creditworthiness of small landholders in the study areas and willingness of financial institutions to supply more credit.

5.3. Whether access to digital land registers signaling creditworthiness.

Available evidence show that based on well-defined land rights in a legal framework, low cost accessible to reliable information on individual land rights reduces transactions costs and uncertainty that hinders the exchange such as the use of land as collateral to secure credit [214]. Likewise, making information accessible in the digital land registers may facilitate the credit market. The results of the current study revealed that perception of credit transaction risk was found to influence negatively and significantly on the creditworthiness of households with an average marginal effect of 27.8 percent due to asymmetry of information. Meaning one-fourth of household heads found risk averse. This indicates that households perceive lack of access to information from the land registers which is the legal information bearer of their land right may hinder their creditworthiness.

However, since 2020 access to information about their legal rights from woreda digital land registers improves when needs arise to process credit application. Abab et al [163] find that all mortgages or credit transaction had registered in the digital land registers in Basona worena woreda of Ethiopia where the system is up and run since 2019. Results from the digital land registers of the current study shows that the total number of households who received SLLC-linked credits was 10,789 with credit value of 8 million US dollars equivalent although only 3% of smallholder households obtained this volume of credit in the study kebeles. This should not underestimate by any measure given that the digital registers have been fully operational only starting 2020. This clearly indicates that the role played by access to the digital land register signaling the creditworthiness of small landholders found encouraging. Deininger and Goyal [214] find similar results in India in that computerization of the land registers reduces the cost associated keeping the land register up to date, eliminate informal side payments that have traditionally been associated

with property rights registration, and improves third party access to information in the registers as well as increases credit volume.

5.4. Monitoring and enforcement costs and risks of credit agreement

The existing literature suggests that credit transaction costs consist of the costs of measuring the valuable attributes of a right, the costs of protecting rights, and enforcing contracts [222, 223, 229]. During the credit evaluation process the primary focus of the lending financial institutions of smallholder households is whether an applicant has secured land rights that registered in the land registers.

According to the key informants, procedurally, the Woreda Land Offices which are the legal custodian of the digital land registers and provide each credit applicant of small landholder with a "blocking letter." The blocking letter attests that the landholder who possesses a SLLC applies for individual credit is free from third party interest including not already used as collateral for previous credit. The small landholder applies to lending to a financial institution with supporting documents including a copy of the SLLC and business plan demonstrating their capacity. The lending financial institution reviews their application and requests the Woreda Land Office to ensure that the SLLC registered in the land register, only pledged once, and register the mortgage deed on the subject parcel of landholding as collateral once the credit approved to the applicant. The applicants should also pledge their original SLLC upon approval of the credit application to the lender financial institution.

Based on the agreed payment schedule the borrower expected to repay the credit. In case of a default, the lending financial institution has the right to reclaim the land use rights of the subject parcels as a lien according to the agreed terms in the mortgage contract or until it recovers its credit amount including the principal and interest. Recovering the defaulted credit can be collected through renting out the subject parcels to the same landholder as agricultural profits or any other potential tenant. Once the lending financial institution fully recovered the loan amount and interest, the lender writes a letter of mortgage cancellation to the pertinent Woreda Land Office. The lending financial institution also handed back the SLLC to the borrower. The Woreda Land Office updates the record in the digital land register by cancelling the mortgage information registered on the subject parcel. According to the key informants, both the lending financial institutions and landholders have access to information about the legal status of the subject parcels without any service fee. This free of charge land information service is provided since this transaction type

recently introduced as one of the Woreda Land Office services. This may help increase the volume of registered credit transactions in the digital land register. However, if the land administration service needs to be sustainable the Woreda Land Offices should consider a reasonable service change to the registration of mortgages in the digital land registers.

On the other hand, while the establishment and operationalization of a movable collateral registry system is enacted by law. Part four of Proclamation No. 1147/2019 stipulates a collateral registry including establishment of the collateral registry office (Article 20) and the collateral registry (Article 21), grantor's authorization for registration of security rights (Article 22), and public access of the collateral registry (Article 24), among others. Besides, in 2020, the National Bank of Ethiopia (NBE) adopted two directives that help to materialize the implementation of this proclamation. The first one is directive number 186/2020 which stipulates the codification, valuation, and registration of movable properties including land use rights. Directive number 186/2020 Article 7 sub-Articles 1 to 5 stipulate the land use rights codification, valuation, and registration. The second directive number MCR/01/2020 focuses on operationalization of movable collateral registry, which is an electronic registry system established for receiving, storing, and making information available and accessible to the public about the security of rights and non-consensual rights in movable properties (Article 2.2). However, there is no clear plan about the establishment and operationalization of a secured electronic movable collateral registry system and how this new system interfaces with the existing systems such as NRLAIS.

6. Conclusions

This study assessed the policy and technological innovation of land tenure on the creditworthiness of the smallholder households in three highland regional states (Amhara, Oromia and SNNP) in Ethiopia who have often been credit constrained. The study tried to distinguish the effect of access to information from the digital land registry on improving creditworthiness of the smallholder households in the study areas from that of the two-stage land certification program in the country. This was possible by employing quantitative data analysis generated from the digital land register or NRLAIS and the 2021 USAID impact evaluation household survey data complemented with key informant interview and policy and legal document reviews. This approach also allows identifying the effect of policy and regulatory reforms on credit worthiness of small landholders. The approach yielded to fill the knowledge gap on how reforming secure transaction laws and registers increases

creditworthiness of smallholder households, reduces credit transaction cost, and risks, and increases the willingness of financial institutions to provide credits to smallholder households.

These reforms represent a change in basic assumptions from the previous approach and allows rural smallholder households to access the capital required to move from subsistence farming to more productive, sustainable land use practices, commercial farming, and development of the non-farm economy. The study concludes, while the two-stage land certification programs allow smallholders to possess documented land rights and in-crease the value of land, their creditworthiness may remain negligeable without such further technological and policy innovations. This implies two policy implications including land tenure improvement interventions such as land registration and certification need to support with reforming secure transaction law and digitalization of land registers for higher level land rights tradability such as functional credit and land market. Based on the findings, the study recommends policy makers and practitioners in the land sector should strengthen their efforts to raise the awareness and financial literacy of smallholder households as well as streamline procedures and service fee structures of mortgage registration.

While the enactment of Proclamation No. 1147/2019 and its implementing directives are welcoming policy actions, the current study did not assess the implementation effectiveness of this policy from the credit supply side, i.e., financial institution and enforcement mechanism. Future research should look at this dimension particularly the establishment and operationalization of the movable collateral registry system and its effect on the national economy.

5. CHAPTER FIVE. THE EFFECT OF LAND TENURE INSTITUTIONAL FACTORS ON SMALL LANDHOLDERS' ON-FARM INVESTMENT IN SUSTAINABLE LAND MANAGEMENT: EVIDENCE FROM THE HIGHLANDS OF ETHIOPIA

Abstract

Sustainable Land Management (SLM) is one of the key policy responses implemented to curb land degradation in the highlands of Ethiopia. However, there is evidence gap to what extent Land Tenure Institutional Factors (LTIFs) influence small landholders' on-farm investment in SLM. The overall objective of this study is, therefore, to understand the extent to which LTIFs influence on-farm SLM investment in the highlands of Ethiopia through unbundling tenure security (de jure, de facto, and perceived) across a bundle of rights. Survey data collected between April and May 2021 from 2296 smallholder households and 6692 parcels of nineteen highland woredas (districts) in three regional states (Amhara, Oromia, and SNNP) in Ethiopia. A probit regression model is used to estimate the average marginal effects of LTIFs quantitatively and supported by an in-depth qualitative analysis. The results revealed that ten out of 16 LTIF-related variables have significantly influenced households' on-farm investment in SLM with average marginal effect ranging from a minimum of 3% (tree tenure security risks) to a maximum of 14% (possession of land certificates), at 95% confidence interval, compared to a mean probability of 45%. The results also revealed that households' socio-economic and demographic factors and parcel-specific variables have significantly influenced an on-farm SLM investment. These imply two policy issues. Firstly, it strengthens the notion that security of tenure may be a necessary condition, but not a sufficient, factor to incentivize smallholders' on-farm SLM investment. Secondly, an in-depth analysis of the security of tenure categories across a bundle of rights is necessary to help formulate context-specific SLM policy and strategy incentivizing smallholders' on-farm SLM investment.

Keywords: land degradation; bundle of rights; security of tenure; SLM; investment; Ethiopia

5.1. Introduction

With increasing competitions on land resources and mounting climate change uncertainties, policy makers, practitioners and researchers are becoming more aware of the importance of clear, secure, and inclusive access to and control over land resources. Under the United Nations, land tenure indicators were adopted as a fundamental element of measuring the global sustainable development goals (SDGs). For instance, the SDG 1.4.2 aims to measure the "proportion of total adult population with secure tenure rights to land including (a) with legally recognized documentation, and (b) who perceive their rights to land as secure, disaggregated by sex and tenure type (%)" [230]. Besides, the SDG 5.a.1 measures "proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and share of women among owners or rights-bearers of agricultural land by tenure type"[231]. Tenure security also matters SDG 2, Target 2.3 (2.3.1 and 2.3.2 addressing smallholder farmers); and Target 2.4 (2.4.1 on agricultural land). It also clarified that the term "agricultural land," as a productive resources, used to indicate land used for farming, livestock, and forestry activities which monitor farm-based livelihood people as well as people whose main sources of livelihood is livestock and forestry. Land tenure also influences land use and is thus key to achieve SDG 14 (b) to provide access to small-scale fishers and marine resources, and SDG 15 on the sustainable use of land and natural resources as well as a significant driver of conflict and source of resilience that implies SDG 16, promoting peace and inclusive societies and institutions.

Land tenure significance also demonstrated by research exploring households land use decisions at micro-levels that indicate the need for physical capital to span economic growth and land governance systems [232]. Particularly, the land tenure security issue is an important development agenda for strengthening land governance systems thereby improving social stability, spur economic growth and promote environmental sustainability of citizens, communities, and business firms [5, 43]. Scholars argue that policies that strengthened land tenure security to advance SDGs are based on the assumptions that recognizing land and resources rights will benefit the rights holders by 'unlocking' capital through access to credit or by enabling full utilization of production factors, reducing uncertainty, providing opportunities and empowerment, and incentivizing the sustainable use of natural resources [233].

Tseng et al. [233] and Robinson et al. [45] also identified two dimensions of tenure issues with strong potential to influence conservation investment decisions including the type of rights

landholders have and the security of those rights. The former comprises the bundle of rights including access, use, management, exclusion, alienation, and the rights to compensate during compulsory expropriation [45, 48]. Whereas the latter understood as a perception by right holder that rights to land will recognize by others and protected in the event of specific challenges [49]. Meaning, land rights secure when a person perceives it to be stable and predictable over a reasonable period and protected from expropriation or arbitrary change, with claims that backed up by a type of authority [234]. This also reflects the SDG 1.4.2a secured tenure rights definition that comprised two sub-component, namely (a) legally recognized documentation and (b) perception of the security of tenure.

Asaaga et al. [51] and Masuda et al. [38], further looked at land tenure security distinguished among three categories: 1) de jure/legal security, 2) de facto/contextual security, and 3) perceived tenure security and its implication in investment. This category of security is associated with a given tenure system and the myriad social, economic, political, and environmental factors that condition the de facto performance of such arrangement [38]. This arrangement may be formal, informal, or customary institutions that can be a major hindrance or enabler to sustainable development [161]. Particularly, land tenure institutions are of fundamental importance to increased investment and the efficient allocation of economic resources [37, 39, 53]. This is because land tenure insecurities frequently lead to poor uses of limited resources as this influence's practices, abilities, and choice of landholders in line with adoption, sustainability, effectiveness, and efficiency of their investment among others [43, 233]. Thus, a relationship between a rights holder and a subject parcel of landholding depends on the characteristics of land tenure rights that qualify its usefulness in economic exchange and influence economic behavior on investments [6, 39, 79] and the financing of these investments [81].

While this argument is theoretically convincing, empirical findings on the link between LTIFs such as the three categories of land tenure security and investment and between access to credit and investment on SLM appear inconclusive at least in Ethiopian context. This is because, firstly, landholders have only perpetual usufruct rights and cannot use as collateral to access formal credit until recently or forbidden land exchange or sale. This implies that SLM investment made in the rural landscapes specifically at farm level by the small landholder households cannot attribute neither to greater access to credit nor to enhanced functions of land market as land sale ruled out by

law. Secondly, perceived tenure security and de facto tenure security vary in a range of transferability of legally recognized (de jure) bundle of rights such as risks related to inheritance, gift, lease/rentals, conservation, tree tenure, and land redistribution risks. Thirdly, the previous studies rely on a cross-sectional data that targeted to a specific watershed and looked at secure tenure without any categorization, thus limiting more robust analysis of factors influencing on-farm investment in SLM by small landholders. Specifically, this hinders the full understanding of the land tenure institutional factors (LTIFs) and their implication on small landholders' on-farm SLM investment.

By taking the three categories of LTIFs into account and using household and parcel level survey data collected from three regional states (Amhara, Oromia, and South Nation Nationalities and People (SNNP)), nineteen highland woredas/districts and 183 kebeles/villages, the current study tries to address this limitation and fill knowledge gap. The study considered household socioeconomic and parcel level variables and range of LTIFs including the three categories of tenure security (de jure, de facto, and perceived) [5, 51]. For instance, legally recognized rights might be represented by registering of the rights and provisioning of land certificates as a de facto protection of land rights. However, the impact of land certificate on tenure security differs by how perceived tenure security measured [93]. Hence, the perceived tenure security dimension specifically measured along risks related to the bundle of rights such as inheritance, land redistribution, land transfer through land rent/sharecropping, conservation, and tree tenure security risks as well as credit transaction which are important sets of land rights recognized in the existing legal framework.

The findings of the study revealed that small landholder households were investing in an on-farm SLM which affected household socioeconomic, parcel specific variables, and LTIFs. However, the results show that different components of the LTIFs influence an on-farm SLM investment which are not consistent with the different components of the LTIFs (de jure, de facto, and perceived tenure security) across the bundle of rights that (de)incentives and affect capacities of small landholders to invest in an on-farm SLM. The results further revealed that despite the use of land use rights as collateral allowed recently (since 2019), access to credit was a limiting factor to undertake sustainable and resource intensive on-farm SLM investment by small landholder households.

This result has three important implications. Firstly, while the household and parcel level variables are especially important to consider when planning an on-farm SLM investment at household level, the LTIFs are even more important to take into consideration at the planning phase. Secondly, while securing tenure through land certification (de facto) incentivized the on-farm investment in SLM, land management policy should also consider the issue of access to credit (de jure) for small landholders that creates the capacity to invest in durable and resource intensive on-farm SLM investment. Meaning, in the absence of access to credit small landholders with secure tenure rights may still find it difficult to invest in an on-farm resource intensive SLM investment such as physical and biological SWC measures. Thirdly, regardless of the forms of tenure rights, their recognition (de jure) and enforcement (de facto) tenure security combined with the regulatory functions of land tenure institutions (enforcement of land use regulations) are also critical factors for sustainable land use and resource management. For instance, secure private land use rights, without enforced local level land use planning which regulates land use zoning and other environmental management measures, may bear little on-farm investment in SLM that could not balance the exploitation of land resources and may result in adverse environmental outcomes. This will affect the sustainability of SLM investment made at landscape level including communal landholdings. Hence, compromises the achievements of the country's national sustainable development goals and undermines the fulfillment of its international commitments such as the Nationally Determined Commitment, the national Land Degradation Neutrality targets and the Paris Climate Agreement.

5.2. Materials and Methods

This subsection highlights the methods and material employed including sample size and data as well as empirical model specification.

5.2.1. Sample size and data

The study uses survey data collected for the impact evaluation (IE) studies of the USAID funded two legacy land administration programs, namely Ethiopia Land Tenure Administration Program (ELTAP, run between 2005 and 2008) and Ethiopia Land Administration Program (ELAP, run between 2008 to 2013). The evaluation examines land certification in four highland regions of Ethiopia including Amhara, Oromia, SNPP, and Tigray regional states to better understand the impacts and limitations of the land certification programs on rural land users. Data previously

collected in three rounds namely, 2008 as baseline, 2015 as end line, and 2021 as follow-on impact evaluation study [27, 215].

In 2021 Landesa, a contractor commissioned by USAID conducted a follow-on impact evaluation study for which they resurveyed the households that surveyed in 2008 and 2015 in all but three circumstances. The 2021 survey excluded households from Tigray and the twelve kebeles in Amhara because of the conflict and security issues while the ELAP targeted households also excluded to reduce selection bias on the results since they targeted by the land administration programs with higher potential for agricultural investment [215], Figure 16.

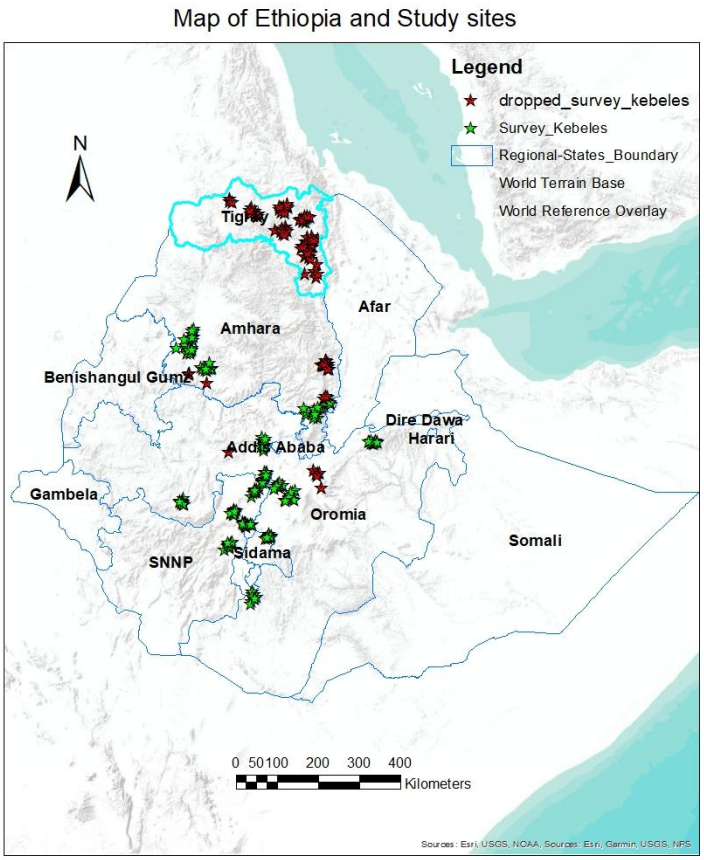

Figure 16. Map of Ethiopia and study survey sites. Compiled by the Author, 2023. The red shows study sites excluded from the 2021 survey due to security issues in Tigray and 12 Kebeles of Dawa Chefa woreda in Amhara region. Besides, ELAP supported woredas with high agricultural investment potential also excluded to avoid selection bias. Source [215] *https://www.land-links.com/*

As explained earlier, the 2021 survey collected data from the same households during April to May who had interviewed in 2008 and 2015. However, 3 percent of the household's attrition observed due to reasons including household change of place, death, separation or dissolution of household,

illness, among others. The sample for the survey in 2021 includes 2,306 households from 183 kebeles villages and nineteen woredas in the Amhara, Oromia, and SNNP regional states. Ten households dropped from the sample because their information on land certification status was incomplete, Table 23.

Table 23. Summary of Tools and Methods used for the 2021 survey data collection. Source [215].

Data Collection Tools/Sample Size	Sampling Strategy
2021 survey: Data collection for all surveys & focus groups took place between April 1 and May 16, 2021	
Total HH surveys = 2,306 HHs with no certification = 123 HHs with FLLC only = 388 HHs with parcel survey but no SLLC = 394 HHs issued with SLLC = 1,391	Panel, using heads of HH and wives from 2008 and 2015 with these exceptions: HHs from Tigray due to security 12 kebeles from Amhara due to security ELAP specifically targeted HHs with higher potential for agricultural investment and productivity leads to selection bias

5.2.2. Empirical Model Specification

The study employed a probit model to better understand the average marginal effect of the factors influencing the soil and water conservation practice as SLM investment in the study areas. The model looked at the fitted probability of the dependent variable i.e., investment in the soil and water conservation practices due to the influence of a set of explanatory variables. Meaning the outcome variable is determined or predicted as a non-linear model that forces the probability function to fall between 0 and 1 based on a communitive density functions of independent variables derived from the standard normal distribution. The probit regression equation specified as:

$$P(Y = 1|X) = G(X\beta) = \int (2\pi)^{-5} \exp(-\frac{X\beta^2}{2}) \quad (1)$$

$$the\ G\ function\ of\ X\beta\ =\ \beta_0 +\ \beta_1 X_1 + \beta_2 X_2\ +\ \beta_3 X_3 +\ \beta_4 X_4 \quad (2)$$

That means:

$$fitted\ probability = p\hat{}(Y = 1|X) = G(X\beta\hat{}) \quad (3)$$

Where:

$$lim_{X\beta\to\infty}\ G\left(X\hat{\beta}\right) = 1$$

$$lim_{X\beta\to\infty}\ G\left(X\hat{\beta}\right) = 0$$

To estimate the $\hat{\beta}$coefficient, we use the maximum likelihood estimation that maximize the joint probability of the outcome variable and constructed as the product of each observation probability of observing what we see, can written as follows:

$$L = \prod_{i=1}^{N} P_i^{Y_i} \ln(1 - P_i)^{(1-Y_i)} \quad (4)$$

Taking logs, we can get the "log likelihood" as follows:

$$lnL = \sum_{i=1}^{N} Y_i \ln(P_i) + (1 - Y_i) \ln(1 - P_i) \quad (5)$$

The marginal effects depend on X where the average marginal effect calculates each individual observations marginal effect, and then take the mean which is the derivative of G with respect to Xβ constructed as:

$$\frac{\partial P(Y=1|X)}{\partial X_1} = \beta_1 G'(X\beta) \quad (6)$$

Where G'(Xβ) will change as X changes that allows for diminishing returns or non-linear relationship. Therefore, the final probit empirical model constructed as:

$$Y_{ih} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots \beta_{24} X_{24} + \varepsilon_{ih} \quad (7)$$

Where Y is a dummy outcome or dependent variable which represents small landholder's investment in any soil and water conservation practice by a household h, and X is the set of explanatory variables related to household, parcels, and categories of the three secure tenure rights across the bundle of rights as recognize in the existing legal framework. More specifically, Y = dependent variable (investment in any SWC); β_0 = constant term; X_1 is age; X_2 is sex; X_3 is highest school grade; X_4 is marital status; X_5 is land area; X_6 represents time to walk to parcel; X_7 is walking distance to parcel; X_8 is water erosion risk, X_9 is usufruct rights - de jure; X_{10} is transfer rights(rent/sharecropping) - de jure, X_{11} is bequest - de jure; X_{12} is collateral rights - de jure; X_{13} is

decision on what to grow/invest - de facto; X_{13} represents decision on the use of the produce - de facto; X_{14} represents decision on transfer, i.e., who decides on the transfer (rent/sharecropping-OUT) to others - de facto; X_{15} represents credit obtained-de facto; X_{16} represents possession of First Level Landholding Certificate - de facto; X_{17} is possession of Second Level Landholding Certificate - de facto; X_{18} represents bequest-perceived; X_{19} is transfer to others (rent-out/sharecropping) - perceived; X_{20} represents credit transaction - perceived; X_{21} is perceived conservation risk - perceived risk, X_{22} is tree tenure risk-perceived risk; X_{23} represents land redistribution risk-perceived risk; X_{24} represents enter in to any business transaction risk-perceived risk and εih is the error term of explanatory variables.

5.3. Results

5.3.1. Characteristics of the Study Kebeles (Villages)

As part of the 2021 survey, the sample kebele authorities asked, about estimated number of populations, means of livelihoods of residents, land use, land scarcity, migration (in and out), and services including road, market, mobile phone network coverage, financial institutions, transportation, and religious institutions. The means and percentages of these variables are calculated and presented in Table 24 for all 183 survey kebeles.

The mean number of households in the study kebeles is 1072 with standard deviation of 885 households. There is migration in and out of kebeles, with slightly more than half of kebeles reported net outmigration. This net outmigration may increase household labor productivity and improve land use efficiency through freeing land for land rental market. Agriculture is the predominant land use and livelihoods while 14 percent of kebeles have no remaining bush land and 83 percent have fewer than 25 percent kebele land area left as bush land. Besides agriculture, pity trade and casual labor are the primary means of livelihoods of kebele residents. About 72 percent of kebele main roads are all weather roads meaning accessible year-round while 77 percent of kebeles have a large weekly market.

Notably, 92 percent of the kebeles have access to mobile phone network coverage which facilitates information flow thereby reducing cost of information services. However, only 4 percent of kebele have access to a bank although 39 percent of kebeles have access to a microfinance institution. This

shows kebeles have limited access to formal financial services, given that 80 percent of the total credit provided to rural households has supplied by financial cooperatives and Micro Finance Institutions (MFIs). Moreover, only 10 percent of the kebele authorities reported that there is a soil and water conservation project between 2016 and 2021. This also shows that kebele with limited project-based extension services related to SLM that may hinder on-farm investment by small landholder households. On average, survey Kebeles were about twenty-three kilometers by road to the nearest major urban center from the kebele center. This implied Kebele residents face barriers to access to services available outside their kebele. For instance, one-fourth of kebeles not having passable roads year-round and face substantial cost for public transportation to get service from the woreda capital, meaning approximately 10 percent of the daily household per capita expenditures.

Table 24. Kebele Characteristics as Reported by Kebele Authorities. Source: USAID 2021.

Kebele characteristics	**Mean or percentage**	**Std. Dev**
Population		
Total number of households in kebele	1,072	885
Percentage of kebeles in which in the last 5 years …		
More people moved in	39	
More people moved out.	56	
About the same of both/ Neither arrivals nor departure	5	
Land Use		
Kebeles, in which the most land use is farming.	95	
Kebeles in which the % of land covered by bush is.		
None	14	
1 to 24%	83	
25 to 49%	2	
50 to 99%	2	
Livelihoods		
Kebeles where at least 75% of the population is employed in farming.	84	
Percentage of kebeles where ____ is one of the main economic activities.		
Farming	99	
Small trade	72	
Mining such as Sand/stone sale	10	
Casual/Daily worker	35	
Other	27	

Services		
Kebele's main road accessible all year	72	
Kebele has a large market weekly.	77	
Kebele has mobile phone network coverage.	92	
Kebeles has a bank.	4	
Kebele has a microfinance institution.	39	
Kebele has an SLM related project, 2016 to 2021.	10	
Total cost in ET Birr from kebele to the woreda capital via public transportation	20.33	20.66
Kilometers by road to the nearest major urban center from the kebele center	23.01	24.22
Number of Churches in kebele	4.36	4.24
Number of mosques in kebele	2.56	3.81

5.3.2. Descriptive Statistics

Table 25 summarizes detailed socio-economic characteristics of the survey respondents, parcel characteristics, land tenure institutional factors (LTIFs), description of the variables, means, frequencies and standard deviations. The datasets also collected a range of tenure security related information. The authors grouped the LTIFs in to three categories of security of tenure: de jure/legal security, de facto/contextual security, and perceived security, as used by Asaaga et al. [51].

Based on the survey result, 78 percent of the respondents were men headed households while the remaining 22 percent were women headed households with an average household size of 5.3. Besides, 76 and 18 percent of household heads were married and widower/ed, respectively while 3% household heads were divorced. For the entire sample, the average age of the household heads in the study area was fifty-five, indicating that the household heads were active and productive. Moreover, the survey result shows that the majority (51 percent) of the respondents were illiterate while 19 percent of the respondents completed grade 4 schooling, meaning the majority require a sort of literacy assistance to read and write information about their land use rights, restrictions and responsibilities.

The survey also collected data on the parcel's biophysical characteristics. Most households in the study areas characterized as smallholder, with an average of 1.59 hectares and 3.1 parcel per landholding, indicates a bit higher than the national average landholding size, i.e., 1.22 hectares but

with lower fragmentation [183]. A land holding may consist of one or more parcels within a Kebele, which is the lowest administrative and land registration unit. In terms of land use type and their proportion, households reported that about 80, 7, 10, and 3 percent of their landholding area used for annual crop, perennial crop, grazing, and wood lot, respectively. This indicates that the land use is dedicated to food production and little for conservation. The average walking distance from home to the farm/parcel of land was 1.5KMs which takes 15 minutes. This may have an implication on small landholders' on-farm SLM investment. The survey also collected data on whether households are in areas where land use policy mandates soil and water conservation (SWC) investment due to the topographic nature (slope gradient) of their parcels of landholdings. Accordingly, about 39 percent of households reported that they had at least one or more parcels located on sloping lands with high exposure to soil erosion of water. As a result, the survey also revealed that, two thirds of the small landholder households have been required by the woreda/kebele administration to implement land and water conservation measures that the land use regulation mandated investment in SWC.

Regarding investment in SLM such as practicing any SWC, about 45 percent of the households constructed/practiced any soil and water conservation such as stone bund, soil bund, water retention structures, trees and perennials planted on their parcels of landholdings. For instance, the average length of stone bund constructed per parcel of landholding by the household own resources was eleven meters with a maximum of six hundred meters on average per parcel area of 0.38 hectares in the past one year. Likewise, the average length of soil bund constructed by the household own resources on the same parcel was twenty-eight meters with a maximum of eight hundred meters, shows households employed at least two or more complementary physical SWC practices on their farm. The survey results also revealed that one in ten parcels of landholdings have on-farm water retention structures such as ponds that constructed by the household own resources. Moreover, the average number of trees and perennials planted by the household (using their own resources) to date and existing on land possessed by the household were about 106 and 163, respectively. This also shows households were practicing/complementing the physical SWC with long-term biological measures.

Regarding legal security or de jure tenure security, the survey measured whether households know what type of land rights recognized under the land laws including usufruct, transfer

(rent/sharecropping), bequest/inheritance, and collateral. According to the survey results households reported that they know their land rights recognized in the land law including 98 percent to usufruct, 97 percent to transfer including rent and sharecropping, ninety-five to bequest, and eighty to collateralize their rights. This indicates respondents were aware of what type of tenure rights recognized and secured in the land laws, meaning their rights are legally recognized and protected by the land laws.

Regarding de facto tenure security the survey collected data on decision making power of the households on the crops to grow, the use of the produce, the transfer of their land parcels or rights such as through rent/sharecropping, actual credit obtained between 2019 and 2021, as well as whether they received land certificates (either FLLC or SLLC). Accordingly, about 60 percent of the crop grows, 64 percent on the use of the produce and 64 percent on the transfer rights of decisions made by both husband and wife jointly while 15, 11, and 11 percent of decisions made by husband only, respectively. Whereas less than 1 percent of the decisions accounted for or made by the wife only on the mentioned variables, meaning women have less decision-making power on their land rights matters within their household or joint holding. On the other hand, only 6 percent of the household heads responded that they obtained credit over the past 2 years, meant small landholders are still credit constrained, which may limit their on-farm SLM investment capacities. Moreover, in the 2021 survey, about 32 and 58 percent of respondents received FLLC and SLLC, respectively. Meaning about 90 percent of the respondent household heads categorized as having "any certificate" in the study areas.

Perceived tenure security also measured in terms of the right to bequeath, anticipated land redistribution within 5 years, and participation in credit transactions. The risk dimensions of perceived tenure security were also measured in terms of conservation security risks, tree tenure security risks, land redistribution risk, land rental risk and participation in any sort of transaction involving credit if it were with a farmer who has a land certificate of possession over their land than that a farmer who does not have a land certificate. Accordingly, about 39 percent of households perceived that inheritance right secured after land certification while one fourth of the households expect a land redistribution within five years. This means about 61 percent of respondent household heads feel their inheritance rights insecure while about 76 percent feel that they secured from further land redistribution in the coming five years, meaning, more needs done in terms of

removing such perceptions. Moreover, the survey result revealed that 83 percent of households feel that they are more secure to credit transactions with land certificate holders, meaning they can lend or borrow money with anyone who possesses a land certificate. This shows the issuance of landholding certificates strengthens the legacy informal credit market and leverages the creditworthiness of small landholders among their communities.

Regarding the risks of perceived tenure security related variables, about 96 percent of respondents either strongly agree or agree that they are fully convinced that they will stand to benefit in the future from whatever SWC measures they may undertake on their land at present. This indicates that respondent household heads perceive no risk of losing the benefits of their present investment in the future as their land tenure secured. On the other hand, about 79 percent of respondents either strongly disagree or disagree that they are fully convinced that they will not stand to benefit in the future from trees that they may plant on their land at present. This means, one fifth of respondent households perceive tree tenure insecurity that disincentives on-farm investment such as agroforestry which is one of the proven on-farm SLM practices.

The survey results also revealed that about 70 percent of respondent households either strongly agree or agree that they feel renting out their land for money or on sharecropping basis even for one (1) cropping season is a risky business that they should avoid unless they have no other options of overcoming their difficulties. Meaning small landholder households perceive land rental is a risky business even for one cropping season. This may hinder the emergence of land rental market in the study areas even for short-term contracting implied land use inefficiency. Contrary to this, the survey results showed that about 93 percent of respondent household heads will either strongly agree or agree on they will more feel secure to enter in any sort of business transaction involving credit if it were with a farmer who has a landholding certificate of possession over their land than that a farmer who does not have a land certificate. This implied that landholding certificates facilitates credit market among landholders who possessed landholding certificates. However, only 6 percent of respondent household heads borrowed money using their landholding certificates as collateral in the past two years either from financial institutions or informal lenders.

Table 25. Descriptive and summary statistics of variables.

Variables	Description of variables	Expected sign	Mean/Ferq.	Std. Dev.
	Dependent Variable			
Invested in any soil and water conservation practices	Households invested in any soil and water conservation in their landholding, dummy (1 = yes, 0 = otherwise)	±	0.45	0.50
Stone bund	Length of STONE BUNDS constructed (in meters) by the household ITSELF (using its own resources) to date and existing on land owned by the household, continuous	±	10.93	46.62
Soil bund	Length of SOIL BUNDS constructed (in meters) by the household ITSELF (using its own resources) to date on existing land owned by the household, continuous	±	27.75	75.16
Water retention structure	Number of ON-FARM water retention structures (ponds, retention ditches) constructed by the household ITSELF (using its own resources) to date and existing on land owned by the household, continuous	±	0.087	0.004
Number of trees planted per hectare	Number of trees planted by the household ITSELF (using its own resources) to date and existing on land owned by the household, continuous	±	105.54	819.75
Number of perennials planted per hectare	Number of perennials planted by the household ITSELF (using its own resources) to date and existing on land owned by the household, continuous	±	162.49	734.79
	Independent variables			
	Household demographic and socioeconomic variables			
Age	Age of the household head, continuous	±	55.17	14.26
Gender	Gender of the household head, dummy (1 = man, 2 = woman)	±	1.22	0.41
Education	Highest level of education completed by household head, categorical.	±	51.14	
	Illiterate		2.55	
	Read only.		11.77	
	Read & write.		19.42	
	Grade 4 complete		8.24	
	Grade 8 complete		4.94	
	Grade 10 – 12 complete		1.95	
	Above grade 12			

Marital status	Marital status of the household head, categorical: 1 = Unmarried/Never married, 2 = Married, 3 = Divorced, 4 Widowed, 5 = cohabiting, 6 = preferred not to respond	±	0.02 0.77 0.03 0.18 0.00	
Holding Size	Area of land possessed by household in hectares, continuous	±	1.68	1.78
	Parcel variables			
Time travel to parcel	Time to walk to parcel one way (in minutes), continuous	±	15.3	24.79
Parcel distance	Walking distance to parcel one way (in meters), continuous	±	1460.26	2314.94
Water erosion risk	Does household have parcels located on sloping lands? where soil erosion caused by water is a problem, dummy (1 = yes, 0 = otherwise)	±	0.389	0.488
	Legal tenure security			
Usufruct rights	Does the law allow you to use the parcel? dummy (1 = yes, 0 = otherwise)	±	0.976	0.154
Transfer rights (rent/sharecropping)	Does the law allow you to make a contract, for example rent? dummy (1 = yes, 0 = otherwise)	±	0.965	0.185
Bequeath or inherit rights	Does the law allow you to bequest it to someone? dummy (1 = yes, 0 = otherwise)	±	0.946	0.226
Collateral rights	Does the law allow you to use it as collateral to get a loan? dummy (1 = yes, 0 = otherwise)	±	0.801	0.398
	De facto/contextual security of tenure			
what to grow	Who decides on the crop (s) to grow? Continuous (1=Husband, 2=Wife, 3=Husband and Wife, 4=Children, 5=Family, 6=Single Household Head, 8=Household Head and children, 97=Other)	±	15.17 0.51 59.80 2.22 5.52 13.90 2.61 0.26	
on the use of produce	Who decides on the use of produce from the land? Continuous (1=Husband, 2=Wife, 3=Husband and Wife, 4=Children, 5=Family, 6=Single Household Head, 8=Household Head and children, 97=Other)	±	11.14 0.85 63.83 1.84	

			6.01	
			15.37	
			0.86	
			0.12	
			11.23	
			0.63	
on the transfer	Who decides on the transfer (rent/sharecropping-OUT) to others? Continuous (1=Husband, 2=Wife, 3=Husband and Wife, 4=Children, 5=Family as a whole, 6=Single Household Head, 8=Household Head and children, 97=Other)	±	63.90 1.78 5.42 16.42	
			0.34	
			0.29	
Credit obtained	HH obtained credit (formal or informal) during the last 2 years, dummy (1 = yes, 0 = otherwise)	±	0.058	0.233
	Perceived tenure security			
Bequeath land	HH believes that the land that is currently under their possession will remain within their control during the coming fifteen (15) years (%), dummy (1 = yes, 0 = otherwise)	±	0.39	0.49
Land redistribution	HH expects a land redistribution within five years (%), dummy (1 = yes, 0 = otherwise)	±	0.24	0.43
Credit transactions	HH feels more secure in credit transactions with certificate holder (%), dummy (1 = yes, 0 = otherwise)	±	0.83	0.37
	Perceived security risks			
	HH head fully convinced that they would stand to benefit in the		52.69	
Conservation risk	future from whatever SWC measures they may.	±	42.53	
	undertake on their land at present., categorical (1 = Strongly Agree, 2 = Agree, 3 Disagree, 4 Strongly Disagree)		3.44 1.34	
	HH head fully convinced that they will NOT stand to benefit in		9.59	
Tree tenure risk	the future from trees that they may plant on their land at present, categorical (1 = Strongly Agree, 2 = Agree, 3 Disagree, 4 Strongly Disagree)	±	11.73 35.06 43.62	
			3.48	
Land redistribution risk	HH believes that a redistribution of land is likely to take place in their kebele in 5 years, categorical (1 = Strongly believe, 2 = Believe, 3 = Do not believe, 4 Strongly do not believe)	±	6.98 34.13 55.45	
	HH feels that renting OUT their land for money or on		30.19	
Rent out risk	sharecropping basis even for one (1) cropping season is.		39.72	
	a risky business that they should avoid unless they have no other	±	23.62	

	options of overcoming their difficulties, categorical (1 = Strongly Agree, 2 = Agree, 3 Disagree, 4 Strongly Disagree)		6.46
Business transaction risk	HH will feel more secure to enter any sort of business. transaction involving credit if it were with a farmer who. has a Land Certificate of Possession over their land than that a farmer who does not have a Land Certificate, categorical (1 = Strongly Agree, 2 = Agree, 3 Disagree, 4 Strongly Disagree)	±	53.98 39.01 6.47 0.53

5.3.3.Estimates of the parameters of the probit regression model

Estimates of the probit regression model results and average marginal effects of the explanatory variables are presented in Table 26. The probit regression model results indicated that among the twenty-four hypothesized explanatory variables 16 variables were found to influence the small landholder households' on-farm investment significantly in SLM. Out of the total (24) hypothesized explanatory variables, 15 variables (two-third of the variables) are related to the LTIFs. The results of the regression model revealed that ten out of 16 LTIFs related variables have significantly influenced the small landholder households' on-farm investment in SLM. Parcel distance and travel time to parcel were found to insignificantly influenced the households' on-farm investment in SLM. From the results, the study regression model outperformed by 14.02 percent than the baseline model. The likelihood ratio Chi-square of 704.08 with a p-value of 0.000 indicates that the research model is statistically significant.

Those variables with positive average marginal effects include marital status, FLLC, SLLC, perceived land rental risks, tree tenure security risk, water erosion risk and decision on land rental. Whereas gender, age, education, means of original land acquisition, land area, credit obtained, perceived conservation security risks, decision on the use of the produce, and the laws recognize bequest have negative average marginal effects of the small landholder households' on-farm investment in SLM in the study areas. The average marginal effects of each of the parameters and their implications are presented and analyzed as follows.

Gender - the result revealed that gender of the household head significantly and negatively influenced the on-farm investment in SLM. The survey result revealed that a household headed by a woman has a 9 percent reduced probability of investing in any SWC compared with their

counterpart household headed by a man. Meaning there is a significant and negative gender differential effect on investing in the on-farm SLM between a man and a woman headed household.

Age - the age of a household head negatively and significantly influenced investment in the on-farm SLM with an average marginal effect of 0.2 percent, meaning every one-year increase in the age of the household head leads to a 0.2 percent decrease in the probability of on-farm investment in SLM. This may relate to the decrease in household labor within the household and inability of a household to conduct farm management as households get older.

Education – The results revealed that school attainment negatively and significantly affected the small landholder households' on-farm investment in SLM in the study areas with an average marginal effect of 2.4 percent. This shows that when school attainment of the household head increases by one grade the probability of investment in the on-farm SLM decreases by 2.4 percent.

Marital Status – The results of the current study revealed that the marital status of the head of the household positively and significantly affected the small landholders' on-farm investment in SLM with an average marginal effect of 5 percent. This shows that households headed by married couples have a 5 percent higher on-farm SLM investment probability than households headed by unmarried and widowed/r.

Means of land acquisition – Access to land determines on-farm investment of households. In this regard, the results unfolded that means of original land acquisition negatively and significantly influenced households' on-farm SLM investment with an average marginal effect of 0.7 percent. This shows small landholder households who originally acquired their landholdings under their possession other than administrative land redistribution or allocations have a 0.7 percent reduced probability of on-farm SLM investment incentives.

Land area – The survey results revealed that land area was also found to influence the on-farm investment negatively and significantly in SLM in the study areas with an average marginal effect of 1.3 percent. Meaning every one unit increase in the land held by the household head leads to a 1.3 percent decrease in the probability of investment in the on-farm SLM.

Time taken from homestead to parcel – the survey result revealed that time taken to parcel is also found to effect households' on-farm investment in SLM positively but insignificantly in the study area with an average marginal effect of 0.14 percent, meaning every one-minute increase in the travel time from home to the parcel leads to a 0.14 percent increase in the probability of investment in on-farm SLM. Likewise, the results of the study revealed that parcel distance from home was also found to influence households' on-farm SLM investment negatively but insignificantly. This may have an insignificant effect since the parcels possessed by the landholders are found within the reach of 15 minutes on average walking distance.

Possession of landholding certificates – land registration and certification are one of the mechanisms sought for improving tenure security in Ethiopia to incentivize long-term land-based investment such as on-farm SLM and climate smart agriculture. Under the current study, the survey result revealed that possessions of either FLLC or SLLC were found to influence on-farm SLM investment positively and significantly in the study areas. The results indicated that landholding certification increases the incentives to invest in on-farm SLM with an average marginal effect of 14 and 8 percent for FLLC and SLLC, respectively. This shows that small landholders who possessed either FLLC or SLLC for their parcels have a 14 and 8 percent increased on-farm SLM investment than those households without both FLLC and SLLC for their parcels, respectively.

Credit access - the survey results also revealed that credit access is significantly but negatively affected investment in SLM with an average marginal effect of 9 percent, meaning households without credit have a 9 percent reduced capacity investing in on-farm SLM practices.

Water erosion – the result also revealed that water erosion risk was found to affect investment positively and significantly in SLM practices. The result revealed that households who held a parcel of landholding located on sloping lands with soil erosion risk from water has a 16 percent increased incentive to invest in SLM technologies.

Conservation security risk - Likewise, perceived conservation risk is found to influence household's investment negatively and significantly in SLM. The survey result revealed that those households who are fully convinced to benefit in the future from whatever SLM investment have 5 percent increased investment incentives in SWC.

Tree tenure security risk - in another measure of tree tenure security risk, the survey results revealed that those households who are fully convinced that they will not stand to benefit in the future from trees have 2.5 percent reduced investment incentives in on-farm SLM. Meaning households who foresee a tree tenure insecurity risk will disincentivized investing in on-farm tree planting.

Regarding de jure tenure security, household heads who know their usufruct and bequest land rights recognized and protected by the land laws have 5 and 8 percent increased on-farm SLM investment, respectively. Meaning those households who were aware of their usufruct and bequest rights recognized by the laws were better off in on-farm SLM investment.

Table 26. Estimates of the probit regression model and average marginal effects. Source: calculated by the author based on the survey data obtained from USAID Impact Evaluation data repository, 2022.

Dependent Variable: any on-farm SLM investment	Independent Variables	Coefficient (Robust Std. errors)	dy/dx	z	p>|z|	[95% Conf.	Interval
HH demographic and socioeconomic variables	Sex	- 0.4178735 (.1145124)	-0.0883315	-3.67	0.000	-0.1355363	-0.0411267
	Age	- 0.0083073 (0.0017542)	-0.001756	-4.76	0.000	-0.0024797	-0.0010323
	Education	-0.1066318 (.0145214)	-0.0225402	-7.40	0.000	-0.0285068	-0.0165736
	Marital status	0.2170497 (.0603256)	0.0458807	3.62	0.000	0.0210237	0.0707378
Parcel specific characteristics	Means of original land acquisition	-0.0378159 (0.0107423)	-0.0067725	-3.03	0.002	-0.0111551	-0.0023898
	Land area	-0.0503588 (.0125353)	-0.0126224	-4.47	0.000	-0.0181613	-0.0070835
	Time taken from homestead to parcel	0.0071993 (0.0027112)	0.0014135	2.45	0.014	0.000282	0.0025449
	Parcel distance	-0.0000617 (0.0000284)	-0.0000117	-1.89	0.058	-0.0000238	4.1700007
	Water erosion risk	0.7215662 (0.0384517)	0.1577806	19.23	0.000	0.1417	0.1738613
De facto/actual tenure security	FLLC	0.5684453 (.0720468)	0.1412601	8.48	0.000	0.1086007	0.1739194
	SLLC	0.352477 (0.044427)	0.0755028	7.73	0.000	0.0563506	0.094655
	Credit obtained	-0.440749 (0.0935047)	-0.0815989	-4.02	0.000	-0.1214053	-0.0417926

	Decision on crop to grow	-0.0697866 (0.0424118)	-0.0147517	-1.65	0.000	-0.0323039	0.0028005
	Decision on the use of the produce	-0.2506868 (0.0642267)	-0.052991	-3.93	0.000	-0.0794387	-0.0265433
	Decision on to rent out land	0.2731232 (0.055941)	0.0577337	4.93	0.000	0.0347664	0.080701
	Perceived land redistribution risk in the coming 5 years	0.0203412 (0.026744)	0.0042998	0.76	0.447	-0.0067734	0.0153729
	Inheritance risk	0.0450935 (0.0296294)	0.009532	1.52	0.127	-0.0027263	0.0217903
	Rent out risk	0.0867749 (0.0266221)	0.0183428	3.27	0.001	0.0073618	0.0293237
Perceived tenure security	Any business transaction risk using land	0.057798 (0.0358516)	0.0122175	1.61	0.107	-.0026457	.0270808
	Perceived conservation security risk	-0.2159043 (0.0309938)	-0.0459637	-6.96	0.000	-0.0589067	-0.0330208
	Tree tenure risk	0.1184363 (0.0193521)	0.0252138	6.11	0.000	0.0171198	0.0333079
De jure/legal tenure security	The laws allow HH to use the parcel/usufruct rights?	-0.2513301 (0.1437449)	-0.053127	-1.75	0.080	-0.1126784	0.0064245
	The laws allow HH to bequest it to someone?	-0.3752617 (0.0958247)	-0.0793241	-3.92	0.000	-0.119007	-0.0396412
	The laws allow HH to use it as a collateral to get a loan	-0.0006374 (0.0575664)	-0.0001347	-0.01	0.991	-0.0239844	0.0237149
	Constant	-1.140621 (.1965337)		-3.75	0.000	-1.633789	-0.5116059

Note: n = 6,692 Wald Chi2(24) = 704.08, Prob > Chi2 = 0.0000; Pseudo R2 = 0.1402; p<0.01, p<0.05; Robust standard errors are given in parentheses. Average marginal effect (dy/dx) are calculated at the mean for continuous and for a discrete change from 0 to 1 for dummy variables.

5.4. Discussion

This section discusses the results of the current study comparing with previous studies of the working hypotheses in a broader term with particular emphasis on land tenure institutional factors (LTIFs) including de jure, de facto, and perceived tenure security as well as risks of tenure security in a range of bundle of land rights. The role of land tenure institutions, be it formal, customary, or informal, in sustainable land use and resource management has paramount importance. This is because the way land tenure institutions organized and enforced can influence how communities and landholders use land resources and whether durable sustainability on-farm SLM investment made. Regardless of the forms of tenure rights, their recognition and protection are also critical

factors for sustainable land use and resource management. For instance, secure private land use rights, without enforced land use planning which regulates land use zoning and other environmental management measures, may result in adverse environmental outcomes. While evidence on improved natural resource management, including soil and water conservation as well as biological measures such as tree planting is compelling after land certification in Ethiopia [20, 21, 30, 235], small landholders' on-farm investment in SLM remains limited in the study areas. However, there is scant evidence to what extent small landholders' on-farm investment in SLM affected by LTIFs.

To help fill this knowledge and evidence gap, this study assesses the effect of land tenure institutional factors on small landholders' on-farm investment in SLM in the highlands of Ethiopia. Historically, Ethiopia's highland agriculture dominated by small landholders' farmland tenure model and characterized by fragmentations. Land degradation is one of the major environmental and development challenges in the highlands. SLM also considered as one of the key policy responses implemented particularly in the highlands of Ethiopia using watershed as a unit of planning. However, at landscape level the landholding types are a mosaic of communal, private, and state/public lands associated within a certain socio-ecological systems and highly dominated by individual or private land tenure. The interaction and relations of these diverse tenure types affect the land use and on-farm SLM investment practices of individual small landholders and its sustainability.

As presented in the result section and exhibited in Table 25 and Table 26, the overall results suggest that small landholders in the study areas have been investing in different SLM technologies/practices at farm level. These include SWC measures such as stone bund, soil bund, and water retention structures strengthened by biological measures (trees planting and perennial crops growing).

Based on the findings of the current study, demographic and socioeconomic factors are essential elements to consider which influence smallholder households' on-farm SLM investment. This includes age, gender, education, marital status, and means of original land acquisition of the households. Besides, the area of landholding possessed by the small landholder households found to influence on-farm SLM investment significantly. Moreover, the results of the current study revealed that different components of the LTIFs (de jure, de facto, and perceived tenure security) influence small landholder households' on-farm investment in SLM unevenly across a range of

bundle of rights. The bundle of rights are legally recognized and protected landholding rights under the current land laws include usufruct rights such as the rights to grow crops and build houses, the right to transfer the land use rights through rent/sharecropping, the rights to bequeath the landholding to someone else, collateralize land use rights, and the rights to protected from alienation of landholding rights. This section particularly discusses the effect of LTIFs represented by the three categories of land tenure security and their corresponding bundles of land tenure rights on small landholder households' on-farm investment in SLM in the study areas.

5.4.1. De jure Land Tenure Security and On-farm Investment in SLM

The current study revealed that except recognition and protection of collateralizing land use rights small landholder households in the study areas acknowledge that the existing legal framework provides legal or de jure tenure security that significantly affected their on-farm investment in SLM. According to Masuda et al. [5, 38] , Holland et al. [9] and, Robinson et al. [45] as societies grow and land pressure increase, there becomes a need for clear and transparent processes that assign and enforce rights among various parties and spell out the rules for how rights can be accessed, transferred, terminated, or gained. Locke [234] even argued the primary function of government is to secure and protect such property rights. Meaning that sustained land tenure security must come with the state recognized backing of land rights [233].

Accordingly, in rural Ethiopia, individual land rights recognized under the federal and regional land administration and use proclamations. The 1995 Constitution of the country enshrined the ownership of land to the state. Ethiopian nationals can have individual usufruct rights in that peasants and pastoralists can obtain land for cultivation and grazing purposes free of charge for indefinite time. Proclamation 456/2005 of the federal democratic republic of Ethiopia also recognizes acquiring of individual landholding rights through allocation, redistribution, settlement programs, donation and/or inheritance free of charge. However, neither collateralization of landholding rights to access credit nor acquiring land through sales or any other exchange is ruled out by the existing legal framework. This indicates that the existing legal framework recognizes and provides protection of small landholders' rights clearly and implies there is a de jure tenure security except collateral and land sale.

The econometric results revealed that those households who were aware off their usufruct rights, transfer rights through rent/sharecropping, bequeath/inheritance rights recognized by the existing laws have a 5 to 8 percent better probability of investing in on-farm SLM investment. This implies that legal literacy or awareness on what bundle of tenure rights recognized and protected by the existing land laws makes a significant difference in on-farm SLM investment among small landholders in the study areas. This is consistent with what Vu H. and Goto D. [236] find in Vietnam that awareness about the land tenure security towards agricultural land tenure rights increases sustainable investment such as in irrigation, soil and water conservation, and the adoption of organic fertilizer. However, the results also revealed that landholders know that the then land laws did not recognize collateralization of land rights, hence insignificantly influences small landholders' on-farm SLM investment. Meaning collateralization of land rights was not an option to the small landholders to access credit and finance on-farm SLM investment until recently. However, since 2019/20, there was a policy change of the use of land use rights as collateral to borrow money from financial institutions.

5.4.2. De facto Land Tenure Security and On-farm Investment in SLM

The de facto tenure security is also measured across the bundle of tenure rights as recognized in the existing legal framework and as actually practiced by the smallholder households and protected by the state or local governments in the study areas. Overall, the econometric model findings show that the set of the de facto tenure security was found to influence the smallholder households' on-farm investment in SLM significantly. Regardless of countries' specific legal systems, legal documentation of rights refers to the recording and publication of information on the nature and location of land, rights, and right holders [102]. In a formal system or statutory context, land titling sought as one of the mechanisms that provides rights holders with a secure tenure right and incentivizes them to use land efficiently by investing in land conservation & improvement [5, 6]. Likewise, since early 2000, the government of Ethiopia launched one of the biggest two-stages land registration and certification programs in Africa that improve land tenure security in the highlands of Ethiopia with the aim to incentivize long-term land-based investment such as SLM practices and curb land degradation.

As well documented in the existing literature, land degradation is one of the major environmental and development challenges in the highlands of Ethiopia that reduces agricultural production, increases food insecurity, and disrupts sustainable ecosystem functions [235, 237, 238]. Guided by Ethiopia's Sustainable Investment Framework (ESIF) for SLM, the government of Ethiopia embarked a national SLM flagship program since 2010. ESIF presumed that the removal of the key barrier of insecure land tenure believed to be one of the way-outs to greater adoption of SLM practices and reduces further land degradation [239]. Component two of the ESIF recommends the improvement of the land administration and certification system. Under ESIF, the combination of participatory and integrated watershed management and secure land tenure rights expected to lead to increased adoption of SLM practices, then reducing land degradation, increasing carbon sequestration, and delivering more resilient and sustainable livelihoods.

The econometric model of the current study revealed that possessions of either FLLC or SLLC were found to positively influence small landholder households' on-farm investment in SLM significantly in the study areas. This is consistent with what Adere et al. [235] found similar result in southern Ethiopia that land certification has a positive but with a heterogeneous impact on diverse types of SWC techniques among farmers with different risk preference. Tilahun et al. [235] also find that land certification enhances land investment and that the effect is very stronger for more risk-averse farmers in Ethiopia. Deininger et al. [20] also find consistent evidence on the impact of land certification on tenure security, investment, and land market participation in Ethiopia. Gebremedhin et al. [240] also find land tenure security contributes to land conservation through influencing soil and water conservation actions in watersheds by enhancing household willingness to invest in high-cost and long-term conservation practices like stone bunds in Ethiopia's Tigray regional state. Likewise, Frank [80] also found, in Sub-Sharan Africa countries, the clarity and recognition of land tenure rights through land registration and certification of small landholders and communities incentivized land managers to engage in higher value and more productive land use practices. Mugagga [241] also found land tenure secure communities through communal land certification invested in longer-term soil conservation measures in Uganda.

However, it is worth noting that having a certificate does not necessarily fully secure or causes a person to believe that there is an absolute guarantee. Meaning the impact of land certification on tenure security differs by how perceived tenure security is measured. Besides, the type of tenure

security risks matters the intensity and adoption of SLM practices. This leads me to the discussion on the third categories of land tenure security, i.e., perceived tenure security and risks related to the bundle of rights as recognized in the existing land laws. Before turn into the perceived tenure security discussion, it would be important to flashlight on another de factor tenure security bundle of rights, i.e., collateralization of land use rights and its effect on the smallholder households' on-farm investment in SLM.

The econometric analysis revealed that credit access significantly but negatively affected smallholder households' investment in SLM. This result is in line with the work of Mulwa et al. [242] who found that access to credit allowed households to adopt SWC activities that help them to invest more in agricultural inputs in Malawi. Abeje et al. [238] also found access to credit have a positive effect on adopting a higher number of SLM practices in Ethiopia. Similarly, Asaaga et al. [51] found that access to credit plays a critical mediating role of the relation between tenure security and SLM investment in Ghana. This implied that in the absence of access to credit small landholders may still find it difficult to invest in an on-farm resource intensive SLM investment such as SWC measures.

Contrarily, the econometric analysis shows that decision making on the crop to grow was found to negatively influence the smallholder households on-farm SLM investment significantly. Likewise, decision on the use of the produce found to negatively influence the smallholder households' on-farm SLM investment significantly. This shows that although landholders have legally secured joint tenure rights under the current legal framework, there is a de facto tenure insecurity within intra-household. This may be due to customary and social norms specific to the study areas. On the other hand, the decision on the transfer of rights through rent and/or sharecropping found to positively influence the smallholder households' on-farm investment in SLM significantly. This indicates that smallholder households with joint landholding rights recognized through joint land certificates should decide on the transfer of their joint landholding rights in the form of land rent/sharecropping. This is consistent with the legally recognized requirements in that the parties need to agree and provide their consent jointly to enter a land rental/sharecropping contract arrangement. This implies that joint landholding rights holders in the study areas have secured de facto tenure security that facilitates on-farm investment in SLM. This is consistence with what Ghebru and Girmachew [93] find in Ethiopia that the value-added direct and spillover effect of

SLLC favors the supply side of the land rental market, likelihood of renting/sharecropping in land significantly enhanced even for non-beneficiary households who resides in or around land certification treated program woredas.

5.4.3.Perceived Land Tenure Security and On-farm Investment in SLM

Coming to the perceived tenure security of small landholder households, the econometric analysis of the current study shows that this category of tenure security found to influence their on-farm investment in SLM significantly but with different directions. For instance, regarding perceived conservation security risk, the econometric analysis shows that perceived conservation security risk found to negatively influence the small landholder households' on-farm investment in SLM significantly in the study areas. This is in line with what Gebremedhin et al. [240] found that investment in stone terraces positively influenced by factors associated with long-term investment perspective such as capacity to invest and land tenure security in Tigray region of Ethiopia. Ghebru and Girmachew [93] , on the other hand, found that while SLLC a positive effect in reducing private land tenure risks, this intervention shows a negative effect on men's perceived risk of private tenure security. The fact that the SLLC implemented by issuing joint landholding certificates to heads and spouses could explain the extra sense of security married women perceive while men perceive the contrary [93].

Likewise, perceived tree tenure security risk was found to positively influence the small landholders' on-farm SLM investment significantly. This shows that there should be clarity on the security of tree and land tenure nexus. As per the existing legal framework, in Ethiopia, land tenure rights and tree tenure rights are exclusively independent bundles of rights. According to the land administration laws, small landholders have perpetual land use rights while the forest development law proclaimed private individual households have forest ownership rights on their individual landholding including tree planting. However, this might not well understand among the smallholder households which negatively influences on-farm SLM investment such as agroforestry which is one of the proven on-farm SLM technologies promoted under the ESIF. However, other previous studies in Ethiopia also found that improvement in perceived tenure security has witnessed after the land certification program [21, 93, 215, 243].

The econometric analysis further shows that perceived tenure security risk to enter any sort of business transaction involving credit found to insignificant influence if it were with a farmer who has a land certificate of possession over their landholding than that a farmer who does not have a land certificate. Since this right is not legally recognized /secured, households feel that it is a credit security risk transaction. Contrarily, Byamugisha [80] find that landholders having secure tenure rights and secure access to credit spur long-term productive investment in sub-Saharan Africa countries [79].

5.4.4. Households' Socioeconomic and demographics and On-farm Investment in SLM

Regarding the demographic variables of the households, the current study found that gender, age, and education were found to negatively influence households' on-farm investment in SLM significantly. For instance, the econometric analysis shows that gender and age of the household head was found to negatively influence the households' on-farm investment in SLM significantly. This is consistent with earlier studies such as with Ghebru and Girmachew [93] finding in that female headed households with SLLC are less likely engage in investment and/or maintenance of sustainable land management practices compared to households without SLLC in Ethiopia.

Likewise, the educational level of the household head was found to negatively influence the households' on-farm SLM investment significantly. Contrary to our expectation and with others on the effect of education [242, 244, 245] on adoption of sustainable agricultural practices and climate adaptation measures, the current study finds that small landholder household heads with more years of schooling are less likely to invest in on-farm SLM. This may indicate that well educated household heads tended to look for non-land-based livelihood options such as off-farm activities or prefers out-migration. More specifically, insufficient availability and productivity of land may also be among the disincentives of investment in the on-farm SLM among household heads with more school years attainment. This implies that with increasing pressures on land and decreasing productivity due to land degradation compounded by climate change risks, households' educational attainment and their on-farm investment in SLM should be seen carefully.

The economic analysis further shows that the socioeconomic factors such as marital status, means of original land acquisition, and area of landholding of smallholder households found to influence

significantly but with different directions. For instance, the econometric analysis reveals that land area found to negatively influence the on-farm investment in SLM significantly in the study areas. This is in line with what Etsay et al. [246] found out a negative relationship between farm size and adoption of Indigenous conservation practices in the Tigray region of Ethiopia. However, the current result disagrees with findings by Wondimu et al. [237] that find land area has a positive significant effect of crop rotation in the Abay basin of Oromia region of Ethiopia.

5.4.5.Parcel Specific Factors and On-farm Investment in SLM

The econometric analysis shows that distance and walking time to parcels were found to influence insignificantly while the exposure of the land parcels to water erosion risks found to positively influence smallholder households' on-farm investment in SLM. This is consistent with what Adimassu et al. [239, 247] who find that farmers who are vulnerable to erosion hazards are more likely to invest in different land management practices but was highly variable across their production domain. Wondimu et al. [237] also find that the perception of erosion hazard has a positive and significant effect on adoption of soil bund SLM practice in the Abay basin of Oromia regional state in Ethiopia. As land is household heads' ultimate resources for their livelihood, parcels which were exposed to water erosion were more likely to receive on-farm investment in SLM thereby reducing land degradation and improving their productivity. Similarly, Abeje et al. [238] find that the parcel level factors also influence the SLM investment including slope gradient, fertility status, area, and distance to and from home.

5.5. Conclusions

This study assessed factors affecting households' on-farm SLM investment in nineteen highland woredas of three regions (Amhara, Oromia, SNNP) in Ethiopia, where land degradation considered a daunting environmental and development challenge. This study considered selected household and parcel-level variables and land tenure institutional factors. This was achieved by employing a probit regression model that estimated the average marginal effect of the explanatory variables on the outcome variable quantitatively, i.e., the probability of a household head invested in any on-farm SLM practices. While the existing land tenure literature recognizes the need to ensure the security of tenure in broader terms, this may hinder an in-depth yet broader perspective of understanding about the effect of LTIFs along categories of land tenure security across bundle of rights and, hence limits context specific SLM policy and implementation strategy. Therefore, the current study empirically assessed this approach and demonstrated that the approach might be replicated in other countries and contribute to the broader body of evidence.

The findings of this study revealed that households' on-farm investment in SLM was affected by demographic and socio-economic factors, parcel-specific variables, and LTIFs. Particularly, the LTIFs also found to jointly influence the probability of households' on-farm investment in SLM significantly but differently across the various categories of tenure security and bundles of rights. These results demonstrated that unbundling the categories of land tenure security across the bundles of rights and understanding their specific influence on households' on-farm SLM investment are important aspects of designing context-specific SLM policy and implementation strategy.

These results have three important implications. Firstly, while the household and parcel level variables are especially important to consider when designing SLM investment policy at the household level, the LTIFs are equally important to consider across the bundle of rights. Meaning categories of secure tenure rights must see in perspective along with other influencing factors. Secondly, while securing tenure through land certification incentivizes the on-farm investment in SLM, land policies and regulatory frameworks should also consider the issues of access to credit to small landholders that create the capacity to invest in durable and intensive on-farm SLM investment. In the absence of access to credit, small landholders with secure tenure rights may still find it difficult to invest in an on-farm resource-intensive SLM investment. Hence, the SLM policy needs to strengthen access to credit for smallholder households across the country. Finally,

regardless of the forms of tenure rights, their recognition (de jure) and enforcement (de facto) tenure security combined with the regulatory functions of land tenure institutions, such as the enforcement of land use regulations, are also critical factors for sustainable land use and resource management. Secure private land use rights, without enforced local level land use planning which regulates land use zoning and other environmental management measures, may bear little on-farm investment in SLM that could not balance the exploitation of land resources and may result in adverse environmental outcomes. This will affect the sustainability of SLM investment at the landscape level, including communal landholdings.

However, this study did not undertake an in-depth assessment of local-level land use plan implementation where available and its implication on households' on-farm SLM investment. Future research should focus on the impact of local-level land use plan implementation compliance by smallholder households and its implication on their on-farm investment endeavors in SLM.

6. CHAPTER SIX: SUMMARY OF KEY FINDINGS, CONCLUSION AND RECOMMENDATION

This chapter summarizes key findings emanated from each of the previous chapters of the research. The chapter blends and answers the quest of the broader operational sustainability issue of the NRLAIS and its implication to credit and investment in SLM that enhance capacities of small landholders in managing environmental externalities and diversifying their livelihoods for resilience. It also suggests implications on policy, research, and practices of the study and offers conclusions and recommendations.

6.1 Introduction

The role of effective land administration systems cut across the sustainable development goals. Land administration systems should perform in the face of an increasingly complex and uncertain context and fierce competition on land and other natural resources compounded by climate change. Land administration systems have a long history of paper-based records, although now geo-ICT enabled systems are readily available and successfully applied in developed economies. However, establishing a digital land administration information system and making it sustainable is a challenging development issue, particularly in developing countries. This is because the procedures and the vested interests of staff are one of the key determinant factors for operational acceptance and functional usability of the system for land administration services delivery. Besides, registering subsequent land transactions after a systematic first-time land registration and certification not consistently reported by rights holders due to a lack of public perception and/or awareness of the benefits, cultural norms, and complex legal and administrative requirements to register, among others. These risks the functions, operations, and sustainability of the land administration information system of a country.

Despite maintenance of a land register is well known issue of sustainability in land administration systems, over the past decades, scholars have focused their attention on the first-time systematic land registration and certification programs or upgrading requirements and its effect on development and environmental outcomes. This leaves a knowledge gap in understanding of what factors influence the acceptance and actual functional usage of an established digital land administration information system that measures its operational success and sustainability and as well as its effects on development and environment. This research fills this knowledge gap and

generates new insights, by seeking to understand the sustainability of the NRLAIS with implications to credit and investment in SLM in Ethiopia. This broader objective has divided into four specific objectives, namely:

- To explore factors that influence the acceptance and actual use of the NRLAIS as a proxy predictor for its operational success and sustainability.
- To investigate factors that influence landholders' intentions to formalize subsequent land transactions as a proxy measure of the NRLAIS sustainability.
- To assess whether the NRLAIS underpinned by policy and regulatory reforms and technological innovations increases creditworthiness of smallholder households, incentivize financial institutions, and reduce transaction costs and risks.
- To understand the effect of land tenure institutional factors on small landholders' on-farm investment in sustainable land management practice.

The rest of this chapter is organized as follows. Section 6.2 presents a summary of key findings for each of the specific objectives. Section 6.3 presents a summary of the research synthesis, while 6.4 and 6.5 cover general conclusions and recommendations, respectively. Section 6.6 and section 6.7 cover a reflection on the contribution of the current study and indicate future research directions.

6.2 Summary of Key Findings

6.2.1 Factors influencing the acceptance and actual use of the NRLAIS.

This specific objective provides an understanding of the factors that influence the acceptance and actual use of the NRLAIS as a proxy predictor for its operational success and sustainability. Additionally, the section gives an account of the relationship among the identified influencing factors and their level of significance for acceptance and actual usage of the system by woreda level land administration experts.

Over the past decade and half the rural land administration information system has dominated by manual registry systems. Particularly, the FLLC program was dependent on manual registers except in Amhara region. The FLLC program has also additional shortcomings including lack geospatial information of parcels, incompleteness of tenure and land use information, and lack of enough updating space in the manual land register. Besides, after the FLLC subsequent land transaction undergone which require the maintenance and updating of the land information in the manual land

registers. However, in various instances, the land registers are not maintained properly. As a result, availability and accessibility of accurate, complete, and current land records or information supporting sound development decisions and investment prioritizations have challenged. Over time, this jeopardizes the development objectives of the massive land registration program of the country. This has evidenced when the SLLC program started to implement.

With the aim to store and manage the data acquired through the SLLC program systematically, a digital land register developed, piloted, and rolled-out after fulling an operational acceptance test. By the end of 2022, over three hundred woredas have been covered with this digital land register and the NRLAIS made operational to register subsequent land rights transactions. During the same period, the information for over twenty million parcels of landholdings have been cleaned and migrated into the system, and over half a million subsequent land transactions registered in the system.

NRLAIS is the largest distributed LIS in Ethiopia and currently operates in eight regional states, 60 Zones, and over three hundred woredas. The initial NRLAIS implementation focused on delivering a digital system, which was used by woreda land administration offices for recording and managing rural land registers. However, the wider area network (WAN) that connects woredas to zonal, regional to federal/central servers for an online data replication and information flow is yet to be deployed due to underdeveloped ICT infrastructure in the country. The study findings indicate that, despite this backdrop, with enhanced data management functionality, the NRLAIS provides security, transparency, service quality, and continuous maintenance and updating of the land records at the woreda level. It also serves as a legitimate bearer of land information including the socio-spatial aspects of landholdings and users' rights in land and helps federal and regional governments to make informed land policy and investment decisions.

The study findings further indicate that acceptance and actual use of the system by the woreda land administration experts are good proxy predictors of its operational success and sustainability. The research also discovered that understanding and aligning the functional, technical, legal, and administrative requirements ensures operational success. These factors significantly affect the acceptance and actual use of the system and better predict its operational sustainability. The study concludes that the acceptance and actual use of the system by the woreda land administration experts influenced by socio-psychological, organizational, and technological factors including system quality, information quality, service quality, and perceived usefulness of the system. The

study revealed that selected socio-psychological variables including perceived usefulness and perceived ease of use of the system influenced the acceptance and actual use of the system differently. Moreover, the organizational aspects of the system related to support services and information quality also influences the behavioral attributes of woreda land administration staff to accept and use NRLAIS who have been relied on it to make daily business decisions and services delivery. The result shows that the quick acceptance and actual functional use of NRLAIS improves land administration services delivery at the woreda level, promotes upstream data integration and information sharing, and fosters daily business and strategic decision-making. Hence, as extension of the existing IS theories and models such as IS success model, TAM and TPB, the designed research model under the current research has empirically evaluated and found a good predictor of sustainability.

6.2.2 Factors influencing landholders' intentions to formalize subsequent land transactions.

This specific objective examines the factors that influence landholders' behavioral intentions to formalize sporadic subsequent land transactions made after receiving land certificate for the first-time.

It is notable that the FLLC and SLLC only adjudicate and register the existing landholding rights attached to the claimed and demarcated parcels. In other words, the two successive land certification programs formalize the de facto land rights as per the de jure land rights through the established systematic land registration system. However, the existing legal framework and administrative procedures require that landholders who made any land rights transfer in their registered parcels of landholding should formalize, and the land registers must maintain and kept up-to-date accordingly.

This guarantees the completeness, accuracy, availability, and currency of the information in the land registers. These attributes are essential as information in the land registers reflects the reality on the ground. However, keeping the information in the land registers up to date is more challenging than establishing a new register through a systematic land registration and certification programs for the first time. Literature shows that without registering subsequent land transactions the information in the land register will quickly become obsolete. This lack of updating in turn risks the long-term functionality and sustainability of the land administration information system and

leads to informality and rollback to insecurity of land tenure. Hence, how rights holders perceive and respond to the established process of formalizing subsequent land transactions after the first-time land certification is a critical issue in land administration systems.

However, scholars in the field of land administration rarely study the formalization of subsequent land transactions through the lens of landholders' intentions. Under this specific objective, the research argues that studying these intentions of landholders is important for at least two reasons. Firstly, the analysis of landholder's intentions helps to predict formalization rates. Secondly, it helps to improve our understanding of the factors that are responsible for the realization, or not, of these intentions. This information can help inform target interventions for diverse types of landholders facing various constraints in putting their intentions into action and ensure a functional and sustainable LIS in Ethiopia and elsewhere. Through the lens of TPB, among other issues, the research considered and explored the influencing factors of formalizing rural land rights transaction and their relationships, including attitudes, subjective norms, and perceived behavioral control to the intentions and actual behavior of land rights holders registering subsequent land transactions.

Based on the results of this study, the researcher concludes that landholders' attitudes to land registration benefits or values they created in land registration and their perceived normative beliefs (subjective norms) can influence their intentions and actual practices of formalizing land transactions. An implication of this is the possibility that affects the currency, accuracy, and completeness of information in the land register. Participants in the study admitted that the two stages of the land registration and certification programs brought about positive development outcomes, including improved secure tenure, enhanced transferability of land rights, safeguarded enforcement of land rental contracts, incentivized longer-term land-based investment, and opened new opportunities for SLLC-linked individual loans. Hence, the long-lasting functionality and sustainability of the land administration information system ensured if landholders continue formalizing the subsequent land transactions and the woreda land administration offices kept the land register up to date. Therefore, the study underscored that facilitating landholders' attitudes to the formalization of subsequent land transactions and helping them to overcome hurdles facing subjective norms are critical issues for the daily functionality and long-term sustainability of the NRLAIS in Ethiopia. The result also revealed that this system will also facilitate the standardization

and integration of the fragmented land information system in the country and bridge the rural-urban land governance divide.

6.2.3 Technological and policy innovations for smallholder's creditworthiness.

This specific objective deals about the technological innovation of NRLAIS and policy and regulatory reforms to the creditworthiness of small landholders in Ethiopia. Access to credit for small landholders was much more limited in rural Ethiopia. Microfinance institutions and saving and credit cooperatives and their unions have been the main source of finance, through group-lending arrangements since smallholder households were unable to provide sufficient collateral. This is not because of the small landholders lack assets but due to the lack of enabling policy and regulatory framework. Absence of such enabling policy and legal framework mean smallholder households could not be able to use their usufruct rights to land, which is the main asset held by them, to use as collateral to access individual credit.

Moreover, the creditworthiness of individual smallholders for collateral is dependent on the absence of uncertainty and asymmetric information. On the other hand, the effect on the credit supply is an increase in the willingness of lenders to provide credit if borrowers can use secured land as collateral. The availability and accessibility of a digital land information system can then contribute to an increase the supply of credit and reduce the costs and risks of contracting and monitoring enforcement of collateralization. The presumption is when smallholder households facing capital constraints, they resort to unsustainable land use practices and production systems that leads to environmental degradation, biodiversity losses, and depletion of ecosystem functions.

This chapter also generate evidence from the existing literature in that transaction costs consist of the costs of measuring the valuable attributes of a right, the costs of protecting rights, and enforcing contracts. This mostly moderated by the availability and accessibility of reliable information from a functional land register. Enforcement of contract also depends on a constellation of supporting arrangements and implementation mechanisms such as the coordination between financial institutions, land administration institutions and law enforcement institutions. With certified land that secures land rights as a collateral for credit and contract enforcement, creditors can lawfully repossess land, if necessary, arise from a default. Also, it believed that the threat of repossession collateral acts as an incentive to the borrowers to repay the loan on time.

This chapter shows that policy and regulatory reforms at the Federal and Regional state level governments in Ethiopia suggested a promising avenue for increasing the collateral capacity of small landholders. The results reveal that availability and accessibility of information from the NRLAIS, and enforcement of the policy change and regulatory reforms related to collateralization of land use rights increase creditworthiness of smallholders, reduce transaction cost, and heighten willingness of financial institutions to provide land certificate linked credit. The study concludes, while the two-stage land certification programs allow small landholders to possess documented land rights and increase the value of land, their creditworthiness may remain insignificant without such further technological innovation, policy, and regulatory reforms. This discourse transforms the concept and practice of collateralization in Ethiopia's land tenure history. Based on these findings, the research recommended that policy makers should closely monitor the implementation of this reform, strengthen liquidity of financial institutions, improve functionality of NRLAIS for registering, storing, and sharing mortgage records as per the new law, and educate small landholders on financial literacy.

6.2.4 Land tenure institutional factors effects on an on-farm investment in SLM.

This specific objective assesses the effect of property rights institutional factors such as secure land tenure via land certification, credit access, and perceived conservation and tree tenure security risks on small landholders' on-farm investment in SLM. This chapter also considers other household and parcel level parameters and their effects on investment in SLM. This chapter uses survey data from 2,294 smallholder household heads of which 22 percent were women. The survey also covers 6,692 parcel level surveys conducted in nineteen highland woredas (districts) of three regional states (Amhara, Oromia, and SNNPR) in Ethiopia. A probit regression model employed to estimate average marginal effect of each predictor. The results revealed that those institutional factors including possession of either FLLC or SLLLC, access to credit, conservation and tree tenure security risks found to significantly influenced smallholder households' investment in SLM along with the household (gender, age, and education) and parcel (land area and slope gradient) levels specific variables. The latter shows the exposure of the land parcel to water erosion risk which also found to significantly affected the on-farm SLM investment of small landholders. The result also revealed that in the absence of access to credit small landholders with secure tenure rights may still find it difficult to invest in an on-farm resource intensive SLM investment such as SWC measures. Based on the findings, the study recommends that policy makers should strengthen the removal of

property rights institutional barriers such as perceived conservation and tree tenure security risks and strengthen access to credit that overcome the on-farm investment challenge in SLM.

6.3 The research synthesis

This section highlights a summary of the research synthesis of the proceeding chapters. The study was instrumental to elaborate the theoretical basis of the model and examined the model empirically which integrated and extended selected variables from the IS success and TAM models to explain the acceptance and actual usage of NRLAIS in Ethiopia. The acceptance and actual usage served as proxy predictors of NRLAIS' operational success and sustainability. To this end, the research identified factors influencing acceptance and actual usage of NRLAIS including technical, organizational, and behavioral aspects and measured their relationships using structural equation model. The technical aspect of the system refers to the system quality (SYQU) that reviews the functional and legal requirements and provides an understanding of the different components of NRLAIS including data capturing, data management, visualization, workflow management and reporting of information on parcels, persons, and interests as well as its scalability and extensibility. The organizational aspects, on the other hand, concerned about service quality (SRQU) and information quality (INQU). Similarly, the behavioral dimension measured the woreda land administration experts' perceived ease of use (PEOU) and perceived usefulness (PRUS) of the NRLAIS for daily land administration services delivery. These constructs, along with measuring their relationships helps to understand the NRLAIS operational success and sustainability which paves the way to scientifically research land administration system digitalization, particularly in developing economies. As to the best of the researcher's knowledge, this is the first attempt of its kind in the country. The research suggests that the IS success model integrated with TAM with context specific and selected variables were applicable and instrumental explaining IS acceptance or uptake and actual usage as a proxy predictor for operational success in the short term and sustainability of the NRLAIS eventually.

Moreover, the research contributed to understand how any ICT-enabled land administration system established and sustained. This is possible by exploring why and how important to deal with the maintenance and actual use of an established land administration information system for its sustainability. On one hand, maintenance refers to either the up-keeping or upgrading of the information system itself (in terms of organization, information quality, and/or technology) or

updating of the record (in the dimensions of spatial/object, person/subject, and interests including rights, responsibilities, and restrictions) that it contains or both. On the other hand, the use of the land information system concerned including both those officials charged with using the NRLAIS for services delivery and landholders who expected to register subsequent land rights transactions through NRLAIS. This approach demonstrated a comprehensive approach rather than a reductionist approach in assessing such a system which facilitates more complete analysis and discourse of the land administration information system including system design, implementation with implications to key development and environmental outcomes such as credit and investment in an on-farm SLM.

The research also elaborated and empirically evaluated the sustainability of the demand side of the system. This refers to the factors that influence the behavioral intentions of rural landholders to register subsequent land transactions after first-time land certification. Theoretically, updating the land registers is a critical element of sustainability in any land administration information system. After the successful implementation of the first level landholding certification in 2010, this updating issue has become a growing concern in Ethiopia. The research demonstrated that there limited empirical evidence about whether landholders' behavior is driving the lack of updating the information in the land registers in Ethiopia. By employing structural equation model and using households as a unit of analysis, the research empirically demonstrated the application of the theory of planned behavior in the land administration domain, which measures the demand side sustainability of the NRLAIS.

Based on literature-driven latent variables and the researcher's own experience, the research presumed and attested seven hypothesis including attitudes, subjective norms, perceived behavioral controls as antecedents to the behavioral intensions of landholders in registering subsequent land transactions. The research argued that studying landholders' intentions to formalize land rights transactions and their actual behavior was assumed to be of particular interest to policymakers for at least two reasons. Firstly, knowing the intentions of landholders to formalize subsequent land transactions helps to estimate the rate of transactions for planning and resource allocation. Secondly, it would also help to improve understanding about what factors influence land rights holders' intentions to formalize subsequent land transactions. Moreover, the research demonstrated that the theory of planned behavior (TPB) can be employed to deepen our understanding of land rights holders' formalization of subsequent land transactions in the land administration domain.

Hence, appropriate interventions to encourage land rights holders to formalize subsequent land transactions could be designed to ensure the sustainability of the NRLAIS in the country.

Based on the existing literature and empirically tested model, the study also focuses on the effect of technological innovation in the land register and policy reform in relation to the collateralization of land use rights on the creditworthiness of small landholders in the highland parts of Ethiopia. In the existing literature, the effects of land tenure on investment are typically hypothesized to occur through a security-induced investment demand and a collateral-based credit supply effect. The former specifies households increase investment when they perceive a reduced likelihood that land in which they might sink, attached, long lived investment will lose, and the latter implies lenders become more willing to make loans when assured that land pledged as collateral is secure and free of competing claims. This implies that getting land administration institutions "right" to build confidence to lending institutions, on one hand, and facilitating land-based investment such as in an on-farm SLM by small landholders, on the other hand.

Accordingly, the results revealed that availability and accessibility of information from the national rural land administration information system and enforcement of the policy change and regulatory reforms related to collateralization of land use rights increased creditworthiness of smallholders, reduced transaction cost, and heightened willingness of financial institutions to provide land certificates linked credit. The research concludes, while the two-stage land certification programs allow small landholders to possess documented land rights and increase the value of land, their creditworthiness may remain insignificant without such further technological innovation, policy change and regulatory reforms. This discourse charts a new era in Ethiopia's land tenure history which transforms the concept and practice of land rights collateralization in Ethiopia and its implication on the country's long term development outcomes and environmental sustainability.

Form this synthesis summary, one can conclude that land rights should clearly define by law and recognized and protected through a functional land registration system for which land records also digitized and kept up to date through continuous business processes scrutinized and facilitated landholders' intention and actual formalization of subsequent land transactions. The land administration information system is also accepted and operated by capable staff that underpinned by appropriate IT infrastructure. The information in the land administration information system

needs to be authoritative, accurate, available, accessible, and unambiguous all the time. This enhances informed decision regarding secure land tenure, transferability of rights, and facilitation of land market such as access to credit and incentivizes long-term and sustainable land-based investment such as in SLM at farm levels. This in turn helps to combat the long-standing environmental degradation challenges in the country and spur development outcomes in the country.

6.4 Conclusion

Based on review literature, the research established a strong theoretical foundation and identified research gaps in the research topic under investigation. This helps to construct a clear research conceptual framework linked to the overall and specific objectives of the research topic. This approach was also instrumental to define literature-driven variables or factors that influence sustainability of information systems as further elaborated and empirically applied in this study including the acceptance and usage of the system (supply side) and the behavioral intentions of landholders (demand side) to register subsequent land transactions in NRLAIS. Moreover, the author established solid theoretical foundation and generated empirical evidence on how the availability and accessibility of credible, accurate, complete, and current land information affects key development and environmental outcomes such as credit and investment.

Based on the findings, the research concludes that the acceptance and actual functional use of NRLAIS among users including both officials and landholders found good proxy predictors to assess the sustainability of the NRLAIS in Ethiopia. The woreda land administration experts are responsible for the usage of NRLAIS for daily land administration services delivery while the rural landholders are required by law to register subsequent land transactions made after first-time land certification. The NRLAIS anchors the relationships between the service providers (land experts) and receivers (land rights holders). Besides, the research exhibited the implications of this technological innovation of the land registers on access to credit and investment in SLM. The research also revealed how the reform in the policy and legal framework such as the collateralization of land use rights signals creditworthiness of small landholders and incentivizes investment in SLM. Methodologically, the research model facilitates more complete analysis and discourse of the NRLAIS including system design and implementation with implications to key development and environmental outcomes such as credit and investment.

6.5 Recommendations

Therefore, based on the findings and conclusions of the current research the following recommendations are suggested.

i. Strengthening behavioral changes of the land administration experts through two enhanced service quality measures - technical and operational capacity to a successful and sustainable digitization of the rural land register. Policymakers should also leverage operational success to upgrade the NRLAIS into a unified national land registration information system that bridges the urban–rural land governance divide.
ii. Facilitating landholders' attitudes of formalizing land transactions will help them to overcome social norms and control beliefs and will increase intentions and actual practice that ensures land registration systems remain up to date and sustainable.
iii. Reform securing transaction laws and continue digitalizing of the rural land registers for higher land rights trade-ability such as access to credit.
iv. Design context specific SLM policy and implementation strategy by unbundling the categories of land tenure security across the bundles of rights in the country.

6.6 Contributions of this study to policy, practice, and research

6.6.1 Policy and practice implications

This study identified major policy implications including the linkages between policy, institutions, process/operations and impacts on environment and development of the national rural land administration information system sustainability in Ethiopia. The research indicates the required policy and legislative reforms in the context of a decentralized federal system framing the institutional integration and alignments. The research also highlighted how such technological innovation drives or facilitates institutional and policy reforms. Moreover, it identified the intentions to and incentives of users of the system (both government officers/experts and landholders as well as financial institutions) and influencing factors for its adoption/acceptance, operational/actual use, and functional sustainability.

6.6.2 Research Implications

For the scientific world, the study contributes to the extension of theoretical insights and empirical methodological approaches. In this regard, inspired by the 2003 Information System (IS) success

modified model of DeLone & McLean, the 1985 Ajzen invented Theory of Planned Behavior (TPB), and Technology Acceptance Model (TAM), the research extends and integrates these theories with the land tenure theory and land registration system discourse. By extension and integration, the research developed and empirically evaluated a new research model which proved the soundness of the set out conceptual framework of the research design. The method applied in this study adds to the knowledge base and replicability of the proposed model under the land administration domain. In sum, the research contributes both for theories and practices about the role of land administration domain to environment and development research agenda and further informs required policy actions to greater environment and development outcomes.

6.6.3 Future Research Direction

The National Rural Land Administration Information System is being implemented without having a proper legal framework, in which its absence may be a further barrier to the land registration information system development, including legal recognition of digital data and signatures, security (confidentiality and integrity), backup, data and information sharing and access protocols, privacy, data pricing, etc.). This may limit the impact of the reform success and sustainability. Therefore, future research should focus on policy and legal framework, system maintenance and/or upgrading, and financing options of such reform. Besides, using the model employed in this research, future research needs to replicate and do the research at scale that can identify the challenges of registering subsequent land transactions and opportunities that inform future policy and programing of investment prioritization. Finally, future research may focus on the supply side of access to finance and the policy implementation effectiveness that anchor the collateralization of land use rights.

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