ALTERNATIVE VALUE CAPTURE SYSTEMS FOR IMPROVED WHEAT VARIETY INTELLECTUAL PROPERTY FOR INCREASED ACCESS BY TANZANIAN SMALLHOLDER EMERGING FARMERS: A CASE STUDY

A Dissertation

by

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ABSTRACT

The purpose of this dissertation is to examine management theory and impact of agricultural intellectual property rights systems in Tanzania to restructure policies and institutions for more efficient technology adoption and diffusion, enhanced market access, and for social, environmental, and economic development of smallholder emerging farmer. The researcher explores the relationships between value chains, intellectual property rights, institutional innovation, and technology transfer in the Southern Highlands of Tanzania. The researcher employs a case study methodology that builds on three theoretical frameworks: institutional development in Africa, management theory for institutions adapting in uncertainty, and institutional innovation for development. Data were collected from key informants representing stakeholders along the wheat value chain in Tanzania. These data were analyzed using a value chain approach to understand decisions of value chain actors (both public and private sector) in relation to one another. The analysis provides clarity to stakeholders to understand how recent legislation on plant variety protection will impact agricultural development and smallholder farmers in the wheat value chain. It provides a framework for showing how premiums for improved wheat varieties can be distributed to actors along the value chain and benefit the entire chain without disadvantage to smallholder farmers. The framework contains both qualitative and quantitative indicators that allow for longitudinal monitoring of the value chain to understand the effects of intellectual property on smallholder communities. It delineates the network effects of institutional innovation and the institutional innovation cycle and how these impact development in Tanzania.

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NOMENCLATURE

Actor	Participants (individuals or institutions) that have direct responsibilities for resources or activities in the value chain or development process.
Capacity	"The ability of people or institutions to carry out their core functions efficiently and effectively" (World Bank, 2011, p. xvi).
Clusters	"Geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions" (SAGCOT, 2011a, p. 3).
Disruptive Change	The obstacles to innovation within an institution that must be managed in order for institutional innovation to be successful.
Emerging Farmers	As distinct from subsistence farmers. Emerging farmers are engaged in value-added production and economic systems beyond local communities. Characterized by portions of farm production beyond household consumption are sold into provincial, national, or regional markets.
Institutions	"The formal and informal "rules of the game." They include formal rules, written laws, organizations, informal norms of behavior and shared beliefs—and the organizational forms that exist to implement and enforce these norms (both state and non-state organizations). Institutions shape the interests, incentives, and behaviors that can facilitate violence. Unlike elite pacts, institutions are impersonal—they continue to function irrespective of the presence of particular leaders, and thus provide greater guarantees of sustained resilience to violence. Institutions operate at all levels of society—local, national, regional, and global" (World Bank, 2011, p. xvi).
Innovation	New technologies, processes, and thought for changing aspects of life, businesses, communities, institutions.
Intellectual Property	"Creations of the mind: inventions; literary and artistic works; and symbols, names and images used in commerce. Intellectual property is divided into two categories:" industrial property and copyright (World Intellectual Property Organization, n.d.).
Intellectual Property Rights	"The rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time" ("What are Intellectual Property Rights?," 2014). Plant variety protections are a specialized form of intellectual property rights.

Key Informants	Persons who offer first-hand information that is deemed useful for research.
Kilimo Kwanza	"Policy of the Government of Tanzania, meaning 'Agriculture First,' which establishes agriculture as a top priority across all government ministries" (SAGCOT, 2011a, p. 3).
Plant Variety Protection	A type of intellectual property rights for plant breeders and farmers that allows for returns on investment in technology and technique for improved genetic material.
Resiliency	How a system or institution can withstand external or internal shocks to its functions or operations. The capacity to recover quickly from difficulties. "The ability of the system to return to its original state after a major disruption" (Bhatia, Lane, & Wain, 2013, p. 19). A measure of responsiveness to threats to stability.
Robustness	How well a system performs when subjected to external pressure or when there is uncertainty about internal dynamics (Anderies, Janssen, & Ostrom, 2004). A measure of stability amidst change. Capacity to perform without failure under range of conditions.
Royalty Capture	Point within the value chain where premium payments for technology or process innovation is collected – either explicitly or implicitly.
Smallholder Farmer	Generally, smallholder farmers are defined as operating farms of two hectares or less. This dissertation respects this guidance but focuses on farms with capacity to produce two hectares of wheat or less (World Bank, 2007).
Stakeholder	Individuals or institutions that have an interest in a value chain or a development process but might or might not be directly involved in the chain or process. Broader definition than an 'actor' but still dependent on the health and success of chain or process.
Supply Chain	"The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" (Christopher, 1998, p. 15).
Technology Transfer	The communication and adaptation of information, knowledge, processes, techniques, and tools from the originators of such technologies to the intermediary and end users of such technologies (Bozeman, 2000).
Value Chain	The map of all the processes and functions of a firm, institution, or economic system to understand the competitive

advantage of various activities in order to increase competitiveness and differentiation.

Abbreviations and Data Notes

ARI	Agricultural Research Institute
ASA	Agricultural Seed Agency
CBD	Convention on Biological Diversity
CIMMYT	International Center for Maize and Wheat Improvement
EAAPP	Eastern Africa Agricultural Productivity Programme
FAO	Food and Agricultural Organization of the United Nations
GOT	Government of Tanzania
IPR	Intellectual Property Rights
ITPGR	International Treaty on Plant Genetic Resources for Food and Agriculture
MOA	Ministry of Agriculture
NGO	Non-Governmental Organization
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
TOSCI	Tanzania Official Seed Certification Institute
TRIPS	Trade-Related Aspects of Intellectual Property Rights Agreement
Tzs	Tanzanian Shillings
UN	United Nations
UPOV	International Union for the Protection of New Varieties of Plants
VEO	Village Extension Officer
WIPO	United Nations World Intellectual Property Organization

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CHAPTER I

INTRODUCTION

Purpose of the Study

This research explores strategies to increase food security while improving market systems for resiliency of agricultural development. The purpose is to improve the management theory and impact of agricultural intellectual property rights systems in Tanzania and influence policies and institutions for more efficient technology adoption and diffusion, enhanced market access, and for social, environmental, and economic development of smallholder emerging farmers.

Statement of Problem

Agricultural productivity remains low in many Sub-Saharan African countries. The United Nations Food and Agricultural Organization (FAO) reports that cereal yields in Sub-Saharan Africa have remained stagnant compared to the rest of the world at a little more than 1.3 metric tons per hectare (figure 1). This is compared to approximately 5.5 metric tons per hectare in Eastern Asia, 3.0 metric tons per hectare in Central America, 3.7 metric tons per hectare for the world average and 6.8 metric tons per hectare in the United States (FAO, 2012).

> Since the 1960s, rising cereal yields have been driven by widespread use of irrigation, improved crop varieties, fertilizer, and pest control. Although crop improvements have extended well beyond the irrigated areas to embrace huge

areas of rain fed agriculture, Sub-Saharan Africa has not participated in this agricultural success. (World Bank, 2007, p. 51)

Public expenditures on agriculture (research, extension, and infrastructure) are drivers of agricultural productivity growth but this investment has not been present in Africa (Headey, Alauddin, & Rao, 2010). There are adapted technologies available but the extension structures and market/social networks are not adequately driving adoption among smallholder emerging farmers who make up the majority of producers (Juma, 2011). This adoption of technology will benefit both food security and rural livelihoods. Rogers speaks of the necessity for extension systems and similar institutions as not only responsible for the diffusion of innovation but also how those technologies are diffused for "greater equality in their socioeconomic consequences" (Rogers, 2010, p. 159).

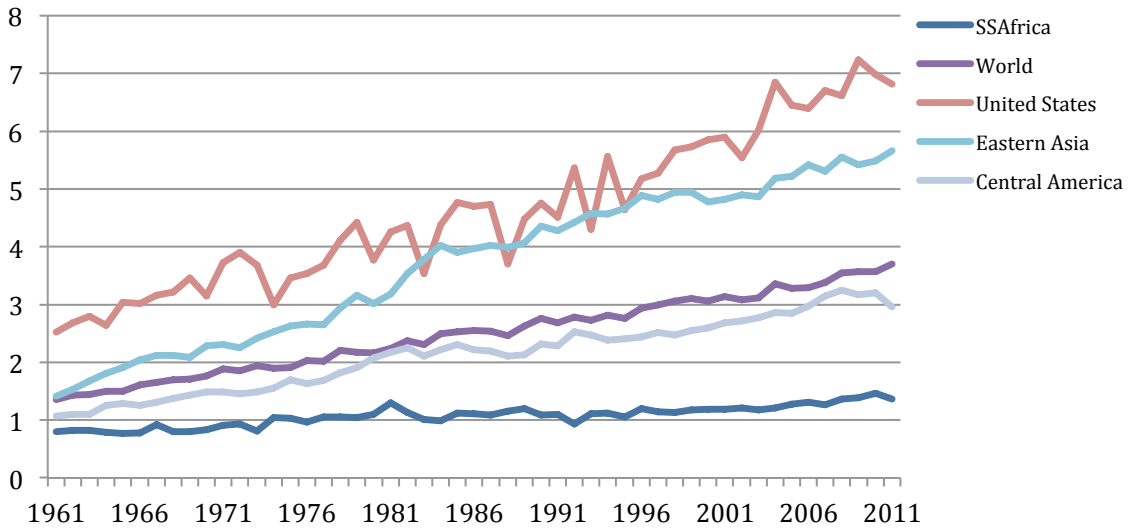

Figure 1: Agricultural Productivity. Cereal Yields, Metric Tons per Hectare (FAO, 2012)

Alternative policies and systems are needed to make improved agricultural technologies available and affordable to agricultural communities in Africa. “There is huge potential in trying to grow the rural wealth of African nations through smallholder farmers… introducing technical advancements as they relate to what farmers are doing today” (Schroeder, 2014, p. 140). Such systems might include feasible solutions for promoting technology innovation through the protection of intellectual property rights within the agricultural value chain. Intellectual property rights are rights relating to:

(1) literary, artistic and scientific works;

(2) performances of performing artists, phonograms, and broadcasts;

(3) inventions in all fields of human endeavor;

(4) scientific discoveries;

(5) industrial designs;

(6) trademarks, service marks, and commercial names and designations;

(7) protection against unfair competition; and

(8) all other rights resulting from intellectual activity in the industrial, scientific, literary, or artistic fields. ("Convention Establishing the World Intellectual Property Organization," 1967)

It is acknowledged that intellectual property rights have a controversial role within developing economies. The literature and historical context show a negative relationship between liberalization of intellectual property rights and broader development indicators. This is compounded by fears of colonial and neo-colonial interests of developed countries and multinational corporations imposing systems upon Sub-Saharan African farmers that could further harm rural communities (Kuyek, 2002). However, development scholars

must increase their understanding and application of targeted localized policies to promote increased technology adoption. Such targeted policies for local use in the rural sector might have distributed economic benefits that are lost in aggregate analysis of Sub-Saharan African politics.

If smallholder emerging farmers are to benefit from policies that protect intellectual property rights, stakeholders must gain an understanding of the local context and provide a model for dialogue about alternative value capture systems for improved on-farm technology adoption. A baseline model of the value chain and a conceptual framework of the agricultural systems are necessary for public and private stakeholders to communicate and plan effective market interventions for the development of the sector. This baseline case study will provide such a framework for the current wheat value chain system in Tanzania. This study will describe the current context and will provide tools for testing targeted interventions that improve the social and economic development of smallholder emerging farmers.

The researcher examines the relationship between the technology diffusion processes in the public and private sector by examining the creation of intellectual property, the protection of intellectual property and the utilization of intellectual property. More importantly, the study aims to explain the relationships between these three components in terms of resources, processes, and values required for institutional innovation. While there are complex connections between and among components, it can be said that institutions generally use (1) resources to drive the creation or exploration of new technology, (2) processes to drive protection and enforcement of technology policy, and (3) values to drive utilization/adoption of new technology. It is important that all of

these components are considered when conceptualizing an institutional structure for technology diffusion throughout a developing value chain. Such models and resulting case studies are important for informing international and national policy for intellectual property frameworks and targeted development initiatives.

Statement of Purpose

Increased total production and yield productivity of wheat in Tanzania has the potential to promote rural livelihoods in strategic communities for the social and economic development of the country. An increase in domestic wheat production will substitute for wheat imports saving valuable foreign currency reserves. The Government of Tanzania in partnership with both domestic and international partners wants to understand the consequences of implementing intellectual property protection institutions on the development of domestic wheat productivity.

In order to understand this relationship, the partnership proposes creating a five-year long-term case study to understand the local context of wheat production, processing, and marketing (see Figure 2). This research is the first phase of the five-year case study establishing the baseline understanding. This first case examines management theory of agricultural intellectual property rights systems in Tanzania for development impact. It explores the relationships between value chains, intellectual property rights, institutional innovation, and technology transfer. The partnership will focus on intellectual property protection along the wheat value chain and explore how alternative value capture strategies can drive technology adoption in smallholder farm communities to improve domestic wheat production. The partnership wants the case study to have two

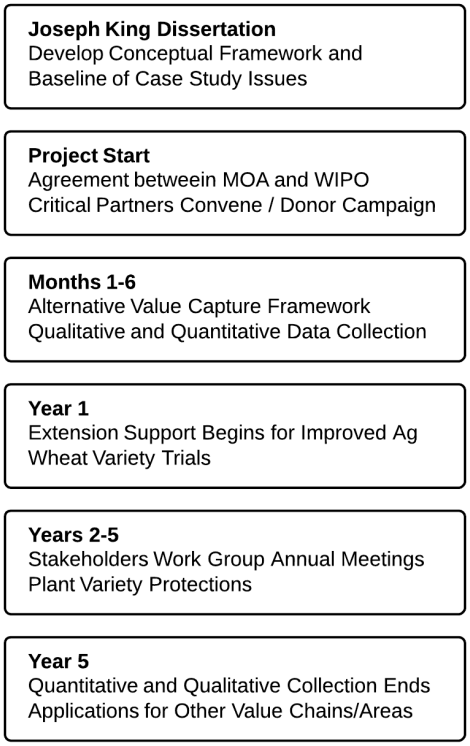

Figure 2: Case Study Framework, Five-Year Timeline

primary objectives: (1) explore alternative points of value capture for intellectual property premiums and (2) increase knowledge of technology adoption from intellectual property institutional innovation.

This case study is important to inform both policy makers and development practitioners about the relationship between intellectual property institutions and social and economic development. Intellectual property rights (specifically plant variety protection) can have consequences on productivity throughout the agricultural value chain and therefore a value chain approach to economic development is required. There is a need for greater understanding of the impact of plant variety protections on smallholder farmers verses firms with more market power in developing economies. In addition, there is a need for public-private partnerships for stimulating the use of intellectual property

protections for focused development of smallholder productivity. International organizations and the government of Tanzania suggest that the sharing of intellectual property royalties throughout the value chain may be such a mechanism for increased productivity while driving domestic agricultural research. If true, policy makers should align resources, processes, and values of new intellectual property regulatory frameworks to provide holistic solutions for maximizing development impact.

The case study is expected to provide four outcomes that will directly contribute to the economic and social development of Tanzania. First, it is hoped that the case study will lead to equitable pricing of intellectual property premiums on new plant varieties. Second, the case study will create value chain partnerships for alternative value capture of intellectual property premiums in order to stimulate technology adoption among smallholder farmers. Third, it will promote domestic public and private research capacity for improved crop varieties. And finally, it will strengthen food security and agricultural productivity throughout Tanzania. This dissertation outlines the background for the case study, the frameworks required for understanding the dynamics of the wheat value chain, a baseline assessment for the case study, and recommendations for proceeding to implement the case study.

The World Intellectual Property Organization (WIPO) of the United Nations is charged with developing "a balanced and effective international IP system that rewards creativity, stimulates innovation and contributes to the economic, social and cultural development of all countries, while safeguarding the public interest" (World Intellectual Property Organization, 2012b, p. 3). WIPO manages 25 international conventions and treaties regarding the protection of intellectual property and facilitates international

protection for new inventions and copyrights. Even though it is the only self-supported United Nations agency through its public-sector service activities, WIPO is governed by its 185 member states through the WIPO General Assembly, the WIPO Conference, and the WIPO Coordination Committee.

Specific to this case study, WIPO has engaged key stakeholders of East African wheat production in the private and public sector. WIPO would like to explore the role intellectual property rights protection plays in the wheat value chain and how adjustments to policies and institutions supporting those property rights might enhance livelihoods and economic development of emerging agricultural communities through increased productivity. The stated objective of WIPO (2012a) is, "to demonstrate the effectiveness of the IP framework in all aspects of wheat supply and would like to help to establish a positive framework in Tanzania…WIPO wishes to see where there might be common ground for partnership" (p. 2).

WIPO is working in collaboration with the Ministry of Agriculture of the Government of Tanzania, the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) sponsored by the World Economic Forum, seed companies such as Syngenta and DuPont, and science institutions such as CIMMYT, Sokoine University, and the Selian Agricultural Research Institute. WIPO is proposing a 5-year case study in Tanzania to explore the existing intellectual property rights protection systems and to understand how targeted interventions with property rights can improve the overall value chain – particularly that of smallholder emerging farmers. WIPO and stakeholders have prepared an outline of expectations for their long-term case study based upon initial discussions with their collaborators. This outline forms an organizational framework for

discussing and planning the WIPO long-term case study implementation and forms the basis for the objectives outlined below (see Figure 3).

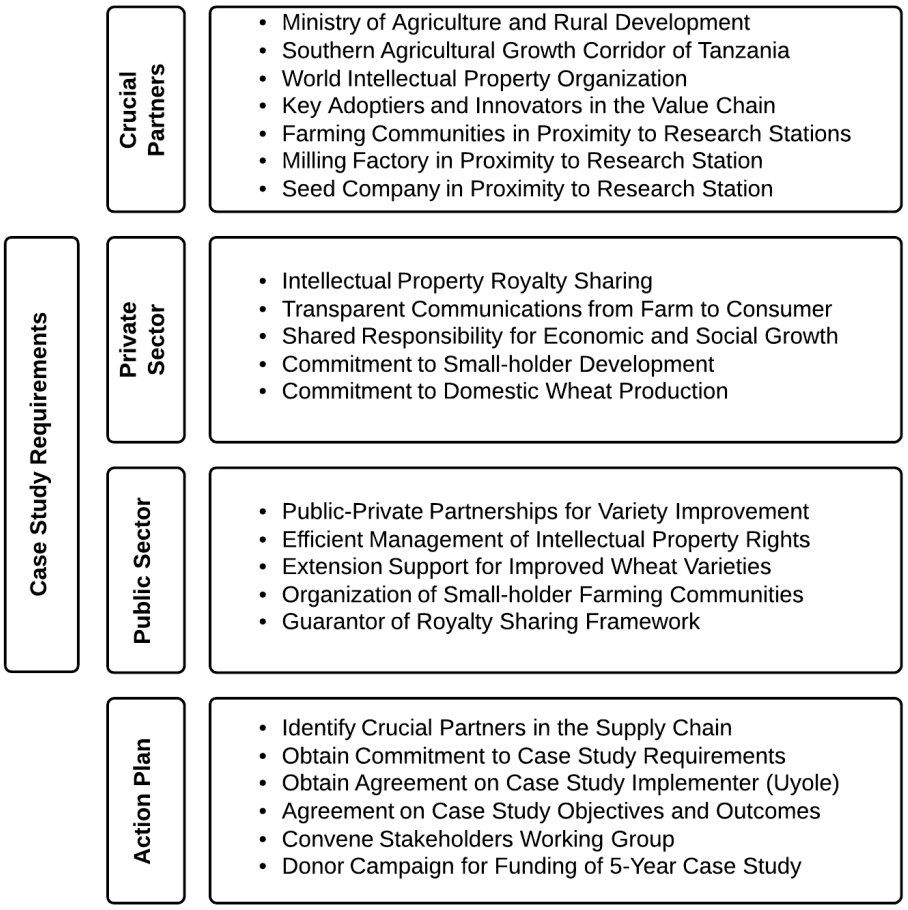

Figure 3: Long-term WIPO case study implementation requirements

The next milestone for the WIPO case study is an organizational conference in Tanzania between local and international stakeholders. The objective of this conference is to secure institutional buy-in from the larger stakeholder community and the provision of an action plan for operationalizing the WIPO case study for the next five years. However, a series of initial tasks are needed for proper conceptualization of the systems and understanding of the current context. This initial conceptual framework and baseline

research is what this dissertation specifically addresses.

Statement of Research Questions

The above statement of purpose for this project and the larger impetus of the development objectives of the Government of Tanzania provide the basis for the three research questions of this study. The researcher designed the research questions to understand the problem and purpose as stated above and provide a structured flow of thought for the collection, processing, and analysis of data. The questions also provide structure for the eventual conclusions and recommendations that this study will produce.

The first research question is "what are the wheat value chains in Tanzania?" This research question explores the market dynamics of wheat in Tanzania, identifies the key actors along the value chain and the stakeholders in the value chain. The second research question is "why (or why not) do farmers adopt improved technologies?" The third research question is "how does intellectual property rights protection promote (or hinder) the innovation of new technology?" These research questions provide a structured progression of logical thought for understanding the dynamics of Tanzania and how development policy might incentivize institutional innovation.

These questions provide data and context for the conceptual models investigated in this research for addressing value chain analysis, institutional innovation, and technology transfer for intellectual property rights protection. These questions are answered through a case study research methodology exploring the Tanzanian smallholder wheat value chain, farming communities in the Southern Highlands, and alternative value capture systems for improved wheat varieties. This case study

methodology focuses on the wheat value chain and its implications for smallholder agricultural development in the Southern Highlands. This case study analysis uses data from farmer communities in the Southern Highlands, participants in the wheat value chain of Tanzania, and stakeholders in agricultural development in Tanzania.

This research is important to incentivize institutional innovation in Tanzania. If it is possible to improve management policies and value chain coordination, then smallholder wheat productivity can be improved resulting in both social and economic development in the Southern Highlands of Tanzania. The institutional innovations addressed in this study are intended to have a direct economic and social impact on both national agricultural productivity and local community livelihoods. The researcher conceptualized the problem, collected data on the situation in the Southern Highlands and throughout Tanzania, and analyzed the data for trends and relationships. The researcher developed solutions and recommendations based on these data. The assumptions of the researcher focus on the presence of a wheat value chain in Tanzania and the presence of institutional capacity within Tanzania to manage and support that value chain. In addition, the researcher assumes that appropriate technology creation, protection, and utilization are necessary for a robust and resilient agricultural system.

Wheat Production in Tanzania

The long-term WIPO case study will have two primary objectives: (1) explore alternative points of value capture for plant variety royalties and (2) increase knowledge of technology adoption from intellectual property institutional innovation. The WIPO case study is expected to lead to the following outcomes; it will: (1) provide equitable

pricing of intellectual property premiums on new plant varieties, (2) create value chain partnerships for alternative value capture of intellectual property premiums in order to stimulate technology adoption among smallholder farmers, (3) promote domestic public and private research capacity for improved crop varieties, and (4) strengthen food security and agricultural productivity throughout Tanzania (Figure 4).

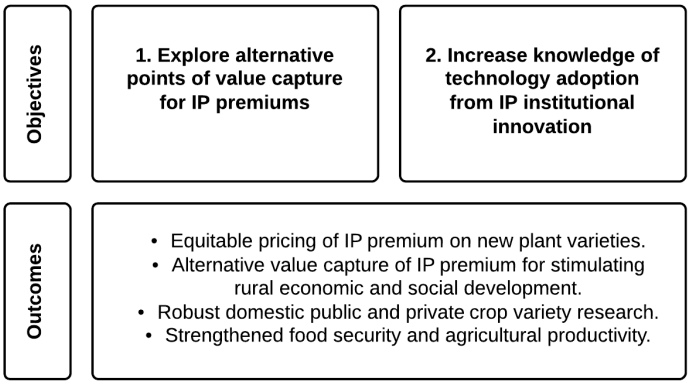

Figure 4: Framework for WIPO Case Study

The government of Tanzania has recently approved plant variety protection legislation and has begun the process of complying with the UPOV convention. UPOV (International Convention for the Protection of New Varieties of Plants) is the international agreement that governs the transfer and exchange of plant material. The Ministry of Agriculture and Rural Development explicitly intends for these institutional innovations to (1) increase the availability of improved technologies, (2) strengthen the domestic agricultural input industry, and (3) drive both public and private agricultural research. In addition, the government has prioritized the Southern Highlands for economic development.

As noted in the discussion of literature, intellectual property rights are important

for the development of high quality improved seed inputs to the agricultural value chain. The recent history of agricultural innovation is marked by the private sector development of agricultural technology and strategic collaboration between the public sector and the private sector to drive institutional and human capacity for managing these technologies. As a knowledge-based entrepreneurial activity, Juma (2011) posits both the private and the public sector need to invest significant resources in order to realize the productivity gains of agricultural technology. The private sector very often has the resources and incentives to adequately bring a technology to market. The public sector drives institutional innovation and is responsible for the creation of human capital and a stable economy. Public institutions, such as agricultural universities, extension services, and research centers, legitimize the use of technologies and very often are instrumental in the local adoption of those technologies.

Wheat is produced in five regions of Tanzania: Arusha, Kilimanjaro, Iringa, Mbeya, and Rukwa. Production practices range from large-scale and medium-scale mechanized production to smallholder non-mechanized production in the Southern Highlands. There is a high growth rate of wheat demand in the growing urban areas of the country. Despite this high rate of demand, most of the wheat consumed in the country is imported. While there was both domestic and donor support in the past, most of the support for domestic production of wheat collapsed and production is only a fraction of domestic demand. In 2011, Tanzania produced 112,658 metric tons and consumed domestically 1,117,422 metric tons. (*Exports and imports of selected countries*, 2014; *Production quantities by country*, 2014).

Wheat is an important commodity for Tanzania because the domestic economy is

sensitive to price shocks of wheat imports that can destabilize foreign currency reserves. However, Tanzania has not maintained investment in agricultural research and development. Despite having a similar sized agricultural GDP to Kenya and a slightly smaller agricultural GDP than South Africa, the Tanzania private sector invests much less in private research and development. It invests half that of the Kenyan private sector and less than 5% of the South African private sector (Pray, Gisselquist, & Nagarajan, 2011). Even though there has been liberalization of markets, the private sector has not enabled a thriving system for supporting growth within the agricultural industry.

The wheat value chain in Tanzania has several critical nodes. Focus of the case study will be on three of these nodes: farm input supply including seed producers and distributers, on-farm production, and post-harvest processing. Each of the three nodes are characterized by value-added engagement in the value chain, a vested interest in the success of the value chain, and are all impacted by diffusion of innovation throughout the chain.

The Ministry of Agriculture and Rural Development of Tanzania is responsible for public-sector research and development of agriculture as well as the regulation and enforcement of agricultural policy, including plant variety protections. Through its Selian Agricultural Research Institute in Arusha and the Uyole Agricultural Research Institute in Mbeya, the ministry advances research and extension for the wheat value chain. The ministry promotes research in wheat breeding as well as improving cropping systems for smallholder farmers throughout the country.

The seed producers and seed distributors have the potential to be the most prominent actors in the Tanzanian wheat value chain with regard to intellectual property

protection (WIPO, 2012). Consisting of both public and private sectors, seed producers are currently limited to domestic replication and distribution of public good or unprotected seed without the latest genetics. There is limited (mostly public sector) investment and initiative by Tanzanian seed producers in developing locally adapted wheat seed varieties.

Farmers and farmer groups are the most critical node on the entire chain. For technology adoption to be successful, farmers must see benefit and trust new seed varieties and other technology inputs. In the Southern Highlands, wheat farmers are largely smallholder farms loosely organized into farmer groups based on communities and are assisted by Ministry of Agriculture extension agents.

Post-harvest activities in Tanzania are the purview of the millers and bakers of the country. There are two levels of millers – national and local. National millers include Azam, Safi, and Azania. These national millers also have food processing/baking components. The millers represent the largest concentration of market power in the supply chain. Local millers do exist for minimal household production but these are not part of the market systems either at the village level or national level. Bhatia, Lane and Wain (2013) warn that the bottleneck of the supply chain consolidated in a few companies allows for control of pricing and distribution. Finally, retailers and consumers are the last piece of the supply chain.

Intellectual Property Institutional Innovation for Development

There are two goals of the case study. First, the case study will explore alternative points of value capture for intellectual property premiums in the wheat value chain.

Second, it will increase understanding of technology adoption with the introduction of the institutional innovation of intellectual property protection. The above value chain frameworks will be used to describe the relationships between each node and to describe how those relationships change over five years. The observed chain will begin with improved locally adapted wheat varieties that will be transferred to smallholder farming communities. The farmers cannot bear the burden of the premium value of these seeds. The final point of our case study value chain will be the transfer of wheat commodity from smallholder farmers to the wheat millers. This three-node stylized value chain (a value chain used for a managed development project) allows for focus on the dynamics of intellectual property protection and emphasis on agricultural development of smallholder farming communities.

This stylized example demonstrates the need to align resources, processes, and values of institutions to achieve meaningful economic and social development. This dissertation will explore the concept of institutional innovation, the specific context of intellectual property institutions for smallholder wheat in the Southern Highlands of Tanzania, and provide recommendations for policy and practices as well as further research to increase understanding of institutional innovation.

Organization of the Dissertation

This concludes the introduction to the purpose and process of this research. This dissertation provides a discussion of relevant scholarship including background on the agricultural development context in Tanzania, intellectual property rights, and the wheat value chain. In addition, this dissertation presents the relevant literature on concepts and

theories related to institutional innovation and technology transfer and it provides a foundation for the advancement of the scholarship and practice of international agricultural development.

In this dissertation, the researcher provides a comprehensive overview of the research methodology employed in Tanzania including the research questions, data collection techniques, and how that data were analyzed. It includes a discussion of the results from this research methodology and how those results are directly applicable to answering the research questions and address the purpose of the research. The analysis includes understanding the data in terms of the value chain, the diffusion of innovation in agricultural communities, and the impact on institutional innovation in Tanzania. It presents a model of institutional innovation theory to improve management practice and development impact. Finally, the dissertation provides a conclusion and recommendations to inform policy and practice of international development in Tanzania. Using these multiple strategies, the findings promote actionable recommendations for stakeholders in the wheat value chain and it also provides recommendations for furthering the scholarship of international agricultural development.

This research explores strategies to increase food security while improving market systems for resiliency of agricultural development. The above introduction provides the background to the problem and how both national and international stakeholders have made advancing intellectual property protections a priority for Tanzania. Now, these stakeholders want to develop theories and solutions for promoting agricultural development through these new institutional innovations. Intellectual property protections are complex legal, economic, and social institutions that require scholarship

and discussion to drive broad-based economic development throughout the relevant value chain. This introduction provides the framework for the research on topics of technology transfer, change management theory, and institutional innovation. The following process, findings, and conclusions are meant to directly impact scholarship and public policy for international agricultural development.

CHAPTER II

LITERATURE REVIEW

> Almost certainly, the first essential component of social justice is adequate food for all mankind. Food is the moral right of all who are born into this world. Yet today 50 percent of the world's population goes hungry. Without food, man can live at most but a few weeks; without it, all other components of social justice are meaningless . . . If you desire peace, cultivate justice, but at the same time cultivate the fields to produce more bread, otherwise there will be no peace. (Borlaug, 1970)

Agriculture in Africa is characterized by low productivity stemming from difficult growing conditions and inadequate technology (Kassie, Jaleta, Shiferaw, Mmbando, & Mekuria, 2012). Some of the complex reasons that have been posited for low productivity include low levels of scientific capacity at national institutions, little availability of locally adapted improved inputs, and low levels of technology adoption by farmers. "Agriculture needs to be viewed as a knowledge-based entrepreneurial activity" (Juma, 2011, p. xiv). As such, appropriate improved technology is a driver for improved productivity and agricultural development. The World Intellectual Property Organization posits that agricultural development now and into the future will be largely dependent on the degree to which national institutions responsibly support and facilitate intellectual property rights (IPR) for improved technology (World Intellectual Property Organization, 2003). Such IPR provide both the institutions and the incentives required for private

sector investment in both the discovery of new technologies and the networks required for dissemination of innovations. Tanzania provides the context for a stylized baseline case study to understand the agricultural market dynamics in a targeted wheat value chain. The case study is stylized in that it is creating a conceptual model for understanding a system in Tanzania and it is a baseline in that it is providing the groundwork for a longer and larger effort by WIPO. Tanzania has one of the stronger government institutional structures in Africa with a coherent intellectual property rights frameworks (Jackson, 2011). Moreover, Tanzania has institutions that are willing to explore alternative methods for driving innovation throughout the agricultural systems (World Intellectual Property Organization, 2012a).

The researcher consulted the literature to understand wheat production systems in Africa, the agricultural value chains in Tanzania, the role of intellectual property rights in international development, and the theoretical frameworks for the institutional structures required for economic growth. Each of the elements are explored below and will provide a basis for constructing a theoretical model for supporting intellectual property rights that drives agricultural development. The history of international agriculture development (as a discipline) has progressed with both the globalization of economies and the advancement of science. As such, the discipline has advanced the understanding of how property rights contribute to international agriculture development. However, intellectual property rights and their relationship to international agricultural development is a largely ignored field of study. This is partly due to the inability to observe the dynamics given inadequate legal frameworks. Simply put, intellectual property rights are not utilized by the private sector agricultural companies in less-developed economies.

This literature review collects related studies of intellectual property rights in other disciplines (such as pharmaceuticals) and related concepts from within international agricultural development (such as property rights and institutional innovation).

Wheat Production Systems in Africa

In general, wheat production systems (like most agricultural production systems) require robust research and technology support for advancing productivity of farming communities. Wheat variety breeding is one of the most important components of such a robust research portfolio. There are several key challenges or opportunities that face wheat breeders in developing new technology for wheat production systems. In addition, breeders try to develop seed systems or combinations of different seed varieties to diversify risk through better technology packages. "As much of the risk of wheat production is associated with heading date, tolerance to winter kill, disease resistance and resistance to environmental stress, wheat farmers can greatly diversify their risk by selecting several wheat varieties" (Miller, n.d.).

Wheat provides one of the most challenging grain crops for African production due to the technology requirements and the market systems. While wheat is not the primary staple grain in Africa, the demand for wheat is increasing as urbanization increases and incomes increase (Doss, Mwangi, Verkuijl, & de Groote, 2003). Smallholder wheat production in Tanzania is a minority crop and it is focused mainly in the southern highlands (Mussei et al., 2001). Even though it has a relatively small production compared to maize, wheat has a long tradition throughout East Africa. Much of the literature discusses this producer trade-off between wheat and maize. Wheat is

considered a luxury crop that is not consumed by smallholder producers. Like other luxury or specialty crops, the options available to a farmer for marketing wheat are often limited. While with maize, farming communities can feed themselves, their livestock, or sell the maize into the market. A farm family can make those decisions based on seasonal or economic conditions (Makanda & Oehmke, 2007).

In Kenya, there has been a history of research effectively developing the wheat production systems both in colonial and post-colonial time periods. Kenya had focused attention both on wheat improvement production and on proper governance of related institutions. During colonial times this created a supportive environment for growth of the sector. After independence, "mixed-signals" and policy stagnation worked against the sector (Makanda & Oehmke, 2007). Good governance and institutions are required for confidence in the market and effective dissemination of technologies. Public sector institutions should be collaborative with international research organizations and the private sector in order to drive local adaption of improved wheat varieties. These effective linkages are dependent upon stable institutions to meet the demands of the local markets and the constraints of local agro-ecological conditions.

As such, building local human capital is critically important for the seed industry. Kassie, Jaleta, Shiferaw, Mmbando, and Mekuria (2012) show empirically that there is a direct relationship between government institutional capacity and the adoption of agricultural technology. Not having effective human capital increases "distrust and transaction costs" (p. 14). In addition, they show that local adaptation of technology and practices is essential for improved productivity. Physical infrastructure is also lacking in many rural communities throughout Africa. Smallholders typically lack the infrastructure

requirements necessary to deliver their goods to markets and have knowledge about quality, pricing, and technology. Private sector investments in infrastructure are necessary to drive economic development (Eicher & Kupfuma, 1998).

Specific to Tanzania, wheat is produced in five regions: Arusha, Kilimanjaro, Iringa, Mbeya, and Rukwa (Kilima, 2006). Production practices range from large-scale and medium-scale mechanized production (in the northern regions of Arusha and Kilimanjaro) to smallholder non-mechanized production in the southern highlands. Kilima (2006) states that wheat is an important commodity for Tanzania because the domestic economy is sensitive to price shocks of wheat imports that can destabilize foreign currency reserves. In addition, there is a high rate of growth of demand for wheat in the growing urban areas of the country. Like most staples, the government historically heavily managed the wheat sector. Prior to market liberalizations, "wheat along with other major food crops such as maize, rice, cassava, millet, sorghum, and beans were bought by state institutions" (p. 11). At the time, these practices created distortions throughout the value chain. When the liberalization reform process was complete, "the lifting of the restrictions on traders brought about active participation of the private traders in grain procurement" (p. 11). However most of the support for domestic production of wheat collapsed and production is only a fraction of demand. "Tanzania only produces five per cent of its wheat requirements and imports in excess of 500,000 [metric tons] of wheat annually at a cost of US$175 million per year. There is significant potential for import substitution" (SAGCOT, 2011a, p. 21). Wheat requirements include both domestic consumption and processing for re-export.

However, there exist significant constraints within the wheat smallholder value chain. There are relatively few large-scale producers that maintain the resources, access, and capital to produce commercially at scale.

> [Smallholder] lack of competitiveness due to comparative disadvantages such as relatively short daylight hours and long distances to the millers, particularly for farmers in the south, compounded by poor access to high yielding seeds and expensive inputs, has initially to be overcome by higher import duties. However, in the long term competitiveness can improve by offering guarantees to seed breeders in the form of certification and more efficient ways of transport. (SAGCOT, 2011b, p. 9)

Tanzania is a country where the majority of people are dependent on a healthy agricultural economy. "An estimated 85% of the country's poor live in rural areas and rely on agriculture for their livelihood and their primary source of income. 98% of rural women who are economically active are engaged in agriculture" (SAGCOT, 2011a, p. 11). Despite this overwhelming reliance on agricultural production, the level of technology employed on Tanzanian farms is below both the international standards and that of its regional neighbors. For example, "Tanzania uses an average of 9 kg of fertilizer per hectare, compared with 27 kg per hectare in Malawi, 53 kg in South Africa, and 279 kg in China" (SAGCOT, 2011a, p. 11).

Agricultural production systems in general and wheat production systems specifically require research and development to drive productivity increases. Wheat seed technology presents one of the more challenging cropping systems for plant breeders. This is even more so in Africa where institutional capacity and market systems for wheat

technology are still weak. Tanzania is no exception where the wheat production value chain is still immature with limited market support for wheat production technologies and no coherent national strategy for improving wheat production.

Agricultural Value Chains in Tanzania

It is helpful to understand the importance of value chains and supply chains in general. Supply chains are critical for businesses to attain the resources and the access to markets for achieving success. But supply chains are more complex than just businesses. They can include organizations, groups of people, governmental entities, and other institutions. "A supply chain is a network of organizations that are involved through upstream and downstream linkages in different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" (Christopher, 1998). Firms and industry tend to use the phrase 'supply chain' to connote more discreet input, processing, and marketing units. Value chain is a term that includes the dynamics of supply chain but also implies broader, more intangible strategic interests to firms or industries. These definitions apply to both established and developing markets such as wheat in Tanzania.

Value chain methodologies allow us to explore both the market forces acting on related firms and industries as well as the societal implications and institutional implications for investments and strategic management of those firms and industries.

> There is growing interest in looking beyond internal economic costs and benefits to investigate why and how to incorporate broader societal costs and benefits in ways which contribute to long term (sustainable) competitive advantage.

> Increasingly, government, civil society, and special interest groups are holding businesses accountable for their negative environmental and social impacts, challenging the sustainability of corporate strategies built on self-interest and an insular view of the world and organizational impacts thereon. (Fearne, Garcia Martinez, & Dent, 2012, p. 575)

These methodologies and processes can be brought to the rural and agricultural context of Tanzania. "Tanzania's agriculture is predominantly smallholder, characterized with very low productivity due to very limited use of modern technology and techniques of production. As a result, therefore, the country's huge agriculture potential remains unutilized" (SAGCOT, 2011a, p. 4). To understand this potential, value chain methodologies are needed. A simplified value chain model of Tanzanian agricultural would include technology development, creation of inputs, extension and distribution of technology and inputs, large-scale and smallholder agricultural production, food and fiber processing, and finally logistics and marketing. All of these functions need support from infrastructure, financial capital, and other institutional structures (SAGCOT, 2011a, p. 8).

Tanzania liberalized its markets in 1990 and since that time the number of private agribusinesses has significantly increased (Doss, Mwangi, Verkuijl, & de Groote, 2003). In addition, there is a public sector company, Tanseed, which provides government produced improved seeds from public-good research. However, this private sector has not maintained significant investment in agricultural research and development. Despite having a similar sized agricultural GDP to Kenya and a slightly smaller agricultural GDP than South Africa, the Tanzania private sector invests much less in private research and development. It invests half that of the Kenyan private sector and less than 5% of the

South African private sector (Pray, Gisselquist, & Nagarajan, 2011). Even though there has been liberalization of markets, the private sector has not enabled a thriving system for supporting growth within the agricultural industry. This is despite ample evidence to show that improved technologies can have a direct impact on livelihoods of farmers:

> 695 farmers in the northern highlands and eastern lowlands of Tanzania... [upon] switching to proprietary hybrids increased yields by 58 percent over open pollinated varieties despite virtually no use of fertilizer, pesticides, or irrigation; farmers using hybrid seed realized higher net incomes. (Pray, Gisselquist, & Nagarajan, 2011, p. 5)

The current institutions and systems were introduced in response to the failure of the socialist system of the Tanzanian government in the 1960s and 1970s (Lofchie, 1978). The failure of the agricultural system was due to a number of factors such as unwillingness of rural populations to relocate to collectivist farms and inability of production to match domestic demand (causing the government to purchase grain from international markets). The strain on foreign reserves convinced policy makers that a change was necessary. Prior to socialization, "approximately 90% of Tanzania's wheat was grown on large capital-intensive farms in Arusha-Kilimanjaro-Mbulu area, and many of the owners had deliberately allowed these to run down in anticipation of nationalization" (p. 454).

This historical perspective is important to understanding the grain industry in this part of Africa. Lofchie (1978) continues to describe the institutional situation of the agricultural economy. There was little attention paid by the urban political elite to the needs of the rural agrarian society and producers. Policies were implemented that paid

little attention to sound administration of the collective farms. This was either by intent (pro-urban) or by ineptitude (no knowledge of rural/agricultural development). Poorly planned resettlement programs, startup costs, and inadequate technology transfer compounded to the failure of the farm collectivization.

In addition, Lofchie's article characterizes the peasantry (agricultural societies) as inherently philosophically opposed to collective agricultural systems. The article identifies 5 attributes: (1) family as unit of production, (2) sense of land tenure, (3) simple technology, (4) mixed farming practices, and (5) partial proletarianization. "The history of peasant political movements throughout Africa does not document a radical potential, but rather the fact that peasants have sought time and again to secure and stabilize their status as individual land-holders" (p. 472). Kilima (2006) presents the post-reform structure of wheat marketing in Tanzania as comprised of four channels:

> Inter-regional traders buying wheat from producers and shipping it to major markets in urban areas; small-scale millers buying wheat for milling and selling flour to buyers in major markets, agents, or specific firms; commercial millers buying wheat locally or importing it from abroad and selling wheat flour via agents; private traders buying wheat from producers and selling it to millers and individual producers selling wheat in specific target markets. (p. 12)

Analysis shows that middlemen in the system act as shock absorbers to world market prices. Because of the significant demand in urban centers such as Dar es Salaam, wheat is imported year round – domestic production can never meet demand. Therefore price differentials between Dar es Salaam and other regions of the country are significant. In addition, wheat is a "tradable" commodity and thus its price is not only influenced by

local demand but also by regional and world wheat markets and by the Tanzanian exchange rates.

Figure 5 provides a summary of constraints to agricultural productivity in Tanzania. Understanding these constraints is important for developing appropriate policy and interventions for effective economic and social development. Value chain analysis as discussed in the research methodology is key to understanding these constraints. Primarily, value chain analysis allows the researcher to understand (1) barriers to entry within the value chain and rent seeking activities, (2) the governance of the value chain, and (3) whether the value chain is buyer-driven or producer-drive (or a combination of the two) (Kaplinsky & Morris, 2001).

Infrastructure
- Farm-to-market transport corridors are not available for affordable shipments of produce to markets.
- Lack of rural electrification infrastructure.
- Lack of processing capacity in rural agricultural communities.

Access to Long-Term Finance
- Few banks lending for agricultural finance.
- Existing financing options limited to short-term loans with high interest rates.

Access to Land
- No land survey for facilitating titling and investments.
- Limited access to 'Right of Occupancy' title.
- Soils are nutrient poor however soil structure is good.

Market Access
- Limited on-farm economies of scale leads to dependence on intermediary dealers.
- Broad distribution of farms provide challenges for investment and installation of transport and processing infrastructure.

Perception
- Younger generations want to be off-farm.
- Tanzania lacks the next generation of agricultural leadership in public and private sectors.

(SAGCOT, 2011a, p. 30)

Figure 5: Constraints on Productive Agriculture in Tanzania

Bagachwa (1992) discusses the appropriateness of technology within the agricultural value chain in Tanzania. Bagachwa's article speaks specifically to the appropriateness of technology in the food processing industry, but there are important lessons that can apply across the value chain. When evaluating a technology and understanding its importance to a value chain, it is important to consider the following attributes: potential for employment generation (capital to labor ratio), capacity utilization of existing verses improved technologies, generation of linkages (economic,

labor, social), profitability (return to capital), and appropriate products (in this context nutritious and affordable). Bagachwa provides a micro-context for understanding the placement of a technology within a larger value chain and provided a rubric for the evaluation of a new appropriate technology. In addition to Bagachwa's methodology, additional attributes can be proposed such as the risk that is introduced or mitigated because of a technology, the environmental impact of a technology, or the crowding out of traditional competing technologies. These can be included in measures of linkages or appropriateness or can be standalone measures.

An important component of the value chain (especially in the rural sector) is social capital. Social capital can be defined as set of variables including:

> Membership in farmers' groups or associations, number of relatives in and outside the village that a household can rely on for critical support, and number of traders that a respondent knows in and outside the village…With scarce or inadequate information sources and imperfect markets and transactions costs, social networks facilitate the exchange of information, enable farmers to access inputs on schedule, and overcome credit constraints. (Kassie, Jaleta, Shiferaw, Mmbando, & Mekuria, 2012, pp. 4-5)

The government of Tanzania (GOT) is supported by the World Economic Forum (WEF) to implement the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) project to drive economic, environmental, and social development throughout the rural sector of the country. This program is an integrated effort that brings together partners in the public and private sector to address the multidimensional development issues throughout the southern region of the country. "SAGCOT aims to facilitate the

development of clusters of profitable agricultural businesses that result in strong synergies across the agricultural value chain, helping create the conditions for a competitive and low-cost industry" (SAGCOT, 2011a, p. 17). SAGCOT is using an explicit value chain approach to addressing these issues. In addition, SAGCOT is promoting both dialogue and action between the public and private sectors – both local companies and international corporations. In addition, SAGCOT is explicitly focused on the development of smallholder agricultural communities. "At the international level, leading private companies were converging around the idea that responsible new private investment in agricultural in the developing world – directly engaging small-scale farmers – could be a key to accelerating poverty reduction and food security" (Milder, Buck, Hart, & Scherr, 2012, p. 1).

Figure 6 shows the wheat value chain as conceptualized by SAGCOT for their purposes. It is heavily focused on post-harvest transformation and value-added processing to drive economic development throughout the southern corridor. This case study provides more focus on wheat production itself (bottom two grey boxes of Figure 6) and how smallholder practices might be transformed through promotion of technology innovation as indicated in the following 'notional' value chain (Figure 7). The SAGCOT wheat value chain is important in that it provides context for wheat production, processing and marketing. In addition, the tri-fold conceptualization of smallholder emerging farmers, integrated smallholder channel, and commercial production captures the three broad categories of wheat farmers in Tanzania and will continue to be used throughout the case.

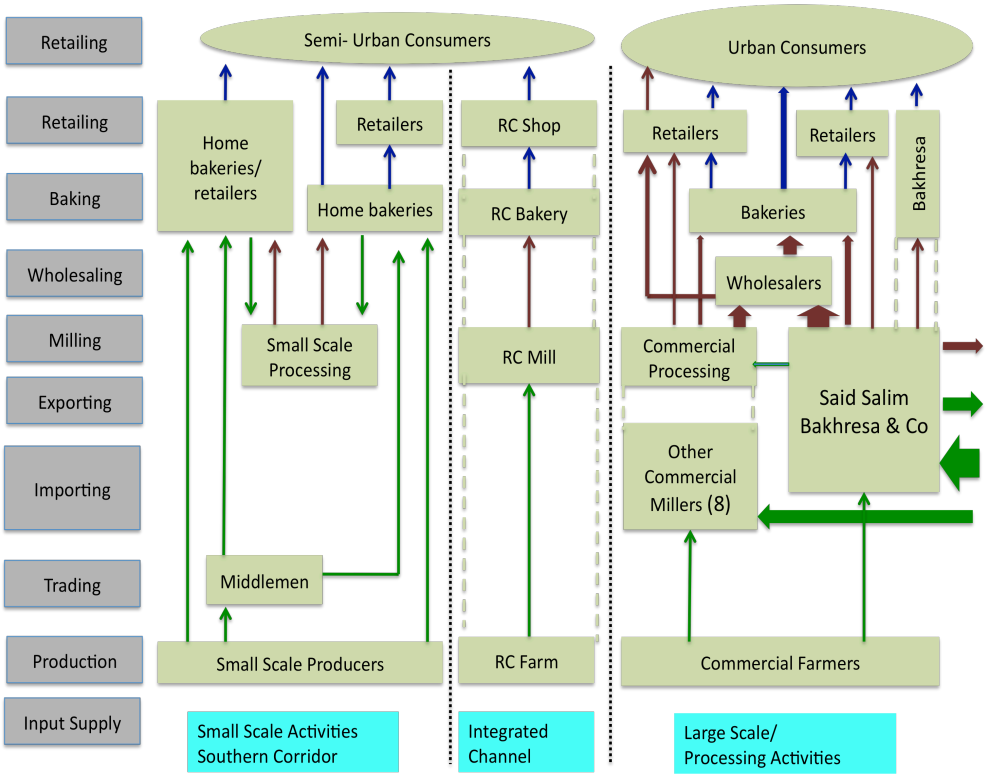

Figure 6: Value Chain Map for Wheat Sector in Tanzania (SAGCOT, 2011b, p. 6)

This case study used a modified value chain map that provides greater attention to farmer decisions and farmers' interaction with technology. In Figure 7, there is more detail about on-farm value propositions and how technology (including intellectual property protected technologies) is relevant or not relevant to on-farm decisions. Off-farm / post-harvest steps are critically important as well as they provide context for the medium and end use of those improved technologies.

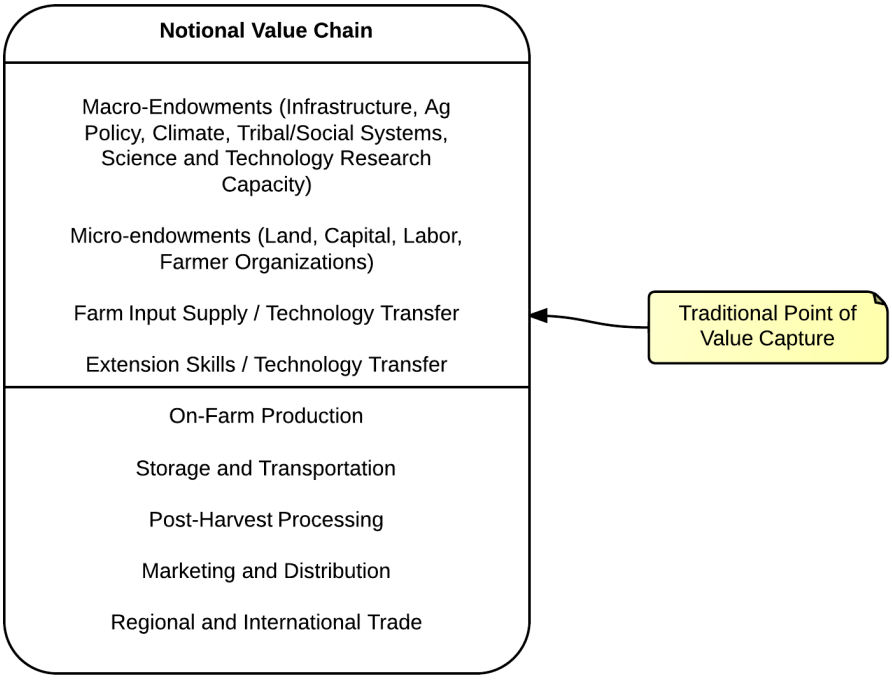

Figure 7: Researcher Proposed Value Chain for Wheat Baseline Case Study in Tanzania

In the analysis of value chains, it is important to recognize the tension between the introduction of new technology to a value chain and the capacity of humans and institutions within the value chain. Capacity to utilize the new technology or innovation needs to be present in order for that technology to be appropriately utilized. Christensen (2013) and Toyoma (2011) posit technologies are not ends in themselves but tools to be used. This also applies to differential access to technologies resulting in conflict among participants or competitors within a value chain. This "amplification theory" of technology for development implies that technology and innovations amplifies existing capacity and does not supplant it. Consequently:

> (1) Technology cannot substitute for missing institutional capacity and human intent; (2) technology tends to amplify existing inequalities; (3) technology projects in global development are most successful when they amplify already

> successful development efforts or positively inclined intent, rather than seek to fix, provide, or substitute for broken or missing institutional elements. (Toyama, 2011, p. 75)

This is true in Tanzania where human and institutional capacity is needed for innovations in the agricultural value chains to be successful. Development impact is dependent upon successful introduction of technology that is appropriate to the human and institutional capacity throughout the chain.

Agricultural value chains provide a rich context for understanding agricultural innovation and the potential for agricultural development. Agriculture is a system whereby farmers are dependent upon suppliers for inputs and infrastructure and markets for selling farm produce. Understanding value chains, their benefits, and their limitations is important for strategies to improve agricultural productivity.

Intellectual Property Rights in International Development

Intellectual property rights are important for the development of high quality improved seed inputs to the agricultural value chain (Knudson & Hansen, 1991). Improved technologies that are protected by intellectual property rights are evident throughout mature agricultural systems that are characterized by high rates of production and efficient distribution. The recent history of agricultural innovation is marked by the private sector innovation of agricultural technology and strategic collaboration between the public sector and the private sector to drive institutional and human capacity for managing these technologies. As with any technology that requires change, there must be investment (public, private or both) in research efforts to drive innovation. Much like the

pharmaceutical industry, the discovery and creation of new agricultural technologies is time-intensive and capital expensive. In order to realize the productivity gains of agricultural technology, both the private and the public sector need to invest significant resources up front to advance the innovation.

Adams (2008) provides an excellent theoretical construct for intellectual property rights to promote international development. He provides a definition of globalization as not only mobility of factors of production (capital and labor) but also integration indicators such as trade, foreign direct investment, and intellectual property rights enforcement. Adams empirically demonstrates that intellectual property rights can have a negative impact (cost) on a developing economy resulting from globalization and liberalization of economic barriers. Liberalization of intellectual property rights can lead to the amplification of income inequalities and dependencies of developing economics. Therefore, it is critical that IPR frameworks are structured to promote domestic production while gradually integrating with global systems. "Economic gains can best be realized within an environment that supports and promotes sounds and credible government institutions, education, and technological development" (p. 725).

However, there is a tension associated with intellectual property rights between the holders of the rights and the users (Adams, 2008). This has certainly been seen in the US experience of IPR and is quite evident around the world as a consequence of globalization. With intellectual property rights come the costs for the use of those rights. Very often, the owners of those rights do not reside within the societies or economies where those rights are needed. Globalization allows the intellectual property to be portable across borders, but that also means there are related costs. Intellectual property

has the potential to be a driver of innovation but it is certainly a cost of globalization that benefits the holder of the intellectual property rights. This question is even debated within the United States agricultural system pitting the corporate interests creating the technologies against farmers using the technologies (Saez, 2013). Intellectual property rights are a critical challenge for driving technological change in developing country. Many developing countries lack strong public sector research and development institutions to promote innovation. Thus, private sector investment is needed for both the creation of appropriate technologies and the networks required for technology (Adams, 2008).

In order for intellectual property rights to be effective in a development context, there needs to be strategic collaboration between private investment and public institutions (Chan, 2009). This dynamic is working effectively in the pharmaceuticals sector and is urgently needed in agricultural inputs. Private sector very often has the resources and incentives to adequately bring a technology to market. The public sector drives institutional innovation and is responsible for the creation of human capital and a stable economy. Public institutions, such as agricultural universities and research centers, legitimize the use of technologies and very often are instrumental in the local adaptation of those technologies. Public sector institutions have dominated the development of agricultural technology in Africa, in particular. This dominance by public institutions has created opportunity for efforts to promote private sector innovation throughout the continent (Toenniessen, Adesina, & DeVries, 2008).

It is important for technology and intellectual property to be available. However, it is especially important for agricultural technology that the innovations be locally

adapted for the specific context of a community. As intellectual property rights are established within economies, it is important that local capacity (and policies and institutions) within those economies evolve to manage, support, and strengthen those technologies in order to be attractive to private investment (Pray, Gisselquist, & Nagarajan, 2011). Otherwise, those technologies will not drive the economic, environmental, and social development intended. As a consequence of globalization, large differentials in human capital have increased inequality. "As the larger return to education and skill is likely the single greatest source of the long-term increase in inequality, policies that boost our national investment in education and training can help reduce inequality while expanding economic opportunity" (Bernanke, 2007). Therefore, support for human and institutional capital is crucial in order for policy institutions such as intellectual property rights to be effective. This further supports collaboration between the public sector and the private sector.

Intellectual property rights will drive economic and social development in regimes that match the protection of intellectual property rights to the needs of the economy. Masood (1998) states there should not be wholesale liberalization (globalization) of institutions protecting intellectual property because of the costs implicated. Intellectual property rights should be implemented in the best interest of the economy while promoting institutional collaboration between the public and private sector and while driving innovation throughout the value chain. There are critical social and ecological considerations for the implantation of intellectual property rights, including the notion of 'bioprospecting' of indigenous resources where local

communities do not receive equitable compensation. There should be balanced discussion and balanced frameworks where these issues can be addressed.

The UN organization, WIPO, is responsible for managing and coordinating the suite of agreements that govern international intellectual property and copyright laws. WIPO not only provides a forum among nations for the discussion of issues related to intellectual property, it also actively assists individuals, corporations, and nations with harmonizing of intellectual property frameworks and providing global protection of intellectual property. In this current context, WIPO has a mandate to facilitate the discussion of how intellectual property might play a greater role in African agricultural development to promote rural economic growth without jeopardizing social and environmental development goals. WIPO has a facilitation role to bridge and promote various forms of intellectual property throughout the world. It also has a capacity building role to work with governments and policy makers to strengthen institutions and local laws to harmonize with international treaties while respecting local values and resource constraints.

Additionally, it is acknowledged among the international community that coordination of intellectual property systems is key to effective trade. With the creation of the World Trade Organization (WTO) in 1994, there was specific provision for intellectual property rights. This was codified in the WTO's Trade-Related Aspects of Intellectual Property Rights, or TRIPS for short. The objectives of the TRIPS agreement "include reducing distortions and impediments to international trade, promoting effective and adequate protection of IPR, and ensuring that measures and procedures to enforce IPRs do not themselves become barriers to legitimate trade" (Taubman, Wager, & Watal,

2012, pp. 12-13). The TRIPS agreement created both a forum and a framework for investment in technology innovation and provides dialogue between the developed and the developing world. The objectives of TRIPS "reflects the search for a balanced approach to IP protection in the societal interest, taking into account the interests of both producers and users" (Taubman et al., 2012, p. 13).

Specific to agriculture, the agreement that governs plant material is known as the International Convention for the Protection of New Varieties of Plants (UPOV Convention). Begun in 1961 and currently supported by 58 countries, UPOV governs the rights of breeders and promotes research for the creation of new plant varieties.

> In recognition of the fact that new varieties of plants are a powerful tool to enhance agricultural and overall economic development, the States party to the UPOV Convention wished to provide incentives for sustainable plant breeding. Their aim was to guarantee the moral and material rights of breeders in respect of their varieties, in accordance with clearly defined and internationally harmonized principles. (Jordens, 2005, p. 233)

The UPOV framework not only harmonizes with other intellectual property agreements (including TRIPS) but also provides a technical scientific platform for addressing plant breeding. These agreements have been of interest to developed and developing countries alike. Besides breeding, "plants can also be protected through trade secrets, trademarks, and geographical indications. Trademarks have particular value if the variety has market potential, and consumers come to specifically associate the trademark with desirable characteristics and qualities of the variety" (Krattiger et al., 2007, p. 59). This is especially important for developing countries whose economies are dominated by

agricultural production. Other agreements such as the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture further advance the global dialogue of intellectual property with regard to plants. It is important to note that all of these agreements and conventions specifically include provisions protecting indigenous knowledge and farmers as important stakeholders and rights-holders within the intellectual property frameworks. However, there continues to be concern that the implementation and enforcement of these protocols continues to benefit developed economies at the expense of developing countries and their rural communities (Helfer, 2004). It has been noted that the underlying intents behind these international protocols are at odds with each other. Some protocols favor the private sector with economic globalization as the end goal (TRIPS) and some favor the protection of biodiversity and indigenous rights (CBD). "A key issue… will be how to reach a compromise, between the commitments to accessibility and equity enshrined in [the Convention on Biological Diversity] and the pressures for private ownership and profit-based systems of reward represented by TRIPs" (Masood, 1998, p. 537).

Intellectual property rights and the more specific plant variety protections are important for driving innovation and development of new technologies in agriculture. While there is discussion about the development impact equity of such institutions, these systems provide recognition and incentives for new technologies that are relevant to agricultural systems. Development policies, national strategies, and markets should work to reconcile these incentives with increased value throughout the chains so there is not only the generation of new technology but also the development of markets to utilize and support continued generation of technologies into the future.

Theoretical Background: Frameworks for Institutional Structures

International development literature provides several frameworks that will be used for the theoretical basis for looking at intellectual property rights in Africa. In addition, there are key insights from business management and value chain management literature. Eicher (1989) provides a historical prospective of the development of institutions within Africa, Christensen and Overdorf (2000) provide a private sector perspective of necessary ingredients for a system adapting in uncertainty, and Ruttan and Hayami (1984) provide a classic paradigm of the importance of institutional innovation to international agricultural development. These three theoretical frameworks of development are critical for exploring the role of intellectual property rights and how their related institutions can to be structured to promote economic, environmental, and social development of smallholder emerging farmers.

Historical Perspective of Institutional Development

Eicher (1989) gives an excellent review of institutions in Africa that are necessary for productive development. “One is forced to conclude that the resource-transfer model of foreign assistance must be replaced by a human-capability/institution-building model of development” (p. 7). Eicher highlights both the successes and the failures that are evident in the history of development on the African continent. He provides lessons learned and key ingredients necessary for building effective institutions for agricultural development. Eicher provides a central construct: “institution-building strategies should be tailored to the stage of a nation’s institutional, scientific, and political maturity (1989,

p. 32).” Often times, development solutions are pre-packaged and delivered as rules or models to follow. Eicher demonstrates that institutions need to be highly sensitive to localized conditions and capabilities. Not all institutions for development need to look like the USDA, or EUROGAP, or WTO treaties. Eicher stresses that institutions must be specialized to the given challenges of an economy and the endowments and resources present to local communities.

Global strategies, continental strategies, or even regional strategies for institutional development have the potential to cause greater domestic instability. Such strategies should be carefully adapted for local application. Donor countries/agencies have continued to show an inability to bridge the gap between their own capacity and “with Africa’s early stage of institutional and scientific maturity” (Eicher, 1989, p. 7). As such, development efforts should continue to focus on human and institutional capacity building throughout Africa – preferably within the African context. It is difficult because of the methodical and cumulative nature of capacity building. There are no quick fixes. And donors should discourage any regional or continental strategies for institutional development across Africa. African countries are highly heterogeneous and there cannot be one effective solution (Eicher, Maredia, & Sithole-Niang, 2006).

Systems Adapting in Uncertainty

Christensen and Overdorf (2000) provide a framework for understanding the necessary elements for institutional change. While their context is “disruptive change” in corporations, their framework is relevant across many institutions. Interestingly, Ruttan and Hayami (below) provide a similar framework for institutions although in the context

of institutional development. Christensen and Overdorf suggest key lessons for understanding the dynamics of change and emerging market opportunities that businesses and systems face. Their framework consists of three elements that are critical for an entity to survive: resources (human, capital, assets, land, intellectual property), processes (procedures, policies, tools), and values (culture, goals, objectives). A disruptive innovation or change (such as improved agricultural technology) facing a business or system can be assessed through the analysis of these elements. By understanding this framework, decisions can be made on how to address the disruptive change. Possible solutions are changes to internal processes or values through senior leadership, spin-off organizations, or smaller functional teams within the organization.

Also, the institutional researcher should seek out these disruptions or anomalies in order to advance the understanding of organizational/social theory. These disruptions allow for theories to be challenged. "It is only when an anomaly is identified – an outcome for which the theory can't account – that an opportunity to improve theory occurs" (Carlile & Christensen, 2005, p. 4). This is true in most social sciences, especially in the development context where there is an amplification of data across most indicators – there can be large disparities in economic and social variables. Thus it is important to identify anomalies to push development theory. Related, systems analysts should research, identify, and support potential disruptive innovations that can build on such anomalies.

> Disruptive innovations don't attempt to bring better products to established customers in existing markets. Rather, they disrupt and redefine that trajectory by introducing products and services that are not as good as currently available

> products. But disruptive technologies offer other benefits – typically, they are simpler, more convenient, and less expensive products that appeal to new or less-demanding customers. (Christensen, 2013, p. 3)

Systems and organizations should certainly plan for change, even disruptive change. However, it might not be enough just to have resources, processes, and values. Systems should also expect change that cannot be planned for – or cannot even be expected. Systems must specifically build robustness into their core operations to perpetuate their existence and take advantage of disruptive change (Taleb, 2010, 2014). An extreme and tragic scenario for agriculture: an economy that relies entirely on wheat production is stricken by a new, virulent form of wheat rust, previously unknown to science. The entire wheat crop is wiped out. No data provided advanced notice, no scientists were studying the disease – the industry was helpless. How can the communities diversify? Are there ways to take advantage of the exposure to the wheat rust? Are their opportunities for research or exporting of experience? Leaders and strategists should plan for the unexpected through creating resilience within processes and policies that help communities recover. This is even more so in a political development context that is highly dependent upon hierarchical structures and singular personalities. Systems should be strengthened towards resilience embedded within the resources, processes, and values through building upon local capacity and nurturing local ownership of systems (see Figure 8).

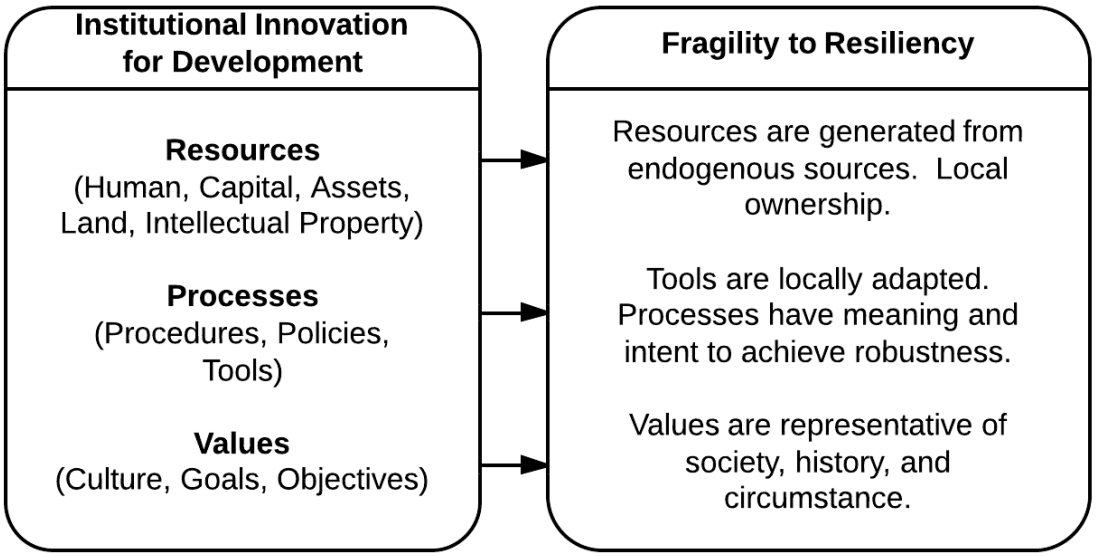

Figure 8: Components of Institutional Innovation for Development

Institutional Innovation

There are many international development systems and organizations that are consistently faced with rapid economic, environmental, and social change. However, institutions, businesses, and community groups are often unable to meet the needs of innovation within the systems. Time after time, this leads to system failure or stagnation. For technologically diffused aspects of development like agriculture, dealing with disruptive technologies in a direct and coherent framework is necessary. Briefly, the work of Norman E. Borlaug on innovative wheat and wheat-breeding technologies can be labeled as a disruptive technology for the developing world (Wright, 2012). It required a great deal of change (some negative) but promised great rewards throughout the market. "[The] plan flew in the face of established practice" (p. 1721). Some places it worked, some places it still has not (nor will). Mexico and India created the conditions and put the

processes in place to make Borlaug's improved wheat a success – but it also had the senior leadership to drive a change in values.

Christensen and Overdorf's (2000) framework of resources, processes, and values will be an important aspect of analysis of intellectual property rights within a local African context. Both IPR and the technology it protects can be seen as disruptive change to institutions and systems in Tanzania. This framework will provide structure for depicting the current status of the wheat value chain in Tanzania and for positing innovations necessary for the introduction of productive intellectual property rights institutions.

The third theoretical framework is that of noted international agricultural development economists Ruttan and Hayami (1984). Much of their scholarly work is directly relevant to institutional innovation and the necessity of locally adapted and appropriate institutions for development. Furthermore, they provide grounding for the very notion of an institution. They define institution as "rules of a society or of organizations that facilitate coordination among people by helping them form expectations which each person can reasonably hold in dealing with others" (p. 204) Thy go on to further clarify that "institutions provide assurance respecting the actions of others, and give order and stability to expectations in the complex and uncertain world of economic relations" (p. 204). Ruttan and Hayami state that institutions must be stable to provide trust but must also have flexibility to adapt over time to changing circumstances. This is very similar to the stable-flexible nature of technology. Both technology and institutions need to progress similarly in order for systems and organizations and people to benefit both economically and socially.

Ruttan and Hayami (1984) discuss Marx's view that institutional change is a function of changes in technology through revolutionary action. However, they expand on this by saying that institutional change can also be caused by changes in technology development, factor endowments, and product demand shifts. Here, they first discuss the importance of property rights (the precursor to intellectual property rights). "More incremental change of institutions such as property rights and markets through 'secondary' mechanisms such as modifications in contractual instruments or shifts in boundaries between market and non-market activities" (p. 205). These institutions such as property rights are necessary in order to provide efficient functioning of the economic and social systems in an economy. It provides structure from otherwise chaos to modern economic systems based on rule of law rather than on might or on traditional cultural/tribal understandings of ownership rights to assets such as land or capital. However, the authors note that these structures create a tension between efficiency and equity within a society. Oftentimes innovation leads to efficiency at the cost of equity. There is a need to explore the equilibrium between efficiency and equity and promote balance for both economic and social development. As discussed above, development innovation must be designed to amplify existing human and institutional capacity, not supplant it. Innovation is not a solution in itself. And the amplification of capacity by innovation tends to also amplify differential access to resources within a community or the larger society (Toyama, 2011). Thus introduction of innovations should directly address the amplification of inequalities.

Ruttan and Hayami (1984) briefly discuss biotechnology intellectual property rights and (at the time) the authors posited that protection of intellectual property rights

was unavailable or inadequate to drive public sector innovation for balanced development.

> If agricultural research were left entirely to the private sector the results would be serious bias in the allocation of research resources. Resources would flow primarily to those areas of mechanical technology that are adequately protected by patents and to those areas of biological technology where the results can be protected by trade secrets. (Ruttan & Hayami, 1984, p. 213)

This limited understanding of intellectual property rights and their application to the beginnings of the biotechnology industry shows the development of thought and the need for coherent and effective IPR frameworks to drive technological change through institutional cooperation between the public and the private sector. The authors are clearly skeptical of public benefit from the protection of private intellectual property rights. However, the authors note that private organization of research through cooperative or associative efforts with shared interests might be successful in driving public development. Such examples can be seen in the sugar, banana, and rubber industries.

From an economic perspective, it is helpful to understand the sources of demand and the supply of institutional innovation. Ruttan (2003) tells us that "the disequilibria in economic relationships associated with economic growth, such as technical change leading to the generation of income streams and changes in relative factor endowments, have been identified as important sources of demand for institutional change" (p. 16). Institutional innovation is required to correct these imbalances via social supports, infrastructure requirements, and capacity building. Ruttan warns that it is important to

recognize the sources of supply of institutional innovation. Political entrepreneurs within society who have responsibility for managing political and social resources largely supply institutional innovation. But this can easily cause imbalance within society if there is not alignment between political will and social will. This is a political economy, not a market economy:

> The supply of institutional innovation depends critically on the distribution of economic and political resources among interest groups in a society. If the power balance is such that the political entrepreneurs' efforts to introduce an institutional innovation with a high rate of social return are adequately rewarded by greater prestige and strong political support, a socially desirable institutional innovation may occur. (Ruttan, 2003, p. 17)

Ruttan (2003) further explained that this dynamic could be studied in the context of rural development where institutional innovations in infrastructure, market access, and technology transfer are necessary in the absence of mature market systems:

> The failure of many developing countries to institutionalize the agricultural research capacity needed to take advantage of the large gains from relatively modest investments in technical change may be due, in part, to the divergence between social returns and the private returns to political capital. (p. 17)

In summary, Ruttan and Hayami (1984) provide an equilibrium framework for induced institutional innovation for agricultural development. This is directly related to Christensen and Overdorf's (2000) framework for disruptive change. Institutional innovation is considered endogenous to development. "New insights on institutional innovation and diffusion can be obtained by treating institutional change as an economic

response to changes in resource endowments and technical change (p. 218).” They also include changes in cultural endowments (values) as a part of this equilibrium. By understanding institutional innovation as a function of these endowments, the development scholar can propose policy changes for institutions that serve the economic and social needs of a society.

Interestingly, Ruttan and Hayami (1984) commented on the costs of institutional change and the relation between those costs and the social sciences (including education):

> Advances in knowledge in the social sciences can reduce the cost of institutional change in a somewhat similar manner as advances in the natural sciences reduce the costs of technical change. Education, both general and technical, that facilitates a better understanding among people of their common interests can also reduce the cost of institutional innovation. (p. 205)

The literature provides a rich base of development scholarship to understand the dynamics of intellectual property rights and their interaction with agricultural value chains. It is important for policy makers and development practitioners to have frameworks to achieve agricultural development objectives. These are issues of management, technology transfer, and institutional innovation. Eicher (1989) gives the background for institutional development in Africa, Christensen and Overdorf (2000) gives the management theory for institutions adapting in uncertainty, and Ruttan and Hayami (1984) show the importance of institutional innovation to international agricultural development. These three theoretical elements are important to understand how intellectual property rights and the related institutions along the value chain might

collaborate to promote economic, environmental, and social development of smallholder emerging farmers in the Southern Highlands of Tanzania.

CHAPTER III

METHODOLOGY

Objective of the Research

The objective of this research is to improve the management theory of agricultural intellectual property rights systems in Tanzania. The research will present policies and institutions for more efficient technology adoption and diffusion, enhanced market access, and for social, environmental, and economic development of smallholder emerging farmers.

The research presents the following set of goals to address the challenge of depicting the wheat value chain in Tanzania. The study provides a baseline assessment of the current context of the Tanzanian wheat value chain. This baseline assessment collects socioeconomic indicators of wheat farming communities, perceptions of actors throughout the wheat production system, the value chain model of the wheat value chain, and the accounting of tangential and related industries and interests groups. Engagement with these groups is critical for the successful planning of alternative value capture systems for improved wheat variety intellectual property for increased access by Tanzanian smallholder farmers. Key informants from these groups provide critical primary data and expert opinions on the dynamics of the wheat market, the agricultural development potential for Tanzania, and the potential interaction among and between stakeholder interest groups in the wheat value chain.

The research builds upon these data to develop a conceptual framework for understanding the development context and for intervention in the intellectual property

rights systems for Tanzanian wheat markets. The framework outlines the stakeholders, the value chain of the wheat industry in Tanzania, and an action plan for potential interventions that are components of the long-term WIPO case study. The framework catalogs existing research and development efforts by collaborators throughout the value chain. It provides suggestions for collaboration and communications tools for the dissemination of information throughout the case study. It provides a draft monitoring and evaluation (M&E) framework for the long-term case study (building on the baseline assessment) that tracks overall progress and insures focus and consistency throughout the life of the case study. See following graphic (Figure 9) for the long-term WIPO case study framework along with the data points and resulting outputs and outcomes intended from case study implementation.

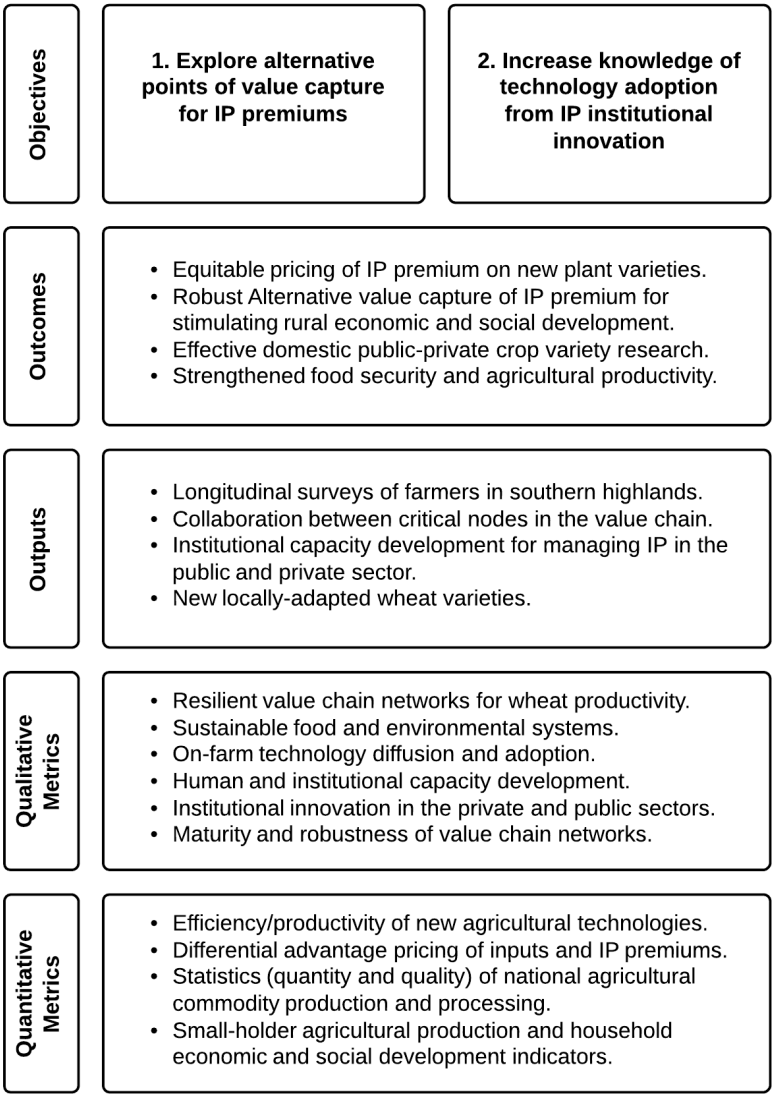

Figure 9: Long-Term Case Study Framework

This model delineates the value chain, various key actors and stakeholders, targeted points of intervention, and intellectual property influence. The conceptualization provides an organized structure for understanding the entire wheat systems and how intellectual property impacts those systems. The conceptual framework is a visual/graphic representation of the relationships throughout the system as well as a narrative description. This addresses relationships between technology development, traditional knowledge within community-based agricultural systems, commercial regulatory frameworks, public research and extension systems, and commodity markets. This model can then be adjusted to simulate interventions throughout the long-term case study or modified as the case study matures.

In addition, economic data from the baseline assessment is analyzed to understand wheat farm budgets and to develop an economic model for wheat production in Tanzania. The model includes both production as well as marketing data. Marketing data are important to determine potential for price differentiation of quality of production. This forms the basis of the larger value chain analysis that tracks the flow of commodity and the flow of payments from the farm-gate to either retail or export. This model conceptualizes intellectual property production and potential points for intellectual property value capture.

Assumptions, Limitations, Delimitations

The research assumes the collaboration of local governmental and development institutions within Tanzania as well as international governmental organizations and the private sector. The willingness of these institutions to communicate on these issues has

been an asset in framing the context of this study and in collecting data. There is high-level commitment on the part of the leadership of these organizations for driving economic, social, and environmental development in Africa. Tanzania provides a test case. Corporate agricultural leadership makes the case that for future global growth, 'business-as-usual' will not sustain. The private sector needs to have better capacity for reaching and supporting farming communities. "Shared distribution networks between different companies and sectors of society will help bridge distribution gaps to ensure that remote farmers are able to access the best technology and know-how that are already in place in various parts of the world" (World Business Council for Sustainable Development, 2010, p. 55).

This is certainly not a selfless act. These organizations and companies see their future success tied to the destiny of smallholder agriculture across Sub-Saharan Africa. Michael Mack, CEO of Syngenta, has been very outspoken in the World Economic Forum and other international bodies about the need for new thinking and new models for the international community's approach to African agricultural development. He has made the case many times over that agriculture in Africa has to be approached differently. It must include smallholder farmers as part of the solution. It must include capacity building and adapting technology to local contexts. In a recent speech to shareholders of Syngenta, Mack (2012) made a strong commitment:

> Our ambition, however, is not about growth for growth's sake. It is to put the company in service of making a contribution to global food security, by creating a step-change in productivity, and to do so with sustainability, particularly environmental sustainability, firmly in our vision. That may sound like a broad

> ambition - and it is – but it can only be accomplished if we think differently about the solutions and follow some unconventional paths. We must ensure we bring technologies and benefits to small-scale growers... as well as large scale ones. We must adapt technology... as well as invent it. We must rely more on partnerships and not exclusively on our strong in-house innovation. Finally, we must offer advice and counsel to growers about their farms, and not merely information about our products. (p. 7)

This outward willingness is also needed from the government of Tanzania and from local communities. Their demonstrated willingness to engage in the Southern Agricultural Growth Corridor of Tanzania project and related initiatives shows that there is willingness to understand different approaches to development across the country. This research and any resulting actions are dependent upon this willingness from all parties, private and public alike.

Creating shared value throughout society is a recent strategic imperative for management practice (see Figure 10). Porter & Kramer (2011) added the concept to the arsenal of tools of executive management for modern business:

> Our recognition of the transformative power of shared value is still in its genesis. Realizing it will require leaders and managers to develop new skills and knowledge – such as a far deeper appreciation of societal needs, a greater understanding of the true bases of company productivity, and the ability to collaborate across profit/nonprofit boundaries. (p. 64)

Institutions must be in place to support and nurture this shared value through: "reconceiving products and markets, redefining productivity in the value chain, and enabling local cluster development" (p. 65). The wheat value chain institutional innovation in the highlands of Tanzania must include these components for achieving development success. The technology transfer for intellectual property is relevant to all three components: wheat production practices and commodity is improved, quality and quantity of wheat increases throughout the value chain, and all collaborating components experience economic development (See Figure 11).

Porter & Kramer provide a case to illustrate their concept of Shared Value:

[Shared value] is about expanding the total pool of economic and social value...Fair trade aims to increase the proportion of revenue that goes to poor farmers by paying them higher prices for the same crops. Though this may be a noble sentiment, fair trade is mostly about redistribution rather than expanding the overall amount of value created. A shared value perspective, instead, focuses on improving growing techniques and strengthening the local cluster of supporting suppliers and other institutions in order to increase farmers' efficiency, yields, product quality, and sustainability. This leads to a bigger pie of revenue and profits that benefits both farmers and the companies that buy from them. Early studies of cocoa farmers in the Côte d'Ivoire, for instance, suggest that while fair trade can increase farmers' incomes by 10% to 20%, shared value investments can raise their incomes by more than 300%.

Figure 10: Fair Trade Case Study for Shared Value (Porter & Kramer, 2011, p. 65)

A good example of this is distributing the value of intellectual property royalties across several points in the wheat chain. All stakeholders benefit from increased resources into research on plant varieties. However, existing market systems make it difficult to burden smallholder farmers with the initial costs. There is an opportunity for shared value along the chain if institutions can innovate to distribute those initial costs from the farmers to other downstream entities through the alternative value capture framework.

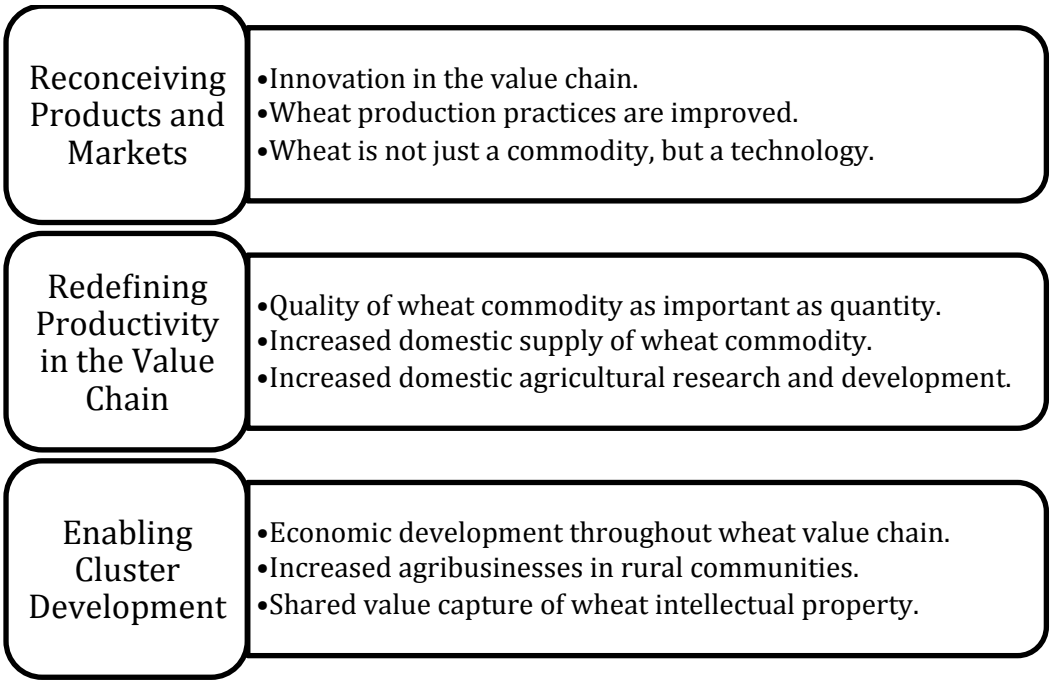

Figure 11: Creating Shared Value in Tanzanian Wheat

Research Questions

From the initial literature review and discussions with representatives of WIPO, there are a number of research questions that become immediately apparent. These research questions provide the context for data collection and the resulting analysis. These questions directly relate to the purpose of the research and provide a structured progression of thought on how the institutional innovation of managing intellectual property rights might relate to the economic and social development of rural communities in Tanzania.

The first research question explores the existing Tanzanian wheat value chain for smallholder emerging farmers: 'What are the wheat value chains in Tanzania?' This is the 'resource' question in model of institutional innovation. It looks at how the value chain is organized and defines the market constraints within that chain. Roughly, the value chain extends from the raw source material of production (inputs), through technology development and communication, production systems (including resource conservation), post-harvest storage and transportation, processing systems, marketing, and regional or international trade. The chain also includes endowments (both in the economy and at the farm level) that set the conditions for productive activity by stakeholders throughout the chain. This initial question explores the context and sets the baseline conditions for the wheat economy in Tanzania. While this question specifically focuses on emerging (smallholder) farmers in Tanzania, it is also helpful to understand the dynamics of wheat production at the subsistence level (if any) and at the commercial level. These different farm types are largely geographically bounded within Tanzania. The boundaries help in identification of farming communities, collecting data about these

communities, and in understanding the dynamics of wheat production at the community level.

The second research question deals with the interaction between emerging Tanzanian farmers and improved technology: 'Why (or why not) do farmers adopt improved technologies?' This is the "values" question for our model on institutional innovation. It looks at the advantages and disadvantages to Tanzanian emerging farmers of increased access to improved agricultural technologies. New technology and practices are disruptive to the status quo. What do farmers value in new technology? What do they not value? For what are farmers willing to pay? In addition to the technology itself, this question looks at the delivery mechanisms of a technology. What are the underlying values and culture that dictate how technology should be adopted into the community? This question is critically important for understanding the development context and for delivering solutions that have meaning at the farm and the community levels. Broadly speaking (and as discussed in Chapter 2), this question is at the heart of agricultural development and forms the basis of most theories of technology transfer and diffusion of innovation. This second question builds upon the resources available and places meaning, priority, and relationship. Understanding these values and the motivations of farmers allow for effective development planning and farmer education. Not understanding these values could lead to the waste and underutilization of resources.

Finally, the third research question addresses how intellectual property rights systems can drive both technology adoption and technology creation: 'How does intellectual property rights protection promote (or hinder) the creation and diffusion of innovation of new technology?' This is the "processes" question for the model on

institutional innovation. It addresses how institutions (existing or future) can better manage intellectual property protections to not only drive technology adoption (to utilization) but also to support continued creation of new technology. These processes could involve localized institutional collaborations between the public and private sector, support for emerging farmers through alternative value capture mechanisms, and processes for building trust between the developers of technology and the users of technology. For agricultural development, this is the development practice question that directly leads to policy formulation.

Figure 12 depicts a stylized system of institutional innovation for intellectual property rights that these questions are trying to address. It depicts the process of technology development in both the public and private sector. It looks at the creation of intellectual property, the protection of intellectual property and the utilization of intellectual property. More importantly, this graphic depicts the relationships between the various components. While there are complex connections between and among components, it can be said that generally institutions use resources to drive the creation or exploration of new technology, processes to drive protection and enforcement of technology policy, and values to drive utilization/adoption of new technology. It is important that all of these components are considered when conceptualizing an institutional structure for a developing economy.

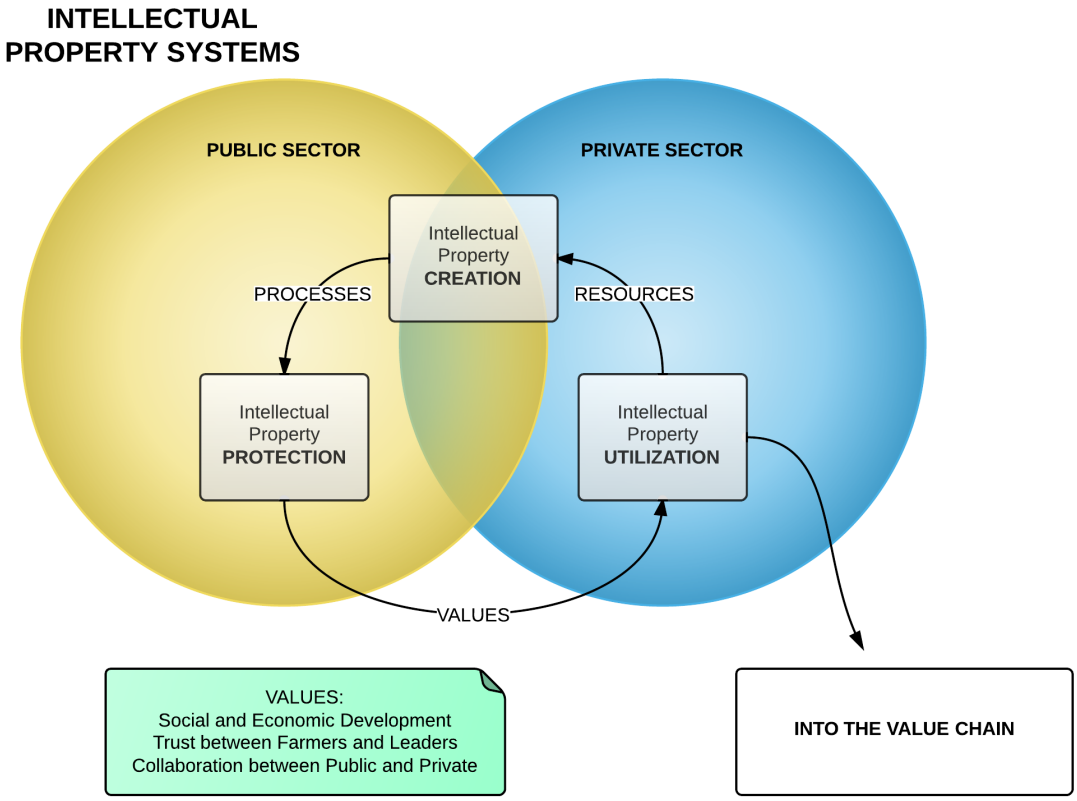

Figure 12: Conceptual Framework of Intellectual Property Rights Institutional Innovation

As mentioned, connecting the research questions to the conceptual framework of intellectual property rights institutional innovation provides the structure for the collection of data and the analysis of the value chain. These relationships are critical for understanding the development dynamics. Figure 13 provides a summary of the relationship between the framework and the questions.

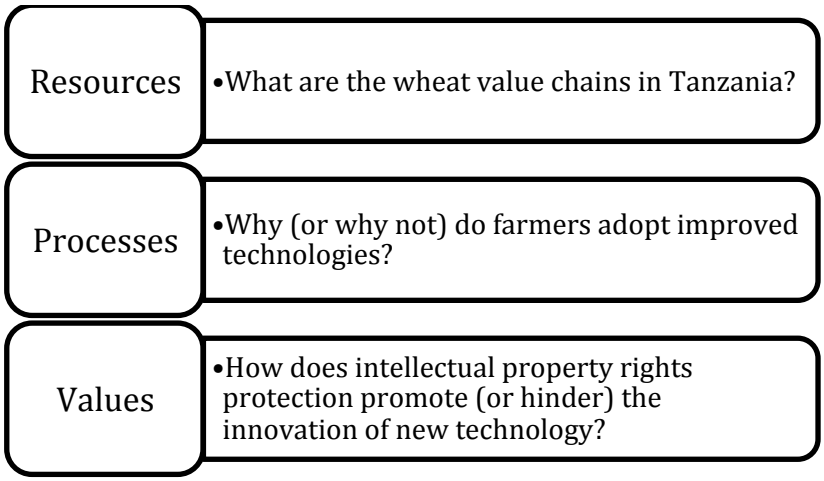

Figure 13: Research Questions and Framework of Intellectual Property Rights Institutional Innovation

In addition to informing data collection and analysis, these research questions are also important for the understanding of the application of research results to further scholarship in the field of institutional innovation and the extension of technology within development practice. These frameworks are important for the discussion among researchers, scholars, and practitioners of international development. They will allow research results to translate to policy formulation and execution. These research questions allow others to understand the progression of thought on institutional innovation and the direct relevance to impact on farms and in communities around the world.

Methods and Data Collection

To address the above questions and test the above conceptual framework, a case study methodology is utilized among Tanzanian farmers and along the Tanzanian wheat value chain. In general, the case study research methodology of Yin (2008) is used to design and implement the data collection within the Tanzanian value chain. The case study method is the appropriate research methodology for this activity because of the

very nature of the dynamics being studied. Principally, this is a "contemporary phenomenon" within a "real-life context," but also these are highly complex situations with little ability to control specific variables (p. 18). In addition, this activity is seeking to describe how a system currently behaves and how it could possibly be improved. A case study methodology is helpful to explore the various components of these issues. It allows the researcher to analyze highly contextualized data and still operate within a framework that allows for theoretical constructs and delineation of partnership relationships (Nguyen, 2011). The case study also allows the researchers to frame those relationships in terms of applied research questions that are directly relevant to stakeholders of the research and potential beneficiaries from extension of the research.

Yin's sequenced and logical approach to case study research provides a coherent framework for the design of the research, the collection of data, analysis of data, and the dissemination of the data. This inclusion of continual feedback throughout the process is important for maintaining flexibility and responsiveness to field dynamics. Throughout the planning and implementation process, the needs of the field and target unit of analysis are considered. Similarly, during data collection and analysis, the design of the case study is continually being considered and refined, as circumstances require. Yin's feedback loop is an excellent conceptualization of the need for continual adjustment to the research design in order to create a case study that accurately describes the intended relationships (2008).

The unit of analysis for the case study research is intellectual property rights institutions in the context of the wheat value chain in Tanzania. As indicated in the problem statement, understanding the Tanzanian wheat value chain is crucial to

understanding how intellectual property rights might enhance (or diminish) social and economic development in wheat production communities. Studying value chains and networks are important for understanding complex relationships. Chain and network science "concentrates on the behavioral and social aspects of organization and governance: the nature of choices being made, the incentives and constraints, the basis and the use of power in relationships, and the nature of interaction and communication" (Omta, Trienekens, & Beers, 2001, p. 77). The research focuses on a value chain analysis of the Tanzanian wheat systems with particular focus on intellectual property institutional dynamics throughout the value chain. As value chains are comprised of various actors, firms, and institutions, value chain analysis is often a complex activity. However, this is simplified by utilizing a case study method combined with focused attention on one commodity in one geographic location.

Agricultural Value Chain Methodology

For this methodology, value chains are defined as, "activities which are required to bring a product or service from conception, through the intermediary phases of production involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal" (Kaplinsky, 2000, p. 121). There are various methodologies for approaching agricultural value chain research. A contemporary method as advanced by Neves, Trombin, Gerbasi, and Kalaki (2014) in transitioning agricultural economies provides a systems approach to the "strategic planning and management" of the value chain. While the quantification of the chain is not critical for this discussion, the dynamics and organization of the chain is very

informative. Neves et al. proposes a five step process for management strategy of the value chain:

1. Initiatives of Leaders, Government and Research Institutes/Universities in planning the future of the chain;

2. Description, Mapping, and Quantification of the Chain;

3. Creation of a Vertical Chain Organization;

4. Elaborating on the Strategic Plan for the Chain; and

5. Management of Strategic Projects and Contract Design. (p. 129)

These steps provide a structured process for organizing and understanding agricultural value chain dynamics. This is helpful for not only structuring research but for defining the form and function of a chain. Rossi, Neves, and Castro (2004) provide a six-step structure for research design:

1st Step – Description of the System (design);

2nd Step – Initial Interviews for adjustments in the design;

3rd Step – Research by data from sales in associations and other sources of secondary data;

4th Step – Interviews with representatives of the organizations involved;

5th Step – Quantification (revenue of the sectors participating in the agro-industry system);

6th Step – Validation of the results by means of a Workshop. (p. 2)

These preliminary procedures provide a structured and coherent approach for conducting research in agricultural value chains. This methodology is easily adapted to local context and to specific commodity and provides structure for both specific

description of the value chain but also for broader research application. This method can be readily integrated into various other qualitative and quantitative research methodologies. It provides a starting point for describing and understanding an agricultural value chain.

The complexity in the wheat value chain is disaggregated into meaningful sub-units for the purpose of data collection and analysis. The focus for this research is placed on improved technologies and intellectual property attached to those improved technologies. In addition, crosscutting development themes are addressed including social justice, environmental stewardship, and economic equity. These themes provide a holistic depiction of the challenges and opportunities throughout the value chain. Varied data collection techniques are utilized to appropriately understand the institutional dynamics throughout the complete chain. This includes data collection in the market systems, institutional systems, and community systems of Tanzania with a focus on the emerging smallholder farming communities of the Southern Highlands. In the end, this assessment creates a baseline dataset for illustrating these systems and for understanding how innovation and intellectual property rights are implicated within these systems. The research is largely qualitative in nature to adequately depict the systems of the value chain (Yin, 2008). However, there is also quantitative economic data used to illustrate dynamics at the farm and market level. This quantitative data is useful for specific data points within the research and is not descriptive of the entire chain. The quantitative data is important for the applied understanding of the research and in providing conclusions and recommendations for policymakers and for further scholarly activities throughout the value chain. Rossi, Neves, and Castro (2004) propose there are four primary production

levels for the wheat value chain. These include agricultural input suppliers include seed, fertilizers, mechanized production (the first level). The second level is farmers and farmer groups. The third level is wheat-milling operations. And the fourth level is baking and other processing of wheat flour. This is helpful for a strictly economic analysis for supply chain management. This framework is slightly modified for this research to focus on institutional innovation frameworks within the wheat value chain.

For this analysis, targeted components of the value chain include the following three general groups that highlight the necessary institutional dynamics:

- Wheat production communities with a focus on smallholder emerging farmers but these include subsistence wheat farmers (if any) and commercial operations. This involves community-farm interactions, community leadership, farm organizations (local and national), and socioeconomic conditions at the community level. This group is the primary focus as the research illustrates social and economic development from institutional structures related to intellectual property.
- Input supply and agricultural-services industry including supply dealers, small seed companies, millers and bakers, and importers. These include firms at the community level and also at the national level. They include commodity brokers, transportation services, storage facilities, insurance services, and other financial services.
- Public-sector institutions such as policymakers and regulatory officials. This also includes science and technology institutions including international research centers, national research centers, private sector research (including NGOs), and universities.

Understanding value chains in this larger context is important to determining the interactions that have direct relevance to economic and social development. Entities

along the value chain do not operate in isolation, but are connected to other entities, to factor endowments, and to technological innovation.

> Firms operate in a given socioeconomic environment, characterized by product-market structures, labor markets, capital markets and economic policy. Like technological change, institutional change and changes in economic policy are not autonomous processes; they are induced by economic and social dynamics. (Omta, Trienekens, & Beers, 2001, p. 81)

Institutional innovation within the wheat value chain in Tanzania is not only a question of understanding the market dynamics and the context they exist. It also includes the governance of that chain. Governance itself is a set of institutions. Kaplinsky (2000) provides a framework for understanding the governance of value chains. These governance structures are a series of institutions that are necessary for providing the legal and regulatory frameworks for value chains to exist and prosper. Kaplinsky's framework is provided in Figure 14. It is divided into legislative, judicial, and executive governance representing the standards, monitoring, and management of various aspects of the value chain. It includes roles played by entities both internal to the chain as well as external to the chain. Intellectual property protection is a function of governance of the value chain and has implications for all three, both internal and external to the chain. This model is used to describe the interaction of intellectual property directly within the wheat value chain in Tanzania.

	Exercised by parties internal to chains	Exercised by parties external to chains
Legislative Governance	• Setting standards for suppliers in relation to on-time deliveries and quality	• Environmental standards • Child labor standards
Judicial Governance	• Monitoring the performance of suppliers in meeting these standards	• Monitoring of labor standards by NGOs • Specialized firms monitoring conformance to ISO standards
Executive Governance	• Supply chain management assisting suppliers to meet these standards • Producer associations assisting members to meet these standards	• Specialized service providers • Government industrial policy support

Figure 14: Examples of Legislative, Judicial, and Executive Value Chain Governance (Kaplinsky, 2000, p. 125)

Planning and design of data collection is conducted in collaboration with partners and local institutions within Tanzania. The primary institutions involved are the Ministry of Agriculture and the Southern Agricultural Growth Corridor of Tanzania. Having local consultations and local support allows for greater access to informants and leads to higher quality of data collected. In addition, local collaboration with Tanzanian organizations and networks also increases the likelihood of policy formulation and adoption of institutional innovation (Rogers, 2010). While local partners are the most directly engaged on the research effort, WIPO and its partners were engaged in the process of design offering their support and expertise. These partners were willing to collaborate on the design and implementation of research because they are invested in the process of institutional innovation of agricultural intellectual property in Tanzania. This collaboration generated a high degree of local knowledge and deep engagement with

entities along the wheat value chain, including smallholder farmers in the Southern Highlands.

While not a permanent institution, the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) project is a key research partner. SAGCOT is the Government of Tanzania's (GOT) focus of development intervention in the southern provinces. In addition, the activities and the reach of SAGCOT provide ready access into the wheat production area of the southern highlands. The World Intellectual Property Organization (WIPO) is working in collaboration with the Ministry of Agriculture of the Government of Tanzania, SAGCOT, and other entities to better understand how recently passed intellectual property legislation will affect the economic and social development of Tanzania. WIPO proposed a 5-year case study in Tanzania to explore the existing intellectual property rights protection systems and to understand how targeted interventions with property rights can improve the overall value chain – particularly that of smallholder emerging farmers.

Specific to systems adapting to uncertainty, the research explores the wheat value chain in Tanzania through measures of resilience. These measures include communications throughout the chain, coherent legislative and regulatory frameworks, and shared risk/reward potential throughout the chain (Bhatia, Lane, & Wain, 2013). This research addresses how marketing and pricing data is communicated throughout the chain as well as understand the mechanisms of technology transfer in the Southern Highlands. The research observes the regulatory and legal frameworks relevant to the wheat value chain and to intellectual property rights and enforcement in Tanzania. And finally, the cases study looks at how the benefits and risks of increased technology are shared

throughout the chain through collaborative activities and the potential alternative value capture mechanisms.

Population and Sampling

As introduced above, there are a variety of firms and actors along the value chain that serve to create the population for the case study. From this population, a purposeful sample is selected at various points in order to understand the dynamics of the supply chain. "Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned" (Merriam, 2009, p. 77). The focus of this research is the Southern Highlands of Tanzania and the wheat production communities around the city of Mbeya. Mbeya is an ideal location for exploring the dynamics of institutional innovation with regards to agricultural technology. Private-sector agricultural market systems in Mbeya are immature yet it is the home to the Uyole Agricultural Research Institute providing strong capacity for research and development efforts. In addition, the wheat production regions around Mbeya are a development priority for SAGCOT and the Government of Tanzania.

From each of the three value chain components (wheat farming communities, agribusinesses, and public-sector institutions), key informants are selected using local expertise that gives the best understanding into the dynamics of that sample. The selection process is adapted to meet the dynamics of specific points along the value chain and the reality of conditions within target agricultural communities. These key informants

were selected based on the following general criteria. There are also specific criteria relevant to each of the component areas:

- Active participant in the wheat value chain in Tanzania recommended by peer leaders and stakeholders.
- Competence as a community leader, opinion leader, or market leader.
- Established history of activity in the agricultural sector.

The sampling plan for the research on wheat value chains in Tanzania is as follows:

Wheat Production Communities

- Smallholder emerging wheat farmers from communities in the Southern Highlands around the wheat production area of Mbeya. Smallholder farmers are chosen that are representative of wheat producers in the region. These smallholder farmers are asked to provide information on their farm production practices, their relationships to agricultural technology and methods of technology transfer, and their relationships to other entities in the wheat value chain.
- Leaders of wheat farmer organizations (both formal and informal) are selected to understand the needs of farming communities in the Southern Highlands and how farmers relate to one another and to service providers in the region. This includes leaders from the communities themselves as well as village extension officers working in the communities of the Southern Highlands.
- Commercial wheat operations of Tanzania are also studied. There are no commercial wheat operations in the Southern Highlands but there are large-scale

commercial operations throughout Tanzania and East Africa that provide context to production potential and insight into the larger market dynamics.

Agricultural Services and Processing Firms

- Seed companies and developers of agricultural technology are interviewed to understand the demand for new agricultural technologies in Tanzania. This includes seed industry organizations as well as multinational corporations that are active in seed distribution in Tanzania. In addition, the research includes agricultural firms in the Southern Highlands including farm supply dealers, farm machinery dealers, as well as millers and bakers.

Public Sector Leadership

- Leadership is interviewed from agricultural public sector institutions including SAGCOT, the Ministry of Agriculture, the Selian Agricultural Research Institute and the Uyole Agricultural Research Institute. These leaders are important to understand the public sector institutional dynamics, the commitment to agricultural technology, and the capacity for institutional innovation among the public sector.
- Agricultural researchers (particularly wheat breeders) are interviewed to understand the human capacity for plant breeding within Tanzania and to develop a clear understanding of the motivations and correlating incentives for improving wheat varieties through plant variety protections.

- The efforts of international agricultural research organizations are also assessed to provide a broader agricultural development context and to understand the available support for institutional capacity development with the agricultural value chains.

This sampling plan provides a critical mass of interviews for the collection of relevant data. Data continues to be collected until saturation of data is achieved where no new information is being gained from additional sources. As all interviewees have experience directly relevant to the Tanzania wheat value chain, this sampling provides a rich data set for the formulation of research results. Sub-groupings are modified based on realities on the ground in the Southern Highlands. For instance, there are no milling operations in the region around Mbeya. However, the research method compensates by building a rich description of milling companies across Tanzania. In addition, this sampling provides a detailed view of smallholder emerging farming communities that are impacted by innovations within the value chain. Sampling is heavy on collecting data on the farming communities themselves, as there is less available information on these communities in relation to the agribusinesses and agricultural institutions.

Techniques

For the data collection of the above sample, the research relies on semi-structured interviews that consisted of flexible open-ended questions related to the wheat value chain and how improved technology and intellectual property interact with that value chain. The interview itself is important in that it provided detailed narratives and opinions about the wheat value chain. It allows for additional information to be collected that might not have been able to be captured in a survey. The interview allows for a dialogue

between the researcher and the respondent (or key informant) that leads to the collection of a rich dataset. In addition, the interview technique allows for the collection of data from multiple kinds of respondents. Each interview is adapted to the circumstances of each individual and the role that the key informant plays with respect to the research (within the value chain). This allows for a more complete understanding of the value chain (Yin, 2008).

The type of interview questions is equally important. Using flexible, open-ended questions is critical for collecting good quality data. The objective is to have the respondent provide as much descriptive data as possible. It is the job of the researcher to use the interview to invite that detailed description (Merriam, 2009). An interview guide drives the interview process in Tanzania (see Appendix A Interview Guide) that provides a menu of questions for the interview as it progresses. The specific set of questions explored might vary slightly between types of respondents but the flow and focus of each interview is similar. This interview guide allows the researcher to be prepared and allows the interview process itself to be organized and the conversation to be continuous.

The interview guide includes questions that aim to illustrate the value chain at both a local or firm level and also at a national or market level. It asks respondents to describe their role within the value chain both in terms of market activity and labor activity. Market activity questions relate to farm budgets, trading, financing, supply, demand, and technology adoption. Labor activity questions relate to community involvement, livelihoods, social issues, opinion leadership, and perceptions about technology. Adoption diffusion questions relate to relationships of risk, integrity, cost-

benefit, scalability, and sustainability. The questions relate both tangentially and directly to the conceptual frameworks discussed above: Tanzanian wheat value chain, the life cycle of intellectual property, and the related dynamics of intellectual property institutions (processes, values, and resources). Finally, the interview guide allows for a structured recording and processing of the qualitative data to determine macro themes and commonalities between key informants.

Interview bias and trustworthiness of data are of concern throughout the data collection and analysis processes. This bias is mitigated through the triangulation of sources and fact checking key points throughout the interview. In addition, the sample is designed to collect information from multiple different types of sources allowing for multiple perspectives on the research subject to strengthen the process. Anomalies are appreciated throughout the process as opportunities for strengthening the conceptual framework and thereby the framework is refined to more accurately reflect the social and economic development dynamics of the wheat value chain (Carlile & Christensen, 2005).

In addition to the questions of the Interview Guide, a basic farm household productivity survey is used to expand the understanding of smallholder farmers of the Southern Highlands. This productivity survey is designed to provide a description of the smallholder wheat farmer and how that farmer relates to other components of the value chain. "Understanding the socioeconomic characteristics of household in farming systems is crucial as these factors tend to influence the decision making process of the household" (Lwezaura, Madulu, Ndunguru, Paul, & Chalamila, 2011, p. 7). Such information collected includes average farm size, crop productivity, input investments, and crop utilization. These data points are not essential for understanding the implications for

institutional innovation along the agricultural value chain, but they do provide additional context and help inform policy formulation and resulting development interventions.

Data Collection

Data collection is led by the researcher and is based within Tanzania. Data collection occurs in two phases – the exploratory phase and the interview phase. The exploratory phase is intended to establish the partner relationships, to determine logistical requirements, and to formulate a detailed plan for the interview phase. The exploratory phase commences upon the approval of the research proposal and continues until the start of the interview phase. During the exploratory phase, the researcher meets with appropriate government officials, industry officials, and university researchers to determine the local context and logistical requirements. The exploratory phase allows for the creation of a detailed interview implementation plan and logistical plan for the interview phase that followed shortly thereafter.

The interview phase occurs immediately after the completion of the exploratory phase. The interview phase lasts approximately eight weeks in duration (August through September) to provide enough time to collect quality field data, triangulation of facts, and work with local partners to appropriately understand the data. Triangulation is "the use of multiple data-collection methods, data sources, analysts, or theories as corroborative evidence for the validity of qualitative research findings" (Gall, Gall, & Borg, 2007, p. 657). All data collected are systematically coded to provide anonymity for the respondents and provide organization and cohesion for the results. Trustworthiness is established through triangulation and debriefing with peers and stakeholders including

the Ministry of Agriculture and the World Intellectual Property Organization. This research analyzes many perspectives of the topic of intellectual property within the wheat value chain with many types of respondents and institutions. Such a rich dataset creates a layer of trustworthiness within the data collection itself. The researcher works in the field with local guides and translators to collect the data. The researcher partners with local research institutes experienced in data collection for both recommendations on target communities and recommendations on guides and translators. Government officials and businessmen throughout the value-chain are able to speak English. Smallholder farmers and rural community leaders require translator assistance. Interviews are not audio recorded.

Analysis of Data

Data analysis was an ongoing process of identifying general strategic themes and assigning data codes using field-based methods (Patton, 2002). Interviews were semi-structured using open-ended questions and exploratory follow-up. Data are analyzed using participants' responses, field notes, and reflexive journals of the researcher. From these responses, themes are identified and coded that were then placed within the analytical framework.

Once the data are collected, they are processed and organized through qualitative software providing summaries of keywords and themes. The data are initially reviewed for macro themes and ideas that are apparent across the majority of the interviews. These macro themes form the basis of understanding the relationships between entities of the production system. Once the macro themes are identified, then the data are analyzed to

construct the wheat value chain. This value chain analysis utilizes a standard methodology for describing agricultural value chains (Neves, 2007; Neves, Trombin, & Conejero, 2010). The value chain analysis relies on the descriptions provided by key informants who are actors within that chain and includes both economic and social descriptions of the chain. The data are categorized and relationships analyzed according to the working theoretical frameworks: Tanzanian wheat value chain, the life cycle of intellectual property, and the dynamics of intellectual property institutions (processes, values, and resources). These frameworks are analyzed individually and as a complete system to understand the partnership and market dynamics. Finally, once a robust system is formulated, a discussion of policy recommendations and development intervention is presented on how to improve intellectual property institutions along the value chain to drive economic and social development.

This research is a continuation of theories for alternative value capture systems of intellectual property rights of improved wheat varieties. These systems will increase access by Tanzanian smallholder emerging farmers while fostering social justice, environmental stewardship, and economic equity. The long-term purpose is to improve the management theory of agricultural intellectual property rights systems in developing countries and to offer robust models that restructure institutions to nurture efficient technology adoption and diffusion, enhance market access, and increase the social, environmental, and economic development and resiliency of smallholder emerging farmers in Southern Highlands of Tanzania.

CHAPTER IV

FINDINGS AND OBSERVATIONS

Tanzania Wheat Value Chain and Intellectual Property for Agricultural Development

The purpose of this research is to improve the management theory and impact of agricultural intellectual property rights systems in Tanzania. Intended outcomes of this research will influence policies and institutions for more efficient technology adoption and diffusion, enhanced market access, and for the development of smallholder emerging farmers. To that end, the immediate proposed output of this research is for the findings and observations to inform a development project long-term WIPO case study of the wheat value chain in the Southern Highlands. The long-term WIPO case study is a logical framework that provides a conceptual model for understanding economic and social development implications from the institutional innovation of sharing value of intellectual property. The long-term WIPO case study is proposed as a mixed methods analysis of quantitative and qualitative data collected over a five-year period that gives insight into the wheat value chain. This case study will analyze both social and economic development indicators and build a rich narrative about the relationships between the institutional innovation of intellectual property protection and the resulting benefits for the communities of the Southern Highlands of Tanzania. This includes the current context of the wheat value chain in Tanzania, the various nodes of the value chain itself, and the individual actors including researchers, smallholder farmers, and post-harvest processing. The goal is to understand the institutional innovation of alternative value capture of improved wheat varieties in Tanzania.

As such, this research provides the localized context, the conceptual model, and the ongoing strategy for achieving development impact for Tanzanian agriculture. It is important that this research and the resulting long-term case study analyze not only the value chain itself, but also the economic, social, and political environment in which the value chain operates. Because of the institutional nature of intellectual property protection, this research observes and analyzes these external and internal forces acting upon the value chain. The diffusion of new technologies resulting from intellectual property protection is dependent on many different factors of the external and internal environment.

This research builds upon the scholarship of international agricultural development and theories of technology transfer while providing actionable frameworks for policy formulation. It advances the theories and practice of managing institutional innovation. It draws upon both qualitative and quantitative data from the Southern Highlands of Tanzania. Throughout the five-year plan, there will be continuous qualitative and quantitative monitoring of social and economic development efforts at critical nodes in the value chain. Such continuous monitoring will communicate the consequences of development interventions in the value chain. The long-term WIPO case study will also clearly communicate stated outcomes from the logical framework. These outcomes will be framed as the results of decisions throughout the value chain and the effects of those decisions on key stakeholders, including smallholder farmers.

From this research, the data and analysis generates policy and business strategy options for improving the value chain and development efforts in the Southern Highlands. These decision frameworks are a valuable outcome of the research and

enhance the dialogue between development efforts in the Southern Highlands and agricultural development efforts across Tanzania. To further this research, the following wheat value chain diagram (Figure 15) is based on collected data to conceptualize the different nodes of the value chain that are directly relevant to institutional innovation of the intellectual property protection. This value chain forms the structure for the analysis of institutions, technology transfer, and agricultural development of Tanzania.

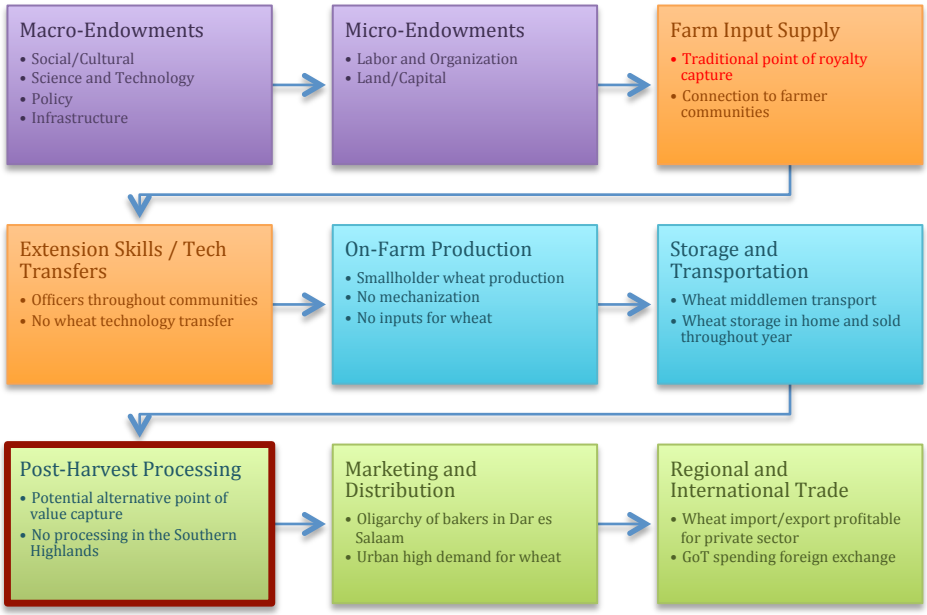

Figure 15: Wheat Value Chain for Research

Profile of Wheat Farmers in the Southern Highlands

Farming communities in the Southern Highlands are characterized by smallholder production of mixed cropping systems. See the Southern Highlands wheat farming household demographics in Figure 16 and pictures of farming communities in the Southern Highlands in Figure 17 and Figure 18. Primary production is a system with maize, wheat, beans, and potatoes. The average farmer is in their late 30s and they farm

about 1.5 hectares. Most farmers claim direct ownership of land with about 14% leasing their land. Despite this, only about 2% of farmers claim they have any title to prove their ownership or tenure. Most farmers have increased their holdings over the year for a number of reasons: need to support greater family size, increase crop diversity, and increase livelihood through increased production. On average, farmers in the Southern Highlands grew 3.3 different crops in the system. There is no adoption of agricultural risk management insurance, little participation in farmer cooperatives (9%), and little mechanization practices. Farmers in the Southern Highlands have no direct or indirect communications with downstream private sector actors in the Tanzanian wheat value chain. These attributes are true across many different cropping systems as demonstrated by officials from the Ministry of Agriculture who were participants in similar farm household surveys across Tanzania. While not directly related to wheat technologies, these studies corroborated the on-farm dynamics of characteristics of smallholder farmers in the Southern Highlands (Lwezaura et al., 2011).

For the crop mix in the Southern Highlands, farmers put approximately 27% towards wheat production, 43% towards maize production, and the remainder to a mix of beans, peas, and other crops with a rotation into potatoes. Farmer wheat varieties are in only two classes: juhudi and sifa. Both of these are white hard spring wheat (*Triticum aestivum*) varieties (See Appendix E). These are generic names for varieties that have been grown and recycled and there are no farmers reporting any advanced lines. Even if certified seed is purchased, it is classified as either juhudi or sifa. This is different from maize, where there is some penetration of lines of Pannar, Seedco, and other advanced varieties (UH6303, UH615, UH618, and UH606). About 39% of farmers

claim to have purchased wheat seed and those that did paid on average US$55 per season. This is compared to 50% of farmers who purchased maize seed for an average price of US$52 per season.

Category	Data	
Head of Household Age	38.8	
Average Farm Size	1.53 hectares	
Ownership	86% own / 14% lease	2% have title
Farm Management	40% keep records	
Experience	17.4 years	
Farm Cooperative	9%	
Crop Mix	3.33 crops	
Crop Distribution	Wheat	0.41 hectares
	Maize	0.65 hectares
	Beans	0.21 hectares
Seed Purchase	Wheat	39%
	Maize	50%

Figure 16: Smallholder Farmer Demographics in the Southern Highlands of Tanzania n=100 (see Appendix B)

Figure 17: Farmers of the Southern Highlands (Copyright 2013 by Joseph King)

Figure 18: Smallholder Plots of the Southern Highlands (Copyright 2013 by Joseph King)

Profile of Wheat Institutions in the Southern Highlands

All value chains operate within unique economic, social, and political contexts. This is no different for the wheat value chain in Tanzania. The wheat value chain operates within a context with several unique attributes that must be considered for proper analysis of the chain. Some of these attributes were alluded to above.

First, as mentioned, the largest concentration of market power in the chain is with the large wheat processing and re-export capacity that is based in Dar es Salaam. This control of pricing and trade of commodity by a few dominant players creates a distortion within the chain. This concentration of market power can create negative social and economic benefits for the country as a whole as intellectual property rights institutions are implemented. The distortion will likely have the greatest effect on smallholder farming communities that have the least amount of market power (as individual farmers).

Wheat is heavily consumed by the local population and is the main ingredient for several traditional staple foods. The increased urbanization of the country is only increasing this trend. However, most of the wheat consumed in the country must be imported. Because most wheat is imported and these imports are controlled by a few key businesses, there is a concern that lack of transparency in the processing of wheat goods is resulting in problems with quality control and food safety standards. There is concern that there is mixing of higher quality domestic production with lower quality and cheaper imports. The perception is that the national grading standards (and related institutions) are weak and there is inadequate enforcement of commodity import quality.

There is a history of wheat research and breeding in Tanzania but there has not been a consistent effort to strengthen a robust and viable domestic wheat-breeding

program. There is an increasingly sophisticated seed industry that is a mixture of multinational corporations, seed companies from neighboring countries in Africa, and local seed company startups. These seed companies have largely ignored wheat seed and focused on crops such as maize and sorghum. The Ministry of Agriculture and the entire Government of Tanzania has been active the last few years in complying with international protocols for plant variety protection and the UPOV treaty. There is currently new legislation for plant variety protection in Tanzania that is the first step for supporting an agricultural technology industry that conforms to international standards. This legislation is intended to drive agricultural research and private sector investment for future agricultural productivity.

The Southern Highlands are not only a strategically important region for trade, but it is also speculated that there is an abundance of natural resources and the potential for extractive industries. The resulting imbalances and policies have caused rural social unrest over the last few years. Increasing the opportunities for rural livelihoods is a critical part for economic development of the region. Balancing extractive industries with agricultural development will create balanced, sustainable, and equitable growth.

Answering the Research Questions

The three research questions build upon the basic value chain structure to provide direction and a progression of thought on how institutional innovation relates to economic and social development. The innovation of intellectual property rights and the specific proposition on sharing the royalties of intellectual property rights can be understood based on the three research questions and their responses. They are comprised

of what, why, and how questions. What does the wheat value chain in Tanzania look like, why do farmers adopt new technologies, and how does intellectual property rights promote technology innovation?

The three research questions align with the three critical nodes of our model for institutional innovation: resources, processes, and values. This model is important for understanding the ingredients necessary for institutions to successfully innovate. In the context of intellectual property rights, these questions provide insight to the background, the motivations, and the impacts.

The first question addresses the resources component of the model of institutional innovation. It is most directly related to the structure and endowments of the value chain and is a natural point of departure. 'What are the wheat value chains in Tanzania?' As the resource question, it describes how the value chains are organized and describes the market constraints, opportunities, and relationships within the chain. As described above, value chains are comprised of various nodes. The makeup of a value chain is unique to each business or commodity and also unique to the circumstance or market condition being analyzed. Value chains are a reality for any individual, farm, or business in agriculture. Value chain analysis is a value tool to understand markets, suppliers, and competitors. A value chain extends from the raw source material of production (inputs), through technology development and communication, production systems (including resource conservation), post-harvest storage and transportation, processing systems, marketing, and regional or international trade. The chain also includes endowments (both in the economy and at the farm level) that set the conditions for productive activity by stakeholders throughout the chain.

This question explores the context and baseline conditions of the Tanzanian wheat economy. This question is answered in the profile sections of wheat farmers and wheat institutions above and in specific detail in the value chain analysis in the next section, 'Value Chain Analysis of Wheat in the Southern Highlands.' It is important to note that all wheat farmers in the Southern Highlands are beyond subsistence farming. Wheat is beyond a subsistence crop and requires market interaction and some level of technology for production. Unlike maize, cassava, or potato, smallholder farmers primarily use wheat as a store of short-term wealth and not as a food crop. Purely subsistence farmers are virtually non-existent in wheat production communities. In Africa generally, subsistence farmers would not be involved in wheat production because of the resource constraints (seed and input costs) and market barriers (cost of production, relative expense versus other crops). All wheat farmers in the Southern Highlands of Tanzania are at some level of emerging smallholder production. There is still evidence of food insecurity and certainly these smallholder households are still in varying stages of development. However, all wheat-producing households are involved in some form of market interaction with their crops.

There is no high-intensity commercial (large-holder) wheat production in the Southern Highlands of Tanzania. The Southern Highlands lacks the irrigation capacity and the large-scale mechanized capacity for commercial production. Thus, the wheat farmer demographic can be narrowly characterized as smallholder farmers that are living in farming communities throughout the Southern Highlands. These farmers participate in the agricultural value chain in both local markets and national markets as infrastructure and systems allow. The research proved the literature in that different farm types are

largely geographically bounded within Tanzania. Larger commercial agricultural production does not occur in the Southern Highlands and can be found primarily in the central and northern regions of Tanzania. These geographical boundaries help with the identification of farming types and farming systems and allow for focused development policy and intervention at a regional level. It is helpful in understanding the dynamics of wheat production, collecting production data, and learning about the productivity of smallholder farmers.

The agricultural value chain for this research is seen in Figure 15 above. Based on the research, the value chain can be summarized by the following major nodes. It begins with micro- and macro- endowments (infrastructure, research, social systems, land, capital, and labor). The inclusion of these endowments is important because of the policy implications and development practice implications of such. Farm input supply is the traditional point of royalty capture for seeds and other inputs. Extension and technology transfer mechanisms are present in the Southern Highlands although capacity and resources are weak. Next are the farmer functions of on-farm production, storage, and transportation (split between farmers and middlemen buyers). Post-harvest processing by millers and then bakers is the next node. Post-harvest represents the next best alternative point of value capture because of the relatively narrow population of millers in Tanzania as a whole but particularly in the area around the Southern Highlands. Marketing and distribution is the next node on the chain and finally, regional and international trade.

The second research question is the "values" question that involves the interaction between Tanzanian farmers and the innovation of technology. 'Why (or why not) do farmers adopt improved technologies?' Within the institutional innovation model, values

dictate the parameters by which resources are allocated and govern the organization and methods of the institution. Understanding the underlying values of an institution are helpful to determine capacity for institutional innovation and for managing technology transfer within that institution. The values components are also important for promoting adoption of a technology by customers or stakeholders of an institution. The more aligned values (including trust) are between an institution and its stakeholders, the greater chance that institutional innovation has of being adopted by target stakeholders. In the research, the value question looks at the advantages and disadvantages of increased access to improved agricultural technologies by Tanzanian smallholder farming communities.

The research determined that farmers in the Southern Highlands were accustomed to dealing with improved varieties and technologies for some crops but there is a gap of technology available for wheat production. Maize production in particular was marked by the availability of improved seed varieties and technologies from extension and from local agricultural dealers. Wheat production consisted of generic varieties with little support from extension, from input suppliers, and from market systems – in particular farm-gate purchasing and processing capacity in the Southern Highlands. Wide variance in wheat commodity pricing and in on-farm productivity provided evidence of these weak market systems and technology systems. The farmers in the Southern Highlands value the capacity for increased productivity, food security, and livelihoods. They are largely optimistic about their future. In addition to absence of improved wheat technologies, there is also an absence of delivery mechanisms and reliable market institutions. Middlemen dominate farm-gate commodity sales and transport the commodity to larger commercial centers like Iringa or Dar es Salaam for processing. The lack of milling and

storage capacity in the Southern Highlands is a clear disadvantage for farmers in the Southern Highlands. They lack market power because it is cost-prohibitive for farmers to deliver commodity to market themselves. Farmers are organized into associations and have experience working with the extension agents of the Ministry of Agriculture as well as the researchers at the Uyole Agricultural Research Institute in Mbeya. The farmers in the Southern Highlands have relatively good infrastructure access to Mbeya and proximity to neighboring countries in southern Africa. However, the lack of market systems and processing systems limited the impact of wheat technology innovation. This gap indicates a need for institutional innovations to allow for added capacity both within the technologies that are available and in the market systems to support those technologies.

Finally, the third research question is the "processes" question for the institutional innovation model. It addresses how intellectual property rights systems can drive technology creation and adoption. 'How does intellectual property rights protection promote (or hinder) the innovation of new technology?' This question helps to understand the management of institutions and how better practice and allocation of resources can promote markets and increase livelihoods. The research is designed to determine how institutions can better manage intellectual property protections to drive technology adoption and also technology creation. These management processes must involve collaboration between the public and private sector, between stakeholders invested in the wheat value chain, and between innovators of agricultural technology. These processes must build trust between the developers of technology and the users of technology.

The research determined that there are few currently existing processes for the development, dissemination, and utilization of wheat technology in the Southern Highlands of Tanzania. The absence of intellectual property protections and immature market systems means that agricultural companies do not provide the services or products to develop the wheat industry. There does currently exist wheat extension capacity and wheat research capacity in the Southern Highlands but there should be more effort dedicated to public-private collaboration.

Figure 19 depicts the system of institutional innovation with information from research results included to show the interaction between the creation, protection, and utilization of intellectual property within the Southern Highlands. As depicted, there are no functioning institutions in the Southern Highlands for either the creation or the protection of intellectual property. There are extension systems and some market systems available for the utilization of intellectual property but there is disconnect between the needs of the farmers and the information and technology that these systems are able to provide. There should be a functioning system whereby technology is generated through public-private partnerships that are focused on the needs of the value chain and those technologies are protected for the benefit of all actors throughout the value chain.

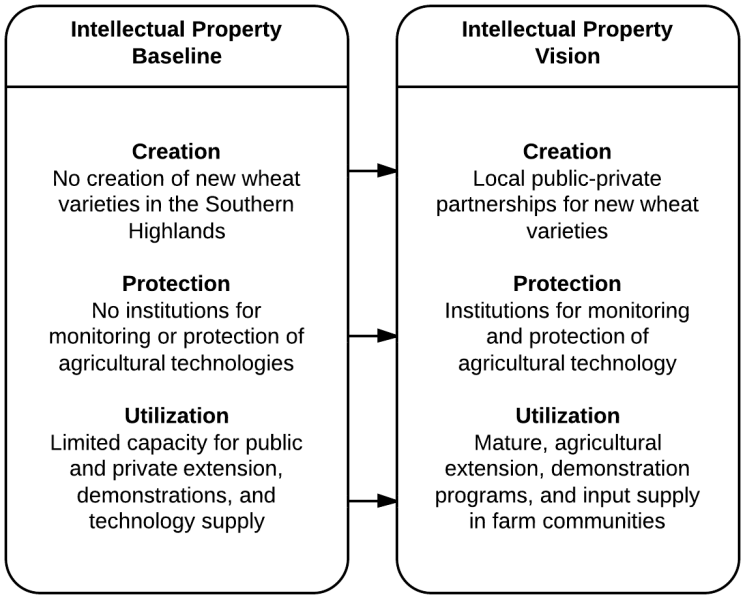

Figure 19: Intellectual Property System of Institutional Innovation in the Southern Highlands of Tanzania

Value Chain Analysis of Wheat in the Southern Highlands

The wheat value chain in Tanzania has several critical nodes. The wheat value chain depiction (Figure 15) delineates the main links within the chain that are most helpful for understanding the role of intellectual property. Each of these links has direct value-added engagement in the chain, a vested interest in the success of the value chain, and are all impacted by diffusion of innovation throughout the chain. Focus of the research recommendations for the long-term WIPO case study will be on three of these critical nodes: farm input supply including seed producers and distributers, on-farm production, and post-harvest processing. They are each addressed below.

For wheat seed production, the Ministry of Agriculture and Rural Development of Tanzania is responsible for public-sector research and development of agriculture as well as the regulation and enforcement of agricultural policy, including plant variety protections. Through its Selian Agricultural Research Institute in Arusha and the Uyole

Agricultural Research Institute in Mbeya, the ministry advances research and extension for the wheat value chain. The ministry promotes research in wheat breeding as well as improving cropping systems for smallholder farmers throughout the country. Similarly, the government of Tanzania has created the Southern Agricultural Growth Corridor of Tanzania for focusing development policy and public-private investment in the Southern Highlands of the country. This focus provides integrated leadership and resulting strategy for coordination of investments in agriculture, infrastructure, energy, telecommunications, and trade.

Similar to the Ministry of Agriculture, Tanzanian universities play an important role in the wheat supply chain by equipping both human and institutional capital for the public and private sectors. Students, faculty, and researchers at Tanzanian universities such as Sokoine University of Agriculture and the University of Dar es Salaam have a commitment to furthering research and education throughout Tanzania. It is important that faculty and students understand the implications of intellectual property protection within their systems and the potential for intellectual property protections to impact their research and careers. Students can be a dynamic force for change in a country. Connecting students to the legal, scientific, and market systems engaged in intellectual property protection will provide a sustainable human capital investment for agricultural resilience in Tanzania.

The seed producers and seed distributors are perhaps the most prominent actor in the Tanzanian wheat value chain with regard to intellectual property protection. Consisting of both public and private sector, seed producers are currently limited to domestic replication and distribution of public good / unprotected seed and seed that does

not contain the latest genetics. In addition, there is only limited (mostly public sector) investment by seed producers in developing locally adapted wheat seed varieties. In addition to seed producers and distributors, suppliers of other agricultural inputs are important participants in the supply chain. Most wheat seed intellectual property is not effective without high quality inputs for farm production. Agro-dealers supplying quality products are important for soil fertility management, pest management, and ecosystem management.

The farmers themselves are the next participants in the value chain. Farmers and farmer groups are the most critical node on the entire chain. For technology innovation adoption to be successful, farmers must see benefit and trust new seed varieties and other technology inputs. In the Southern Highlands, wheat farmers are largely smallholder farms loosely organized into farmer group based on communities and assisted by the efforts of Ministry of Agriculture extension agents.

Post-harvest activities in Tanzania are the purview of the millers and bakers of the country. There are two levels of millers – national and local. National millers include Azam, Safi, and Azania. These national millers also have food processing/baking components. They are also quite involved in the import and re-export of processed wheat flour and baked goods. Local millers and local bakers are much smaller and only represent a small fraction of the market. There are no large milling operations in the Southern Highlands. The closest miller is in Iringa. There are a few small milling operations but usually only focused on providing services to small missions and isolated communities without easy access to markets. The millers represent the largest

concentration of market power in the supply chain. The bottleneck of the supply chain consolidated in a few companies allows for control of pricing and distribution.

Finally, retailers and consumers are the last piece of the supply chain. Retail products include processed wheat flour and other baked goods. Baked goods from wheat flour are a staple of the urban Tanzanian diet. Bakers, grocers, other retail outlets all depend on a reliable supply of wheat flour of good quality. Consumers are increasingly dependent on baked goods for daily ration of food. Food security is also related as increasing segments of the population rely on wheat products.

Specific to resiliency in the supply chain, the research examines three measures: communication throughout the value chain, integrated strategies for policy and regulatory frameworks supporting the value chain, and shared risks and rewards of actors in the value chain. These three measures depict the development dynamics of the value chain and how well it can serve to create meaningful development in the Southern Highlands. The research shows that there is little communication between actors in the value chain. There is limited communication between the Ministry of Agriculture and wheat farmers in the Southern Highlands. A limited number of wheat farmers obtain quality seed from the Ministry of Agriculture and there is limited capacity for wheat technology transfer through extension. While this engagement between the Ministry of Agriculture and smallholder farmers in the Southern Highlands is limited, it is the best communication present in the value chain. There is no communication with seed companies, no communications with millers and bakers, and no communications with import/export companies.

While the government is currently improving the legislative framework for plant variety protection in Tanzania, this is only a first step. It was in response to promoting a domestic seed industry in Tanzania, and not specifically to drive food security or smallholder farm productivity. There is currently no national strategy for wheat production and are entrenched public and private sector incentives for the status quo. The focus is only on the creation of new intellectual property through plant variety protections and UPOV compliance. This lack of a harmonized legislative framework makes it difficult for the protection and utilization of wheat intellectual property. A coherent strategy and corresponding policies are necessary to support institutional innovation throughout the value chain that will drive public-private research cooperation for benefiting smallholder farm productivity.

Finally, there are no shared risks/costs and no shared opportunities/benefits throughout the value chain. Each node on the chain has a unique risk/reward dynamic that prevents resiliency. Existing market distortions at the miller/exporter nodes provide disincentives for economic development collaboration in the Southern Highlands. The lack of enforcement capacity makes introducing improved seeds difficult. And there is currently no system for monitoring collaboration to spread risk (costs of alternative value capture) and stimulate the value chain. The concept of an alternative value capture system is intended to share both the risks and opportunities at key points in the value chain and remove the highest risk and costs from smallholder farmers. All three of these measures of resiliency are related and are measuring the success of institutional innovation. In order to achieve these measures, the resources, processes, and values of the institution must be properly aligned.

Data Results of Smallholder Wheat Production in the Southern Highlands

The research observes various aspects of smallholder wheat production activity in the Southern Highlands of Tanzania. The research is not primarily concerned about agronomic practices or socioeconomic activities of smallholder communities but did learn as much as necessary to understand the context of smallholder wheat farmers. However, there are a number of aspects of smallholder production that are directly relevant to the research and the model of institutional innovation of intellectual property protection.

Wheat production in the Southern Highlands is a smallholder activity. Smallholder communities are responsible for the agricultural activity in this region. The primary production crops are wheat, maize, beans, and potatoes. Potatoes are a recent introduction to crop mixes and are not used as a food commodity but as a cash crop. Wheat is used as both a cash crop and also as a food crop. Smallholder farmers have a unique challenge in that their fields are not used for only supporting livelihoods, they are also used for providing food security for the farm household. Smallholder farmers need to make decisions about production and consumption for their households (Timmer, 1998). These food security decisions make farm economic planning difficult and prevent long-term investments in new technology. Asking farmers to pay additional to cover the cost of royalties or other value-added products is not just a question about farm economics, but also a question of household food security and the production/consumption tradeoff.

Land is a sensitive issue to many smallholder communities. Owning land is certainly important for smallholder farmers. From a development context, having title to land is just as important for the ability to make long-term management decisions,

investments, and using land as collateral for farm financing (Norton, 2004). Most farmers in the Southern Highlands of Tanzania claim to own the land they work. However, very few claim to have any official title to their land. This can lead to confusion and does not provide the asset necessary for farm financing and long-term investments to conserve soil quality and improve plot productivity.

Middlemen have played an important role in developing economies by connecting smallholders to markets however lack of infrastructure and communications systems cause this status quo to remain in place. While not necessarily detrimental and certainly playing an important part in trading, institutional innovations are needed to reduce the market power of middlemen and increase value to agricultural production communities themselves (Hayami, 1998). Middlemen control the farm-gate purchase and transport of commodities. They are currently necessary because they provide connection across the long distance to processing capacity in Dar es Salaam. However, the value that these middlemen collect is an economic justification for the introduction of processing capacity in the Southern Highlands as farm productivity increases and total production capacity increases.

Data Results for Institutional Innovation Framework

The research provides data for our understanding of the institutional innovation cycle. The data are classified by resources, processes, and values, and themes are identified that provide insight into the development dynamics in Tanzania but also our general understanding of institutional innovation and technology transfer. These data are

important for building a strong model that can provide relevant development policy and practice for Tanzania and beyond.

With regard to resources in the institutional innovation cycle, there is wide divergence of resource allocation throughout the wheat value chain. The processing and marketing nodes of the value chain have a large amount of both capital and human resources at their disposal with multinational relationships, sophisticated technology, and complex market interactions. This is different from the domestic wheat seed industry and on-farm production that has low levels of human capital, little resources for technology, and little market power. Even though agriculture in general is a priority for the government, there are inadequate resources placed in wheat technology development and extension services. The lack of public-private partnerships prevents sharing or spillover effects from investments in resource allocations. Proper alignment of resources, processes, and values will allow for private sector confidence in the value chain and incentivize investments in research and development, marketing, input distributions, and market linkages.

On farm in the Southern Highlands, farmers will invest labor and capital into wheat production if they are confident that the market is present. Farmers are allocating their resources for both their livelihoods and for their household food security. If resources, processes, and values are aligned, farmers will have increased confidence in the wheat value chain and make corresponding investments to improve their farm inputs and cultivation practices. The lack of financial resources and education/extension resources make taking such risks very difficult.

The research provided data on the processes involved in the institutional innovation cycle – market processes, technology transfer processes, and institutional management processes. These processes are crucial for the functioning of the value chain. If principle importance, the data shows that there are no market linkages and little communication between and of the actors of the value chain. There are significant communications and coordination gaps between extension and farmers, between farmers and middlemen, and between processors and researchers. Key informants repeatedly spoke to the need for greater collaboration across the chain and to establish clear strategy for promoting wheat production in the country. There are private sector seed companies in Tanzania however the processes for the protection of intellectual properties are not present to give confidence for increased investments. Increased collaboration should be for enhancing value in the supply chain, for public-private improved variety research, and for improved quality of commodity and value-added products throughout the chain.

In addition, the researcher found lack of extension support relevant to the wheat value chain and to smallholder farmers in the Southern Highlands. The public sector should increase efforts to serve the needs of farming communities and provide appropriate technologies for improving smallholder productivity and livelihoods. This renewed effort should logically flow from a national strategy for wheat production and should include the private sector as stakeholders in the value chain. The processes for extension should include close linkages with the value chain to not only provide technology transfer to farming communities, but also demonstrating the relevance of that technology transfer. In addition, processes are needed that provide market-based

guarantees for farmers to produce wheat. The most straightforward process would be to provide contract guarantees for farmer-miller linkages.

Finally, the research provided a series of data on the values involved in the institutional innovation cycle for the Southern Highlands. Of note, there is a lack of a coordinated government policy for domestic wheat production. This lack of a policy (and vested interests working against such a policy) is confusing and disconcerting to stakeholders in the value chain. A strong public-private commitment to the development of the value chain is necessary for resilience and robustness. This lack of value is a primary contributor to the stagnation of the wheat value chain in Tanzania. The coordinated policy not only provides commitment, but it also provides a clear signal that distortions and subversions of the value chain will not be tolerated.

At the farm and firm level, there must be trust between the developers of technology and the users of technology. Without trust, agricultural extension and technology transfer will not be effective. Trust must be a key value to the stakeholders of the wheat value chain and reinforced through shared vision, shared value, and continued communications. Finally with regard to intellectual property rights, transparency must be a central value to the institutional innovation cycle. There must be a high degree of transparency because of the technology involved and the inherent distrust with any new technology. Transparency includes openness about public-private partnerships, public research and discussion about new technologies, and transparency management about any collaborative systems including the royalty sharing framework.

Critical Observations on Smallholder Wheat Production in the Southern Highlands

Smallholder wheat production in the Southern Highlands provides a unique context for the scholar of international development and the development practitioner. The development landscape of the Southern Highlands is relatively uniform with smallholder farming communities the dominant rural economic enterprise of the region. In addition, the Southern Highlands are geographically removed from the industrial center of Dar es Salaam and even from the agribusiness center of Arusha in the northern region of Tanzania. This relative isolation allows the development scholar to better understand the relationships within rural Africa and to analyze the infrastructure, capacity, and resource constraints that might exist. It also allows for formulation of development policy to craft institutions that will directly impact the target community of the Southern Highlands and the related value chains.

The qualitative data provided straightforward baseline information about the wheat chain in the Southern Highlands. It was determined that there was no mature wheat value chain (of substance) in the Southern Highlands and that the smallholder wheat farmers were largely dependent upon value networks in Iringa and Dar es Salaam for markets. In addition, the wheat seed industry in the Southern Highlands is immature with only one local producer (the Uyole Agricultural Research Institute and the larger Ministry of Agriculture). The value chain in the Southern Highlands is even further distorted by the presence of rent-seeking middlemen that create difficulty for price discovery and quality control. Smallholder farmers in the Southern Highlands keep wheat produce commodity as a temporary store of wealth (or bank) to be sold throughout the year as cash is needed. Wheat stores better than maize or other grain crops and it is not part of

the staple rural diet. Furthermore, there is little appreciation by farmers for the need for improved seed varieties. There is neither extension support nor market support so farmers do not see improved production practices as a priority.

Answer to Statement of Problem

If smallholder emerging farmers are to benefit from policies that protect intellectual property rights, stakeholders must gain an understanding of the local context and provide a model for dialogue about alternative value capture systems for improved technology adoption by smallholder emerging farmers. A baseline model of the value chain and a conceptual framework of the agricultural systems are necessary for public and private stakeholders to communicate and plan effective market interventions for the development of the sector. This baseline research provides such a model for the current wheat value chain system in Tanzania. This research communicates the current context and provides tools for testing targeted interventions that improve the social and economic development of smallholder emerging farmers.

This dissertation explores the relationship between the technology diffusion processes in the public and private sector by examining the creation of intellectual property, the protection of intellectual property and the utilization of intellectual property. More importantly, the researcher aims to understand the relationships between these three components in terms of resources, processes, and values required for institutional innovation. While there are complex connections between and among components, it can be said that generally institutions use (1) resources to drive the creation or exploration of new technology, (2) processes to drive protection and enforcement of technology policy,

and (3) values to drive utilization/adoption of new technology. It is important that all of these components are considered when conceptualizing an institutional structure for technology diffusion throughout a developing value chain. Such models and resulting research are important for informing international and national policy for intellectual property frameworks and targeted development initiatives.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Context of Institutional Innovation for International Agricultural Development

International agricultural development is crucial for our global society to meet shared goals of food security, poverty eradication, and sustainable natural resource management. International agricultural development requires the combined talents and skills from farmers, educators, politicians, researchers, and businessmen. Nowhere is the theory and practice of international agricultural development in need more than in Africa.

> With the global population projected to rise to more than 9 billion people by 2050, Africa lies at the heart of what promises to be a new Agricultural Revolution and holds the key to ensuring a sustainable food supply. This will only occur if a new roadmap for progress is developed, harnessing both the expertise of the private industry sector and the knowledge of local communities. (Schroeder, 2014, p. 142)

Institutional innovation is a key concept for international agricultural development. We can use this concept of institutional innovation to show the development dynamics and consequences of intellectual property protections in the Southern Highlands of Tanzania. The institutional innovation framework is used to show the relationship between intellectual property protection and the development of the wheat value chain. Intellectual property protection of new wheat varieties is an institutional innovation that has implications for increasing the capacity for agricultural development in the Southern

Highlands as well as promoting economic and social development for farming communities in Tanzania.

Institutions are crucial participants in the international development process (and especially for international agricultural development) because they provide rule of law, clear expectations, and stability. Stable institutions promote and nurture trust but they also provide a mechanism for managing change. We are able to understand the long-term development impact of institutional innovation by analyzing the resources, processes, and values involved with intellectual property protection in Tanzania. These components are an institutional analysis framework that provides structure to the development research and management implications of institutional innovation.

Development and management scholars (Carlile & Christensen, 2005; Christensen, 2013; Christensen & Overdorf, 2000; Rogers, 2010; Taleb, 2010, 2014) provide us with a framework for conceptualizing the elements for institutional change. The framework context is relevant to "disruptive change" in corporations, governments, and any other form of institution. The framework of Christensen and Overdorf (2000) consists of three elements that are crucial for an entity to survive: resources, processes, and values. This framework allows for us to understand these dynamics and determine best practices to manage disruptive change. Management practices can then be determined to influence public policy, development practice, and increased capacity throughout the value chain.

This is true in many different types of institutions. Specifically for international development, many systems, organizations, and corporations experience rapid economic, environmental, and social change. Understanding these changes in a development context

are important for planning to anticipate and manage the changes. This understanding is also important for addressing the needs of institutional innovation and assisting institutions with the resources, processes, and values that lead to impactful innovation. If institutions are not adequately equipped to handle innovation or change, this leads to system failure or stagnation. For more technical aspects of developments like agriculture and resource management, it is necessary to deal with disruptive technologies within a structured framework, as presented here.

Christensen and Overdorf's (2000) framework of resources, processes, and values is central to the analysis of intellectual property rights for wheat variety protection within the Southern Highlands of Tanzania. Both intellectual property rights and the new wheat varieties they protect are disruptive changes to systems in Tanzania. This framework provides the structure and the flow for the research and allows a methodology for constructive management of institutional innovation. The framework is presented again below in Figure 20. It shows how the component of institutional innovation can lead from fragility to resiliency in a development context. As discussed above, the measures of success of resiliency are communication throughout the value chain, harmonized policy and regulatory frameworks, and shared risk/reward throughout the value chain. The components of institutional innovation each support all three of these measures of success and contribute to a holistic development approach for the strengthening of the value chain.

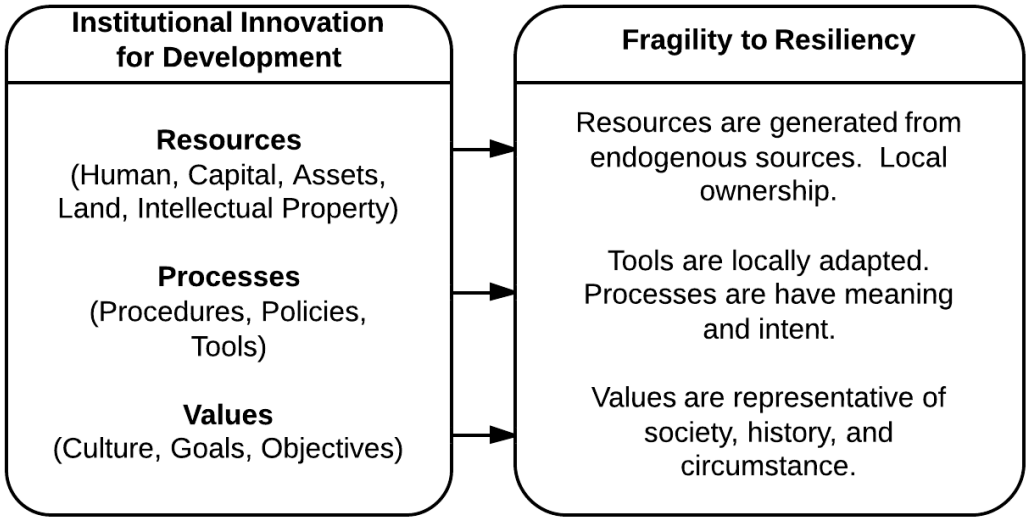

Figure 20: Components of institutional innovation for development

This framework presents resources, processes, and values leading to strategies for resiliency within institutions and the stakeholders of the institutions. Resources must be generated from endogenous sources with local ownership, however appropriately defined for the institution in question. Technology and processes must be locally adapted with meaning and intent. And finally, values must be representative of society, history, and circumstance. Specific to institutional innovation in Tanzania, newly introduced intellectual property rights legislation and systems are intended to drive both technology creation by agricultural researchers and technology adoption by agricultural communities to achieve resiliency and robustness. This research provides a methodology for local processes to move this institutional innovation forward. This research demonstrates how collaboration between the public and the private sector can provide support for smallholder farmers through alternative value capture mechanisms while building trust between the developers of technology and the users of technology.

Figure 21 provides the summary research conceptualization of the intellectual property institutional innovation cycle for the Southern Highlands of Tanzania. It builds

on the stylized system discussed in Chapter 1 and summarizes the research questions and responses. It explores the relationships between the creation of intellectual property, the protection of intellectual property, and the utilization of intellectual property in the agricultural development context of Tanzania. Of note, this concept specifically addresses the need for institutional collaboration between the public and the private sectors. In the Southern Highlands and in much of rural Africa, many disjointed activities are carried out in isolation by organization, corporate, and government efforts. To achieve scale and capacity required, these development activities must always be conducted through institutional collaborations to (1) build robust local capacity, (2) promote local resiliency, and (3) leverage resources.

The Tanzanian government must design intellectual property systems in collaboration with agribusiness and agricultural researchers to promote efficient protection and enforcement of technology policy. The Tanzanian government and the private sector must understand and communicate values of stakeholders in the agricultural value chain to promote the utilization and adoption of new agricultural technology. And the private sector through collaboration with the Tanzanian government should focus resources to promote the creation and exploration of new agricultural technology. It is important that all these components are considered when conceptualizing the institutional structure for a policy or practice in international development. As seen in Figure 20, all three are critical to this research on alternative value capture of intellectual property systems within the wheat value chain.

Technology and the institutions that support technology need to develop simultaneously in order for systems (developing or developed) to benefit both

economically and socially. This institutionalization of the innovation diffusion paradigm is central to delivering impact from investments in technologies and promoting resiliency within target communities. It must be emphasized that institutions provide balance between efficiency and equity to deliver both social and economic benefits for development policy and practice.

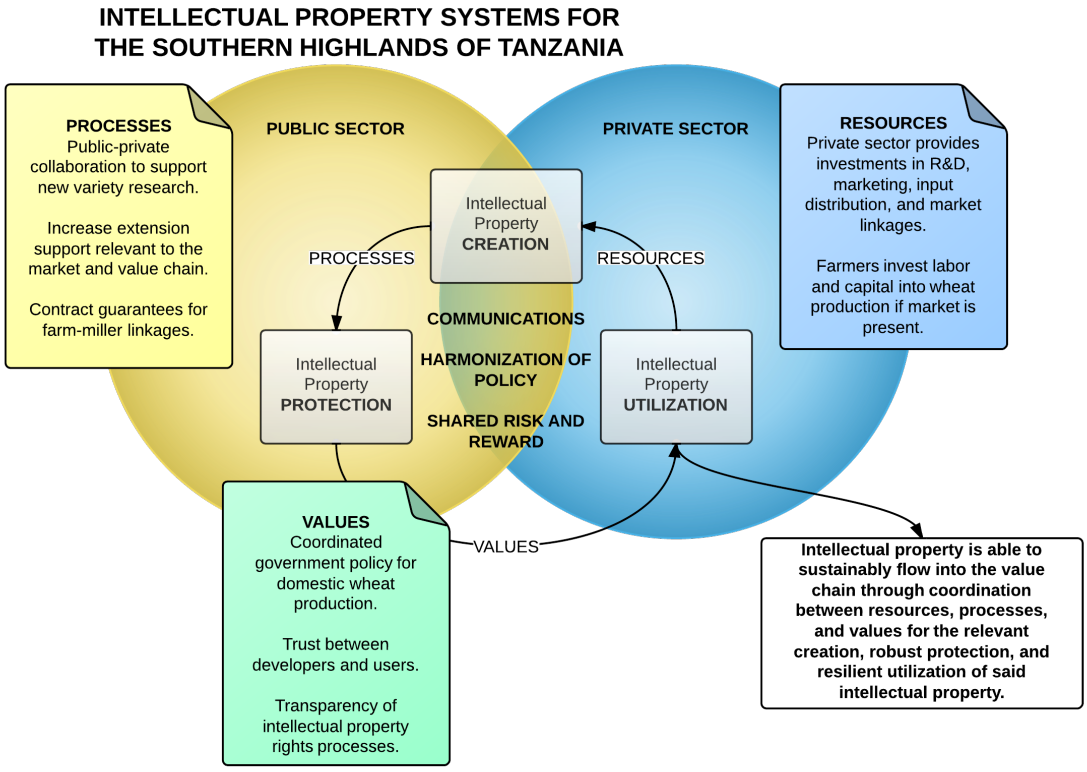

Figure 21: Intellectual Property Institutional Innovation Cycle for the Southern Highlands of Tanzania

Context of the Wheat Value Chain in the Southern Highlands

The wheat value chain in the Southern highlands of Tanzania is weak and immature. There are several critical pieces to the value chain that are non-existent in the Southern Highlands that create vulnerabilities for smallholder producers. In order to strengthen the chain and increase the value of overall production, public-private

collaborations will need to coordinate resources, processes, and values. The wheat value chain in the Southern Highlands will develop when there is a value proposition for each and all stakeholders in the chain. It is the primary responsibility of the stakeholders in the chain to create this shared value. However, public-private collaboration is necessary due to the lack of market power on the part of smallholder farmers and the lack of capacity among existing government resources. Achieving a mature value chain and the shared value that it produces falls to all stakeholders. "There is also recognition that failure to create shared value leaves government and civil society to mitigate the negative impacts of business in trying to build sustainable societies, regions, and nation states" (Fearne, Garcia Martinez, & Dent, 2012, p. 575). This is certainly the case in the Southern Highlands where businesses in the existing value chain (i.e. middlemen, millers, and bakers) are promoting activity in the chain but they are causing negative or neutral development impact in the current context.

Case Study Methodology and Application

As indicated above, the long-term WIPO case study is based on a logical framework. This logical framework drives the implementation and understanding of both this research and the long-term case study. It clearly communicates project objectives and outcomes to the stakeholders in the wheat value chain and provides structure for the stakeholders to discuss appropriate partners and activities.

The objective of the long-term case study is to improve the management theory of agricultural intellectual property rights systems in Tanzania. To this end, this research explores alternative points of value capture for intellectual property premiums in the

wheat value chain. It also increases understanding of technology adoption with the introduction of the institutional innovation of intellectual property protection. For each of these, there is a set of observable metrics that lead to the long-term case study objective, the outputs of the value chain analysis, and outcomes for the economic and social development of the Southern Highlands.

Valuing intellectual property and capturing that value is not a simple exercise. Long-term analysis of the value chain is needed to determine the contributions of each node on the value chain. The above value chain frameworks are used to describe the relationships between each node and to describe how those relationships will change over the five years of the long-term case study. The observed value chain begins with improved locally adapted wheat varieties that will be transferred to smallholder farming communities. The farmers will not bear the burden of the premium value of these seeds as in traditional agricultural systems. Premium value is conceptually defined as the difference between the average price of improved locally adapted wheat seed with intellectual property protection and the average price of traditional wheat seed on the market (Figure 22). The final activity of our value chain will be the transfer of wheat commodity from smallholder farmers to the wheat millers. This three-node stylized value chain allows for focus on the dynamics of intellectual property protection and emphasis on agricultural development of smallholder farming communities.

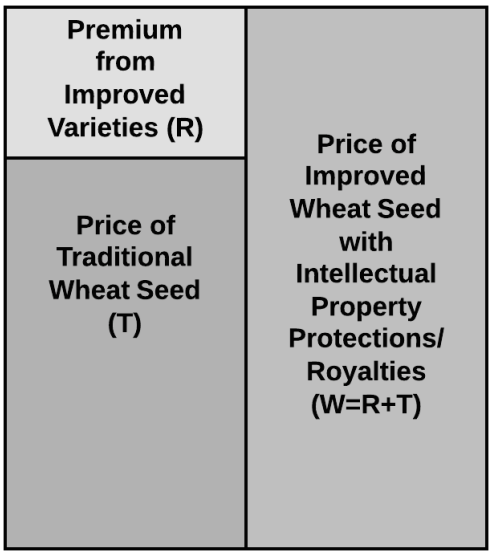

Figure 22: Definition of premium from improved varieties

It is recommended that the ideal point of value capture occur at the processing stage, at the wheat millers. This is the most consolidated point on the value chain with the greatest possible amount of oversight and control. This research concludes that collaboration between the millers, the smallholder farming communities, and the seed producers is necessary to improve the quality of seed supply in the country and agricultural productivity of smallholder farming communities (Figure 23). The value capture of intellectual property premiums will occur at the miller stage. The premium will be used to support continued research and development of improved varieties of wheat in Tanzania. Through alignment of values and shared incentives, the seed producers must be willing to commit to long-term research, development, and marketing of improved wheat varieties. The farming communities must commit to best practices of wheat production, extension support, and collaboration with the seed suppliers and millers for quality control. And the millers must commit to premium pricing in exchange for higher quality wheat commodities (in terms of both milling and baking qualities and levels of protein

content). All parts of this stylized value chain have responsibilities and costs. However, it is intended that all nodes on the value chain will benefit. The long-term case study will track this collaboration, the overall increased productivity of the value chain, and the economic and social benefits to each node on the value chain.

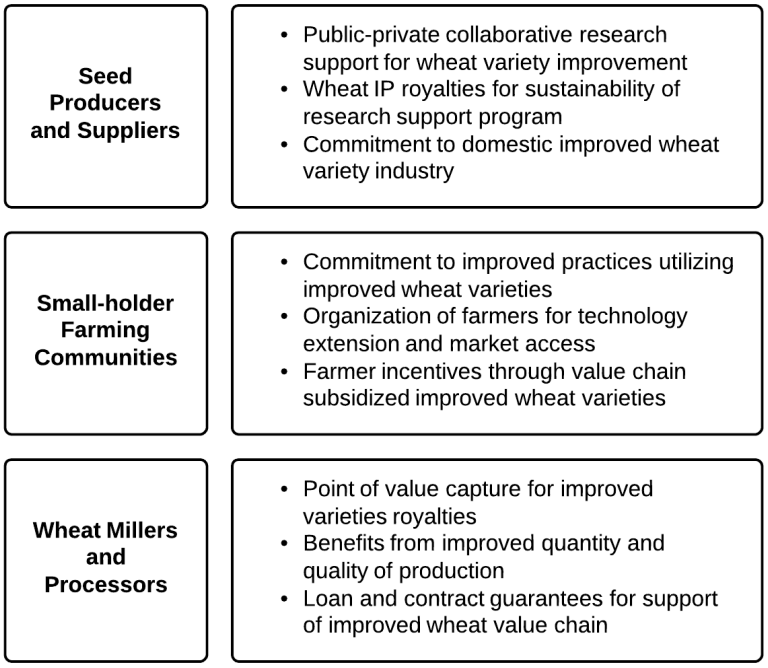

Figure 23: Simplified long-term case study value chain to show target nodes

The pricing of intellectual property premiums of wheat seed should be negotiated through the mediation of the stakeholders committee according to the above conceptual definition of premium. Premiums should be priced according to international norms of both private and publically produced plant varieties. Pricing should take into account both domestic and internationally available wheat varieties. All partners and nodes on the chain must agree that the premiums that are designated as attributed to plant variety protection collected through the long-term case study must return directly to support both

public and private research collaboration on improving domestic wheat varieties. This arrangement should be formalized through a value capture sharing agreement. This agreement will be flexible to accommodate for the experimental nature of the long-term case study. And it should also include provisions for expansion to additional partners and additional nodes of the value chain as the long-term case study progresses.

In exchange for participation in the long-term case study, there should be external support to initially incentivize research and development within this stylized value chain and encourage participation and compliance with the activities. External support will be unique to each node. For the seed industry, there should be a public-private collaborative research support program to drive improved domestic wheat varieties. There would be a base research-funding amount that begins the plant-breeding program for the first few years that would then continue to be supported by proceeds from the value capture sharing agreement. This collaborative research support program should reward both institutions that participate (companies and research centers) as well as individual breeders to encourage continued development efforts.

There should be focused agricultural production extension support for best on-farm practices and post-harvest handling for farming communities in the Southern Highlands. Communities themselves are stakeholders and therefore they should contribute to the design of the extension support through their participation on the stakeholders committee and partnership with the Ministry of Agriculture. However, the Ministry of Agriculture should be allocated resources to provide training, testing, and expertise to farmers throughout the course of the long-term case study.

External support for the millers should be in the form of underwriting production contracts with farming communities, loan guarantees for long-term case study specific investment needs, and funding for quality control and quality monitoring systems in the value chain. Millers have the most market power and the most to gain from a stable and productive domestic value chain. Therefore, direct resource allocations should not be necessary for their participation. However, guarantee mechanisms will go a long way towards mitigating downside risk for their participation.

As discussed above, the most critical component of the long-term case study is to implement a pilot end-point royalty system as farmer groups make delivery of wheat produce to wheat millers in the Southern Highlands. For example, the stakeholder working groups will set royalty prices for specific lines and traits, but the prices will likely range around a target royalty price of US$5.00 per metric ton of wheat. This end-point royalty is collected from the millers upon receipt of increased quantity and quality of wheat seed. It is suggested that the long-term case study have an initial target production goal of 10,000 metric tons and a production goal of 50,000 metric tons by the end of the pilot campaign. This would provide an initial amount of at least US$50,000/year to the wheat-breeding program in the Southern Highlands with a final target budget of US$250,000/year. Current smallholder productivity in the Southern Highlands is between 1.2 and 1.5 metric tons per hectare (19 to 24 bushels per acre). The wheat-breeding program should target achieving an initial 2.0 metric tons per hectare (32 bushels per acre) with a final target goal of 3.0 metric tons per hectare (48 bushels per acre) across the region. The potential success of these long-term case study goals represents a significant increase in profitability for smallholder households. This would

provide approximately US$6,000,000 per year of new smallholder household revenue ($500 per year per household) as well as increased production throughout the value chain. In addition, seed and other agricultural input systems will be strengthened to promote long-term economic development of the Southern Highlands.

This initiative of intellectual property premium value sharing will drive domestic agricultural research, support public and private agricultural innovation, and support domestic wheat breeders. It encourages technology adoption through the strengthening of value chain networks and incentivizes participation by extension and agricultural education programs. This initiative is a platform for communication and collaboration throughout the value chain for locally adapted technology to benefit the entire value chain.

Beyond technology adoption, the long-term case study is a platform for the development of the value chain itself. Value chain improvement is a key driver for long-term success of agricultural development activities. Selecting the initial critical nodes and the partners within those nodes is important for success of the case study. It is intended that this value sharing agreement will not only drive technology innovation but also strengthen a strategic value chain for the productivity of Tanzanian agriculture. In turn, this value sharing agreement will become a long-term driver of technology innovation throughout the country.

This research provides a platform for institutional innovation in the country creating conditions for long-term social and economic development. The research and the strengthening of the value chain enable the strengthening of the intellectual property institutional innovation cycle of technology creation, protection, and utilization. Finally,

the long-term case study is designed to not only collect data on institutional innovation. It also drives the growth and prosperity of the entire wheat value chain. The long-term case study will be a catalyst for collaboration among stakeholders. As it progresses, additional stakeholders and nodes of the value chain will join the effort to achieve benefits of scope and scale.

After the above collaboration activities commence, the long-term case study will collect both qualitative and quantitative metrics that will directly inform the objectives of the stakeholders. Local researchers in Tanzania will collect these metrics thereby contributing to the understanding and the cycle of institutional innovation. The below metrics are indicative of the requirements of the long-term case study. But these metrics will be subject to edit and approval by the stakeholders as the initiative commences.

The long-term case study will continue to collect information about on-farm technology adoption, technology transfer systems, and opinion leadership within agricultural communities of the Southern Highlands. It also collects information about the human and institutional capacity of stakeholders in the value chain and tracks the development of these critical resources as the case study progresses. The long-term case study will collect information on not only institutional capacity, but more importantly, institutional innovation in both the public and private sectors. It will continue to examine the resources, processes, and values of institutions of the value chain over time and document how these resources, processes, and values are driving technology creation, protection, and utilization. The long-term case study will also document the strengthened networks of the value chain and show diffusion of both technology and innovation through these strengthened networks.

This qualitative baseline information is straightforward. In conversations with current stakeholders and review of research data, it was quickly determined that there exist no wheat value chain of substance in the Southern Highlands. There is some public-sector seed provided by the Ministry of Agriculture but there is no public-private collaboration for creating a wheat seed industry. In addition, produced commodity is purchased from farmers by middlemen transporters to wheat mills in Iringa or further. Farmers have no mechanism for price discovery or market power with regard to both seed purchase and sale of commodity. Farmers keep their wheat as a commodity "bank" to be sold throughout the year as cash is needed and there is little appreciation on the part of farmers for the need for improved seed varieties. Extension professionals of the Ministry of Agriculture serve all the communities of the Southern Highlands but they have limited access to inputs or best practices regarding wheat production. There are private sector seed dealers and distributers in the Southern Highlands but there is no private sector investment improving the wheat varieties. There is no quality control of wheat seed or wheat commodity. See Figure 24 below for an overview of the value chain qualitative attributes. This lack of capacity throughout critical nodes of the supply chain is of vital importance for development scholars, policymakers, and practitioners and cannot be overstated. Missing institutional and human capacity undermines development interventions, investments in the supply chain, and cooperation between stakeholders. If government officials and donor agencies wish to strengthen agricultural production systems through the institutional innovation of intellectual property protections, they must address these existing weaknesses. Institutional innovation cannot supplement lack

of capacity, but is intended to leverage capacity for achieving economic and social development.

	Resources	Processes	Values
Seed Producers and Suppliers	Limited resources and incentives for wheat improvement.	Limited capacity for variety improvement and distribution.	Commitment to agricultural development and creating new varieties.
Smallholder Farming Communities	Limited access to resources and limited access to markets.	Limited capacity for improved techniques and agricultural technology.	Commitment to wheat production. Limited commitment to organization.
Wheat Millers and Processors	Relatively strong access to resources and strong market access.	Integrated with retail. Limited integration with farming communities.	Limited commitment to economic and social development.

Figure 24: Qualitative Summary of Value Chain Critical Nodes

The research quantitative metrics are focused on the development of the wheat value chain and the development of smallholder farming communities of the Southern Highlands. The quantitative metrics include on-farm efficiency of agricultural technologies and the impact of those technologies to smallholder farming communities. These metrics examine household productivity and income. They also examine the pricing of inputs and any intellectual property premiums associated with those inputs. The research tracks the national production of wheat commodity as well as the quality of national wheat production. This quantitative information adds to the baseline

understanding of farming communities and data will continue to be collected throughout the course of the long-term case study. Figure 25 shows the complete framework for the long-term case study.

In addition to metrics and evaluation of intellectual property and technology transfer, the case study should also provide general performance indicators of productivity of income and of yield. Outcome indicators should include rate of adoption of new varieties, and rate of adoption of improved management practices (Lwezaura, Madulu, Ndunguru, Paul, & Chalamila, 2011).

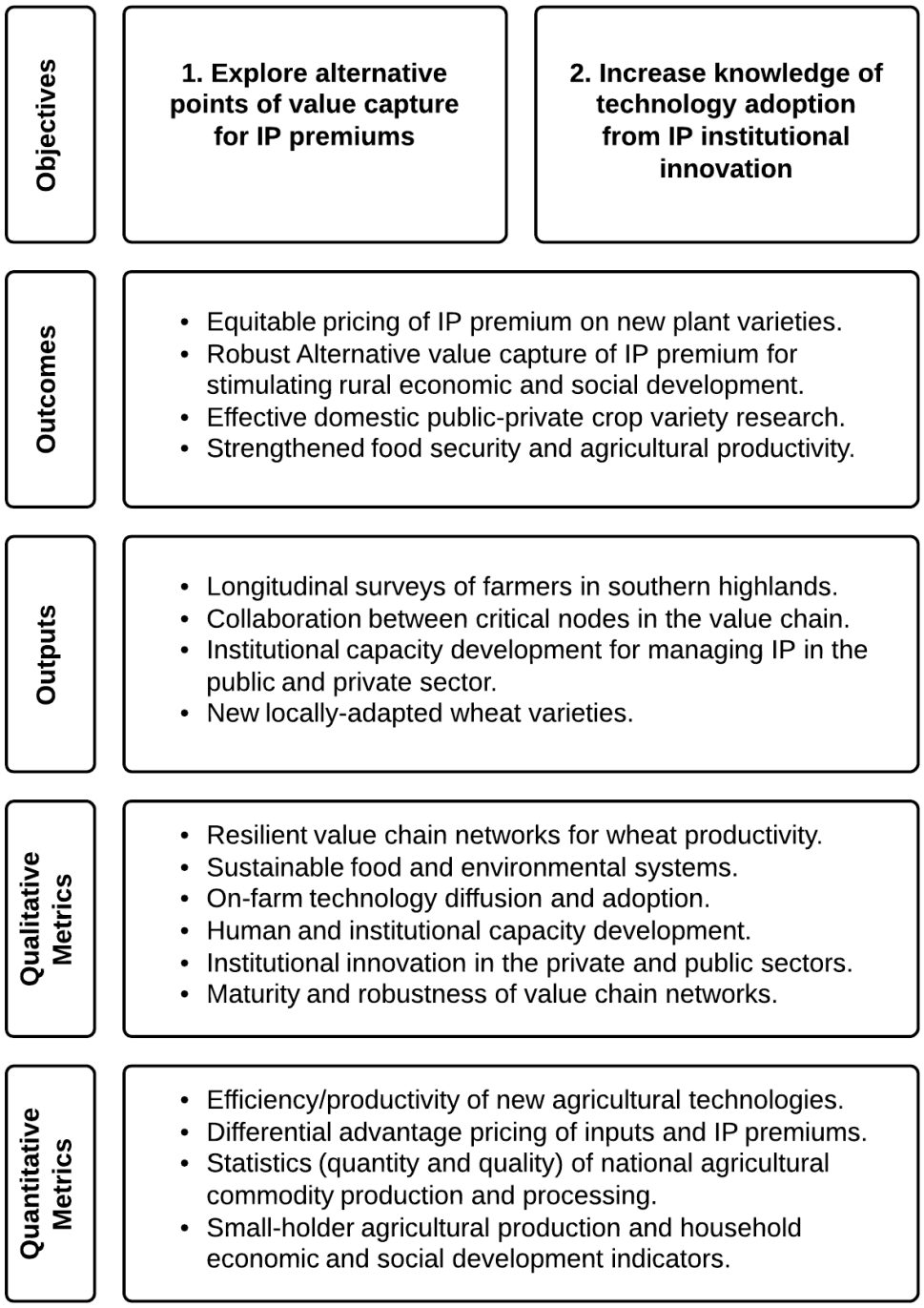

Figure 25: Complete Framework for Case Study on Smallholder Wheat Production in the Southern Highlands of Tanzania

Once the above long-term case study is approved and funded by stakeholders, it will be necessary to implement the case study. The first step in implementation will be to convene the stakeholder partnerships. The initiative will be implemented under the auspices of the Ministry of Agriculture and Rural Development of the Government of Tanzania. It will be implemented in cooperation with the Southern Agricultural Growth Corridor of Tanzania and the World Intellectual Property Organization. These three entities represent the public sector participants in the implementation of the case study.

The private sector participants in the implementation of the long-term case study are farming communities of the Southern Highlands in proximity to the agricultural research station. Other critical participants include milling factories in proximity to the research station, bakeries or other processing facilities, and seed companies and farm input suppliers. These private sector participants are direct nodes in the wheat value chain for the Southern Highlands. Participants will be chosen based on their commitment to economic and social development of the region as well as their capacity to impact the health of the value chain. There are firms in the region that have shown a commitment to economic and social development and these firms should be the first to be invited to participate in the case study.

Figure 26 outlines the implementation plan of the case study. It describes the requirements of participants and the action plan for how the case study will proceed.

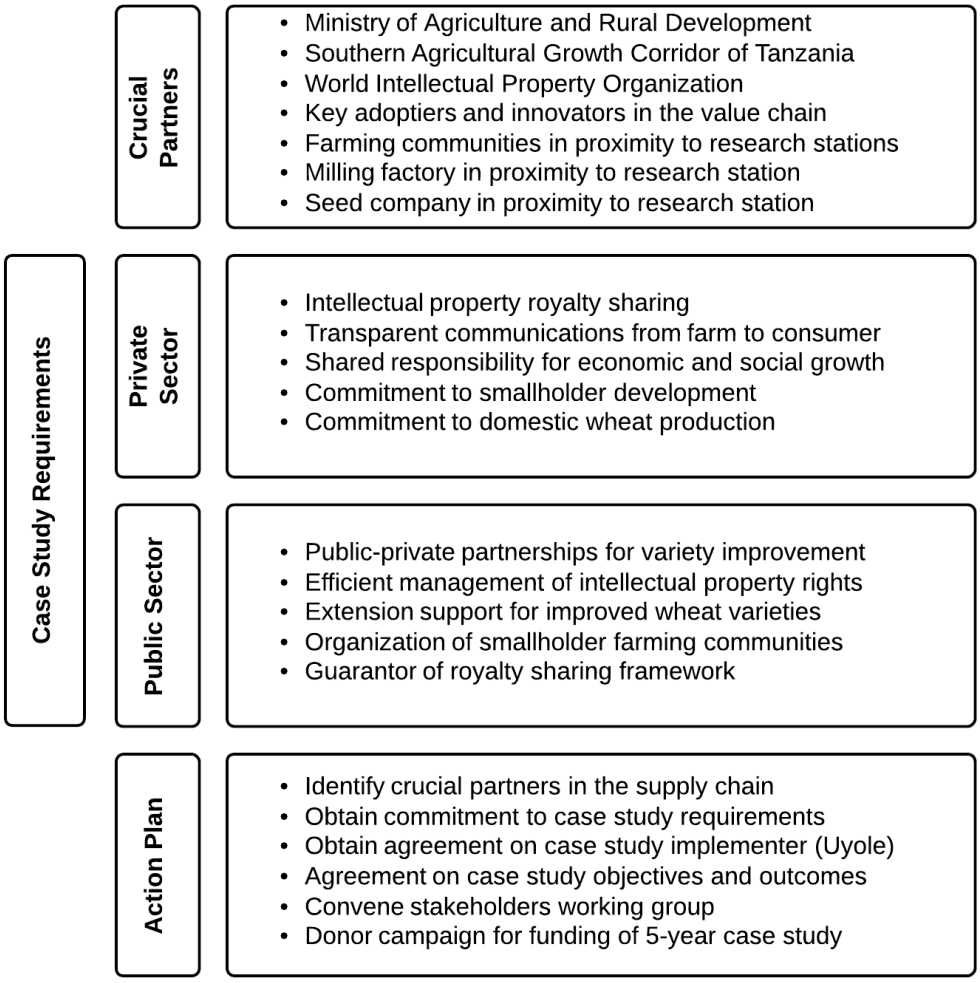

Figure 26: Case Study Implementation Plan

Public participants in the case study will have incentives for participating, but they will also have requirements to demonstrate their commitment to work towards the objectives of the case study. The private sector participants have requirements to strengthen the wheat value chain and promote private-sector support for the generation of new technology. These private sector requirements include the value capture sharing agreement for intellectual property premiums. This sharing of royalties will not only increase accessibility of quality seeds for farmers, but it will also provide a mechanism for private-sector support of technologies that are directly related to the sustainability of

the value chain. Also, private sector participants will be required to have transparent communications with regard to the case study to all partners and the public. Each participant is expected to have a shared responsibility for economic and social development for the Southern Highlands and for the wheat value chain. Finally, each private sector participant should have a demonstrated commitment to smallholder farmer development and a commitment to improving domestic wheat production. As obvious as these may be, there is evidence of competing interests that do not value these objectives.

Similar to the private sector requirements, the public sector participants will also be required to commit to a number of basic responsibilities. Like the private sector, public sector participants must agree to the intellectual property royalty-sharing plan through the value capture sharing agreement. Public sector partners must agree to public-private collaborative research efforts for improving wheat varieties. Joint public-private research is important for ensuring public benefit while at the same time ensuring market relevance. Public sector participants (namely the Ministry of Agriculture) must take responsibility for the efficient management of intellectual property rights and the protection of those rights. They must agree to provide focused extension support for improved wheat varieties. Holistic management of improved technologies is needed. Such management needs training and quality control by extension professionals in the Southern Highlands. The Ministry must also provide organization of smallholder farming communities in the Southern Highlands. Organization of farming communities will be critical for the value capture sharing agreement and for efficient operation of the value chain. Finally, the public sector partners will be required to be the guarantor and mediator of the value capture sharing agreement. It is advised that the Southern Agricultural

Growth Corridor of Tanzania or by the World Intellectual Property Organization itself take on this responsibility to provide separation from the Ministry of Agriculture. There is a role of donor organizations apart from the stated partners to provide incentives for cooperating to strengthen the value chain and for participating in the value capture sharing agreement. The donors will be asked to provide monitoring of the long-term case study and external evaluation of partner collaboration.

Once the partners have been selected, there is a series of steps to launch the long-term case study. All project requirements and objectives should be clearly communicated to partners and stakeholders. This communication should occur at the initial convening of project partners. The project partners should agree on local project implementers and agree on the implementation plan for proceeding with the case study. It is recommended that the stakeholders committee select the Uyole Agricultural Research Institute be the local project implementer. Uyole is committed to this project and has both the technical capacity and the local expertise of the Southern Highlands necessary to be effective in serving the value chain. Uyole has the capacity to collect data as the long-term case study progresses and also the convening power to organize both farming communities and stakeholders of the wheat value chain.

At this first convening, the desired objectives and outcomes for the long-term case study will be presented to the stakeholders and agreed upon. In addition, a stakeholders working group will be created that consists of individuals who are committed to being directly involved in the implementation and oversight of the case study. The convening of partners will also launch a donor campaign (bilateral, multilateral, or private) to acquire necessary resources for the long-term success of the case study.

Figure 27 below provides a timeline for the long-term case study. The above implementation plan is to begin the long-term case study. Data collection will begin in the first six months as the partners agree to collaboration throughout the value chain and as the plant variety research begins. The below timeline communicates the important milestones and activities of the case study. It is important to demonstrate that the end result of the long-term case study is the sustained implementation of value sharing agreements to develop the wheat value chain for increased wheat productivity of smallholder farmers in Southern Highlands.

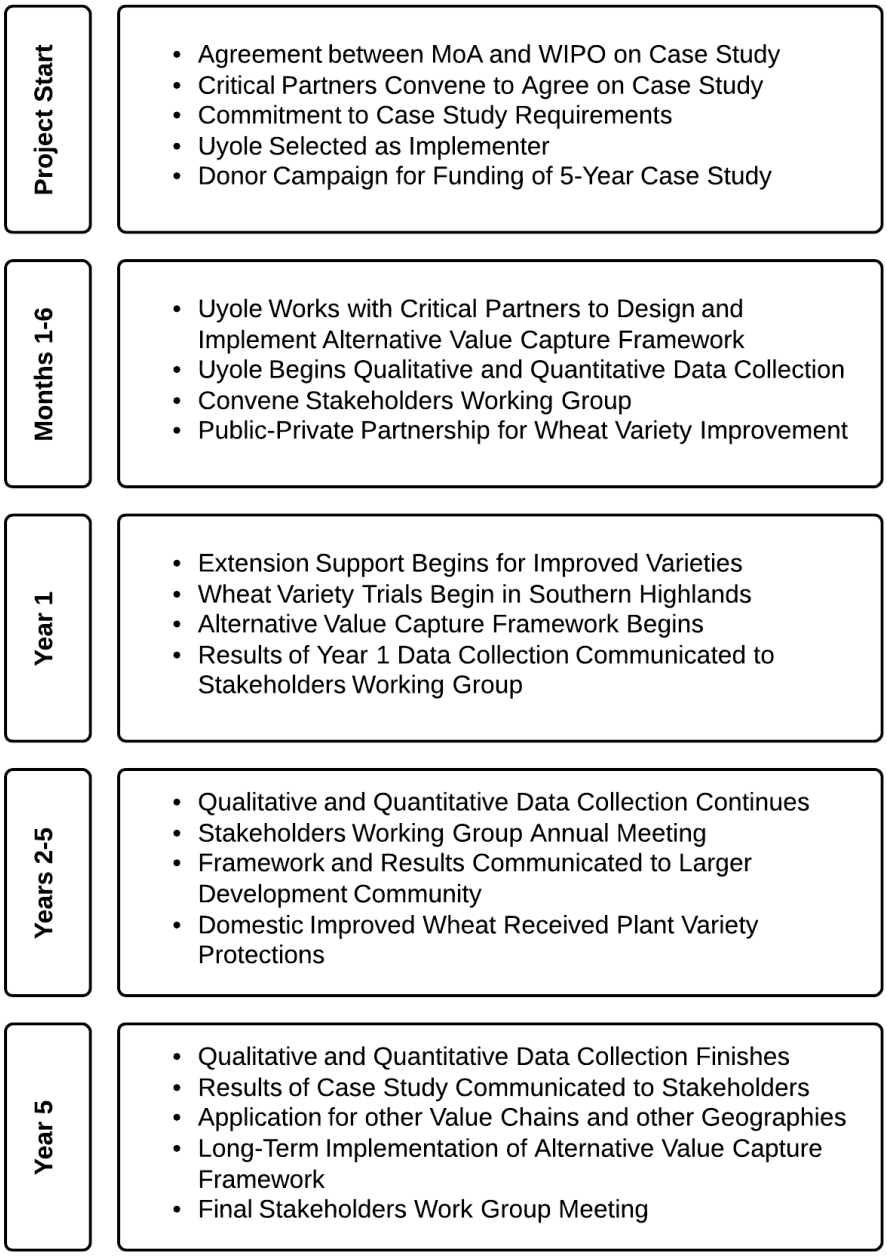

Figure 27: Case Study Timeline

Implications for Institutional Innovation Framework

This research provides the Government of Tanzania and its partners valuable information on the relationship between implementing intellectual property protection institutions and the development of domestic wheat value chain. The research benefits

wheat production in the Southern Highlands by informing development policy throughout Tanzania. To build on this research, the long-term case study will explore intellectual property protection along the wheat value chain in order to achieve development goals of improved food security, reduced poverty, and sustained environments. The long-term case study will have two primary objectives: (1) explore alternative points of value capture for intellectual property premiums and (2) increase knowledge of technology adoption from intellectual property institutional innovation.

The long-term case study will have a number of outcomes. It will lead to equitable pricing of intellectual property premiums on new plant varieties. It will create value chain partnerships for alternative value capture of intellectual property premiums in order to stimulated technology adoption among smallholder farmers. It will promote domestic public and private research capacity for improved crop varieties. It will strengthen food security and agricultural productivity throughout Tanzania.

From the beginning of their management of plant variety protections, it is important that policymakers align resources, process, and values of these new intellectual property institutions to promote technology innovation, private-sector investment, and robust markets. The strategic management of institutional innovation is critical for achieving social and economic development impact. To achieve this, support for agricultural extension alongside technology development is crucial for proper adoption and utilization of improved technologies. Similarly, public-private collaboration for technology development increases market penetration of new technologies. Value chain concentrations of market power should be managed with corresponding responsibilities for the economic and social development of the entire chain. Monopolistic concentrations

of market power to the detriment of other nodes on the value chain should be mitigated. Smallholder farmers are the most vulnerable actors in the value chain but also represent the best chance for significant economic and social development. New intellectual property institutions must provide focused consideration on the economic and social development of smallholder farming families and communities. These institutions can create the stability that allows for necessary diffusion of innovation to create resilient and robust development in the Southern Highlands (Rogers, 2003).

Recommendations for Wheat Long-Term Case Study in the Southern Highlands

It is recommended that an end-point royalty system be implemented as farmer groups make delivery of wheat produce to millers. Royalty prices can be set for specific lines and traits, but a target royalty price of US$5.00 per metric ton of wheat will be used for this stylized example. This is collected from the millers upon receipt of increased quantity and quality of wheat seed. The Southern Highlands case study will have an initial target production goal of 10,000 metric tons and a production goal of 50,000 metric tons by the end of the campaign. This will provide an initial amount of at least US$50,000/year to the wheat-breeding program in the Southern Highlands with a target of US$250,000/year. Current smallholder productivity in the Southern Highlands is between 1.2 and 1.5 metric tons per hectare. The wheat-breeding program will target achieving an initial 2.0 metric tons per hectare with an end goal of 3.0 metric tons per hectare across the region. The potential success of these case study goals represents a significant increase in profitability for smallholder households. This would provide

approximately US$6,000,000 per year of new smallholder household revenue as well as increased production throughout the value chain.

Recommendations for Future Research

This research has provided a comprehensive grounding in the dynamics of international agricultural development and how institutions can manage innovation and technology transfer to impact social and economic development. The institutional innovation cycle described in this research is not only applicable to the context of intellectual property protections, but it can be used to analyze institutional dynamics in many developing contexts. This research program provides a stronger base for further inquiry into institutional innovation and international agricultural development. These provide a structured point of view for exploring methods of technology transfer and the principles of agricultural and rural extension practice. This research provides a framework for the formulation of development policy that will not only impact agricultural productivity and food security, but also drive increased capacity in science and technology. This research also demonstrates the importance of public-private collaboration. The public-private nexus of institutional innovation provides coordination of resources, process, and values for the social and economic benefit of an entire society.

From this comprehensive grounding, five areas are recommended as departure points for further research into the field of international agricultural development. Of direct relevance, there is need for further research into the effects of intellectual property on smallholder communities. The long-term case study will be an important vehicle for collecting data about communities and value chains in the Southern Highlands. There is

also a need for greater understand how value chains are impacted by alternative structures. An immediate question is how alternative systems differ from established market systems. What are the economic and social differences between alternative systems? Can alternative systems be successfully transitioned to market systems when mature? These value chain questions are relevant to both the private and public sectors. Research should continue to foster public-private partnerships to better understand the development dynamics involved.

A second area of research involves institutional innovation and society. Beyond value chains, what are the network effects of institutional innovation? How do institutional innovations impact social networks? Future research would involve taking the institutional innovation cycle and expanding beyond a chain to see the dynamics of society at large looking at social capacity, social goods, public goods, and concepts of social progress.

A third area of further research would be looking in-depth at the values question in the institutional innovation cycle and determining (qualifying or quantifying) institutional values for innovation success. This would look at leadership dynamics, organizational change, the relationship between objectives and vision, and how values are developed and communicated. There is abundant literature about organizational values and this research would connect institutional innovation to how institutions create, share, and communicated value. An ethical subcomponent of the value question would be how leadership values relate to ethics within the institutional innovation cycle. What are the ethics of innovation and how are those ethics related to technology transfer and adoption? Ethics are crucial for institutional leadership and development. Therefore we should have

a better understanding of how ethics relates to technology transfer and institutional innovation.

The fourth research question explores Toyoma and his observations that innovation and technology are never substitutes for capacity but how innovation amplifies (or diminishes) capacity – whether it is human capacity or institutional capacity (Toyoma, 2011). The institutional innovation cycle builds upon established capacity and provides a mechanism for increasing capacity while at the same time amplification of that capacity through appropriate diffusion of innovation. This dual function of strengthening of capacity and amplification of capacity is important for policy formulation and implementation.

The final question for future research is the creation of shared value through institutional innovation. How corporations, organizations, and other institutions should use their capacities to generate shared value that does not only benefit their own interests. This builds on the work of Porter and Kramer (2011) as earlier discussed. For institutional innovation to be effective, what attributes of shared value should exist? Should shared value be an explicit objective of institutional innovations? How is shared value negotiated among stakeholders in the institutional innovation cycle?

All of this research points to the need for a greater understanding of how the scholarship and practice of international agricultural development is focused on creating public good, better societies and more prosperous economies. Through understanding the institutional innovation cycle we are able to focus efforts on providing resources, processes, and values that create positive impact. To re-quote:

Our ambition, however, is not about growth for growth's sake. It is to put the company in service of making a contribution to global food security, by creating a step-change in productivity, and to do so with sustainability, particularly environmental sustainability, firmly in our vision. That may sound a broad ambition – and it is – but it can only be accomplished if we think differently about the solutions and follow some unconventional paths. We must ensure we bring technologies and benefits to small-scale growers...as well as large scale ones. We must adapt technology... as well as invent it. (Mack, 2012, p. 7)

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APPENDIX A

INTERVIEW GUIDE

Interview Guide for Farmers and Community Leaders

Market/Institutional Questions

1. Describe all the crops you grow. What crops do you use for food for your family?

What crops do you sell?

2. Who buys your crops? Who buys your wheat? How do you know the price to sell?

3. Do you belong to a farmer group or community association? Why do you belong?

Labor/Agronomic Questions

1. Where do you get your farm supplies? Seed? Other inputs?

2. Who assists with farming? Do you hire labor? How?

3. What are your top 3 biggest challenges in farming?

4. How do you want to change your farm in the future?

Technology/Adoption Questions

1. Why do you grow wheat? How do you know what kind of wheat to grow?

2. How do you get your advice on growing wheat?

3. How do you want to improve your farming?

Every question should point to facets of resources, processes, and values in Tanzania.

Pay attention for anomalies, arguments, rejections, and sensitive topics.

Interview Guide for Private Sector and Institutional Leadership

Market/Institutional Questions

1. Describe your role within the wheat value chain.

2. How do you support the wheat value chain? How do you improve it?

3. Why is the wheat value chain important for you? For Tanzania?

4. How can the wheat market in Tanzania be improved?

Labor/Agronomic Questions

1. How competitive is Tanzanian wheat production in the region? In the world?

2. Describe wheat production in Tanzania. What agricultural sectors/crops is Tanzania competitive?

3. What are the agronomic constraints for wheat production in Tanzania?

Technology/Adoption Questions

1. What are the technological improvements needed for wheat production in Tanzania?

2. How is technology developed in Tanzania? Public/Private?

3. What investments are needed in Tanzania wheat production?

4. What are the intellectual property rights for agriculture technology in Tanzania?

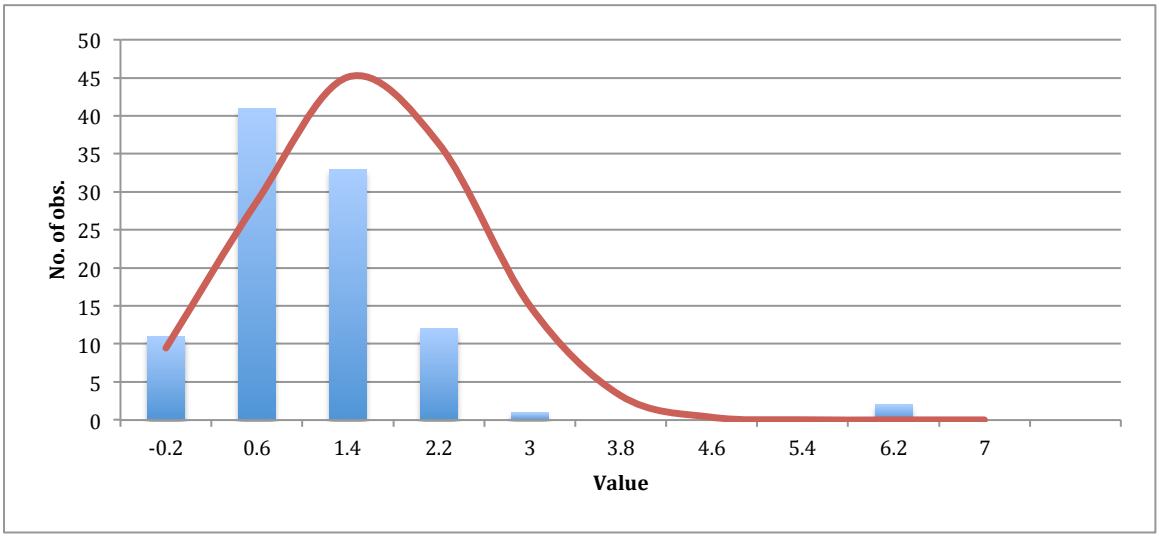
Every question should point to facets of resources, processes, and values in Tanzania.

Pay attention for anomalies, arguments, rejections, and sensitive topics.

APPENDIX B

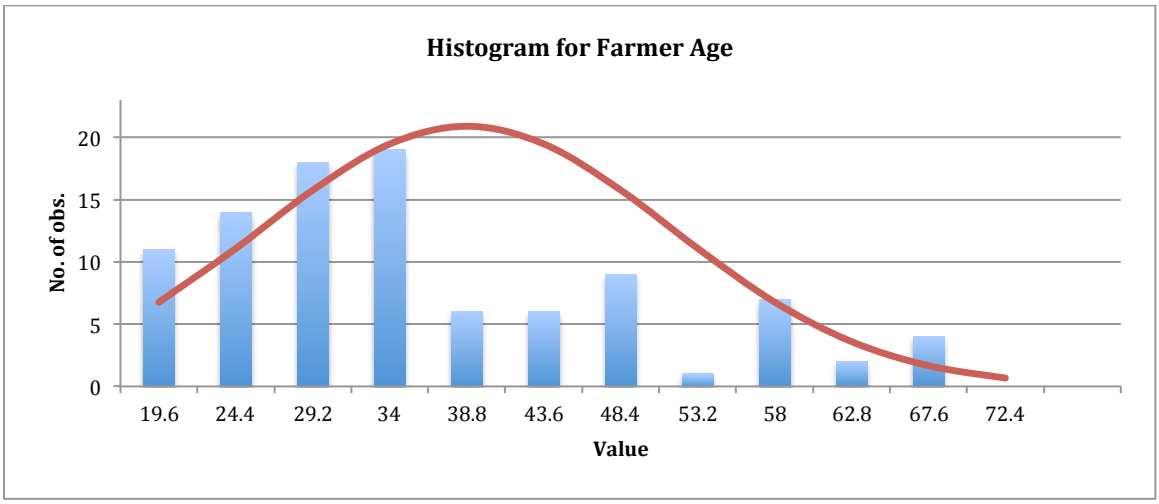
SOUTHERN HIGHLANDS FARM SURVEY

Alpha value (for confidence interval)	0.05		
Household Farm Size (Hectares)			
Count	100	*Skewness*	2.24367
Mean	1.54063	*Skewness Standard Error*	0.23895
Mean LCL	1.34619	*Kurtosis*	11.51711
Mean UCL	1.73506	*Kurtosis Standard Error*	0.46393
Variance	0.96019		
Standard Deviation	0.97989		
Mean Standard Error	0.09799	*Coefficient of Variation*	0.63603
Minimum	0.20833	*Mean Deviation*	0.6926
Maximum	6.25		
Range	6.04167		
Sum	154.0625		
Sum Standard Error	9.79891	*Median*	1.25
Total Sum Squares	332.41102	*Median Error*	0.01228
Adjusted Sum Squares	95.05849	*Percentile 25% (Q1)*	0.83333
Geometric Mean	1.29043	*Percentile 75% (Q2)*	2.08333
Harmonic Mean	1.05725	*IQR*	1.25
Mode	1.25	*MAD*	0.41667

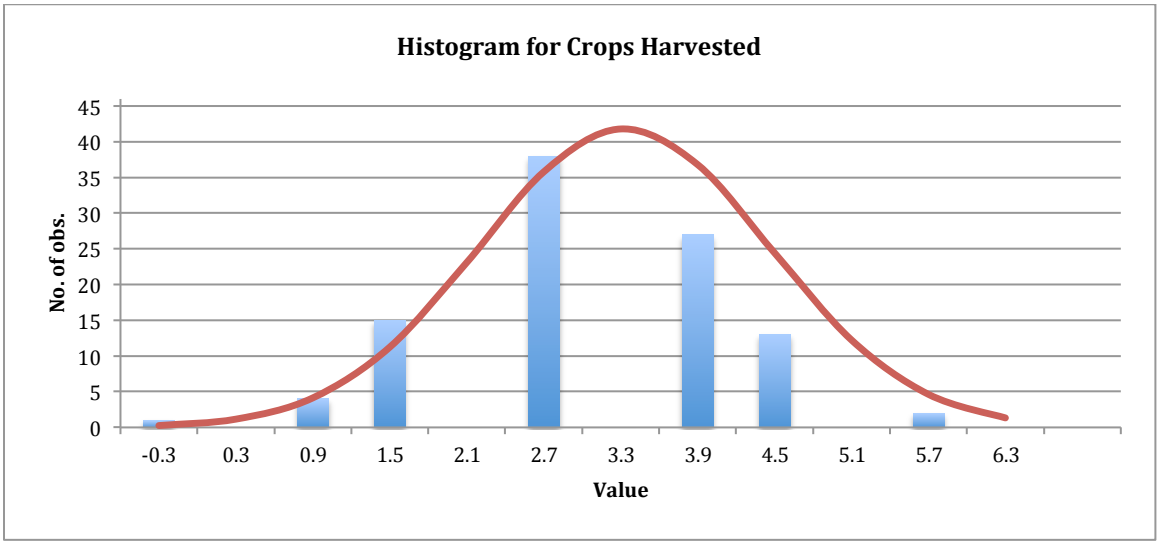


Alpha value (for confidence interval)	0.05

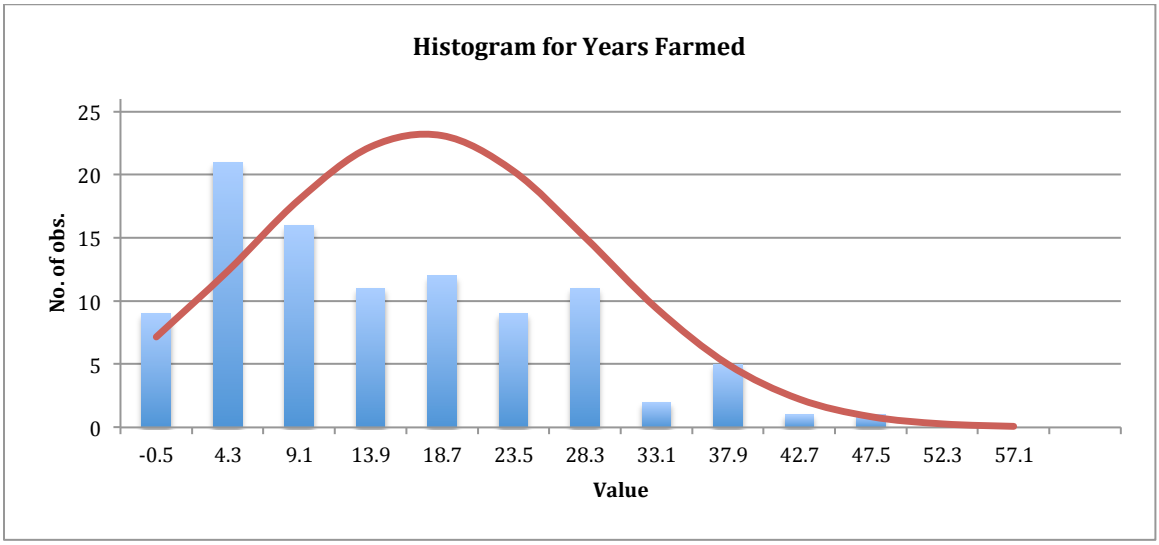
Farmer Age			
Count	97	*Skewness*	0.8328
Mean	38.80412	*Skewness Standard Error*	0.24244
Mean LCL	36.22742	*Kurtosis*	2.78092
Mean UCL	41.38083	*Kurtosis Standard Error*	0.47027
Variance	163.45082		
Standard Deviation	12.78479		
Mean Standard Error	1.2981	*Coefficient of Variation*	0.32947
Minimum	22.	*Mean Deviation*	10.3063
Maximum	70.		
Range	48.		
Sum	3,764.		
Sum Standard Error	125.91556	*Median*	36.
Total Sum Squares	161,750.	*Median Error*	0.16519
Adjusted Sum Squares	15,691.27835	*Percentile 25% (Q1)*	29.25
Geometric Mean	36.91033	*Percentile 75% (Q2)*	48.
Harmonic Mean	35.22285	*IQR*	18.75
Mode	#N/A	*MAD*	8.



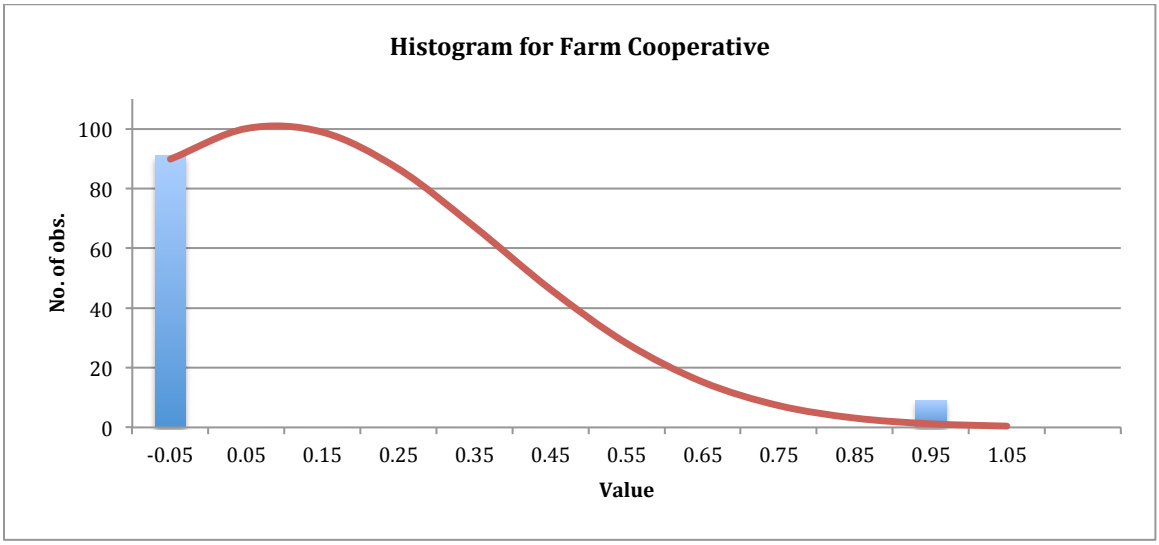
Crops Harvested			
Count	100.	*Skewness*	-0.12
Mean	3.33	*Skewness Standard Error*	0.24
Mean LCL	3.11	*Kurtosis*	3.12
Mean UCL	3.55	*Kurtosis Standard Error*	0.46
Variance	1.27		
Standard Deviation	1.13		
Mean Standard Error	0.11	*Coefficient of Variation*	0.34
Minimum	0.	*Mean Deviation*	0.9
Maximum	6.		
Range	6.		
Sum	333.		
Sum Standard Error	11.29	*Median*	3.
Total Sum Squares	1,235.	*Median Error*	0.01
Adjusted Sum Squares	126.11	*Percentile 25% (Q1)*	3.
Geometric Mean	3.13	*Percentile 75% (Q2)*	4.
Harmonic Mean	2.95	*IQR*	1.
Mode	3.	*MAD*	1.



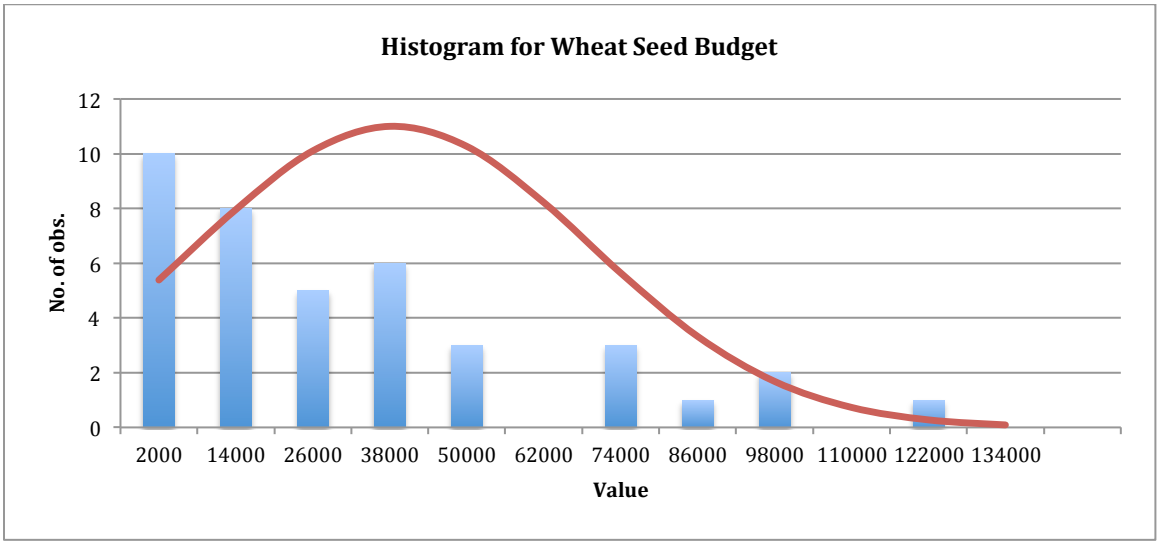
Years Farmed			
Count	98.	*Skewness*	0.67
Mean	17.42	*Skewness Standard Error*	0.24
Mean LCL	15.08	*Kurtosis*	2.48
Mean UCL	19.76	*Kurtosis Standard Error*	0.47
Variance	136.31		
Standard Deviation	11.68		
Mean Standard Error	1.18	*Coefficient of Variation*	0.67
Minimum	2.	*Mean Deviation*	9.87
Maximum	50.		
Range	48.		
Sum	1,707.		
Sum Standard Error	115.58	*Median*	15.
Total Sum Squares	42,955.	*Median Error*	0.15
Adjusted Sum Squares	13,221.85	*Percentile 25% (Q1)*	7.5
Geometric Mean	13.39	*Percentile 75% (Q2)*	27.5
Harmonic Mean	9.73	*IQR*	20.
Mode	10.	*MAD*	8.



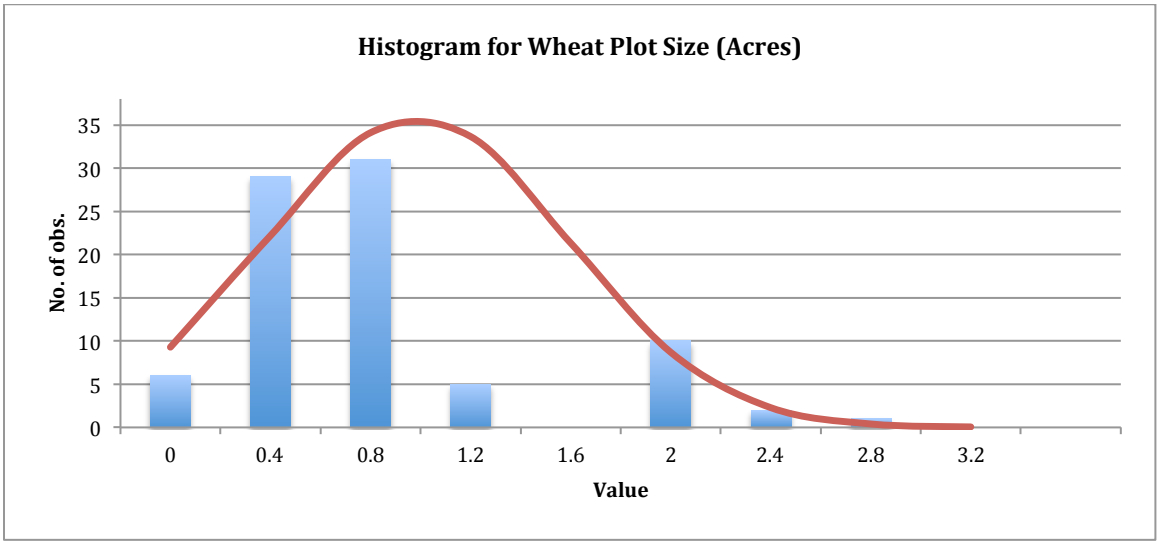
Farm Cooperative Membership			
Count	100.	*Skewness*	2.87
Mean	0.09	*Skewness Standard Error*	0.24
Mean LCL	0.03	*Kurtosis*	9.21
Mean UCL	0.15	*Kurtosis Standard Error*	0.46
Variance	0.08		
Standard Deviation	0.29		
Mean Standard Error	0.03	*Coefficient of Variation*	3.2
Minimum	0.	*Mean Deviation*	0.16
Maximum	1.		
Range	1.		
Sum	9.		
Sum Standard Error	2.88	*Median*	0.
Total Sum Squares	9.	*Median Error*	0.
Adjusted Sum Squares	8.19	*Percentile 25% (Q1)*	0.
Geometric Mean	1.	*Percentile 75% (Q2)*	0.
Harmonic Mean	11.11	*IQR*	0.
Mode	0.	*MAD*	0.



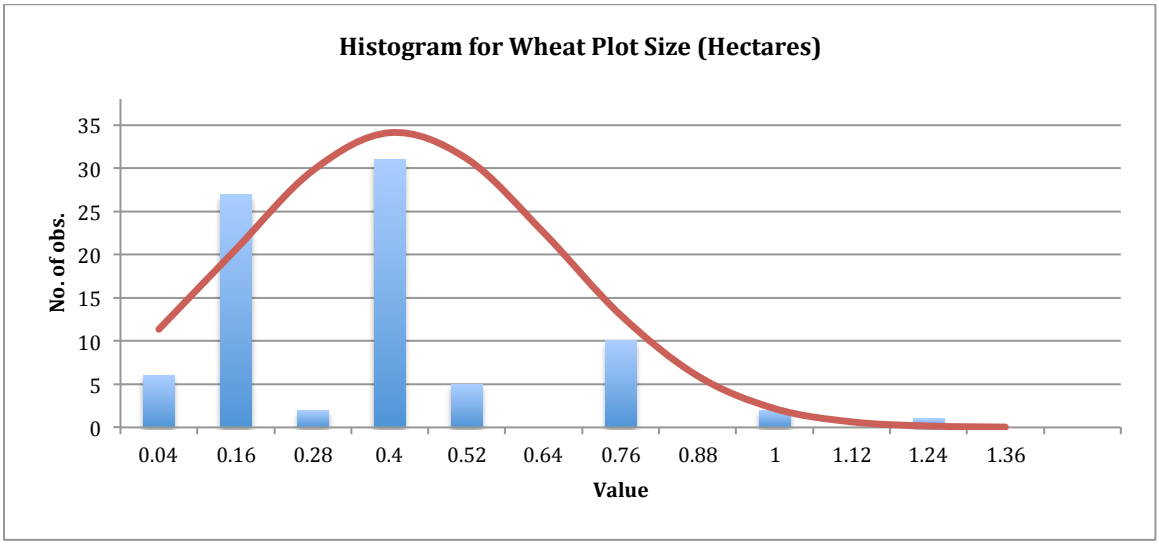
Wheat Seed Budget			
Count	39.	*Skewness*	1.18
Mean	38,628.21	*Skewness Standard Error*	0.37
Mean LCL	28,706.44	*Kurtosis*	3.56
Mean UCL	48,549.97	*Kurtosis Standard Error*	0.68
Variance	936,812,078.27		
Standard Deviation	30,607.39		
Mean Standard Error	4,901.1	*Coefficient of Variation*	0.79
Minimum	8,000.	*Mean Deviation*	23,894.81
Maximum	128,000.		
Range	120,000.		
Sum	1,506,500.		
Sum Standard Error	191,143.06	*Median*	28,000.
Total Sum Squares	93,792,250,000.	*Median Error*	983.61
Adjusted Sum Squares	35,598,858,974.36	*Percentile 25% (Q1)*	14,500.
Geometric Mean	28,792.74	*Percentile 75% (Q2)*	57,000.
Harmonic Mean	21,935.52	*IQR*	42,500.
Mode	#N/A	*MAD*	16,000.



Wheat Plot Size (Acres)			
Count	84.	*Skewness*	1.14
Mean	0.99	*Skewness Standard Error*	0.26
Mean LCL	0.86	*Kurtosis*	3.83
Mean UCL	1.12	*Kurtosis Standard Error*	0.5
Variance	0.36		
Standard Deviation	0.6		
Mean Standard Error	0.07	*Coefficient of Variation*	0.61
Minimum	0.25	*Mean Deviation*	0.43
Maximum	3.		
Range	2.75		
Sum	83.		
Sum Standard Error	5.51	*Median*	1.
Total Sum Squares	112.	*Median Error*	0.01
Adjusted Sum Squares	29.99	*Percentile 25% (Q1)*	0.5
Geometric Mean	0.83	*Percentile 75% (Q2)*	1.
Harmonic Mean	0.69	*IQR*	0.5
Mode	1.	*MAD*	0.5



Wheat Plot Size (Hectares)			
Count	84.	*Skewness*	1.14
Mean	0.41	*Skewness Standard Error*	0.26
Mean LCL	0.36	*Kurtosis*	3.83
Mean UCL	0.47	*Kurtosis Standard Error*	0.5
Variance	0.06		
Standard Deviation	0.25		
Mean Standard Error	0.03	*Coefficient of Variation*	0.61
Minimum	0.1	*Mean Deviation*	0.18
Maximum	1.25		
Range	1.15		
Sum	34.58		
Sum Standard Error	2.3	*Median*	0.42
Total Sum Squares	19.44	*Median Error*	0.
Adjusted Sum Squares	5.21	*Percentile 25% (Q1)*	0.21
Geometric Mean	0.35	*Percentile 75% (Q2)*	0.42
Harmonic Mean	0.29	*IQR*	0.21
Mode	0.42	*MAD*	0.21



APPENDIX C

MAPS OF TANZANIA AND THE SOUTHERN HIGHLANDS

Maps of Africa and Tanzania

Figure 28: Map of Africa and the Location of Tanzania

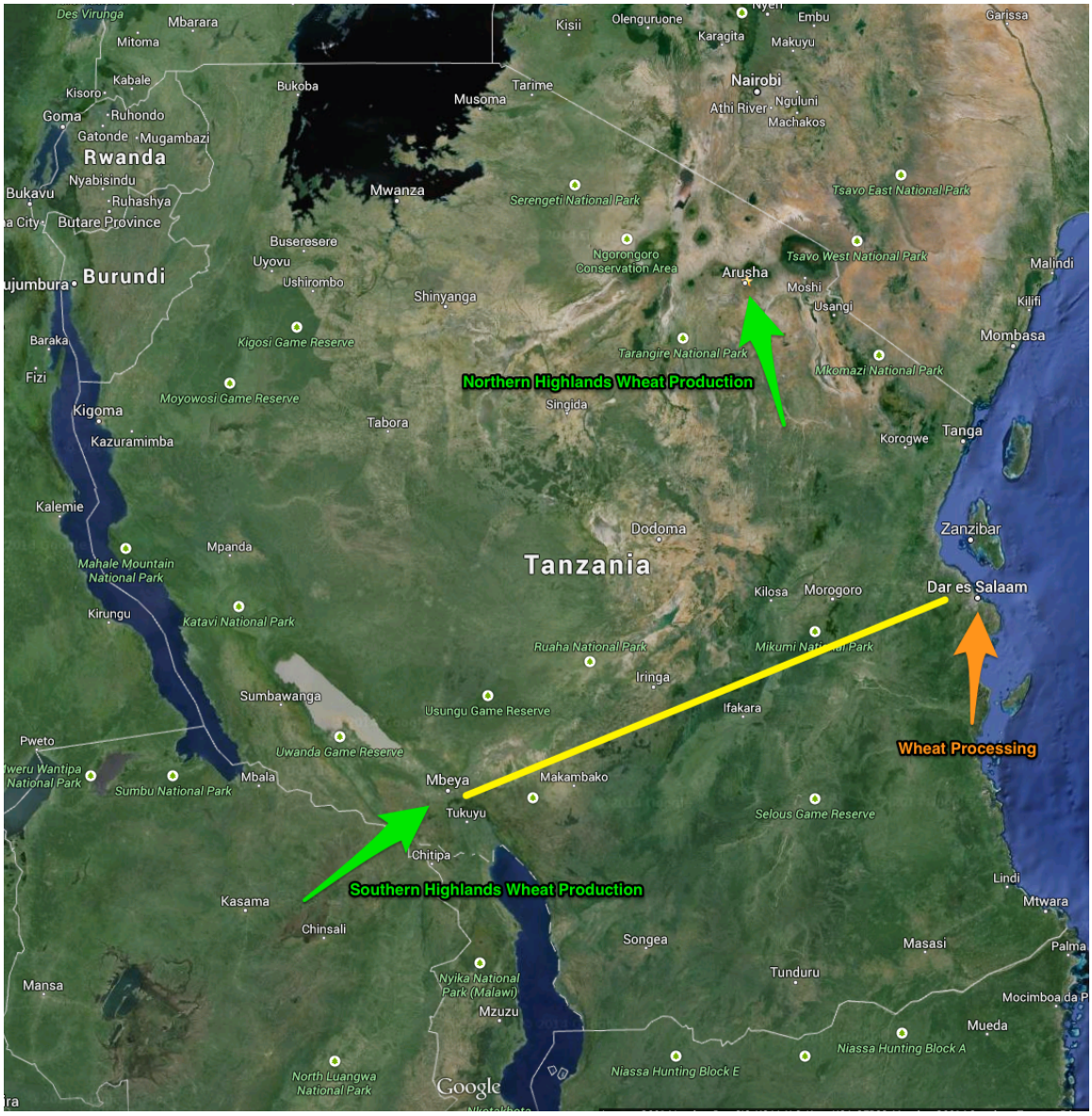


Figure 29: Map of Tanzania, the Highland Wheat Production Regions, and the Market in Dar es Salaam

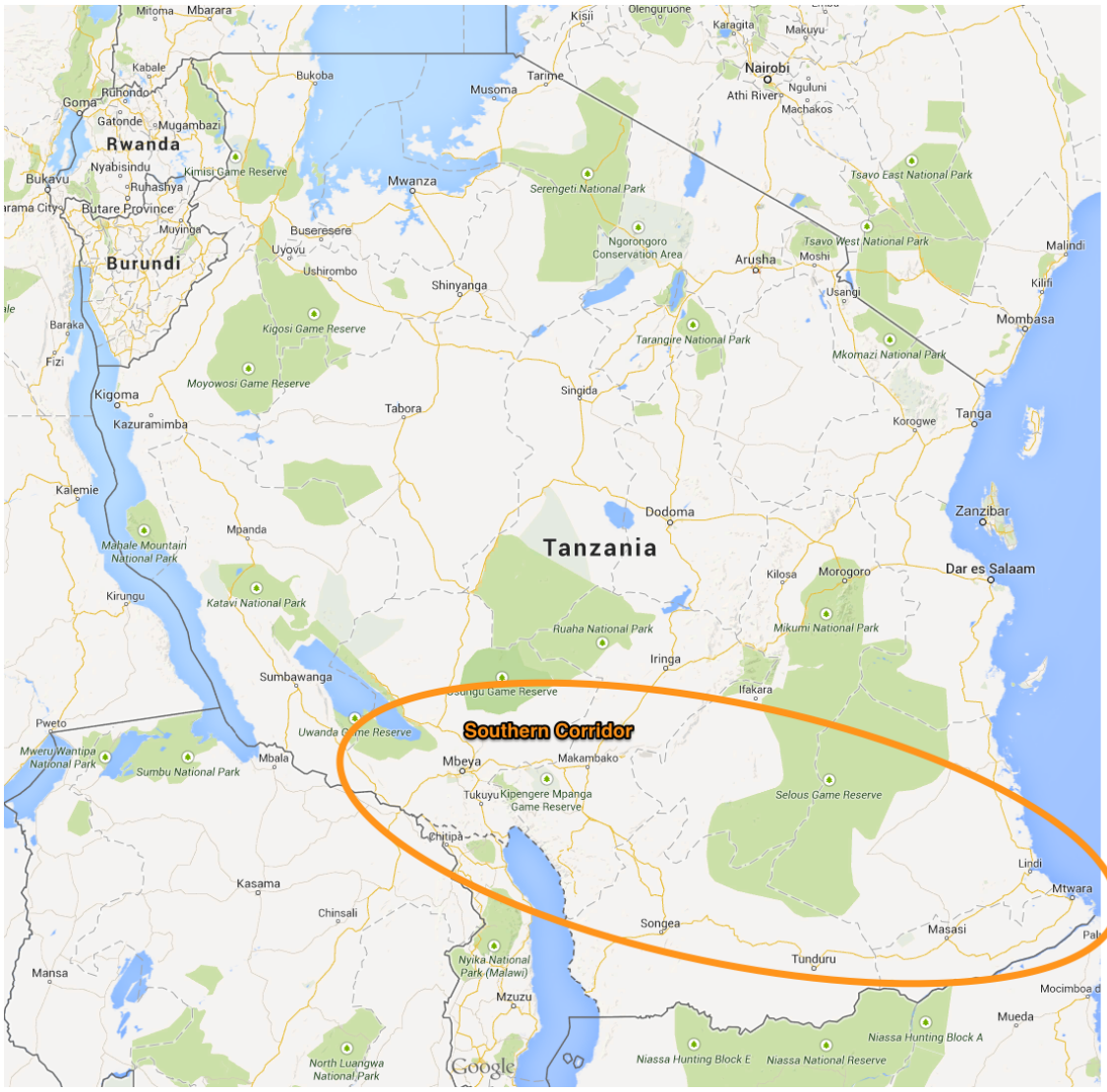


Figure 30: Transport Map of Tanzania and the Southern Corridor

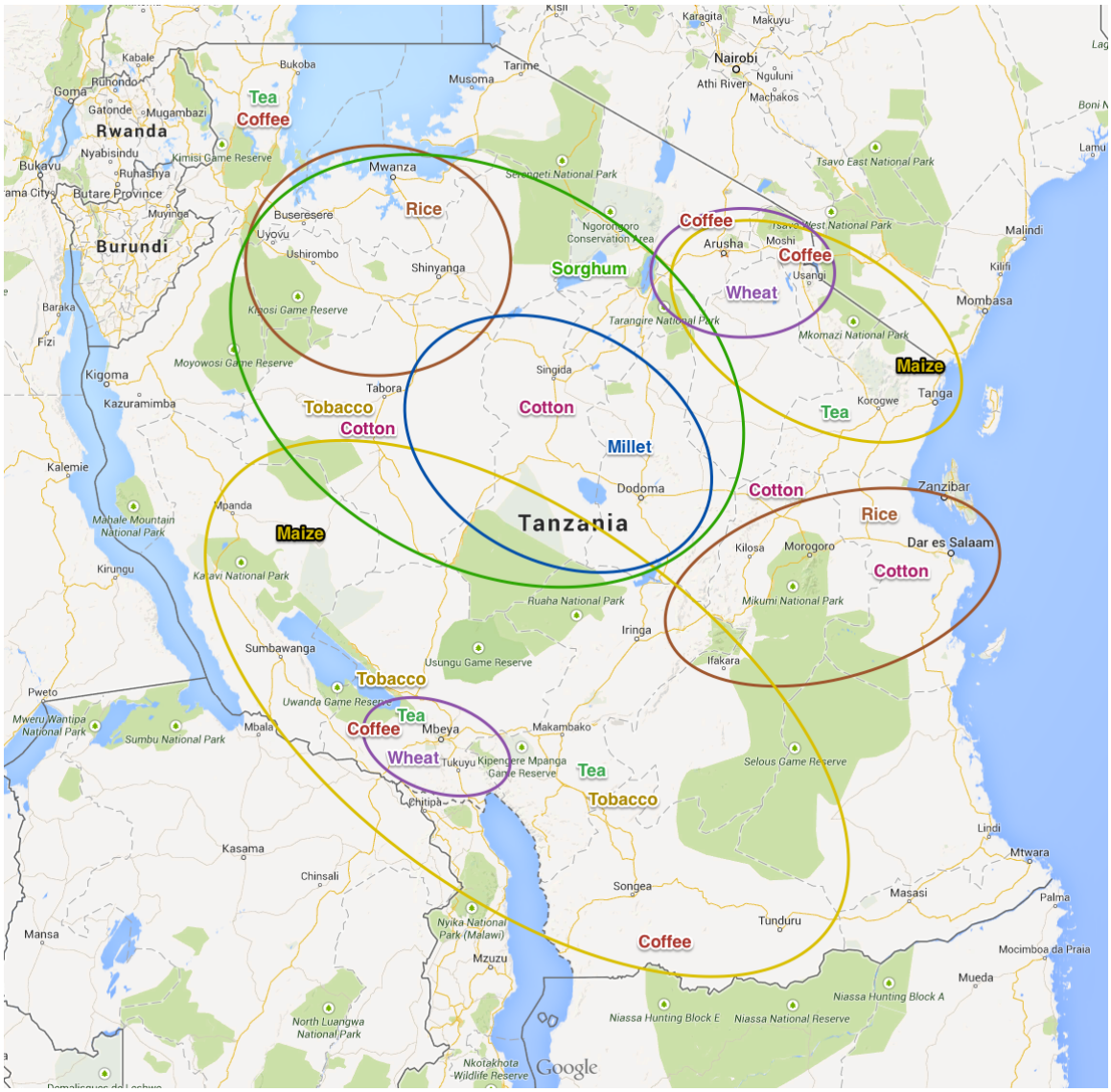


Figure 31: Agriculture Production Map of Tanzania Including Wheat, Maize, Rice, Sorghum, Millet, Coffee, Cotton, Tobacco, and Tea

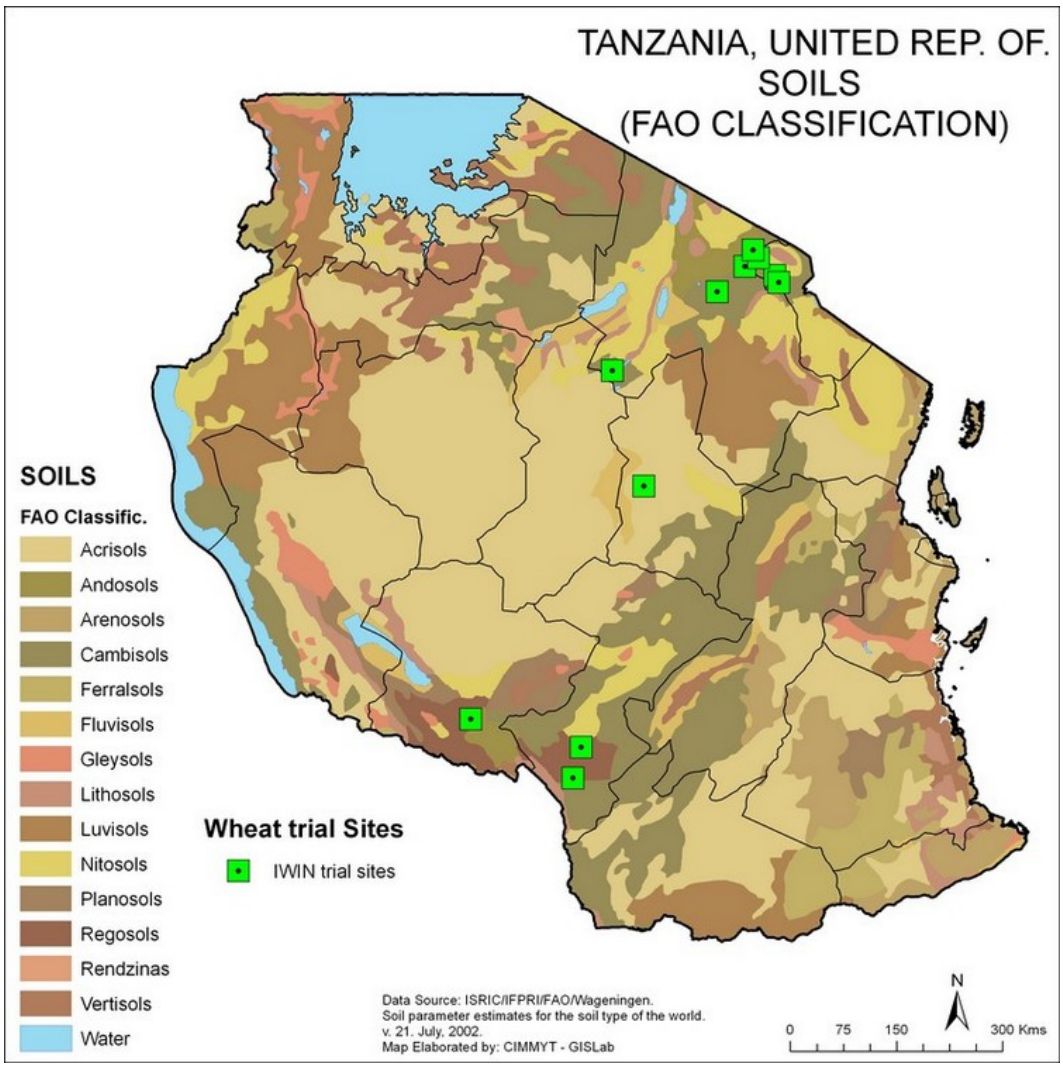


Figure 32: Soils Map of Tanzania (CIMMYT, 2014)

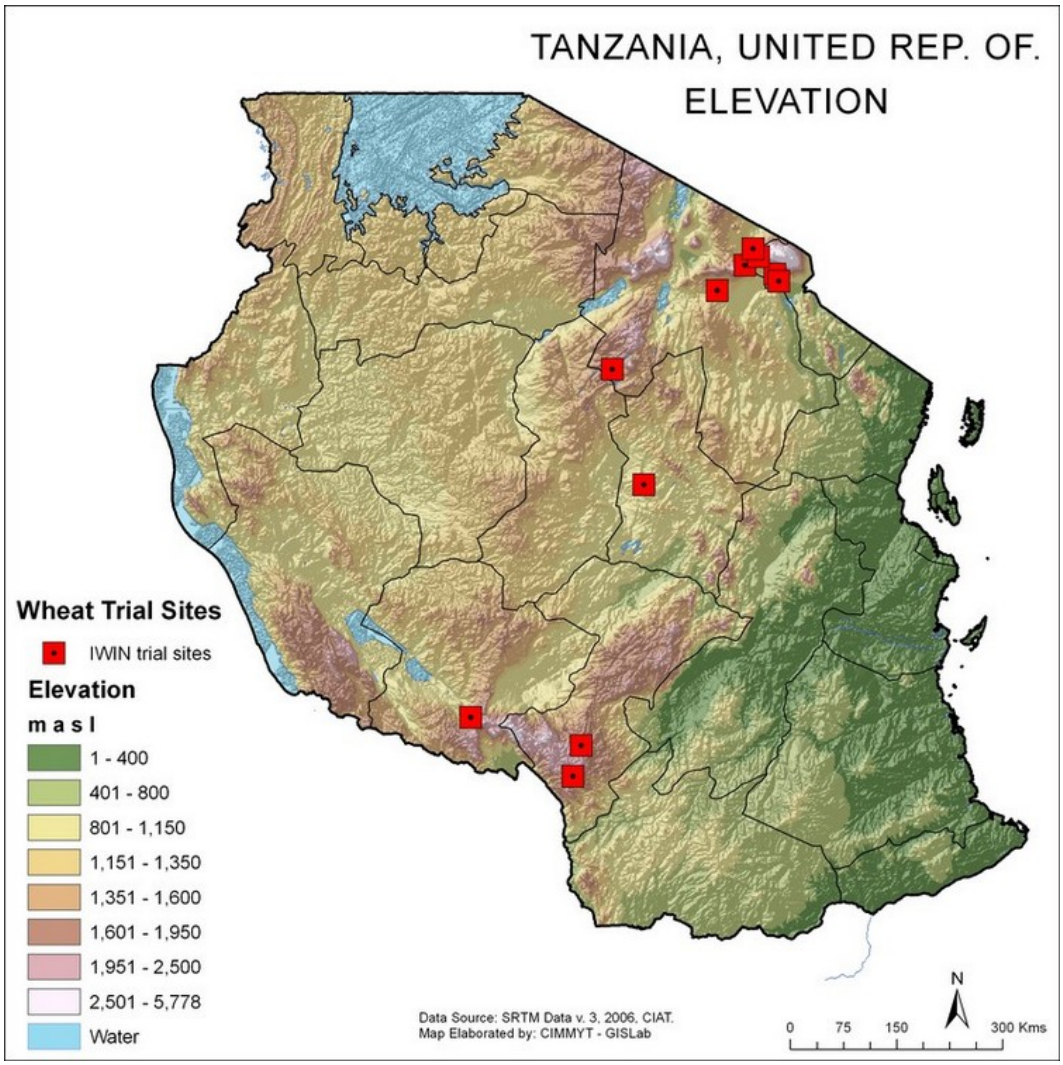


Figure 33: Elevation Map of Tanzania (CIMMYT, 2014)

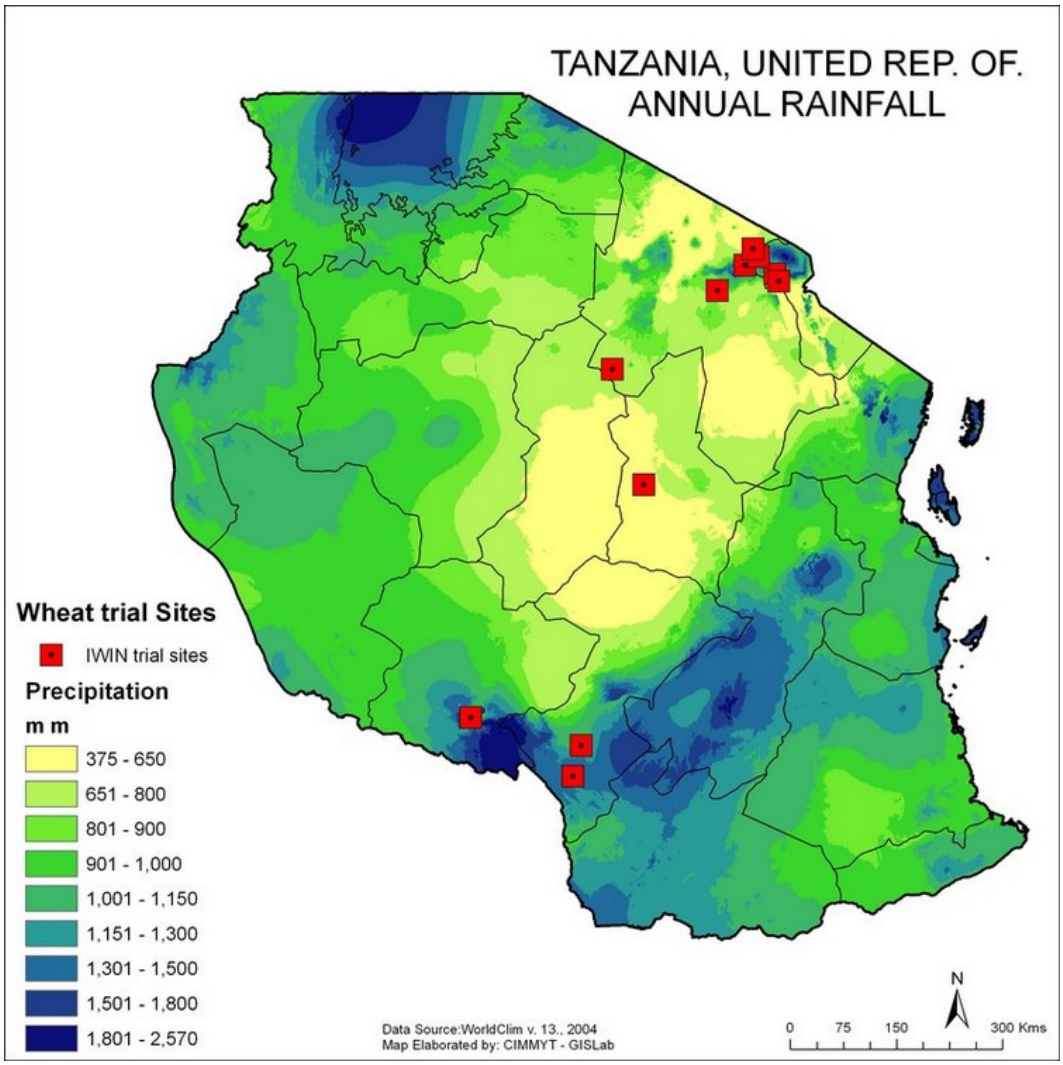


Figure 34: Rainfall Map of Tanzania (CIMMYT, 2014)

Map of the Southern Highlands

Figure 35: Southern Highland Wheat Production Areas around Mbeya

APPENDIX D

QUALITATIVE REPRESENTATIONS OF DATA

Key Findings and Themes from Institutional Respondents

Wheat Market and Chain

Legacy of wheat production in Tanzania
Wheat quality is critical
Wheat seed input market is priority for MOA

Population is increasing
Urbanization is increasing
Therefore utility of wheat increasing

Imported wheat is cheaper because of less quality

No coordinated wheat policy for Tanzania
Need to grow value chain as an institution
Collaboration is needed
between government and agribusiness

Wheat Value Chain
Pricing
Financial Services
Inputs
Production
Transportation
Processing
Marketing
Consumption

Many seed companies exist but they do not produce wheat seed
Currently, no interest from private seed companies on producing wheat
Official government seed systems are not effective

Smallholder farmers sell to middlemen with transport capacity
Smallholder farmers will produce more if they know there is a market
Smallholder farmers should have increased market access for equitable development

Difficult for companies and farmers to get capital
Good transport corridors for improved varieties and fertilizers

Processors should be connected to production
Processors (millers and bakers) selling cheap bread but low quality
No link between bakers and breeders and millers on variety improvement

Government cannot certify seed to levels of private sector for international trade requirements

Private sector has a problem with generics for agricultural inputs

Wheat Production and Agronomy

Increasing wheat production priority for MOA
No national programs to support wheat
Wheat historically had been a large-scale production crop

No research funding to maintain seed varieties
Wide availability is limited because multiplication is limited

Wheat production is increasing in the Northern Highlands
Mostly emerging farmers with between 15 and 20 acres
Northern Highlands system also includes sunflowers and the common bean

Challenges to wheat seed production
- Climate change makes difficult to predict farm needs
- Fertility – fertilizers remain expensive
- Diseases – fungal diseases
- Cold storage for maintaining plant lines

Smallholder farmers often recycle wheat for up to 6 seasons

Quality Declared Seed – Supervised and clean
Not much costs because it is within communities – No cost for transport

Challenges for farmers in Southern Highlands
- Dependent on rain for irrigation
- No significant problem with diseases
- Transportation and market access are biggest issues

Key Findings and Themes from Farmer Respondents

750 – 1250 mm of rain for wheat in the Southern Highlands
1700 meters at Mbeya – 2000-2200 meters in highland farms

Maize, potatoes pyrethrum, wheat, carrot, garden peas, cabbages, common beans
potato/wheat system
Planting potato in September and expect to harvest in February
Plant wheat February/March
Pyrethrum is only a cash crop wheat is for market and consumed at home

Wheat is divided in 3 portions.

1 - household
2 - seed
3 - market

If produce 10 bags, 1 for home consumption, .75 for seed, 8.25 for market

Businessmen buy crops
Middlemen collect to individual farmers at each farm
General price is known in the villages but the price comes from middlemen or the companies

No associations of wheat farmers in the area.
One farmers group for potato only
Only a few farmers belong to farmer group and for reason of collaborating with MOA and for development assistance through agricultural loans

Maize for food
Beans for food
Peas for food
Potatoes for market
Wheat for both food and market

All seed is broadcasted

No defined market but sell to local vendors.
Sometimes vendors come from town 11,000 Tsz/tin for local 12,000 Tsz/tin for Mbeya
Closer to harvesting price is low and then prices rise price for seed in December is 20,000 Tsz/tin
Get pricing from the vendors

For seed - general practices is to recycle from previous years
For fertilizer - buy from supplier in the village or from Uyole
Buy wheat seed from local market - only 1 of 5 farmers get quality
Farmers know they have a mixed varieties of wheat but they cannot afford new seed

During land preparation - family and hired labor
Harvesting requires hired labor

Major challenge is how to take produce from farm to homestead
Harvesting - no machinery to help with threshing

Only have small land so difficult to make plans for larger production

Juhudi variety good seed color, good for baking. 90 days to harvest
Juhudi is the preferred variety
Sifa variety - 120 days to harvest

No fertilizer ever used on wheat
Most seed is recycled seed
If a farmer goes to Uyole then the rest of the community will try and get seed from him.
10 bags (1st year) - 8 bags (after 3 years) but no fertilizer is being used.

Rust is the biggest problem. Can decrease up to half of the crop
Changes from season to season depending on the weather.

Plans for future include increase in land size (capital is limitation) and use fertilizer
Lack of knowledge on improved fertility practices and improved seed
There is a supply store in the local community but only sells - does not advise

Some farmers attend trainings from MOA

During harvesting it is difficult to get labor - 12000 Tsh to fill 1 bag
Cheaper to grow potatoes

December - plant many crops - peak period too many things to do
Sow wheat in February but also need to weed potatoes and so just broadcast because it is less time intensive
Not a choice between wheat and potatoes but what they emphasize with inputs

Many people are growing wheat - almost every farmer grows wheat - dual purpose - eat and sell
Wheat can be stored to wait for good price as opposed to cabbage or more perishable crops
Several middlemen come but it is all usually one price depending on time of year

Ag extension officer covers two villages
Approximately 400 households in this village

Majority of farmers have animals but mix varies between cattle, goats, pig
Every household has chickens

Wheat is a short maturity crop but it is for market and it is inflexible crop - multipurpose
It is cheap to produce wheat
Wheat is the “bank account” - stored value for producing potatoes (potatoes are a chemical intensive crop)

Wheat is a good food -chepati gives nutrition, eat in morning and stay on farm all day
Wheat products prevent disease
Can sell wheat throughout the year
Can protect wheat easily (unlike maize)
Wheat is important crop - before starting wheat production there were no houses with tin

roofs
Wheat allowed the farming communities to afford tin roofs
With wheat - more livelihoods
Wheat is the first cash crops
Potato is more recent
When just maize, life was very bad

There are ag extension officer but very low technology transfers
Farmers are anxious must improve practices research, demonstration, and extension projects

Key Themes from Institutional Innovation Analysis

Resources
Little to no incentive for private sector to invest resources in wheat seed production
No collaboration between value chain actors for support wheat value chain
Wheat processing and marketing is not connected to wheat production

Public sector is not providing technology or techniques to smallholder farmers
Public sector is maintaining juhudi and sifa lines of wheat but not improving them
Public sector is testing QDS system for smallholder farmers

Farmers invest labor, land, and capital in cash crops if they know the market is present
Farmers use wheat as a bank for improving their potato crop
Little pooling of farmer resources

Processes
There are no public-private partnerships to support wheat production or new wheat seed varieties in the Southern Highlands
There are no market systems for wheat in the Southern Highlands
There are no connections between processors and production
Wheat researchers and farmers have little knowledge of the requirements from the millers/bakers and the market

Extension support for wheat production is weak in the Southern Highlands – other priorities are on maize and potatoes
Extension support does not extend to other areas of the wheat value chain

There are no contract guarantees for farm production or established systems for delivery of farm produce to millers

Values
There is no coordinated government policy for a national wheat production program
Government has mixed motivations for supporting an increased wheat industry
The value chain has mixed motivations for increasing domestic production of wheat

Smallholder farmers place great value on wheat production but this is at odds with other actors and stakeholders in the value chain that have greater market power

There needs to be trust between the developers of technology for wheat seed and the users of technology for wheat seed – smallholder farmers. Currently there is little trust and understanding

Intellectual property rights are a new concept for Tanzania and there is little understanding by the industry and smallholder farmers how new plant variety protection legislations might impact the wheat value chain

APPENDIX E –

WHEAT IN THE SOUTHERN HIGHLANDS OF TANZANIA

Descriptor	CIMMYT datasets	GRIS dataset
Country (Y of release)	Tanzania (1987)	TZA:South (1987)
Variety name	Juhudi	JUHUDI
Synonym		CM-33682-0TAZ; CM-33682;
Wheat type	Bread Wheat	TR.AE
Growth habit	Spring	S
Semidwarf (Rht gene)	Yes	
Grain color	White grain	
Grain hardiness	Hard	
Pedigree	CEBECO-148/KATHADIN/7/HEINES-KOLBEN/MIDA-38/4/4777/3/REI//KENTANA-48/YAQUI-48/5/YECORA F-70/6/TUCAN	
Selection history	CM33682	CM-33682-0TAZ; CM-33682;
Breeding program		
Accession number		
CID (Cross ID)	7877	
SID (Selection ID)	0	
Origin	CIMMYT advanced line	
CIMMYT breeding line		
Genes		
Suitable megaenvironments	ME4A	
Notes		

Figure 36: Juhudi wheat variety description from CIMMYT (Permanent link: http://wheatatlas.org/varieties/detail/23560)

Descriptor	CIMMYT datasets
Country (Y of release)	Tanzania (2004)
Variety name	Sifa
Synonym	
Wheat type	Bread Wheat
Growth habit	Spring
Semidwarf (Rht gene)	Yes
Grain color	White grain
Grain hardiness	Hard
Pedigree	NL 456/Vee 'S"
Selection history	
Breeding program	
Accession number	
CID (Cross ID)	
SID (Selection ID)	
Origin	No Info
CIMMYT breeding line	
Genes	
Suitable megaenvironments	---
Notes	

Figure 37: Sifa wheat variety description from CIMMYT (Permanent link: http://wheatatlas.org/varieties/detail/26338)