A report for:

The development of integrated agrifood production systems that address socio-economic development in emerging economies

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Executive Summary

Developing countries that are emerging economies have an important role to play in international markets and global trade. The political and economic mandate of developing countries is to promote growth. The direction development has to be guided through policies that work towards trying to achieve a socio-economic environment that promotes rapid growth and foreign direct investment. The agrifood industry is a key economic driver and a major contributor to employment in developing countries. It makes it important that the focus should be on development in the sector to ensure the sustainability of food security, production, and trade. Developing countries have access to varied natural resources with varied risks to be managed to ensure long term sustainability of the land and the communities that inhabit that land.

Sustainable models of production are becoming more important in these countries to ensure that there is a balance between the economic, social, environmental and political needs and risks that are associated with production. Producers in developing countries require support and guidelines that will enable development at a regional level. There is a role for the government, guided by legislated policy, as well as agribusinesses that interact within the value chain. This study aims to address the opportunities in the development of integrated production models that address socio-economic and environmental development in developing countries.

Integrated production models can help address economic, social, environmental and political needs and risks by integrating production with innovation and development. The agribusiness sector has been challenged to address the human rights agenda whilst operating a business that will be profitable and sustainable. The production environment across value chains is faced with the globalisation of agriculture and the need to innovate to industrialise agriculture to ensure a sustainable and bankable market. Producers are also responsible for internal development to ensure that their business is sustainable.

Producers need guidelines to mitigate regional risks that stem from political agendas. This is prevalent in developing countries where there has been a shift in land ownership patterns, due to land reform systems that entail redistribution, restitution and tenure security for previously disadvantaged communities. To ensure continued foreign investment, producers need to operate businesses that do not infringe on labour rights and tenure to ensure the security of workers and surrounding communities.

Producers benefit from integrated models that optimize energy, alleviate the cost of production inputs and promote the recycling of nutrients. Integrated production systems should aim to ensure that nothing is wasted, and energy is preserved at the farm production level and that a viable ecosystem is maintained. Integrated models also open up land to diversified production streams that create separate cash revenue streams. Most importantly, integrated models promote the production of quality food and promote an increased quantity of food produced per hectare as well as opening up avenues for processing and packaging that production.

The opportunities for developing producers lie in the increasing demand for livestock products as a protein source in the human diet. Important skills include the ability to breed or raise animals and to produce animal feed or substrates, or animal products at the farm level. This

has fostered the development of crop-livestock systems as integrated innovations to optimise production on available or degraded land. Climate change has also led to innovations that produce energy from farming by-products which enable producers to operate off-grid or contribute to the regional or national grid as energy producers.

These sustainable approaches have allowed for the adoption of innovative practices and tools such as integrated pest management, manure management, agro-processing, stud breeding, precision agriculture and beekeeping. These practices manage risk at farm level, reduce producer's vulnerability to market-related risks, ensure food security, increase farm biodiversity, ensure employment opportunities, ensure carbon stock on the farm and improve the energy efficiency of farming production.

The development of sustainable models in developing countries where commercial agriculture is supported by different types of producers in different socio-economic situations needs to be addressed. Challenges include the skewed investment towards commercial monoculture agriculture which includes large cooperation’s and large commercial farmers which has left a gap in development and the absorption of innovation.

This study aims to highlight integrated production models that promote socio-economic conditions aligned with the United Nations Sustainable Development Goals (SDG) and the United Nations Guiding Principles for Business & Human Rights. It will also note the role of the government in guiding proposals for policies that aim to address development in the agrifood sector.

Table of Contents

Foreword

As a first-generation farmer from South Africa, I have learned many lessons that have caused me to reflect on the current state and potential of agriculture in developing counties. An agrarian mindset is based on generational knowledge of the land and natural resources as well as the ability to adapt to innovations that promote sustainable and cost-effective production. The current war to save the earth has put a spin on the question of how we intend to continue feeding billions of people. The ability to feed people is coupled with the socio-economic situation of the producer and the environment in which a producer finds herself in.

Originating from a country which is 24 years into democracy, and which is still mending the integrity of the social conditions in which the majority find themselves. It is evidently difficult for young people or first-generation farmers to be able to break the glass ceiling to enter the agricultural sector. In order to solve the injustices of the past regime, where agrarian communities were displaced to arid and barren land, land reform has been a tool used in developing countries to redistribute land, relocate communities and offer parcels of land for production to smallholders and potential large-scale commercial farmers.

The process of land reform has presented challenges that have the potential to affect a country's economy and stability. A clear example is how land reform was implemented in Zimbabwe, a country which was once the breadbasket of Africa. On a visit in December 2018, I witnessed a country struggling to maintain supplies of food basics like flour, fruit concentrates and cooking oil on store shelves, due to the economic situation. The political agenda and backlash have overshadowed the real implications of taking large parcels of land from individuals and giving access to many on that same piece of land. On the ground, it is clear that the country is rebuilding itself at the hands of many smallholder producers, subsistence farmers, first-generation farmers, and commercial farmers.

The Locke Family, Zimbabwe

A visit to Helen Locke in Marondera, Zimbabwe, in 2016 inspired this paper. The Locke family lost three-quarters of their 4,500ha farm during the land reform process which began in 2008. Around 450 families moved onto the land and Helen and her brother Andrew decided to stay on the remaining piece of land. The Locke's decision was to begin to communicate and build relationships with the locals that were relocated to the land under a political mandate. The Locke family decided to build the relationship by transferring skills, such as maintaining and using tractors which were donated by Brazilian NGO's, offered inputs on credit to the farmers and introduced innovation and diversification.

The 4,500ha farm which was previously owned by one family was now home to nearly 450 families who now were producing crops such as maize, soybeans, livestock such as cattle and sheep and niche products such as blueberries and peas for export markets. The Locke family contributed to the socio-economic stability on a regional basis and the families served as agricultural units who manage resources in a cyclical nature, sharing the resources. The development of an integrated farming approach was the key to the success of this land reform example.

Innovations such as integrated pest management, the management of manure, intensive breeding practices, milking of livestock and processing of fruit and vegetables were introduced skills that enabled those in production to maintain quality and enter into a formal market. To me, this was a clear example of how information can bring about transformation to people who desperately need and want it. It was the pivotal point that made me passionate about developing people and expanding their knowledge so they may access techniques that could enable them in their environment without being dependent on anyone but themselves.

Definitions

Land Reform

Land reform is a political process which involves the changing, modification or replacement of laws, regulations, institutional arrangements or customs regarding land ownership and use of land. Land reform consists of the following processes: redistribution, restitution with the aim to change relationship within and between diverse communities. The processes have taken different forms in different regions with the aim to either evenly distribute land or to correct historical injustices.

Emerging Economies

Emerging economies are countries that are moving away from their traditional markets such as primary agriculture and the export of raw material; and now are rapidly industrializing and adopting a free market or a mixed economy through investing in more productive capacity. This display of rapid growth is coupled with some volatilities such as the risks associated with the political, monetary, and social environment. Leaders of these economies want to create a better quality of life for their people. Emerging markets are synonymous with terms such as emerging economies or developing countries.

Integrated Farming

Integrated Farming is a farming system where high quality organic food, feed, fibre and renewable energy are produced by using resources such as soil, water, air and nature as well as regulating factors to farm sustainably and with as little polluting inputs as possible. The focus is on integrated management of the role and functions of agro-ecosystems and nutrient cycles, which are balanced and adapted to the demand of the crops, as well as the health and welfare of all livestock on the farm. This integration is driven by principles such as preserving and enhancing soil fertility, maintaining and improving a diverse environment and the adherence to ethical and social criteria. Crop protection takes into account all biological, technical and chemical methods, which then are balanced carefully and with the objective to protect the environment, to maintain profitability of the business and fulfil social requirement

Integrated Agricultural Production Systems

Integrated agricultural production is a mixed enterprise approach to farming that uses natural resources through the combination of crop and livestock inputs and outputs to promote environmentally beneficial farming practices (Hendrickson et al., 2008, Boller et al., 2004). A major benefit of integrated agricultural production is its inherent ability to distribute, and thereby minimize, farmer risks through the diversification of enterprises, allowing farmers to exploit a higher spectrum of marketing channels (Hendrickson et al., 2008).

Objectives

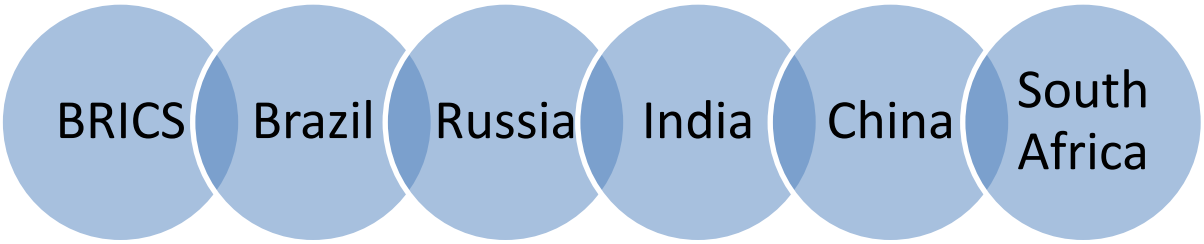
The objective of this paper is to highlight the opportunities and challenges that integrated production systems present in developing countries in cases of land reform. Such systems present a method of mitigating production risks that may be associated with the socio-economic and political circumstances of that country.

Key objectives:

1. Define an emerging economy and a developing country.
2. Identify the socio-economic and political parameters in developing countries.
3. Highlight the successful integrated production systems observed in developing countries.
4. Identify the opportunities and the challenges around implementing integrated production systems in developing countries.
5. Identify the reasons why and how producers adopt integrated farming practices at farm level.
6. Highlight the contribution that integrated production systems make towards sustainable production.
7. Highlight the implications of national policy on the adoption of integrated farming practices on a regional level.

Chapter 1: Introduction

1.1 Key Emerging Markets



In the recent decade, emerging markets and economies have become more important because they drive growth in the global economy. The main emerging markets are BRICS countries (above) which consist of Brazil, Russia, India, China, and South Africa. The main powerhouses are China and India which are home to 40% of the world's total labour force and population. China and India's combined economic output of $32.6 trillion was greater than either the European Union $20.9 trillion or the United States $19.4 trillion in 2017.

The Morgan Stanley Capital International tracks the market capitalization of every company listed on the countries' stock markets and based on this data there are 23 countries listed as Emerging Markets. They are Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Qatar, Peru, Philippines, Poland, Russia, South Africa, South Korea, Taiwan, Thailand, Turkey, and United Arab Emirates. Other sources also list another eight countries which are Argentina, Hong Kong, Jordan, Kuwait, Saudi Arabia, Singapore, and Vietnam.

1.2 Economic Characteristics of Emerging Economies

Emerging economies are defined by these key characteristics:

1.2.1 Lower-than-average per capita income

The World Bank defines developing countries as those with either low or lower middle per capita income of less than $4,035. Low income provides an incentive for rapid growth.

1.2.2 Rapid growth

Leaders of emerging economies have the pressure to improve the lives and living conditions of the citizens of their country thus they have to make drastic changes in order to stay in power and to help their people. The easiest way to achieve this is by developing an industrialized economy that can employ as many people as possible. The economic growth of most developed countries, such as the United States, Germany, the United Kingdom, and Japan, was less than 3% in 2017 while developing countries such as China, Turkey, and India saw their economies grow by around 7%. This displays the potential for growth in a developing environment.

1.2.3 High volatility

Rapid social change leads to high volatility. Examples of changes that result in volatility are natural disasters, external price shocks, and domestic policy instability. Traditional economies that are conventionally reliant on primary agriculture are especially vulnerable to natural disasters, such as earthquakes in Haiti, tsunamis in Thailand, or droughts in South Africa. Emerging economies are vulnerable to unpredictable currency fluctuations due to currency influence by international markets. Developing economies are also susceptible to commodity fluctuations, such as crude oil which affects fuel prices. This occurs as emerging economies do not have enough influence on developed nations and their policies. This influence occurred when the United States of America subsidized corn ethanol production in 2008, which caused oil and food prices to rise steeply. This event caused major social disruptions in emerging economies which lead to protests and riots in South America. Another example is the AGOA agreement set out by the United States of America with South Africa which saw the input of cheap chicken products which crippled the local poultry sector in South Africa.

1.2.4 Foreign direct investment

Rapid growth requires deep investment capital, but the capital markets are less mature in developing countries than the developed markets. Developing economies do not have a long track record of foreign direct investment, so it is often difficult to get information on companies listed on the stock markets. It may also be difficult to sell debt, such as corporate bonds on the secondary market. All these components raise the risk. This implies a greater reward for investors willing to do ground-level research in developing countries.

1.2.5 Higher than average returns of investment

There is a higher-than-average return for investors as emerging economies have an export-driven strategy. There is a demand locally for staple foods which leads to the production of low-cost consumer goods and commodities for developed markets. Producers that are able to export consumer goods will profit more, due to the fact that they will be earning foreign currency. This translates into higher stock prices for investors and a higher return on bonds which means that it costs more to cover the additional risk of emerging market companies.

1.3 Political characteristics of emerging economies

To enable economic development, it is important to minimize political as well as social tensions that cause instability in a country. Land in developing countries is an important resource, as it relates to economic stability and social security. Land and natural resources are a major driver of political stability, as many developing countries have gone through periods of land reform as a political tool to correct historic injustices. This includes restorative justice to communities and individuals who were displaced from productive land to arid land for political reasons and led to the need to redistribute land to communities that need access to economic stability. Agriculture and mining are the key activities in developing countries that rely on land as a resource for economic benefit. Agriculture plays a huge role in the development and employment of people in developing countries and thus the development of the agricultural sector is important in the political and social contexts.

Zimbabwe is an example of a country where politics have played a major role in the once-booming agricultural industry. From 1980, when Zimbabwe achieved independence until the early 2000s, Zimbabwe was the breadbasket of Africa, producing a higher agricultural output than any other country in Africa. This is solely because agriculture and politics were separated, and politicians had no control as agriculture was an independent body. In the early 2000's the political party ZANU-PF led by President Robert Mugabe started losing ground to the opposition party MDC which was led by the late Morgan Changurai. This forced Mugabe to react as his dictatorship was under threat. After 23 years of independence, Mugabe decided to bring about the Land Reform Policy to lure voters to ZANU-PF and strengthen the party which resulted in war veterans, ZANU-PF officials and the military grabbing productive farms from commercial farmers. This resulted in the collapse of the independent state of agriculture, because politically affiliated individuals benefited from the possession of these farms and intermediate communities did not benefit. This is an example of how politics can affect agriculture. The failure resulted from the political circumstance and was not a desirable economic outcome.

1.4 Social characteristics of emerging economies

Farming and food production have been an economic activity that has both a social condition and a way of life in developing countries. The social factors that influence agriculture in developing countries vary from region to region. The main direction of decision making for leaders of developing countries is the aim to reduce poverty and promote social and economic development in order to improve the economic conditions of the population, as well as maintain the health and well-being of people.

Factors that affect the socio-economic situation in developing markets include geopolitical relations, agricultural policy, social and labour significance of agriculture, poverty, and quality of life. Developing countries share a unique problem when it comes to issues pertaining to women and youth as they struggle to have access to and control over productive assets, inputs, information, and market opportunities are marginalized when it comes to participation in the agricultural sector.

1.4.1 The social and cultural context of land

Societies and cultures regard land not only as an economic or environmental asset but as a social, cultural and collective source of wealth. Land remains an important factor in the construction of the social identity of communities, as well as in the organization of religious life and the production and reproduction of culture. These are dimensions that development must address if prescriptions for change are to be implemented in a holistic manner. It is important to identify the values which the people with communities ascribe to the land in order to identify a central value system. The land value systems with developing communities will dictate the current needs of the people and the trajectory in which policies must head, to ensure that the rights of the people are maintained and to ensure that productive communities will be sustained for future generations.

1.4.2 Gender

Women play a huge role in agriculture and food security at the household level. In developing countries, women spend around 98% of their salary on the household compared to 60% by men, which makes women directly responsible for their family's well-being. Women are at the forefront of ensuring that the family unit is in a situation where they have safe and nutritious food to consume. On average 43% of the agricultural labour force in developing countries are women with 50% of the labour force in sub-Saharan Africa being women (FAO, 2012).

The system of patriarchy which dominates social organization in most developing countries tends to discriminate against women when it comes to ownership and control of land resources. This has been re-enforced by imported land law that has tended to cement the system of patriarchy, by conferring title and inheritance rights upon male family members. This means that women, especially married women, can only access land through their husbands or male children. Consequently, women who participate in agriculture and who live in rural areas have less access to productive resources and opportunities.

This male bias in the agricultural system and its supportive tools creates a "gender gap" which is present for many assets, inputs, and services, and has costs for the larger agricultural economy and society as a whole. In addition, because of the ways in which gender inequalities structure employment, remuneration and tenure relations on farms, women may not be able to opt for alternatives to equity schemes or to control the dividend payments that emanate (where they do) within their households.

For government policies, private sector and NGO's to redress gender imbalances in landholding and use, it is necessary to deconstruct, reconstruct and reconceptualise existing rules of property in land under both customary and statutory law in ways that strengthen women's access and control of land while respecting family and other social networks. The United Nations Sustainable Development Goals identifies Gender Equality as a major developmental goal for the future. There have been commitments made in Africa by the AU through the 2003 Maputo protocol to the ACHPR on the Rights of Women in Africa and the 2004 Solemn Declaration on Gender Equality in Africa. These commitments call for action to address gender inequalities including women's unequal access to land. This is important as women remain the primary users of agricultural land in rural communities.

1.4.3 Youth

There has been a deceleration for the promotion of the psychological and professional preparation of the youth to participate in agriculture. Due to the nature of urbanisation, the young have been disenfranchised in rural spaces and thus the only opportunity for youth to find a means to employment is to migrate to urban spaces. There are increasing and more appealing work opportunities outside the agricultural sector, such as in the growing service industry. There are not enough strong policies in developing countries that allow investment opportunity or intervention that focus only on rural and semi-urban youth employment opportunities in the rural and urban agriculture and agribusiness sectors.

Chapter 2: Overview of integrated production systems in emerging economies

Integrated production systems use outputs or by-products and services of one production component as an input to another section within the production unit. These kinds of agricultural systems include agroforestry, integrated crop-livestock, rice-fish, food-energy systems, and aquaponics. There is a demand for innovation to be explored and introduced so that the production environment can remain competitive within the agrifood sector in order to remain responsive to mitigating factors that occur in developing countries. The new millennium approach for agriculture production systems in developing countries must be an integrated one where the efficiencies and the economies of production will come by sharing land space, labour, management, services, professionals, products and by-products utilization, and infrastructures for the production of multiple commodities.

In integrated production systems, the sharing of resources creates horizontal integration; and limited or degraded natural resources are efficiently allocated over space which creates vertical integration. In integrated production systems, the production components of the farm are mutually supportive and mutually dependent. Integrated production systems are cyclical in nature as there are a large number of interactions between their components, and resource competition is a key characteristic. *An important feature of integrated production systems is that the total production from the system is more important than the yield and/or efficiency of any individual production component.*

2.1 Principles of integrated agricultural systems

Agriculture has been very successful in addressing the food and fibre needs of the population in developing countries. There are increasing concerns about the economic, environmental and social costs of feeding people which integrated agricultural systems can address while increasing sustainability. A main feature of sustainability is the ability to adapt to future challenges. Developing countries face social, political and environmental challenges that are risks to the development and growth of the economy, especially when agriculture plays a vital role in job creation. This paper reviews the potential for, and challenges to, integrated agricultural systems in emerging economies.

The nature of integrated agricultural systems is that they possess multiple innovations that interact in space and time, resulting in a synergistic resource transfer among enterprises. The design of integrated agricultural systems is that the innovations are managed in a dynamic manner. The philosophical difference between dynamic-integrated agricultural systems and integrated agricultural systems is in the management philosophy that guides the outcomes of production. In an integrated agricultural system, management decisions, such as the type and amount of products to produce, are predetermined by management. In a dynamic-integrated system, decisions are made at the most appropriate time and space using the best available knowledge to the producer.

2.2 Types of Integrated production systems

2.2.1 Agroforestry

Agroforestry is the practice of integrating crops and/or livestock with trees. Agroforestry is the collective term for land-use systems and technologies in which woody perennials (e.g. trees, shrubs, palms or bamboos) and crops or grasses and/or animals are used deliberately on the same parcel of land in some form of spatial and temporal arrangement (Choudhury and Jansen, 1999). This integrated method is a form of diversification that can enable a producer to increase resilience to market fluctuations that may result from the impacts of climate change and consumer influenced market changes. An observation of this practice was made in Brazil in states such as Matto Grosso, Para, and Minas Gerais.

Most producers are dynamic in their response to variations in climate and markets, thus agroforestry is becoming a useful practice and is being adopted by farmers who intend to have a medium to long term investment by integrating high-value trees on farms. This autonomous adaptation process is unique in different regions as different tree species have different values in regions. Successful agroforestry systems take into context the social, cultural and ecological circumstances of that region. The tree species that is chosen depends on human needs and capabilities and on the prevailing environmental, cultural and socio-economic conditions. Regions in Sub-Saharan countries value tree crops for industrialised uses like making paper and timber while other regions in Brazil see value in trees that produce high-quality furniture.

Agroforestry diversifies and sustains production for increased economic, social and environmental benefits for land users at both the farm and landscape levels (Alao and Shuaibu, 2013). This makes it a valuable and cost-effective climate-smart production system.

There are three main types of agroforestry systems can be identified depending on the components associated with the trees: agrosilvicultural systems, silvopastoral systems, and agrosilvopastoral systems.

2.2.1.1 Agrosilvicultural system

An agroforestry system of land use in which trees and shrubs are grown with herbaceous food crops, pastures, and animals.

2.2.1.2 Silvopastoral system

An agroforestry system of land use where there is a combination of forestland or woodland for both wood production and animal production by grazing off the co-existing indigenous forage, or vegetation that is managed like indigenous forage.

2.2.1.3 Agrosilvopastoral system

An agroforestry system of land use systems where there is a combination or deliberate association of a woody component (trees or shrubs) with crops and animal husbandry on the same site and used to solve immediate domestic needs, to provide for local needs, and also to alleviate the pressure on natural forests.

2.2.2 Challenges and opportunities in agroforestry

The adoption of agroforestry has been constrained by a lack of regional policies that can guide and incentivise producers to adopt this method. Extensive research is being conducted and is contributing to a wide range of scientific papers and institutes that support this practice. The FAO has published a guide to advancing agroforestry on the policy agenda, with case studies of best practice which can be a guide for national policymakers. The World Agroforestry Centre (ICRAF) is leading research on tree varieties and how they can improve soil quality, complement specific field crops, and generate new income streams for smallholders and producers.

A 12-year ICRAF study based on farming systems in Malawi and Zambia displayed the potential benefits of on-farm trees and their ability to replenish nutrient-depleted soil. The results of the study showed that planting the Gliricidia tree variety acts as a fertilizer tree alongside maize crops. Gliricidia is effective at drawing nitrogen from the air and fixing it in the soil, reducing the need for large doses of synthetic nitrogen fertilizers. The leaves shed by the Gliricidia trees also replenish the soil, increasing its structural stability and capacity to store water. The Gliricidia tree improved the stability of harvests of the maize produced in sub-Saharan Africa.

Another indigenous African acacia, Faidherbia acts a fertiliser tree, due to its unusual phenology. The Faidherbia tree goes dormant and sheds its nitrogen-rich leaves during the early rainy season, when cash crops are being planted, and resumes leaf growth in the dry season. That means Faidherbia fertilises crops at a useful time, but does not compete with them for light, nutrients or water. Research studies by ICRAF have found Faidherbia-maize inter-cropping increased maize yields by as much as 400% in one area of Malawi.

Studies also show that trees used for these types of practices vary on a regional level depending on the environment and the localized need. There are often trade-offs that need to assessed and balanced, according to the objectives the producer is trying to achieve. These factors include soil fertility enhancement, erosion control, food production, wood production, and shading. Agroforestry is also a long-term investment, due to the nature of tree development, thus making the decision for producers who are resource insufficient difficult. Such producers would rather allocate land for cash crops instead of trees, due to the shorter return period and thus education is needed at the farm level in order to educate farmers on the trade-offs.

Measures such the PES, (Payment for Environmental Services) are used in countries such as Costa Rica, where the national forestry financing fund pays farmers to plant more trees on their farms. This has resulted in around 78% of farmers who have participated in the scheme increasing their income levels. Farmers will start to realise the importance of such practices once they have access to markets and better access to supply chains which can help producers realise financial rewards from their improved productivity. Opening and organizing markets of indigenous tree crops and products also plays a role to interest farmers in planting such trees. There is documented proof that there is potential for agroforestry, however issues such as insecure land tenure and forest codes can discourage farmer's investment in trees in developing countries.

2.3 Integrated livestock–crop production systems

Integrated crop-livestock systems are found in all regions of the world and account for the main part of livestock production (FAO, 2017). In 2010, integrated production systems generated close to 50% of the world's cereals and most of the staples consumed by poor people: 41% of maize, 86% of rice, 66% of sorghum, and 74% of millet production. These systems also produced the bulk of livestock products in developing countries (75% of the milk and 60% of the meat), and employed millions of people on farms, in formal and informal markets, at processing plants, and at other stages of the value chain (FAO, 2010).

Integrated crop-livestock systems are a dynamic response by producers where livestock is used to transform plant residues and by-products into edible high-quality protein and manure. Manure is important at the farm level in developing countries as it is a cost-effective organic fertilizer which can assist in increasing crop productivity. Sources of fertilizer are important for production in developing countries, as there are challenges associated with synthetic fertilizers in terms of accessibility and affordability.

2.3.1 Integrated rice-fish systems

A rice-fish system is the integration of rice and fish production in a rice field or rice field/pond complex where fish are grown concurrently or alternately with rice. Fish are can be purposely stocked (fish culture) or may enter fields naturally from surrounding waterways when flooding occurs (rice field fisheries), or a bit of both. Fish yields can range widely from 1.5 to 174 kg/ha/season depending on the type of rice-fish system, the species present, and the management employed (IRRI, 2017).

This method was observed in Los Banos, in the Philippines, where wild fish are encouraged to enter rice fields. The farmer makes entrances to rice fields through an opening or a low bund. The farmer attracts the fish by placing branches in the field which provide shelter for the fish or by placing buffalo or cow skins to attract catfish and eels. Wild fish are harvested and collected from rice fields by netting, hooking, trapping, harpooning, throwing nets, or by draining the field. As water levels fall, fish may be channelled into adjacent trap pond areas where they can be held alive until they are ready to be sold on local markets or are marketed live at farm level.

This method is highly variable in terms of input intensity and management practices but provides additional food and income by diversifying farm activities and increasing yields of both the rice and fish crops. Farmers must consider a few factors when undergoing this method such as water control. The rice fields cannot dry up while fish stocks are present, stocked fish may escape if the fields flood, deepened areas for the fish in rice field may result in less rice growing in that area and holding fish may dissuade farmers from using pesticides as the pesticides may poison the fish which would affect human consumption.

2.3.2 Integrated crop-ruminant systems

The method of placing grazing animals (ruminants) on land used simultaneously for crop production is commonly known as integrated or "zero-land" livestock production systems. This method of integration has several advantages and benefits which are; improved fertility of the

land through the return of dung and urine which cycles nutrients and organic matter through the system, the control of waste herbage or weed growth, the reduced use of herbicides, the easier management of cash crops, and increased crop yields per unit area. The dung and urine are often applied to the fields and help maintain soil fertility and structure. Animal waste can also be used to produce energy, in the form of biogas or dung cakes that can replace charcoal and wood. Livestock also serves as a buffer against crop losses in times of crisis, as they can be quickly sold for cash. The sale of animals and their products such as milk, meat, and offspring are important. This system also provides draught power for farm operations, transportation and pumping water which benefit the producer, thus making this integrated method efficient in resource utilization.

In developing countries, there has been an implementation of diverse types of livestock production systems such as open improved pastures, intensive feedlot systems, and extensive systems of smallholders. In Brazil and Kenya, the integration of plantation crops with livestock is a trend that many producers are trying with crops such as dates, rubber, timber, and oil palm. Producers are independently investigating measures of implementation and are continuously improving on these methods in order to find productive ways of introducing livestock to the plantations, without disrupting or influencing yields of plantation crops.

The system shows that feed sources can come from the undergrowth or ground vegetation which forms part of the ecosystem of plantation crops and this can be used for ruminant production. This is an advantage for the producer as undergrowth and ground vegetation are a cost-effective feed source that are freely available as compared to conventional, monoculture animal production systems and extensive animal production systems. An additional advantage to animal production is that the plantation canopy provides shade and is a wind or cold break for the animals which reduces stress on the animals. This is vital in areas that face extreme weather conditions.

One factor that is important to observe is the quality of undergrowth and botanical composition under the plantation crops, which can change due to factors such as light, soil type, crop age, species interaction, and agronomic management, making it difficult for producers to fully understand the complex interactions of the changing ecosystem of the undergrowth. The availability of undergrowth is essential for integrating ruminants into crop plantations and this type of production system has the advantage of diversifying income and controlling weeds.

Crop-livestock integrated systems can be classified in many ways, based on agro-ecological conditions, land size, type of crops and animals and their production focus, their geographical distribution, and market orientation. Integration can happen on farms, in situations where flows of nutrients and energy occur within the limit of the farm, or between farms. Agropastoral systems are an important type of integrated crop-livestock systems.

2.3.2.1 Agropastoral systems

Agropastoral systems are a unique approach to integrated crop-livestock systems. These systems occur in dryland or rain fed crop production areas where the livestock cover short distances. In pastoral areas in Kenya, livestock are the primary source of subsistence. The livestock graze on natural grassland areas and are not supplemented or fed on cultivated fodder. The pastoralists occupy arid and semi-arid regions that are not conducive to rain-fed

agriculture, and animals are often managed in mobile or transhumant systems (e.g. in the Nairobi, Kenya, central Asia and parts of South America). In some cases, as with the Fulani pastoralists in West Africa, the pastoralists manage their livestock using a transhumant system and have arrangements with crop farmers that allow the animals to graze on the stubble after harvests. The crop farmers benefit from the manure and urine which is left by the animals, thus allowing crop farmers to add manure to the field and increase soil fertility, while not heavily relying on fertilizers. In pastoral areas with higher rainfall, livestock herders also cultivate the land to produce additional food and income.

2.3.3 Integrated rice-duck farming

Integrated rice-duck farming is a dynamic farming innovation used in countries such as the Philippines and Vietnam. It is beneficial for resource-poor farmers to produce organic rice at a low cost. Duck raising on a small scale is a common practice in Asian regions and the integration of ducks in a fishpond is also practiced. This integrated method has displayed social, economic and environmental benefits on the farm level.

The method is to release the ducks into the field after 10-20 days of rice transplantation until the time of flowering. The integration of ducks creates a symbiotic relationship between rice and ducks yielding mutual benefits to both commodities. The ducks eat harmful insects and weeds which allow the producer to avoid the use of chemical pesticides and manual weeding in the rice field. These two factors are a major cost to farmers who grow rice as a commodity. The ducks benefit by eating a nutritious protein diet from eating insects and fibre from the weeds in the rice field. The paste urine of the ducks is a natural fertilizer to the rice crop reducing the use of chemical fertilizers. The continuous movement of the ducks in the rice field provides natural stimulation and aeration which increases the availability of nutrient elements like nitrogen, phosphorous, and potash to the rice crop.

This method is a sustainable measure as there is a reduction of emissions of methane gas from rice in the field which is a contributing factor to the reduction of global warming. Compared to the traditional rice farming system, integrated rice-duck systems are a measure to minimize the cost of production, increase rice productivity, provide environmental benefits and increase the income of farmers through the sale of organic rice and duck meat. Organic rice and duck meat can be marketed at a premium to consumers who take into consideration sustainable production. Integrated Rice-duck farming systems have shown to increase the productivity of rice by 20% and the net profit to the farmers by 50%. Duck meat has a high content of protein and other nutrition which can significantly contribute to addressing the problem of food insecurity and malnutrition on a regional level in developing countries.

2.4 Integrated crop-livestock energy systems

There has been a significant demand for animal products in developing countries which has seen the advancement of livestock production. With producers venturing into controlled breeding systems as well as intensive systems that aim to achieve optimal protein production, there has been a rise in the production of animal manure at the farm level. This has forced farmers to be knowledgeable in managing manure and finding ways to either use it for production purposes in a system or extracting energy as an energy source for production.

In China, livestock produced around 5.1 billion tons of manure in 2017 alone which is more than the industrial solid waste produced by industry. The important element of manure is as a source of N which is vital in any production system. Producers in developing as well as developed counties are starting to adopt manure management as a production element at the farm level. An example of this is the ‘manure-biogas-digestate' system which is the anaerobic digestion of manure. This innovation is a valuable manure management technology that has been adopted at the household and commercial level.

The management of manure entails the livestock manure of cattle, sheep, goats and/or chicken being collected and is treated in an anaerobic digester. This process contributes to sustainable production, as it can stop ammonia and methane being emitted into the atmosphere, which is a major concern of the livestock industry where these are viewed as major contributors to climate change. Managing manure also reduces the number of nutrients that can enter the groundwater system and result in aquatic system eutrophication.

The major benefit or by-product of this system is that the biogas is a renewable energy fuel source and the digestate can be used as an organic fertilizer. Biogas production is now being integrated with animal husbandry and has become an important means of manure treatment in the agricultural sector.

The management of manure and production of substrates is vital in ensuring the environmental sustainability of a system and cope with the rising costs of inputs such as electricity and labour.

2.4.1 Integrated dairy farm and greenhouse system

A model observed in Rwanda where the production system entailed the anaerobic digestion of farm wastes such as livestock manure and the collection of kitchen restaurant wastes which were substrates for the production of biogas. The CO_2 needed for plant enrichment in the greenhouses was supplied by biogas and the residues from digesters are used as animal bedding materials, plant growing media, and liquid fertilizers. An additional production line was introduced where the surplus of digestate and CO_2 was used for the production of mushrooms on the farm.

Chapter 3: Integrated production systems which contribute to sustainable production

There are growing pressures on land, water systems, biodiversity and ecosystems globally. A sustainable approach towards the use of natural resources is required to meet the growing demand for food, fibre and energy. Integrated production systems can reverse undesirable trends of biodiversity depletion (Bengtsson et al., 2005) such as fragmentation and isolation of natural habitats (Donald et al., 2001). Integrated production systems can also increase the provision of agricultural goods and services in a sustainable approach while delivering synergistic benefits to the ecosystem. Integrated production systems encourage the maintenance of biodiversity in the agro-ecosystem by growing a number of crops varieties by using techniques such as mixed farming or intercropping, promoting the maintenance of indigenous tree species, encouraging the integrated management of pests and enhancing soil microbial biodiversity by the incorporation of organic matter.

In developing countries where producers and their environment are exposed to elements of risks such as changes in the markets and climate change, livelihood diversification is necessary. An integrated system offers opportunities to ensure stability of production. If one component of the integrated production system is unsuccessful, another may compensate. Integrated farming systems can be more economically resilient as the systems reduce the potential of losses from specific biotic or abiotic stresses that affect genetically uniform crop monocultures or exotic livestock breeds.

Practices observed in developing areas that have undergone diversification display mechanisms which mitigate risks that producers face. Producers are choosing to keep livestock in smaller units and are breeding mixed species to increase genetic resilience, which is a measure to avoid parasitism and emergent diseases typical of animals concentrated in bigger units. Farmers are also practicing crop rotation and cover cropping to protect the soil biome and increase biodiversity for pollinators and are also managing pastures and grasslands to reduce erosion and wild bush fires.

The optimization of production inputs such as energy and labour are a cost-effective measure which enable the farmer to save money, recycle nutrients and organic matter, and thus increasing farm productivity (Seo, 2010; FAO, 2011). The waste products of one production component such as livestock manure, which would otherwise be released into the environment, are used by the other production component such as vegetable production, which in turns returns its own waste products when livestock consume the vegetable waste (Attwood et al., 2017). Maximum efficiency in recycling resources (e.g. waste into biogas) creates a system with minimum environment impact, and lowers the operating costs (e.g. fertilizer, feed and energy). These practices require substantial knowledge and research on the part of the producer and potentially upfront investments to adjust infrastructure to suit the integrated model.

As integrated production systems are diversified, they contribute to more varied landscapes, which in turn favour diverse habitats, trophic networks and interactions between taxa. Integrated systems also promote pest management, the use of livestock for weeding has a positive effect on the environment as it reduces herbicide use, and the manure and urine left

by the livestock provide organic fertilizer for the soil. An example of such a practice was observed in Southern Brazil where goats were used for grazing on sugar cane fields to remove weeds and dry sugar cane leaves. This reduces the need for unskilled labour for weed removal and harvesting and allows for high skilled labour such as grazing management.

This practice takes into consideration the animal densities and the time the animals spend on fields which needs to be managed and controlled to avoid overgrazing and soil compaction through trampling. In terms of nutrient management organic manure from livestock may not always be available in the quantities required by the producer. Integrated soil fertility management becomes important for producers who need to manage the nutrient levels of the soil efficiently to achieve desired crop yields. Integrated soil fertility management includes complementing organic inputs such as manure and urine with synthetic nutrients supplied by synthetic fertilizers which need to be applied in the proper dosage and at the optimal time. Good agronomic practices are needed when increasing input-use efficiency (FAO, 2015) at farm level.

Integrated production systems also conserve agricultural biodiversity at farm level more than traditional conventional production methods that try to meet food demands by focusing on specialized systems. Agricultural biodiversity refers to the variety of organisms used for food and agriculture as well as those that have indirect effects on agriculture, such as soil fauna, weeds, pollinators, pests and predators. Agricultural biodiversity provides the resources farmers require to adapt to variable conditions in marginal areas and increase productivity (Fanzo et al., 2013); this promotes dietary diversity and has consequent health benefits for the producer and the consumer (Bélanger and Johns, 2008). Biodiversity management and food security can be effectively addressed using integrated production practices (Altieri, 2002). Food insecurity displayed in developing countries is not always because of a lack of food available arising from low levels of agricultural production. Food insecurity can be directly linked to unsustainable use of resources by the producers.

Integrated farming practices are capable of producing sufficient yields by maintaining crop-livestock diversities and managing equitable socio-economic access to the developing section of the society (FAO, 2000). Observations show that integrated farming systems are better for sustainability of the socio-ecological process than conventional agriculture (FAO, 2012). In developing countries farmers need to maintain those differences which are critical as emerging and smallholder producers have little social status and poor access to natural resources. Therefore implementing integrated farming systems is a multidimensional and sequential process of meeting the demands and challenges of the farm families food security with relatively low external-input, as well as to manage the negative impacts of farming by producing multiple ecological services (Hazell and Wood, 2008).

3.1 Benefits to integrated production systems

Agricultural multifunctionality is a rural development concept where the policy focus shifts from food and fibre production to a comprehensive inclusion of multifunctional goals in agriculture. This highlights the role of farmers in developing countries to improve food safety, amenities and landscapes, whilst protecting the environment (Van Huylenbroeck, 2002). Sustainable agriculture in developing countries emphasizes food security and sustainability of farmer's

livelihoods, as opposed to food safety and convenience for consumer livelihoods and environmental protection in developed countries (Amekawa et al., 2010).

There are three major benefits of integrated farming systems:

3.1.1 Economic – income

Integrated production systems show a higher farm income and profitability than conventional farming in developing countries (Edwards, 1989; Behera and Mahapatra, 1999; Routaray et al., 2005; Tipraqsa et al., 2007). There is an associated low cost of production and thus increase farmer's net income with sound management. Integrated systems may offer an opportunity for marginal farmers to maintain investment and move away from a reliance on grants. Integrated farming systems allow the producer to even out the risks and uncertainties of income from conventional cropping methods and reduces the time lag between investment and returns. Regular and evenly distributed income throughout the year allow the farmer to be resilient to uncertainties and reduces vulnerability against climatic and market variations (Pretty, 1997).

Crop-livestock- fish systems or crop-livestock systems have seen higher net return than crop-based systems alone (Ugwumba et al., 2010; Desai et al., 2013). The increased adoption of livestock at the farm level has allowed a higher cash income for a farmer. The commodities a farmer chooses for their integrated system will determine the extent of the farm income and its stability.

3.1.2 Social - food security

The concept of food security is the availability of sufficient, safe and nutritious foods for all the members of a community, all the time, allowing them to lead a healthy and active life (Pinstrup-Andersen, 2009). There is a need to provide food security in developing countries due to the growing human population as well as to slow down the quick damage of irreplaceable biological diversity (Chappell and La Valle, 2011). The current state of agricultural production is insufficient to guarantee the future of food security in developing countries. This inability to generate sufficient food for the growing populations in developing countries translates into a need to overcome food insecurity especially in cases where marginalized communities are affected (Rosset, 1999). The current trend in food production favours industrialized high-input, high-yielding practices rather than the traditional indigenous agrarian systems developed and practiced for thousands of years (Altieri, 1999; Netting, 1993; Rosset, 1999).

Integrated production systems that have been developed traditionally show potential to maintain productivity at farm level as well contribute to the availability of diverse food items throughout the year so that all members of the household are fed sustainably thus making such innovative systems a good measure to provide a diversity of food rather than conventional farming. Integrated production systems also improve household food consumption (Prein and Ahmed, 2000), especially for the vulnerable family members such as children, pregnant/lactating women, and the sickly through the provision of animal proteins and vegetable/fruits.

3.1.3 Environmental - energy efficiency

In developing countries, the major users of farm energy are fertilizer, electricity and farm machinery. The current nature of commercial agricultural is heavily reliant on synthetic fertilizers, pumped irrigation and mechanical power. These are energy-intensive practices and thus industrialised agriculture can be less energy efficient (Pretty, 2002). These three sources of energy account for more than 90% of the total direct and indirect energy inputs to farming (Leach, 1992).

The potential crop yield is a function of energy input. Agricultural processes such as land preparation, irrigation, harvesting, post-harvest processing, transportation of agricultural inputs and outputs all include the use of fuel and electricity (Hulsbergen et al., 2001). Agricultural processes such as packaging and transport of fertilizers, seeds, machinery, production and pesticides are forms of indirect energy use (Ozkan et al., 2004).

Traditional integrated farming systems use less mechanization and promote the use of internal inputs such as manure instead of synthetic fertiliser, making the energy use much lower than conventional farming methods. Low-input rice integrated systems that were observed in Shandong Province in China were more energy efficient than irrigated rice grown in the United States of America (John Farrow, IRRI 2017).

3.2 Challenges with integrated agricultural systems

3.2.1 Environmental

Integrated production systems can fail in areas that struggle with extreme conditions where production cannot be supported. Areas that have deteriorating crop/growing land ratio can struggle to balance a mixed farming system due to competition for land use. This occurs in semi-arid areas where the human population grows exponentially and grazing or crop land has competition from intensive cropping coupled with the need for residential land. Farmers also struggle to maintain farm sizes where there is heavy competition for land.

3.2.2 Socio-economic

Producers are faced with challenges in order to meet their objectives for production. A farmer needs to plan well ahead around how they are going to execute their plans at farm level to deal with the financial implications of their production system. These farmers also have to deal with production, economic, social, political and environmental issues. Producers have to be equipped with sufficient knowledge to decide on the most appropriate commodities or products, based on the access to resources and the climatic factors they experience at farm level.

Producers also have the responsibility to consider the social ramifications of their decisions, not only for their own economic well-being but also on society and their surrounding community. Social protection is required in farming areas in rural spaces where farming units are isolated, as well as in peri-urban areas, where there is an encroachment of communities into farming lands. Urban people influence food trends and policies, especially around the protection of the environment and food quality.

3.2.3 Management

Integrated production systems require a farmer to have access to knowledge, and to access resources using unconventional and innovative ways of thinking. The challenge is managing the trade-offs for each commodity and production line. This requires not only sound management but also sufficient planning of each operation. A producer needs to think of the timing of the operations, the type of equipment that will be used and allocated, and the timing of agricultural markets. The challenge of integrated production systems is the task of operationalizing the interactions between disparate measures of productivity and sustainability. This requires an adequate understanding of the complex interactions between the environmental, social, and economic drivers.

Chapter 4: Factors that influence producers into implementing integrated production systems

The environment in which a farmer operates in is the driving factor that influences the choices affecting the management decisions which enable change in farm enterprises.

Farmers and producers have four major factors that drive them towards integrated production systems:

4.1 The socio-political environment

The social environment will dictate the trajectory of their production and the ability to stay viable over a period of time. Farming is associated with culture and heritage in developing counties, especially in the rural environment. A producer's decision on whether to become a farmer is dependent on his social status and history of the farming culture. The social status of the farmer also includes the generational strengths and weaknesses, the ability to adapt to change and to accept new ideas and the to accept or manage risk. The social status of the farmer also influence their commitment to the local community and whether the producer has a direct relationship with the community in which they produce or in which they employ individuals.

The access to quality labour also dictates whether the production system can be viable as hired labour is the normal driver of production, especially for primary and secondary agriculture. The ability of a farmer to access information is vital in his choices and his knowledge base as it is imperative in his ability to make strategic decisions such as irrigation management, crop selection and the need to diversify production streams.

The political affiliation of a farmer will influence how the farmer views policies, how he reacts to policy changes that affect production. Policy can influence whether farmers receive government support, grants and access to certain markets such as government feeding schemes and procurement. Politically active farmers receive government programs such as training, farmer support and extension services. Politically affiliated farmers also have a platform to contribute towards social policies and how governments introduce social policies or programs in their immediate areas.

4.2 The economic situation

The economic situation of a producer will affect the way they view and manage risk. The decision to diversify or integrate production streams is usually driven through government policies that either incentivize the farmer by the attraction of economic relief, aids or grants. The current farm status such as the herd size, soil quality, the ability to apply manure to crops and the size of the farm dictate the ease of adoption of integrated production strategies. The geographic location, quality of roads and distance to population centres influence the market options and the ability to supply different types of markets. A producer also has to investigate the marketing channels, as well as the net return of the production chain based on the demand of the product and price. This is coupled with identifying the input costs such as the nutrient

demand of the product, crop yield potential, tilling costs, manure application costs, on farm sales potential of livestock

4.3 Environmental changes or status

The quality of the land in which the farmer produces is a vital component on the possibilities of integration. Soil type and topography play a role in the choice of crops and location of livestock production. Knowledge of the land is vital in identifying land use types and being able to use different types of land for different production systems. Whether the land is flat, steep, rocky it affects the mode of production. Land management practices such as the use of cover crops to improve soil organic matter and the practice of incorporating organic matter into the soil are long-term strategies adopted by producers to either improve or maintain soils for future land uses. Integrated pest management systems or strategies also affect production strategies due to pest populations and pest influence on production systems. This applies to both livestock and crop management strategies as pest management is an input that has associated costs and labour demands.

4.4 Technological or access to innovation

Technology is an enabler of production, as it makes a process easier and efficient thus reducing turn-around times and contributes to the quality of a product. The access to technology and innovation is coupled to the access of quality education. There are three tiers of education that contribution to the development and adoption of integrated production systems: basic, tertiary and experiential. The university has a role in both tertiary education and research; extension services have a role in demonstration and adoption of technology at farm level; technology transfer through model farms assists in demonstrating farming techniques such as tillage practices, mechanized technologies, precision agriculture and seedling varieties.

Access to mobile connections such as 4G and GSM networks enable producers to access phone applications such as voice calling, mobile internet, GPS, USSD and mobile applications. This is vital in areas where there is a need for geo-tagging and mobile money transactions. This was observed in Kenya where MPESA, a USSD application, has enabled producers of agricultural products in remote or rural areas to access payment or transfer of funds via SMS and USSD codes. In Zimbabwe EcoCash is used by locals and merchants to make monetary transactions over USSD. Geotagging has allowed pastoralists in Kenya to manage their livestock and work with producers within a regional area. Drone technology have allowed herdsmen in Rwanda locate watering sites for cattle in drought-affected areas.

Producers are now entering the mainstream trend of marketing produce on the internet that has allowed for the production of niche products that can be delivered to a consumer. A producer would need access to a mobile network or internet to enable these marketing channels or have access to resources to establish their own marketing platform.

Conclusion and Recommendations

a) Implications of national and regional land reform policies

The state is the institutionalized political organization of society. It articulates and implements public policy and adjudicates conflicts. In theory, the state has a monopoly over the legitimate use of coercive force within its territory, together with the responsibility to pursue public good for all its citizens. This responsibility includes the provision of infrastructure, financing of this infrastructure, management of the resulting services (operation and maintenance) and the financing of operational activities such as agriculture.

b) Role of public good and infrastructure

There are infrastructure deficits in the rural environment in developing economies due to the rapid development of urban and peri-urban spaces, with around 62% of Sub-Saharan Africans migrating and living in the urban spaces in the form of shacks or slums. The spatial deficit due to economic migration has placed a demand on public goods resulting from the continuing growth of poorly serviced areas around areas of development. Public goods and services such as electrification, water, sanitation. Adequate access to public infrastructure such as public transport infrastructure, parks and community facilities affect the quality of life, as well as to the communities' economic efficiency. Management of local government and public infrastructure play a major role in economic growth on a regional basis as poorly maintained and poorly functioning infrastructure can cut economic productivity by up to 40%, as well as cutting economic growth by up to 2% per annum (Foster & Briceño-Garmendia, 2010).

Urban infrastructure in developing countries

Rapid urbanization has resulted in a situation where cities are burdened by high urban infrastructure deficits and associated poor access to services. 61.7% of Sub-Saharan Africa's urban population live in slums (Racelma, 2012) on the periphery of urban and semi urban areas. There is inadequate access to public transport for working class individuals who cannot afford living in central cities thus making inner urban spaces exclusive to the population that can afford it. Policies affecting population migration and immigration patterns should be designed to address stresses that impact production and producers. Governments need to lead the spatial transformation of the urban space to ensure economic activity for both labour and producers.

Rural infrastructure in developing countries

It appears that rural infrastructure—roads, in particular—has the strongest impact on poverty and development. The economic activity that immediately benefits from infrastructure interventions is agriculture. Developing rural infrastructure improves commodity transfer to markets, migration of labour and the inflow of production inputs to farms. Improved mobility of production inputs and outputs to and from farms decreases the prices of inputs and increases income from agricultural produce.

Public investments in infrastructure, especially rural transport and electrification, generate economic linkages and externalities critical to sustained growth and development of the

economy (Balisacan et al.,2002). Agriculture has the ability to increase household income by 40%, which is crucial for socio-economic development.

Policies that affect the rural environment should incentivize the development of public infrastructure in rural spaces to alleviate the population and infrastructure burden in urban spaces. This will open up the rural interface to urban markets by increasing economic activity and the security of labour.

Water supply and sanitation

Availability of water resources in developing countries is highly variable but even where there are adequate resources, water resource management is lacking in major regions. Areas affected by drought, such as Sub-Saharan Africa, have not had major successful investments in water infrastructure in recent decades, with 40% water lost from source to tap. Investments are required to not only maintain current water systems and management but to plan for future population growth, the effects of climate change and the shift in agricultural production methods.

Policies should not only highlight the dignity that comes from accessing clean water and sanitation but should highlight the need to access sustainable water that has been conserved efficiently from source to tap. Government should spearhead efficiency and development to the ensure spend goes towards education and conservation.

Electricity

According to the International Energy Agency (2014), Sub-Saharan Africa is rich in energy resources, but poor in energy supply and infrastructure, which in turn inhibits social and economic development. Developing countries can experience regular power shortfalls in terms of load shedding, diminishing coal stock and shortage in alternative energy resources (UNHABITAT, 2014).

Policies regarding energy production should highlight the need to incentivize independent power producers and explore opportunities in capturing the energy potential from the agricultural sector and its waste.

Infrastructure finance

The provision of infrastructure requires large capital expenditure which is a balancing act for any government in a developing state. The cost to develop required infrastructure may clash with social development needs and support of civilians. Access to finance is clearly a key constraint in providing infrastructure in developing countries.

Policies should promote guidelines for local governments to raise funding for infrastructure. Challenges lie within the institutional and financial capacities of local authorities to dynamically respond to the primary infrastructural challenges of their jurisdiction. Policies should also incentive producers to develop infrastructure through partnerships, technology transfer and value chain development.

c) The role of the local government

There are clear challenges between the national agenda versus the local agenda in terms of vision towards development. The responsibility of ensuring local development falls on the local government. Local governments need to be empowered in implementing agricultural development and require key instruments that will enable for them to diagnose and remedy challenges faced by producers within key industries.

Policies should address inefficiencies and the fragmentation in the provision of services to households and businesses to support socio-economic development. This would highlight the importance of local governments to significantly increase their relative share of local investment financing (Paulais, 2012) in order to facilitate economic transformation. The most important step is establishing capabilities of local governments in developing mechanisms and capacity to establish a platform for agricultural development, infrastructure provision and technology transfer. Policies should also facilitate opportunities for private sector or a parastatal organization to perform the work (Paulais, 2012) in cases where the state does not have the adequate capacity or experience.

d) The role of national government

Policy has a major influence on the pace of change in agriculture. The way a policy is worded or how it is interpreted by a lay man has greater influence on how communities or society will accept the policy and whether they will implement change on the ground. Policies that affect agriculture and land use play a role in the adoption and implementation of policy objectives by land users and land dwellers. Policies that address land reform, tax laws and agricultural incentives, expenditure on agriculture and rural development, social agenda of political parties and voters, influence from civil society organisations all play a role on how the agenda is implemented. Policies also affect farmers' decisions at farm level and thus play a major role on whether producers are willing to adapt integrated production methods. Some policies and shifts in political outlooks in the institutional contexts discourage the adoption of certain practices by producers. The Forest law in developing countries such as Brazil may discourage farmers from having indigenous trees on their farms. Insecure land tenure and short-term farm leases in South Africa may discourage investment in long term soil health by land users.

It is important that government and policy makers are equipped with sufficient information in order to word policy correctly and align policy with hard facts. It is important for governments to work with researchers and academia to postulate objectives that are accompanied with realistic parameters and expected outcomes. It is common for policies to be misinterpreted by land users due to factors such as the illiteracy, the inability for policymakers to understand the socio-economic situation at regional level as well as when the political agenda clouds the science of the situation. Governments and financial institutions need to look at how incentives may be required to enable farmers to invest in innovation practices that bring dividends in the medium term. Research institutions need to look at systematic research to better understand the links between policy alternatives and desirable outcomes and on how best to ensure that policy is evidenced-based, and policy makers and politicians are well informed.

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Plain English Compendium Summary

Project Title:	**The development of integrated agrifood production systems that address socio-economic development in emerging economies**
Nuffield Australia Project No.:	1705
Scholar:	Thato Moagi Legae La Banareng Farms P O Box 2598 Modimolle Limpopo 0510 Phone: +27 67 041 9214 Email: thato@banarengfarms.co.za
Objectives	• Define an emerging economy and a developing country. • Identify the socio-economic and political parameters in developing countries. • Highlight the successful integrated production systems observed in developing countries. • Identify the opportunities and the challenges around implementing integrated production systems in developing countries. • Identify the reasons why and how producers adopt integrated farming practices at farm level. • Highlight the contribution that integrated production systems make towards sustainable production. • Highlight the implications of national policy on the adoption of integrated farming practices on a regional level.
Background	Developing countries that are emerging economies have an important role to play in international markets and global trade. The political and economic mandate of developing countries is to promote growth. The direction development has to be guided through policies that work towards trying to achieve a socio-economic environment that promotes rapid growth and foreign direct investment.
Research	This study highlights integrated production models that promote socio-economic conditions aligned with the UN Sustainable Development Goals and the UN Guiding Principles for Business & Human Rights. It also notes the role of the government in guiding proposals for policies that aim to address development in the agrifood sector.
Outcomes	Opportunities for developing producers lie in the increasing demand for livestock products as a protein source in the human diet. Important skills include the ability to breed or raise animals and to produce animal feed or substrates, or animal products at the farm level. This has fostered the development of crop-livestock systems. Climate change has also led to innovations that produce energy from farming by-products which enable producers to operate off-grid or contribute to the regional or national grid as energy producers.
Implications	The development of sustainable models in developing countries where commercial agriculture is supported by different types of producers in different socio-economic situations needs to be addressed.