SYSTEMIC APPROACH TO EXAMINE THE STRUCTURE, CONDUCT AND PERFORMANCE MODEL OF AGRICULTURE IN AFRICA, EVIDENCE FROM GHANA

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ABSTRACT

The continuous growth in population and consumption, the intensity of competition for land, water, and energy, and the overexploitation of the ecosystem, have affected Ghana's ability to sustain food security and it natural resources. Over the years, many promising agricultural development initiatives could not provide sustainable solutions to agricultural challenges in most parts of Africa, including Ghana, leading to food system failures. The agricultural industry is a complex system and requires a holistic approach to dealing with root causes of challenges. This research therefore uses systems thinking tools including Casual Loop Diagrams (CLDs) and Bayesian Belief Network (BBN) modelling to develop new structural systems models where stakeholders determined the components and interactions between the Structure, Conduct and Performance (SCP) of the agricultural industry in Ghana using the Evolutionary Learning Laboratory (ELLab). The results illustrates how the SCP elements interact together to influence the survival and growth of the agricultural industry among driving forces. The study identifies that stakeholders adopt several strategies to survive and compete, which lead to the overexploitations of the ecosystem. The results from BBN models indicate that the implementation of systemically determined interventions, policies and strategies could significant improve the rate of business survival and growth from 58.8% to 73%, while the chances of improving the SCP could be increase from 39%, 28.3% and 36.4% to 80.1%, 55.9% and 62.4% respectively. This paper contributes to the systemic approach to SCP in that, the improvement of production and allocative efficiency may usher a greater potential for improving food security and the natural resources and further strengthen agricultural sustainability.

Keywords: allocative efficiency; market analysis; policy decision; market information; business survival.

INTRODUCTION

Traditional approaches in agricultural innovation and management can have substantial economic, social, environmental and political impacts on the structure, conduct and performance of the agricultural industry not only in Africa but across the globe (Banson *et al.*, 2014b). Historically, agricultural resources management within the ecosystem several decades ago, hardly revealed any consequence and challenge associated with traditional approaches as demand and competition were low when resources are abundantly available (Roling & Wagemakers, 2000). Traditional agriculture management was performed by

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identifying levels of resolution to part(s) of an element within a holistic system and has been judged successful based on the concept of crop yield without the concepts of sustainability, inter-relationship, and ecosystem wellbeing (Barrett, 1992). The consequences of traditional approaches to agricultural management have increase awareness in the need for amelioration of the rapidly deteriorating state of the ecosystem and to the enhancement of sustainability of resources (Lubchenco et al., 1991).

The recent and prospects for future intensification of agriculture have detrimental impacts on non-agricultural terrestrial and aquatic ecosystems not only in Africa but worldwide (Tilman, 1999). According to Tilman (1999), agricultural food production in past decades was associated with a 6.87-fold, 3.48-fold, and 1.1-fold increase in nitrogen fertilization, phosphorus fertilization, the amount of irrigated cropland, and land in cultivation respectively. It is anticipated that, during the next global food production, approximately a 3-fold increases in nitrogen and phosphorus fertilization rates with irrigated land area doubled, and a 18% increase in cropland will occur (Tilman, 1999). The projected increase would have dramatic impacts on the diversity, composition, and functioning of the remaining natural ecosystems and on their ability to serve society. Agriculture, forestry and fisheries are now facing many challenges as a result of these contamination from chemical residues (Hilborn et al., 1995).

Earth's forestry losses roughly 15 million ha each year, most of this loss occurs in tropical Africa (Donald, 2004). Of this, approximately 60% is lost to slash-and-burn agriculture, and the remaining to fire, logging, other agricultural purposes (ICRAF 1995). As tropical forests support as much as 70% of the planet's plant and animal species, its deforestation represents a significant threat to global biodiversity. These problems will be exacerbated by projected climate change and a projected increase in extreme events (Change Intergovernmental Panel On Climate, 2001; Rosenzweig et al., 2001). The production and livelihoods of agriculture, trees/crops and fish species will be affected as high temperatures can deter their survival. Failure to properly address these problems will make it impossible to ensure food security and sustainability and equitable development and eradication of poverty in Africa.

Ghana's ability in ensuring sustainability in food security and natural resources have been caused by the continuous population and consumption growth where competition for land, water and energy is intense (Banson et al., 2015; Branca et al., 2011; Correa, 2013; Goldstein & Udry, 2008). Over the years, many promising agricultural research and development initiatives were unable to provide sustainable solutions to any national and regional agricultural challenges in most parts of Africa including Ghana, which have led to food insecurity (Banson et al., 2014b).

Failures to achieve food security bring about consequences including lethargic national development efforts, continued high population growth rates with a vicious cycle of poverty for massive numbers of underprivileged people, as evident in all African nations (Bailey, 2013; Welch & Graham, 1999). These consequences can be minimized through a shift from the reductionist approach to a holistic management approach, utilising the SCP of the agricultural industry which is able to reveal the unintended consequences before resources are invested in the actual implementation to increase its competitiveness. The traditional SCP approach was first used by Bain (1951) to account for inter- industry differences in profitability. The basic premise of the SPC is that structure (number of farmers and traders, number of markets, quality and quantity of infrastructure support) affects conduct (production and marketing practices including pricing), which in turn affects performance (prices, quantities and profits) (Hanekom et al., 2010; Milagrosa, 2007).

With the increasing population and rising resource competition for food production, the consequences of poor resource management are paramount. The ability and willingness of

societies to respond to changing conditions are crucial in determining whether it survives (Hannan & Freeman, 1977). The development and use of innovations and knowledge ensures survival or through rapid adaptation. This adaptation to changing conditions depends on perceiving and interpreting signs of impending feedbacks within the system and on the timely development of knowledge, innovation and research approach in reaction to those signs. In the context of basic survival, today's global food demands tend to overshadow consideration for the ecosystems future.

Stakeholders have adopted many survival strategies that contribute towards soil exploitation and the destruction of natural ecosystem for their economic survival aside from traditional research approaches to agricultural innovation under poor policies (UN Documents, 1987). As cited in (Klerkx *et al.*, 2012), a wide range of approaches to agricultural innovation have emerged over the past 40 years. For examples the induced innovation by Ruttan and Hayami (1984), transfer of technology approach by Jarrett (1985), participatory research and participatory technology development by Farrington and Martin (1988), problem solving algorithm to resource management by Barrett and Bohlen (1991), training and visit system by Hulme (1992), farmer first by Chambers and Thrupp (1994), and agricultural knowledge and information systems by Röling (2009). All these approaches attempted to overcome the challenges of a complex world without seeing beyond the details to the context of relationships in which problems are embedded to display the behaviour of cause and effect from a systems viewpoint (Toole, 2005). As a result, billions of dollars have wasted in unsuccessful interventions (Banson *et al.*, 2014b). These have led to shifts in neo-classical theoretical perspectives on agricultural as shown in Figure 1 since the 1960s to date. As indicated in Figure 1, the past theoretical perspectives on agricultural innovation can be found in the systemic approach which go beyond to alert managers of future unintended consequences to ensure cost-effective plan of action in integrated strategic management (Banson *et al.*, 2014b).

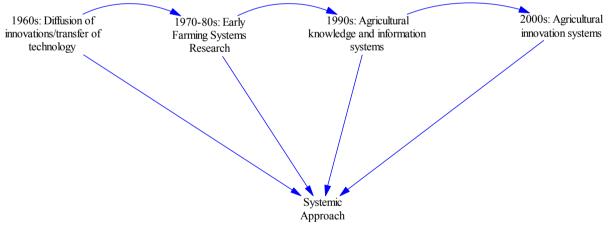| 1960s: Diffusion of innovations/transfer of technology | 1970-80s: Early Farming Systems Research | 1990s: Agricultural knowledge and information systems | 2000s: Agricultural innovation systems |

Systemic Approach

Figure 1: Shifts in theoretical perspectives on agricultural innovation

The application of systems thinking to the SPC model is to identify a set of hypothesis about how relationships within the structure of a system influence its behaviour, given a set of interactions among driving forces (Gali *et al.*, 2000). This also satisfies the demand for new approaches to the traditional models in business (Barile *et al.*, 2012; Gali *et al.*, 2000).

Systemic thinking highlights and addresses challenges using integrated approaches where the uncertainty of structure, conduct and performance of a particular system is mapped to see how these components relate with each other and to identify a leverage point. The dilemma of increasing needs for sustainable solutions in the face of decreasing resources, and the challenge to identify priorities, set the stage for holistic systemic theory to agricultural

challenges into a period of introspection, in which the whole realm of systemic activities are examined. Systems thinking principles lend themselves to effective decision-making and business planning. Understanding these principles and integrating them into planning are critical to understanding and adapting to the dynamic nature of organisational, local and global systems. Traditional approaches have failed to realise the embedded business systems and will certainly lead to business or policy failure in the long term (Banson, 2015). Systems thinking tools are already used and valued by the private and public sectors to better analyse and navigate a range of problems across many disciplines (Nguyen & Bosch, 2013). However, its application to the complex agricultural sector in developing countries is not much exploited to catch on with a number of initiatives and projects in this area. The agricultural industry is a complex system and complexity controls global processes. There is a need for a new integrated program of research methodology for the sustainability of agricultural systems.

Changes that are expected to occur within the complex agricultural system cannot be predicted within the boundaries of the neo-classical approach and historical data reported by traditional sources. For long term planning and policy-making, it is necessary to develop an understanding of unintended consequences and develop scenarios for the likely structure of agriculture and of its food and ecosystem systems. The main goal of this proposal is therefore to develop a new and structural approach with stakeholders to help to improve SCP of food security in Ghana by strengthening local research capacity and stimulating high quality research that supports policy design using the ELLab. This new research effort addresses the inter-relationships, patterns underlying the SCP within the agricultural industry in natural and human-dominated ecosystems in order to prescribe restoration and management strategies that would enhance the sustainability of the whole systems. The purpose of this paper is focused on the application of systems thinking tools such as the CLDs and the BBN model which are appropriate for planning and decision support.

RESEARCH APPROACH

Systems Theory

Systems theory provides a framework for taming complexity, with many systems theory emphasizing different aspects including market information theory, deriving from the pioneering work of Shannon (1996); cybernetics, deriving from Wiener (1954) and the second-order cybernetics of Von Foerster (2003). Systems theory has evolved to another level called chaos theory which refers to the dynamics of a system that apparently has no, little, or underlying order (Charlton & Andras, 2003; Larsen-Freeman, 1997; Levy, 1994). In these systems, small changes can cause complex changes in a holistic system. Chaos theory has led to a new perspectives and tools to study complex systems, such as agriculture, biological, human, groups, weather, population growth and the solar system.

This research approach builds on the ELLab of Bosch *et al.* (2013). The ELLab aims to introduce systems theory for researchers, research managers, policy makers and other decision makers to develop a shared understanding of complex issues and to create innovative and sustainable solutions using systemic approaches. The stakeholder theory of organisational management and business ethics that addresses morals and values in managing an organisation originally detailed by Freeman (2010) is the basis of the ELLab. In the ELLab, the stakeholder approach identifies and models the stakeholders groups within an industry and both describes and recommends systemic interventions by which management can give due regard to the interests of those groups (Donaldson & Preston, 1995). According to Stowell and Welch (2012) and Checkland (2000), tackling today's challenges involves close involvement of stakeholders and researchers to tame complex issues. According to Grimm *et al.* (2000), stakeholders must be integrated into models for complete understanding of extant systems which leads to more success in finding realistic solution to the challenges. The ELLab offers a methodology for creating informal learning spaces and platforms involving stakeholders and researchers in the agricultural sectors to address and manage complex issues. The research processes include generic skills in problem solving, team participation and team learning. It consists of a seven step process for gathering the mental models of stakeholders for collaborative problem solving. This ensures adoption and implementation of sustainable outcomes since the mental models and solutions are derived or owned by the stakeholders.

This research approach is in agreement with pragmatists that absolute knowledge is not possible, thus the ELLab process offers reflection at regular intervals on the outcomes of the interventions which ascertain that , no systems model can ever be completely 'correct' in a complex and uncertain world.

This paper demonstrates the practical application of systems thinking using the ELLab for the conventional models of the *Structure, Conduct, Performance paradigm (SCP)* developed in 1959 by Joe S. Bain Jr., who described it in a book "Industrial Organization (Bain *et al.*, 1976). The objective is to contribute to equip policy makers, researchers and all relevant stakeholders with a new way of 'thinking'. This will help them to evolve from a traditional 'linear' approach to solving problems, to a holistic systems approach that focuses on the root causes and interconnectedness between various components of the agricultural sector. The SCP model is considered a pillar of industrial organization theory, and it has been used since its conception for analysing markets and industries, not only in economics, but also in the fields of agricultural businesses and management. This research also lays the groundwork for improving the communication and holistic application of knowledge.

With the systemic approach data collection is done using the four levels of a thinking model which consists of four distinct and closely related levels of thinking: events or symptoms, patterns of behaviours, systemic structures and mental models as illustrated in Figure 2. This involves gathering the "mental models" of all stakeholders concerned with the challenges in the agricultural sectors. Data collected are then analysed using tools such as CLDs and BBN Models to develop decision support tools. CLDs consist of variables connected by causal arrows with polarities such as; same "S" and opposite "O" signs and delays "||" to describe the causal linkages (Senge, 2006; Sherwood, 2002). Feedback loops describe the circles of cause and effect that take on a life of their own within the CLDs. The construction of BBN models aid in decisions for addressing an important leverage point. The BBNs allow for 'what-if' analyses in decision processes and choices and can be developed simply to provide a mathematically optimal decision on the basis of the information provided (Cain *et al.*, 1999). The BBNs were populated using the Ventana software. Data computed into the software are:

1. Raw data collected by direct measurement (E.g. poverty levels, population measured by census, income measured by accounting).

2. Output from process-based models calibrated using raw data collected by direct measurement.

3. Raw data collected through stakeholder elicitation (E.g. stakeholder perceptions of extension and adoption rate, population and income) and Academic "expert" opinion based on theoretical calculation or best judgement.

And finally using the interpolation factor that is whether an impact will be positive or negative.

The data obtained were also checked to ensure validity with FAO and UNDP data and other publications. A series of workshops were also organised in 2014 for further stakeholder group consultations to confirm and validate the models. Once all the conditional probability tables (CPTs) have been completed in a similar way, the BBN was compiled and used for analysis.

The Evolutionary Learning Laboratory (ELLab)

The structure, conduct and performance of Ghana's agriculture were analysed using the ELLab approaches. The study was conducted in the Greater Accra Region of Ghana of which agriculture is the main economic activity in its peri-urban regions. Stakeholders in this regions were selected for the study because over 80% of its population depends on agriculture and related activities (Banson *et al.*, 2014a). The city also hosts most of the offices of market oriented agriculturalist.

 With the assistance of the Ministry of Food and Agriculture (MOFA) executive officers, a simple random sampling technique was employed to select stakeholders from the lists of producers and exporters. Questionnaires were addressed during a series of workshop organised in Ghana among 75 agricultural stakeholders to identify key drivers which would ensure agri-business survival and growth.

Figure 2 illustrates the ELLab, which the initial step starts at the 'fourth level of thinking' involving a series of workshops with stakeholders to gather their mental model through engagement and exploratory questions. A combination of data obtained at the workshops and a literature review, and the use of the four levels thinking model embedded in the ELLab gave an overview of the current state of the SCP model.
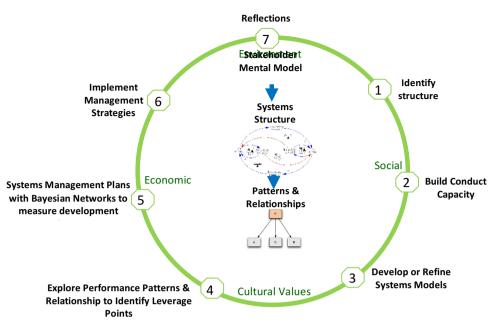
Figure 2: Elements of the paradigm: systemic approach adapted from Bosch *et al.* (2013)

This was followed by step two, which is the 'third level of thinking' through follow-up capacity building sessions during which the participants and researchers involved in the workshops learnt to integrate the various mental models into a systems structure using the Vensim software program (Ventana Systems UK, 2002). It is also important to note that capacity building is an integral part of all the steps of the ELLab process to examine farmers, and traders behaviour, both amongst themselves, and amongst each other competitors. Firms including input suppliers choose their own strategic behaviour, investment in research, in development, advertising levels and collusions.

Upon completion, the participants moved to step three; the 'second level of thinking' by interpreting and exploring the model for patterns, interconnected components, and analyse feedback, reinforcing and balancing loops, which exist. This step was aimed at assisting stakeholders to develop an understanding of their interdependency, role and responsibility in the entire system. These processes led to step four, which provided stakeholders with a better understanding of each other's mental models and the development of a shared understanding of the firms performance in efficiency terms. The interpretation led to the identification of leverage points for systemic intervention. Leverage points are places within the complex agricultural system where a small intervention at a point can generate a large impact. In step five, the outcomes were used to develop a refined systems model for the identification of systemic interventions. For this, BBN modelling was used in identifying the systemic interventions and determining the requirements for implementation of the systemic management strategies and/or systemically based policies (Bosch et al., 2013).

This research focus on the first five steps of the ELLab process. Step 6 and 7 are actual implementation of the management strategies and reflections at regular intervals on the outcomes.

RESULTS AND DISCUSSIONS

Systemic Intervention by Stakeholders

Table I illustrates the results of a focus group discussions among stakeholders deliberation on the constraints and challenges affecting their agri-businesses, the impact of these constraints and suggested potential strategies or solutions needed to overcome these challenges.

Table 1: Intervention by stakeholders to agricultural constraints

Questions	Respondents			
	Farmers	**Input dealers**	**Government (MOFA)**	**Research Institutions**
a. Identify pressing constraint and challenges affecting your agricultural activities in your sector?	-Finance -little to no access to arable lands -Pest and diseases -Difficult access to extension/veterinary service -Unreliable rainfall patterns -Poor breeds and seeds -Lack of markets -Government budget do not reach farmers -Poor Policy	-Difficulty in getting EPA registration for new products, -Stringent protocols of CRIG for fertilizers, -Lack of local markets for direct sales to farmers -Competing with cheap products looted into the country from neighbouring border countries -Lack of farmers trust in product due to their experience with fake ones in the markets	-Lack / insufficient machinery (tractors, logistics, finance), -Irregular finance to travel and visit farms -Farmers inability to form lasting association as point of knowledge transfer. -Lack of research extension farmer linkages -Farmer's inability to adopt technology -Distant farming lands	-Lack or insufficient funding to start research -Inadequate and obsolete laboratory equipment -Dependency on traditional tools as a result of no sponsor for further training -Inadequate technical knowhow -Researchers do not laisse/correspond with primary industries
b. What are the impacts of these challenges on key variables?	-Loan default -No child education -Low Productivity -Failure of farm -High risk of investment -Failure to assume household responsibilities	-Difficult in introducing new and effective brands, -Sales reduction -Inability to reach farmers with quality products	-Inability to transfer innovations to farmers -Lack of enthusiasm -Lugs of response from immediate supervisors -Extension officers persistence for the right actions leads to victimization and job loss	-Delays in finding solutions to pressing challenges -Ideas cannot be materialised - publication difficult -Low productivity of research output
c. What new strategies are needed to overcome these challenges?	-Enactment of laws to reserve arable lands - Dam constructing for irrigation access -Construction of road access from farms -Registration and provision of ID for farmers recognition -Provision of electronic tracking systems to record extension officers visits -Construction of local markets in each community -Creating avenues to announce market information and research break to for farmers	-Enforcing border controls and creating avenues to report fake products on the markets. -Frequent inspection of existence brands by EPA and Quality Control -Periodic testing of the quantities of A.I in the chemicals and market -Training and linkages with research institutions to address current challenges -Developing locals markets and road networks to farming communities	-Creating green belts for farming purposes by the local government -Commercialization of extension services -Extension officers access to agricultural publications and electronic bulletins -Government to provide incentives for long lived farmer associations -Reducing workload per-extension officer to farmer ratio -Sustainable sources of logistics	-Educate agriculture sector and government on the importance of research to development -Making research funding a priority -Investment in new equipments and training programs for researchers -Making it a law for all primary industries to have a link with local research institution -Making it a law for all research institution to showcase quarterly achievement to extension officers, primary industries and farmers
d. What factors can influence these new strategies from being implemented?	-Availability of arable land in the peri-urban regions -Current government policies -Lack of funding form the Government -Landownership and family land disputes	-Government Politics and bribery in law enforcements -Lack of government financial support	-Lack of government funding -High interest rates and depreciation of local currencies	-Lack of vision by the ruling government -Lack of specialised research scientists

	-Low profit and productivity			
e. How can these factors be managed?	-Registration of arable lands to true owners -Government to buy outright arable lands from owners for farming purposes	-Punished corruption and bribery severely -Reward crime stoppers significantly	-Generating local sources of funding through tax	-Taxing primary industries and consumers for funds for research and developments

Agricultural Distribution Demographics in Ghana

Agricultural produce distribution in Ghana can be described as having two types of distribution channels: long distance and peri-urban agriculture. Most farmer (95%) involved in the study are peri-urban farmers, primarily producing perishable item. These goods tend to be sold directly to consumers through the domestic market by farmers relatives or traders and generally must reach the consumer within 24 hours due to lack of refrigeration storage (Ortiz *et al.*, 2010). These traders consisted of itinerant middlemen, retailers, wholesalers and individual households or fellow farmers. The minority (5%) of the farmers who leave in the outskirts of the peri-urban travel long distances to enters through a network of Community Supported Agriculture (CSA), farmer association or middlemen before reaching the consumer. The study found that at the village level, a farmer's first option is selling his/her farm produce at the local market or at the closest main road to the village. The second option is through "itinerant wholesalers" who mostly travel from village to village to buy farmers produce at farm gate. The third option is through farmers associations who then organize themselves and jointly hire a lorry, to transport their farm produce to the market in the cities.

Most highways off the main towns and cities in Ghana are, however in poor condition. Farmers who are far from good roads are marginalized not only because they have difficulty in reaching the markets, but more so because traders avoid farms in areas off the good roads where transport costs are too high (Bryceson, 2002; Eskola, 2005). Despite the long distance, farmers play an important role as food growers and rural stewards. The poor produce prices combined with poor terms of trade and currency devaluation, has led many farmers from market oriented production to subsistence farming (Ferris *et al.*, 2014). One of the principle and most influential stakeholders in this network are itinerant wholesalers and exporters who are the primary financiers of farming costs and thus share any risk of crop failure. They often earn high remunerative returns on their agriculture investments which generate criticism by stakeholders who see this as unfair practice within the food distribution process (Ortiz *et al.*, 2010).

The majority of farmers (98.2%) sell produce to traders or middlemen. Traders serve as source of quantity and price information and acts as guarantors between farmers and consumers in the supply chain. A number of studies in produce supply chains have mainly documented that smallholder farmers incur high transactions costs linked to search for produce buyers, market information, negotiation and other costs associated with marketing their farm produce (Hananu *et al.*, 2015; Poulton *et al.*, 2006). Figure 3 illustrates the major challenges encountered by both small (65%) and large scale (35%) farmers in the study. Small scale farmers cultivate land size between 1-12 acres (Banson, 2014) with average of 2.3 among respondents. Large-scale farm size is above 12.5 acres with average of 14.2 among respondents. Financial challenges were major impediment to both small and large scale farmers' access to new arable land and farm implement. However these challenges intensely impact small scale farmers compared to their large scale counterpart. Large-scale farming have economies of scale in production of quality produce at relatively low cost to their already established markets as shown in Figure 3.
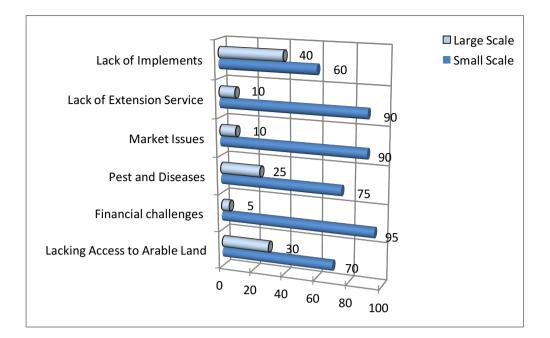
Figure 3: Major challenges encountered by farmers

Systemic Structure, Conduct, Performance (SCP) Model

Figure 4 illustrates how the market structure, firm conduct and performance elements interact to affect the competitiveness performance of the agriculture industry holistically, which is considered as the potential benefits to consumers and society as a whole.

Structure

A structure is a set of variables that are relatively stable over time and affect the behaviour of farmers and/or buyers (Banson, 2014; Policonomics, 2012). The median number of farming years among farmers was 24.5 years and 75 % have had at least primary education. The study identified that the access to arable land and start-up costs are substantial barriers for new farmers to enter the agriculture industry. These are the main issues faced by both new and experienced farmers with shortage of direct farm ownership experience. Stakeholders attested that the requirement to have at least 25% as a down payment to purchase arable land proved to be the most challenging barrier for new entrants and farm expansion. These intend affect the average farm size one can cultivate. Figure 4 illustrates that as the barrier to entry increases, access to arable land per farmer reduces, which in turn causes the average farm size also fall. With fewer acreages or resources, it affects the scale of production, the food security, the economy, and jobs availability. As subsistence based production increases, the chances of forming farmer's association increases, which causes this group of farmers to have access to market information through extension agents and or buyers. Access to market information changes the conduct of these subsistence based farming to market oriented production. This intends give them access to revenue which reduces their financial barriers to entry or expansion. This Reinforcing loop makes sense, but it will only come into play given that resource constraints are a serious issue. Whereas access to arable land and start-up costs are not resource constraints, averages farm size is large which leads to commercial agricultural activities range from intensive crop production and mixed farming. This gives large commercial farmers economies of scale which are typically vertically-integrated, giving their agribusiness a competitive advantage and reduction in transaction (performance) on the global market as shown in Figure 4.

Conduct

Conduct is the way in which buyers and farmers behave, both amongst themselves, and amongst each other (Banson, 2014; Policonomics, 2012). Figure 4 illustrates that access to market information directly influence market analyses which intend determine the type of investment needed for research and innovation. This also reveals market information is in opposite direction to resistance to change which affects productive resource allocation and scale of production creating (BI). This creates reinforcing loops as demonstrated in the Figure 4. Figure 4 illustrates that as commercial farmers or companies invest in research and innovations, it increases their market information and reinforces their quality control methods. Investment in research and innovation increases technological progress which reinforces production and allocative efficiencies (R3 under performance).

Performance

This is the results of the industry in efficiency terms and different profitability levels (Banson, 2014; Policonomics, 2012). In Figure 4, the policy decisions and outcomes affect technological progresses (Nallari *et al.*, 2011). As a technological progress increases, production and allocative efficiency also increase. When this happens, there is full employment of resources which leads to a reduction in transaction costs which in turn a reduction in price. Price reduction leads to more money in consumers' pockets to spend which in turn helps farmers or companies' profitability margin. As such, rising consumer spending will further catalyse to national economic growth (Figure 4).
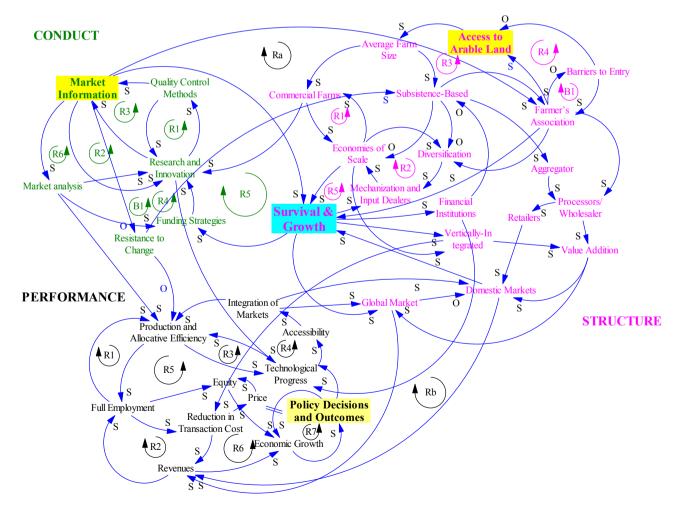

Figure 4: Systemic structure, conduct, performance model

Adaptive Conduct Mechanisms to Survive Within a Failing System

Farmers

Farmers adapt many surviving strategies to be competitive. Growing populations with shortage of arable land has led most farmers to seek new land in forests to grow more food and seek off farm income (VanWey & Vithayathil, 2013). Long distance farmers (5%) follow a traditional path of purchasing or renting more land to increase their acreage, to increase production volume. Although this results in increased income, this will result in the depletion of natural forest and the ecosystems. Forests are crucial for maintaining and improving the productivity of agricultural land. Peri-urban farmers, which represent 95% of the respondents, intensify operations to increase productivity through the use of varied chemical such as fertilizers and pesticides to earn more income from the same piece of land. The run-offs of these chemicals damages water resources which spread and threaten the health of humans and the lives of other species. An example whereby farmers generate revenue streams to supplement farming activities is that, some farmers involved in the study go to the extent of mixing Furadan with the soil as bait for grass cutters (Thryonomys swinderianus) which then eat, become blotted and die on the spot and processed for sales to consumers. Other farmers use poisonous chemical for fishing polluting the water bodies and killing other living organisms in the water.

A 1983 study estimated that approximately 10.000 people died each year in developing countries from pesticide poisoning and about 400,000 suffered acutely as pesticides travel through the food chain (UN Documents, 1987). These numbers have more than doubled with increased folds in chemical usage. Some farmers also engaged in felling and tapping wild palm for palm. Farmers use a number of strategies in order to survive and strengthen their business in an already failing systems to make sure they are not as vulnerable to system fluctuations. In the long run, the ecosystem and it resources will be depleted and worsen the plight of these farmers since most of their practices are not ecologically sustainable in their own areas. Many youths in farming communities see agriculture as an uncompetitive and unprofitable venture and hence, migrating for greener pastures results a lack of succession planning of parents business posing as threats to the long-term existence of family farming.

Traders

Traders do not have the appropriate storage facilities and therefore prefer to deal with peri-urban farmers where they harvest from the farmers' fields when there is market demand and pay after selling, minimising their risk in the value chain. Traders especially wholesalers and exporter sometimes also fail to comply with an agreement to buy specified farmers produce when they detect poor market, forcing farmers to sell cheaply to domestic market or processing companies. Traders take away the "lion share" of the benefit accrued from the sale of farmers produce by taking advantage of small farmers' unawareness of market prices and weak bargaining power arising from low literacy and low social status (Pokhrel & Thapa, 2007). They also engage their young children in marketing to maximise their market share depriving these children from education. Traders sometimes also engage in illegal logging and wildlife trade poached by farmers or community members of endangered species to earn income to support their families. These combined with seasonal shortfalls of cash, lack of storage facilities in villages and farmer's limited awareness of market prices have further given traders an advantage over farmers' bargaining power.

Firms

Lax governments control has resulted in private firms regulating virtually the entire food cycle - inputs and outputs, domestic sales, exports, public procurement, storage and

distribution, price controls and subsidies – and imposing various land use regulations: acreage and crop variety. The manufacturing sectors claim they have lost working capital as a result of the continued rise in the prices of imported inputs due to the depreciation of the local currency. Thus, firms indulge in management's game plan for strengthening the organizational positions (Gumbe & Kaseke, 2011). Survey findings revealed that firms apply different strategies such as quantity reduction which demand the same standard price, reducing the quality of products to maximise their profit through importing low grade products or fake products including fertilizers, pesticides, weedicide which may not work on farmers' fields. Other repackages by diluting potent products such as pesticides, weedicides and fertilizers to increase volume and profit. This has resulted in violation of the recommended application rate by farmers resulting environmental consequences of residues. Others do illegally import through the borders of Ghana where duty is avoided.

Development of syndicates to maintain their market shares among farmers by setting up financial baits through the provisions of extension service and inputs on credit. According to respondents, firms which are reluctant in adapting survival strategies collapsed. Respondents were asked whether their companies will still survive in the next 5 years. Out of 15respondents, 73.3% (11 respondents) believed that their firms will not survive under Ghana's inflation environment. The 11 respondents explained that their firms will fail due to the depreciation of domestic currency to the dollar, the high cost of freight, competition with cheap and illegal imports through lax border control from neighbouring countries, and not operating close to full capacity.

Government

Government intervention in agriculture sector is the rule of the day in Ghana and other countries. Public investments in agricultural research and extension services, and a range of other support systems have all played parts in trying to uplift productivity using traditional approaches in a failing system in the last half-century. Patterns of Ghana government intervention lack systemic approach and an ecological orientation and are often dominated by short-term quick fixes considerations including privatisation. Increasing the survival and growth of the agricultural industries and food security requires more than good traditional interventions. They are often overridden and undermined by inappropriate agricultural, economic, and trade policies. Farmers complained that, getting the attention of MOFA's extension agents requires one's ability to be able to reward them financially, thus commercial farmers mostly benefit from extension services. MOFA agents also engage in illegal transactions of hiring or selling their motor vehicles which could transport them to farmers' fields. Government intervention in Ghana and most developing countries lies in the incentive of weak structures. Market interventions are often ineffective for lack of an organizational structure for procurement and distribution. Farmers are exposed to a high degree of uncertainty, and price support systems have often favoured the peri- urban commercial crops farmers, leading to distortions of cropping patterns that add to destructive pressures on the resource base.

Systemic Interventions Using the BBN

The agri-business survival and growth is affected by the interplay of the structure (number of farmers and traders, number of markets, quality and quantity of infrastructure support), conduct (production and marketing practices including pricing), and performance (prices, quantities and profits, policies) as shown in Figure 5. The degree of effect is dependent on how the structure is improved, the way the conduct is regulated and the optimal utilization of the resource employed. In general terms, this is performed by altering the states of some nodes while observing the effect this has on others. As the BN is a network, the impact of changing any variable is transmitted right through the network in accordance with the relationships expressed by the CPTs. Figure 5 represents the current situation in the Agricultural system in Ghana.
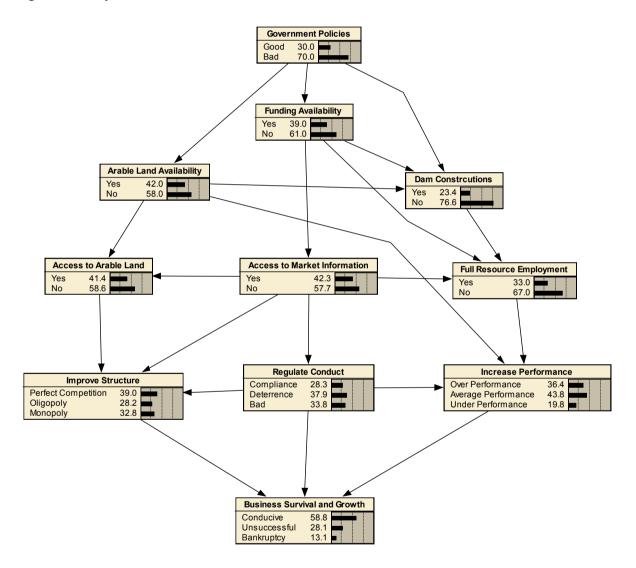

Figure 5: Bayesian networks showing factors determining business survival and growth
(without intervention)

Figure 6 then shows how the probability that the objective (Business Survival and Growth) is in the state of "Conducive" changes as the states of the interventions are changed. Stakeholders identified Business survival and growth as their main objective and the construction of a dam as their preferred intervention. According to stakeholders, dam construction (intervention) would affect agricultural productivity and growth (Business

survival and growth). Stakeholders explained that this would happen due to an increase in water availability through improved surface water storage and increased groundwater recharge, although this would be dependent on rainfall. They also pointed out that a dam construction would probably change the cultivatable area (both by removing land from production and possibly increasing irrigation command areas). Clearly this dam construction would need funding to be implemented.

Funding and access to arable land and market information were the management interventions considered to be the most likely to achieve to achieve the objective (Business survival and Growth) as shown in Figure 6. Here feedback arises throughout the network from the interaction between the SCP, arable land availability, dam construction and full resource employment.
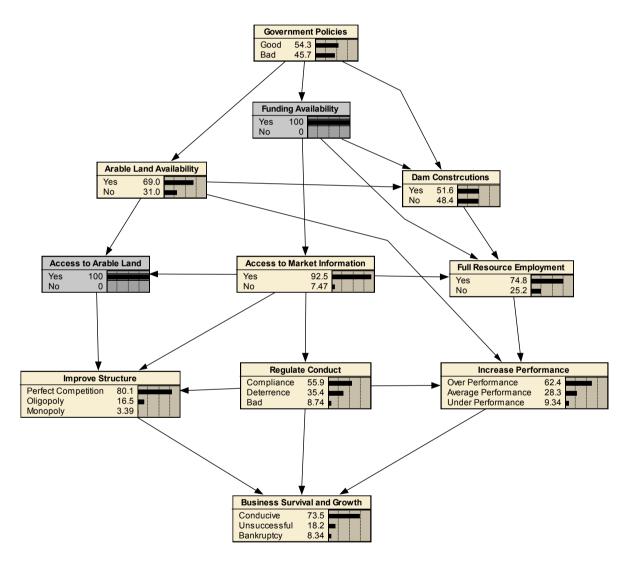

Figure 6: Bayesian networks showing factors determining business survival and growth (with intervention)

Figure 6 shows 73% difference in the chance that Business survival and growth will be conducive depending on the state of "Access to Arable land" and "Funding" from 58.8% conducive as shown in figure 5. Aside that, the possibility of constructing dam increased from 23.4% to 51.6%. This in turn increased the chances of full resource employment and access to market information from 33% and 42.3% to 74.8% and 92.5 respectively. These

thereby led to the chances of improved structure (from 39.0% to 80.1), high conduct compliance (from 28.3% to 55.9%) and increased performance (from 36.4 to 62.4) as shown in before intervention (Figure 5) and after systemic intervention (Figure 6).

CONCLUSION

It is crucial that researchers, policy makers and development practitioners understand the kind of feedback loops of the SCP model in aiding adaptive management and decision support. This research provides a framework that will enable an understanding beyond the boundaries of traditional analysis of structural conduct and performance changes in agricultural industries. This study also serves as a model to enable researchers and policy makers to deal effectively with a wide range of contemporary issues affecting the SCP of the agricultural industry to be dealt with effectively beyond the scope of traditional approaches and analysis. This approach and it models can be used as a simulation model to test the possible outcomes of different systemic interventions by observing what would happen to the whole system when a particular strategy or combination of strategies are implemented: that is, before any time or money is invested in actual implementation at a local level, national level and for future inclusion in global supply chains. Improving Business survival and growth or competitive advantages of stakeholders with systemic approaches in the industry will meet the needs of players such as farmers, donors, governments, private companies, and researchers and thus reduce the exploitation of the ecosystem with traditional approaches. It will also clarifies the role of complex organisations in modern society; and predicts that the complexity of organisations, and therefore the role of management, will probably continue to increase – at least for so long as the efficiency-enhancing potential of complexity can continue to outweigh its inevitably increased transaction costs. This will also initiate a new era where many promising agricultural research and development initiatives could provide sustainable solution to national and regional agricultural challenges in most parts of Africa. Development communities must be convinced well to be willing to take a fresh look at not only development itself, but also at the best mechanisms and models to achieve it." Systems thinking approaches foster maximum collaboration with agricultural stakeholders (farmers, farmer groups/organizations, research scientists, agricultural extension agents, NGOs, private sector, development agencies and policy makers) in the industry. This will pose as an induction to the robust outputs that these multi-stakeholders would ever record. ELLab approach and the Bayesian networks unveil the importance of making decisions with consideration given to how management choices will affect the environmental system in the future. Therefore, for CLDs and Bayesian networks to be a useful tool, they need to be extended, in some way, to allow a long-term view to be taken.

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