"THE GREATER PUSH" FOR GROWTH AND SUSTAINABILITY IN AFRICA - EVIDENCE FROM GHANA

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ABSTRACT

Over six decades, agricultural policies attempting to increase the competitiveness of project performance had limited success. This is due to the use of traditional project management methods that do not address the complex challenges encountered in a systemic way. This paper provides an example of how a systemic approach is applied to agricultural development. The findings are based on a series of workshops conducted in Ghana in 2013 and 2014. Findings include an established community development model, the "Greater Push" and a new way of measuring, monitoring and evaluating sustainable development with Bayesian Belief Network modelling that satisfies the 'Bellagio Principles' for measuring sustainable development indicators. This research contributes to systemic application in project management and can help policy-makers across the world to identify threats to sustainable economic growth and help them to anticipate unintended consequences of their decisions and actions before it is too late to reverse the trend.

Keywords- Adaptive management; development model; economic growth; policy-makers; systems thinking; Agriculture; sustainable development; development indicators.

INTRODUCTION

Agriculture and its related industries are vital components not only for African but world's developing economy (Porter, 2000). More than 90 % of Africa's producers are small scale farmers having limited access to resources compared to their competitive counterparts in developed countries (Leichenko & O'Brien, 2002). African agricultural producers and proponents face increasing challenges, including distorted knowledge, the use of traditional approaches, deteriorating infrastructure, climatic extremes, environmental pollution, social disintegration, loss of community, crime and violence, urban blight, and unmanaged growth (Godfray *et al.*, 2010). Many initiatives have been proposed to address and modernize the agricultural sector in Africa by the World Bank, Food and Agriculture Organization of the United Nations, governments, research institutions and non-governmental organizations but with little success (Banson *et al.*, 2014b). For example, in 1975, the World Bank published a design named 'Rural Development in Africa', which was the bank's initiatives to counteract food shortages and unequal income distribution (Banson *et al.*, 2014b; World Bank, 2013). Then after 10 years, January 1985, the World Bank donated $5m within the space of a single year

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to the World Food Programme for emergency food supplies to Sub-Saharan Africa (Banson *et al.*, 2014b; World Bank, 2013). Productivity levels have been declining to date since 1960 (Banson *et al.*, 2014b).

This indicates that the initial World Bank intervention gave rise to a much bigger problem and their approaches could not fortify the sector. As made known by past interventions, these problems and challenges cannot be addressed and solved with traditional approach which study complex systems by breaking them down into their separate elements and parts. There is a need for a new approach to interventions in development projects and agri-business that can identify relevant indicators and also predict the unintended consequences associated with any strategy before implementation. 'Systems thinking' approach provides the tools that can highlights and addresses problems using integrated approaches and it demonstrate how to translate difficult ideas into potent management tools for change.

Access and adoption of "systems thinking" research and systems tools will result in viable agricultural sustainability, productivity and sustainability measurements or tracking. This will ensure continuous profitability that can contribute to the economic growth and environmental sustainability not only in Africa but the whole world.

The Importance of Sustainability Measurements

There have been many publications that could provide guidance towards improving the quality of life among agricultural stakeholders in Africa; however, most solutions are based on theory established upon ignorance of the subject under discussion (Hagin, 2012). Private and public organizations have experienced significant changes in recent years in both size and complexity. As a result, it is no small task to develop and perfect a system for sustainability measurement (Meadows, 1998). As a consequence, the management process has become more difficult, requiring greater skills in analysis and planning, and a knowledge of the control-skills aimed at guiding the future course of organizations faced with accelerating rates of evolution in technical, social, political, and economic forces (Hilbert, 2013). There is currently much debate about the most effective way to measure and track corporate sustainability progress and the choice and use of indicators (Chamberlain, 2014; Hilbert, 2013). The importance of this concept cannot be over-emphasised, especially if one takes into account the number of summits, conferences and seminars that have been held to discuss the imperative of sustainable development for the benefit of both developed and developing nations. Using precise metrics, sustainability efforts could be perceived as a major indicator for systems health, stability and its long-term prospects (Hilbert, 2013; Mingers & White, 2010). Indicators of sustainable development need to be developed to provide solid bases for decision making at all levels and to contribute to the self-regulating sustainability of integrated environment and development systems (Meadows, 1998). However, due to its vagueness and unclear measurement, sustainability is not incorporated in any financial valuation or investment decision.

Why Systems Thinking?

A systemic approach to strategic agricultural management implies that the natural and human environments make up a holistic system; comprising of individual components that are interrelated, affecting each other and therefore the whole. This helps to build a competitive advantage over traditional approaches which can lead to long-term above-average returns for relevant stakeholders in the system. Systems thinking gives rise to a new art of thinking required in business, management and finance as well the technical aspects of managing economic development for the "Greater Push" effects. The "Big Push model" developed by Rosenstein-Rodan (1957) and further refined by Murphy *et al* (1988) is a model to accelerate economic development. The study also adapted this "Big Push" model for a "Greater Push" model for growth and sustainability in agricultural production systems. The "Greater Push" model assumes holistic and interrelationships to the extent that any small impact of productivity on one sector has impact on the whole system. This is in contrast with the "Big Push" model which assumes that any small increase in the productivity of one sector has no impact on the economy as a whole.

By using a systemic approach, the changing demand, environmental sustainability and the quality of life of communities can be addressed automatically by satisfying the four main goals of systemic management (Noorani, 2009).

1) *System effectiveness* is systems output in terms of its intended benefit, such as sales or export volume, profit, production volume, and market share. (Dahl, 1994; Noorani, 2009).
2) *Systems efficiency* is the ratio of systems output to system input, such as sales volume, sales person, returns on investments, etc. (Noorani, 2009; Sengupta, 1995).
3) *Systems health* is the capacity of a system to renew itself with all functioning parts which is a prerequisite for innovation and growth. Only systemic thinkers will survive in this sector (Noorani, 2009).
4) And finally *systems cohesion*: this is the capacity of the system to adapt to its changing context, a condition for survival, e.g. farmers turn-over, goal of performance. Surviving organizations will be forced to fundamentally restructure their mission, goals, and purpose to adapt to systems cohesion (Noorani, 2009).

This research therefore employs systems thinking tools for accessing stakeholder's mental models on how to overcome the challenges impeding agricultural and community growth, sustainability and for measuring sustainable development indicators. These principles will serve as guidelines for the whole of the assessment process including the choice and design of indicators, their interpretation and communication of the result.

RESEARCH APPROACH AND METHODOLOGY

As mentioned above systems thinking views a problem as part of the overall system to enhance decision making and problem solving abilities. This is different to the current and often used linear approach, which mostly leads to "quick fixes". In this study the Evolutionary Learning Laboratory (ELLab) methodology developed by (Bosch *et al.*, 2013b) has been used for bringing together researchers from industry, academia, and stakeholders to deliberate on the challenges and how to overcome them. This approach has been used to deal effectively with complex issues in a variety of contexts (e.g. Banson *et al.*, 2014c)

Data collection was done using the four levels of a thinking model which consists of four distinct and closely related levels of thinking as shown in Figure 1: events or symptoms, patterns of behaviours, systemic structures and mental models.

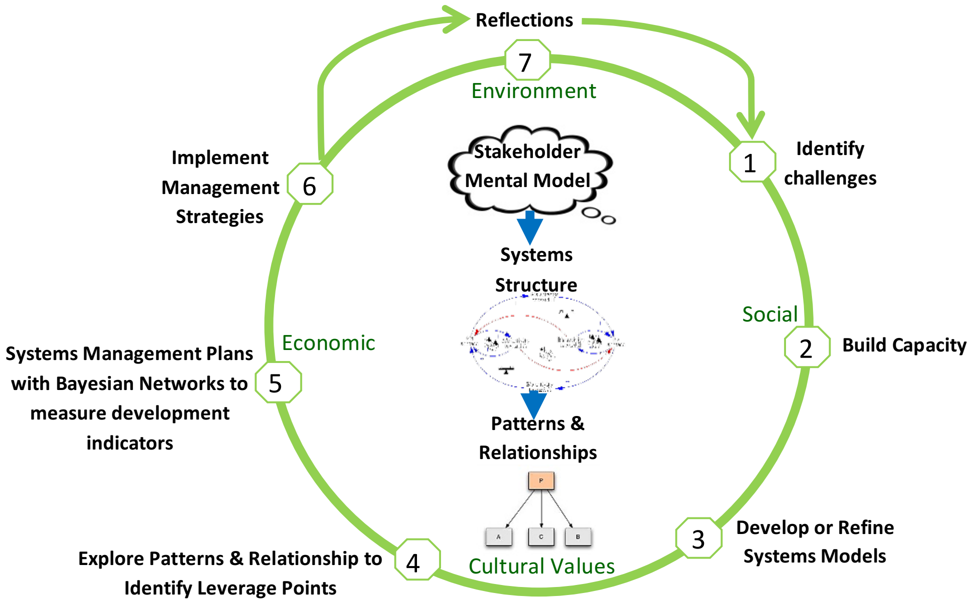

Figure 1- ELLab -The basis of the systemic approach for managing complex issues

Adapted from (Bosch *et al.*, 2013b)

Step 1- Gathering mental models: Establishing an ELLab started at the 'fourth level of thinking', which is the initial step involved in the forum to gather the mental models of all stakeholders involved in the challenges under deliberation. Their opinions concerning the challenges, limitations, implications and potential interventions were discussed during a series of workshops in Ghana. Senge (2006) explains *"mental models as deep-rooted generalizations, or images that influence how we understand the world and how we take action"*.

Step 2- Capacity-building sessions were held during which the participants learned to integrate the various mental models into a systems structure *(Step3)*. The Vensim software program *(Ventana Systems UK)* was used for the development of the CLD, using the variables identified through the capturing of the stakeholders' mental models of the issue under consideration.

Once completed, the participants moved to *Step 4*, the 'second level of thinking', by *interpreting and exploring the model for patterns, relationships* and type of feedback loops that exists. In *Step 5* the outcomes are used to develop a BBN model (Cain *et al.*, 1999b; Smith *et al.*, 2007) that is use to determine the systemic interventions and requirements for implementation and the factors that could affect the expected outcomes or indicators.

BBNs are composed of three elements: 1) a set of nodes representing variables of the management system (indicators), each with a finite set of mutually exclusive states (the terms “nodes” and “indicators” are used as synonyms throughout this paper); 2) a set of links representing causal relationships between these nodes; and 3) a set of probabilities, one for each node, specifying the belief that an indicator will be in a particular state given the states of those nodes that affect it directly. These are called conditional probability tables (CPTs) and are used to express how the relationships between the nodes operate. A CPT thus underlies each node/indicator in the BBN. Once all the CPTs have been completed, the BBN can be used for analysis.

The BBN was used because it fulfil the Bellagio Principles of measuring sustainable indicators according to Hodge and Hardi (1997) as shown in Table I. Principle 1 deals with the starting point of any assessment - establishing a vision of sustainable development and clear goals that provide a practical definition of that vision in terms that are meaningful for the decision-making unit in question. Principles 2 to 5 deal with the content of any assessment and the need to merge a sense of the overall system with a practical focus on current priority issues in a holistic perspective. Principles 6 to 8 deal with key issues of the process of assessment, while Principles 9 and 10 deal with the necessity for establishing a continuing capacity for assessment (Hardi & Zdan, 1997).

Table I: The Bellagio Principles for Assessment and the BBN Model Similarities

	BELLAGIO PRINCIPLES	BBN
1	**GUIDING VISION AND GOALS**	
	Assessment of progress toward sustainable development should: • be guided by a clear vision of sustainable development and goals that define that vision	A software framework to integrate vision and reasoning components that can be compiled and used for analysis. By altering the states of some indicators while observing the effect this has on others (Cain *et al.*, 1999a; Henriksen & Barlebo, 2008; Henriksen *et al.*, 2007; Lynam *et al.*, 2007; Ponweiser *et al.*, 2005)
2	**HOLISTIC PERSPECTIVE**	
	Assessment of progress toward sustainable development should: • include review of the whole system as well as its parts • consider the well-being of social, ecological, and economic sub-systems, their state as well as the direction and rate of change of that state, of their component parts, and the interaction between parts • consider both positive and negative consequences of human activity, in a way that reflects the costs and benefits for human and ecological systems, in monetary and non-monetary terms	The basis of a BN is a diagram conceptualising the environmental system to be managed (Cain *et al.*, 1999a; Molina *et al.*, 2010).
3	**ESSENTIAL ELEMENTS**	
	Assessment of progress toward sustainable development should: •consider equity and disparity within the current population and between present and future generations, dealing with such concerns as resource use, over-consumption and poverty, human rights, and access to services, as appropriate • consider the ecological conditions on which life depends • consider economic development and other, non-market	The BN modelling allows account to be taken of systems models to determine the components and interactions between the policy and the social, environmental, economic and other factors (e.g. unstated political considerations) dimensions of the industry(Banson *et al.*, 2014b; Cain *et al.*, 1999a).

	activities that contribute to human/social well-being	
4	**ADEQUATE SCOPE**	
	Assessment of progress toward sustainable development should: • adopt a time horizon long enough to capture both human and ecosystem time scales thus responding to needs of future generations as well as those current to short term decision-making • define the space of study large enough to include not only local but also long distance impacts on people and ecosystems • build on historic and current conditions to anticipate future conditions - where we want to go, where we could go	BN models provide insights into potential system behaviours and leverage points for systemic interventions required for sustainable development over a time horizon long enough to capture both human, ecosystem, political, economic etc. It also helps to anticipate the long-term consequences of their decisions and actions, as well as helps to avoid any unintended consequences of policies and strategies such as 'silo mentality' and 'organizational myopia' (Banson *et al.*, 2014b; Nguyen & Bosch, 2013).
5	PRACTICAL FOCUS	
	Assessment of progress toward sustainable development should be based on: • an explicit set of categories or an organizing framework that links vision and goals to indicators and assessment criteria • a limited number of key issues for analysis • a limited number of indicators or indicator combinations to provide a clearer signal of progress • standardizing measurement wherever possible to permit comparison •comparing indicator values to targets, reference values, ranges, thresholds, or direction of trends, as appropriate	As the BBN is a network, the impact of changing these variables is transmitted right through the network in accordance with the relationships expressed by the conditional probability tables (CPTs) or current indicator value. It consists of a set of interconnected nodes, where each node represents a variable in the dependence model and the connecting links represent the causal relationships between these variables. This means that decision makers can balance the desirability of an outcome against the chance that the management option selected may fail to achieve it (Banson *et al.*, 2014b; Cain *et al.*, 1999a).
6	**OPENNESS**	
	Assessment of progress toward sustainable development should: •make the methods and data that are used accessible to all •make explicit all judgments, assumptions, and uncertainties in data and interpretations	A fully functional BN model recognises stakeholder perspectives by two major activities: "Stakeholder consultation" and "Data collection and collation" Data collection may also raise the need for modification of the BN diagram which may, in turn, lead to further stakeholder consultation(Cain *et al.*, 1999a).
7	**EFFECTIVE COMMUNICATION**	
	Assessment of progress toward sustainable development should: • be designed to address the needs of the audience and set of users • draw from indicators and other tools that are stimulating and serve to engage decision-makers •aim, from the outset, for simplicity in structure and use of clear and plain language	The BN address the needs and the "mental models" of all stakeholders involved concerning the challenges under deliberations through brainstorming to identify appropriate management strategies. This approach takes into consideration support guidance as a way of explaining/translating in the local dialect of the participants where necessary (Banson *et al.*, 2014b; Bosch *et al.*, 2013a).
8	**BROAD PARTICIPATION**	
	Assessment of progress toward sustainable development should: • obtain broad representation of key grass-roots, professional, technical and social groups, including youth,	The development of a BN model within the Evolutionary Learning Laboratory (ELLab) process offers a methodology for creating informal learning spaces or platforms for managing complex issues. It aims to introduce systems thinking for researchers, research managers, decision or

	women, and indigenous people - to ensure recognition of diverse and changing values • ensure the participation of decision-makers to secure a firm link to adopted policies and resulting action	policy makers and especially stakeholder groups who are marginalised in decision making but who are, nevertheless, crucial to successful implementation together with women at all levels to develop a shared understanding of complex issues and to create innovative and sustainable solutions using systems approaches(Banson *et al.*, 2014a; Bosch *et al.*, 2013a).
9	ONGOING ASSESSMENT	
	Assessment of progress toward sustainable development should: • develop a capacity for repeated measurement to determine trends • be iterative, adaptive, and responsive to change and uncertainty because systems are complex and change frequently • adjust goals, frameworks, and indicators as new insights are gained • promote development of collective learning and feedback to decision-making	Parts of a BN developed for one decision problem (including the information used to drive it) might well be useful in a later BN developed for another problem. In the long run, stakeholders take ownership of the solution which ensures adoption and implementation because it is their own mental model (Banson *et al.*, 2014a; Bosch *et al.*, 2007; Bosch *et al.*, 2013b; Cain *et al.*, 1999a).
10	INSTITUTIONAL CAPACITY	
	Continuity of assessing progress toward sustainable development should be assured by: • clearly assigning responsibility and providing ongoing support in the decision-making process • providing institutional capacity for data collection, maintenance, and documentation • supporting development of local assessment capacity	The BN model is used as a simulation model to test the possible outcomes of different systemic interventions by observing what would happen to the complex system as a whole when a particular strategy or combination of strategies are implemented: that is, before any time or money is invested in actual implementation. The BN helps decision makers anticipate the long-term consequences of their decisions and actions, as well as help avoid the danger of "shifting the problems" or "giving rise to bigger problems to fix later" (Banson *et al.*, 2013; Bosch *et al.*, 2013b).

The BBN model was used to identify systemic interventions through rapid sensitivity analysis (identifying those factors that had the biggest effect on the goal (achieving the leverage point)) that were subsequently used to develop an integrated master plan with orderly defined goals (leverage points), strategies (systemic interventions) and indicators to measure success in the next step of the ELLab (implementation).

Indicators were suggested by the stakeholders during these workshops based on how well they can address the issue of the community's carrying capacity relative to community capital: natural, human, and social resources that is not at the expense of global sustainability (Hart *et al.*, 2014). According to Hart *et al.* (2014) an indicator helps you to understand how well a system is working by pointing to an issue or condition. This study focuses on the first five steps of the ELLab, but they form part of the seven-step process as they will be embedded in the co-learning cycle of the ELLab. Step 6 will include implementation of the strategies and/or policies that will create the biggest impact by the managers or policy makers Targets will be determined, and monitoring programs will be implemented to measure and/or observe the outcomes of the strategies and policies. Step 7 is an important part of the ELLab process, because no systems model can ever be completely 'correct' in a complex and uncertain world. The only way to manage complexity is by reflecting at regular intervals on the outcomes of the implementation phase. Successes and failures are then used to identify unintended consequences and to determine through co-learning how to adapt the strategies that do not result in the desired outcomes (Bosch *et al.*, 2013a).

RESULTS AND DISCUSSIONS

Causal Loop Diagram and the "Big Push" Model

The data in a form of mental models collected from all the workshops and discussions (*Step 1* of the ELLab) were integrated into a CLD as illustrated in Figure 2 (*Step 3*). This reveals the causal relationships amongst a set of variables (or factors) influencing competitive development within the agricultural systems. The CLD in Figure 2 explains the sources of complexity that has given rise to poor sustainable economic development within Ghana's agricultural communities. An inspection of this CLD reveals that the current undesirable outcomes (poor quality of life, poor to zero infrastructures, unemployment, migration and unsustainable community development) can be traced back to the lack of community resources leading to poor wellbeing of communities. An unintended consequence of this is that agricultural productivity diminishes increasing food prices effects and poverty and victims relies on forest covers (charcoal burning, hunting, firewood) which in turn affects river flow and the ecosystem. Having identified the root causes of complex problems, the appropriate intervention strategy can be devised. In the case of Ghana's agricultural communities, the leverage lies in integrated planning and coordinated government policies. The effects of these strategies are shown in the Figure 2. As can be seen, these strategies create twenty-two positive reinforcing 'loops' (shown by the 'R' sign). These loops represent the reciprocal and beneficial effects of government support in resources and the chain impact of these on sustainability and livelihood of the communes.

Stakeholders proposed modern agriculture to include innovation and access to agricultural machinery and farming methods, genetic technology, techniques for achieving economies of scale in production, the creation of new markets for consumption, the application of patent protection to genetic information, and international trade.

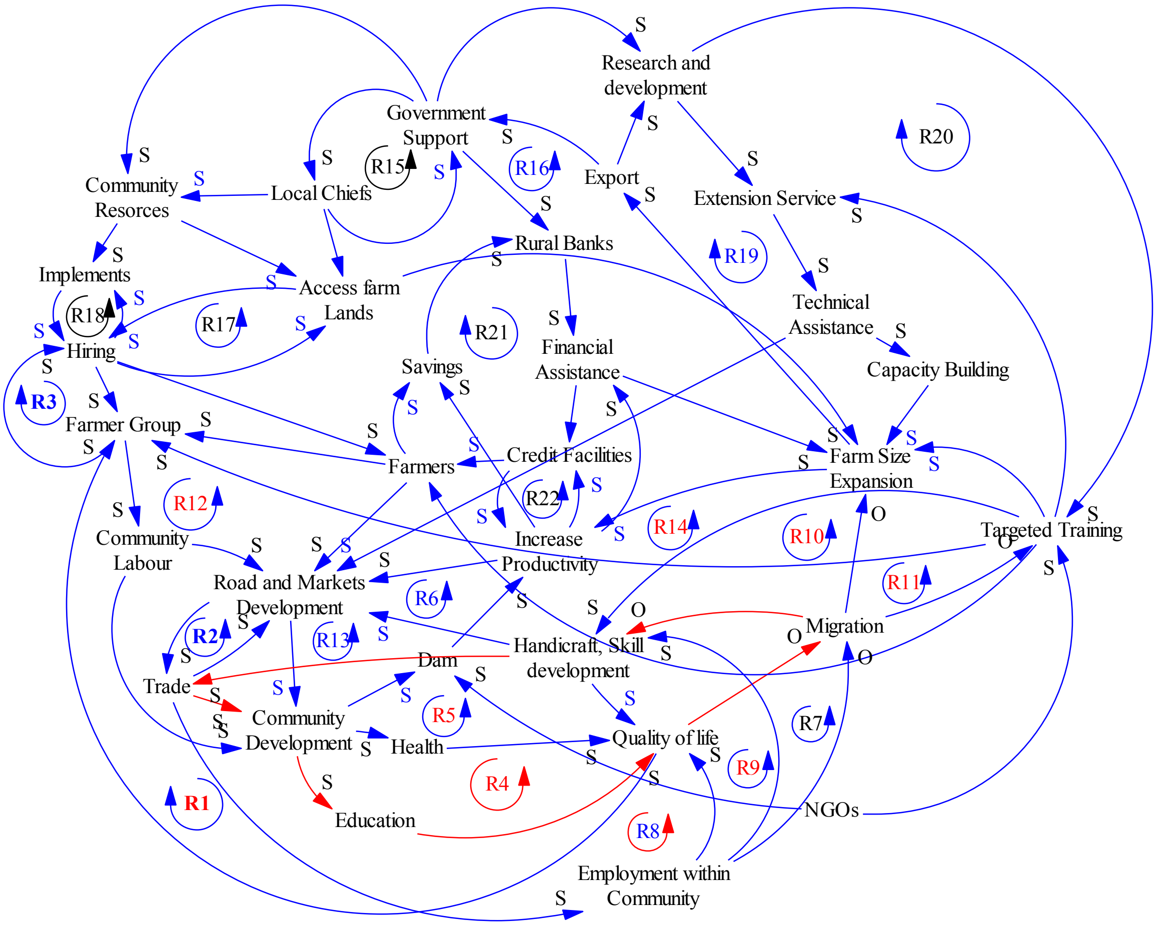

Figure 2: Competitive development model

Figure 2 illustrates how the economy can be leveraged to a greater productivity and at the same time industrializing while improving the quality of life as proposed by the "Big Push" model (Rosenstein-Rodan, 1957). Government support in the form of provision of implements and alliance with local chiefs to demarcate and protect arable agricultural lands will initiate community development and system cohesion.

The "Big Push" model as shown in Figure 3 is a concept in development economics or welfare economics that emphasizes that a company's decision whether to industrialize or not depends on its expectation of what other companies will do (Murphy *et al.*, 1988). It assumes economies of scale and an oligopolistic market structure and explains when industrialization would happen. The "Big Push" model emphasizes that underdeveloped countries require large amounts of investments to embark on the path of economic development from their present state of backwardness (Todaro & Smith, 2009).

This theory proposes that a 'bit by bit' investment program will not impact the process of growth as much as is required for developing countries. It stipulates that, injections of small quantities of investments will merely lead to wastage of resources. Paul Rosenstein-Rodan, approvingly quotes a Massachusetts Institute of Technology study in this regard, "There is a minimum level of resources that must be devoted to a development program if it is to have any chance of success. Launching a country into self-sustaining growth is a little like getting an airplane off the ground. There is a critical ground speed which must be passed before the craft can become airborne (Rosenstein-Rodan, 1957).

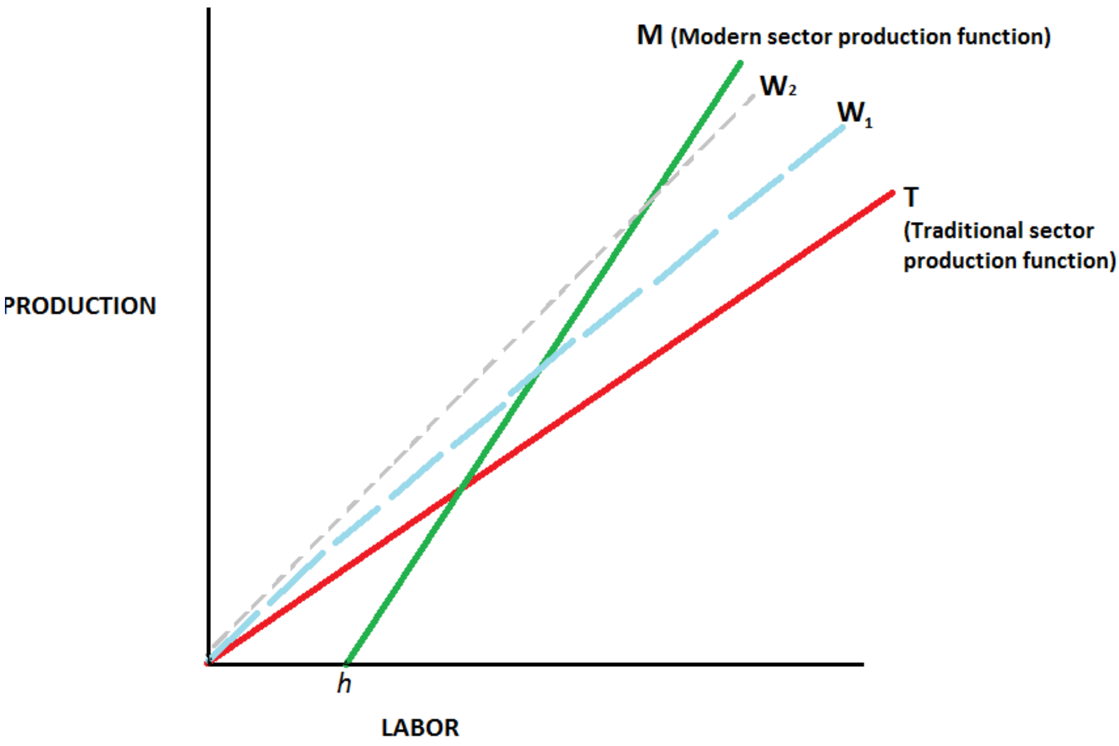

Figure 3: the “Big Push” model.

source:(Todaro & Smith, 2009)

Stakeholders proposed that if governments can support them by providing a minimum level of resources in the form of mainly tractors, harvesters and caterpillars, it will give them hope and a chance of success which can catapult them to self-sustaining growth. They proposed that they can hire these equipments at a subsidised rate to pave their own community roads and develop their own community markets through cooperative or individual groups depending on their availability. According to Rosenstein-Rodan (1957), when a group of stakeholders plan together according to their social marginal products, the rate of growth of the economy is greater than it would have otherwise be. Stakeholders ascertained that with this, other development within the community will be triggered such as schools, hospitals and dam development and improve performance and the quality of life of its members as shown in Figure 2.

It was also ascertained that with the developed community market, trade can increase to promote handicraft and skill marketing, thereby reducing out-migration and promoting system health as shown in Figure 2. This will in turn promote the development of rural banks and increase farmers savings and credit worthiness. With financial and technical assistance from the rural banks and extension services, capacity will be ensued and farms sizes and productivity will increased which will leads to more trade (sales volumes, returns on investment etc.) and employment within the community to facilitate systems efficiency. These will boost systems output in terms of its intended benefits such as high sales volume, profit, production volumes and market share expansion leading to export as shown in Figure 2.

The "Big Push" has drawbacks (Easterly, 2006; Guillaumont & Guillaumont Jeanneney, 2007). Guillaumont and Guillaumont Jeanneney (2007) argue that, there is a probability that a poverty trap exists for many developing countries and that an increase in aid is relevant for them. However, they proposed that the decrease in marginal aid returns is slower in vulnerable countries, which supports the rationale to include vulnerability as one of the aid-allocation criteria. The main obstacles to absorptive capacity, such as disbursement constraints and short-term bottlenecks, macroeconomic problems, including loss in competitiveness and macroeconomic volatility, as well as the weakening of institutions are not factored by the "Big Push". The "Big Push" recommendation overlooks the unsolvable information and incentive problems facing any large-scale planning exercise (Easterly, 2006). It also assumes that, any small investments do not have impact on the whole which contradicts systemic principles – thus this paper adjust the big push model from a systemic point of view called, to the "Greater Push" model" as shown in Figure 4.

Systemic Development - The "Greater Push" Model"

As in the case of Ghana, African economy is characterized by a large number of sectors which are interrelated to the extent that any impact on productivity of one sector has impact on the whole system. Each sector can either rely on traditional approaches or switch to a systemic approach to deal with challenges which would impact on its efficiency. With the following two assumptions in mind:

1. There are l investments to be made in n sectors, each sector will have l/n investment (Lange, 1960; Todaro & Smith, 2009);
2. The traditional approach only deals or treats the symptoms of the challenges, while systemic approach deals with the root cause of the challenges (Banson *et al.*, 2014a; Bosch *et al.*, 2007; Bosch *et al.*, 2013b);

Then when using a *traditional approach*, a sector would produce l/n amount of output, which may result in further consequences such us shifting the problem to other sectors with each investment producing less than one unit output or even negative. However, when using a *systems thinking approach,* a sector would produce much more, because the productivity would be greater than one unit per investment through leverage points with positive cascading impacts on the other sectors.

In Figure 4, the x-axis represents the investment employed and the y-axis represents the level of productivity.

The productivity as a result of using the traditional approach in the sectors is given by the curve 'T' and the productivity using the systems thinking approach in the sectors is given by 'S'. The curve 'S' has a positive intercept on the y-axis, implying that there are self-organization cascading positive impact of growth and sustainability of the whole system (Heylighen, 2001).

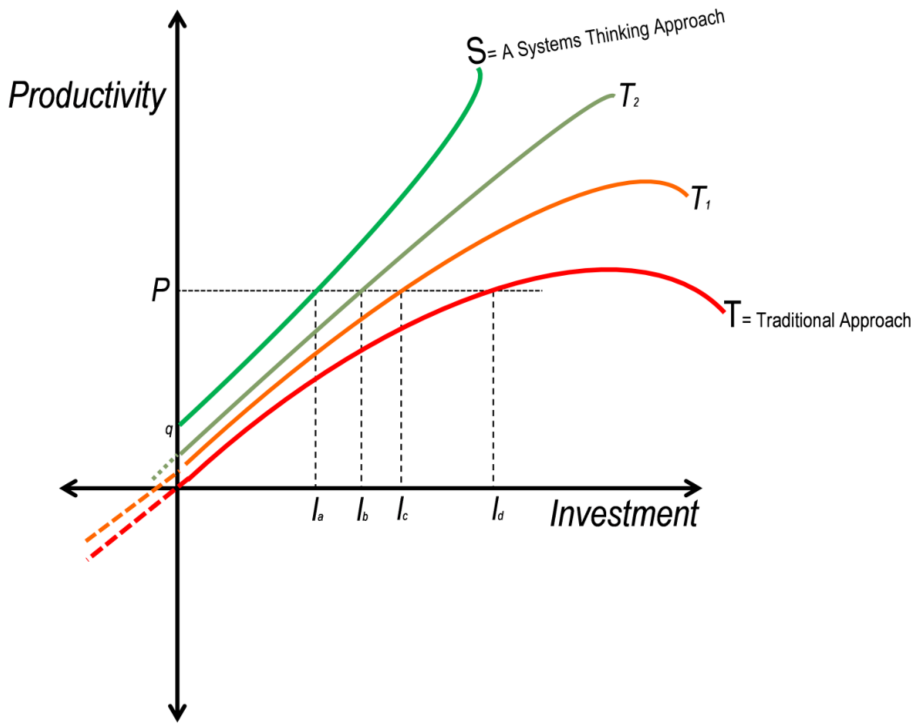

Figure 4: The "Greater Push" model. Adapted from the "Big Push" model

Therefore with the assumption of l/n investment in the economy, the systemic approach will have a higher level of productivity than the traditional approach. The production function as a result of the systems thinking approach is steeper than that of the traditional approach as a result of dealing with the root causes of challenges, thus the higher productivity of investment in the former. The slope of both production functions is $1/S$, where 'S' is the marginal investment required to produce more than one additional unit of output. This level of 'S' is lower using the systemic approach than it is for the traditional one.

Assume that a *traditional approach* was used to address a particular challenge in the sectors using one unit of investment; then the output generated in the whole system is

$Output = \frac{1}{n} - Z^{\{1+x\}}$. We have two possible cases: a fix "now" shifting the problem to other sector or giving rise to a much bigger problem to fix "later" thus $Z^{\{1+x\}}$ is the diminishing factor as a result of organizational myopia with $\{1+x\}$ as the compounding rate at which the problem is cascading in the whole system (Luehrman, 1998).

However, using the *systems thinking approach*, output generated in the whole system will be $Output = \frac{1}{n} \times Z^{\{1+x\}}$

Thus productivity 'P' increases as an economy shift from the traditional to a systemic approach. The BBN model in the next section provides ways to measure sustainable indicators and to ascertain how well a community is meeting the needs and expectations of its present and future stakeholders.

Indicators for Sustainability

Sustainability requires that the wellbeing of community - the combination of community liveability, environmental sustainability and economic prosperity - is maintained or improved over time (Australian Government, 2013). Measuring sustainability is about monitoring how each indicator performs over time. A good indicator alerts one to a problem before it gets worse and helps to recognize what needs to be done to address the problem. Indicators of a sustainable community point to areas where the links between the economy, environment and society are weak. Indicators of sustainability are different from traditional indicators of economic, social, and environmental progress. Traditional indicators such as stakeholder profits, interest rates, and quality of life - measure changes in one part of a community as if they were entirely independent of the other parts. For all workshops and interviews during the study, indicator selection generated discussion among people with different backgrounds and viewpoints, and, in the process, helped to create a shared vision of what the indicators should be. Using the Netica software package (Norsys Software Corp, 2014), the indicators were constructed into a simulation model in which the original plan (or baseline) are identified and managed to keep the project within scope, on time, and within budget as shown in the Figure 5. Saving a baseline plan enables the identification and solving of discrepancies and planning more accurately for similar future projects. The sustainability indicators have been designed to reflect both stocks (quantity and quality of resources) and flows (uses or drivers of change in stocks) of social and human, natural and economic capital. Sustainability indicators reflect the reality that the different segments are intrinsically interconnected. In contrast, a comparable sustainability indicator is the Index of Sustainable Economic Welfare.

As Figure 5 illustrates, the natural resource base provides the materials for production on which jobs and stakeholder profits depend. The structure of this diagram encodes the perception that revenue is affected by market development and this, in turn, affects the income and investment rate (entrepreneurship) which determines economic prosperity and the entire wellbeing of the community. Also river flow is affected by forest cover (10.2% of land area) (Koranteng & Zawila-Niedzwiecki, 2008) and this, in turn, affects the ecosystems and bio-diversities on which the entire wellbeing of the community depends. Other relationships represented by the diagram can be obtained from the BBN in a similar way. Jobs affect the poverty rate and the poverty rate is related to crime. The development of social capital with available infrastructures and institutions has positive impact on innovations through the provision of health care and education, which affects community productivity and liveability. Economic prosperity encodes the perception that, market development impacts on revenue which in turn affects poverty, crime rate and entrepreneurship development. They may also have an effect on stockholder profits.

Sustainability requires this type of integrated view of the world since it requires multidimensional indicators that show the links among a community's economy, environment, and society. For example, the Gross Domestic Product (GDP), a well-publicized traditional indicator, measures the amount of money being spent in a country. It is generally reported as a measure of the country's economic well-being: the more money being spent, the higher the GDP and the better the overall economic well-being is assumed.

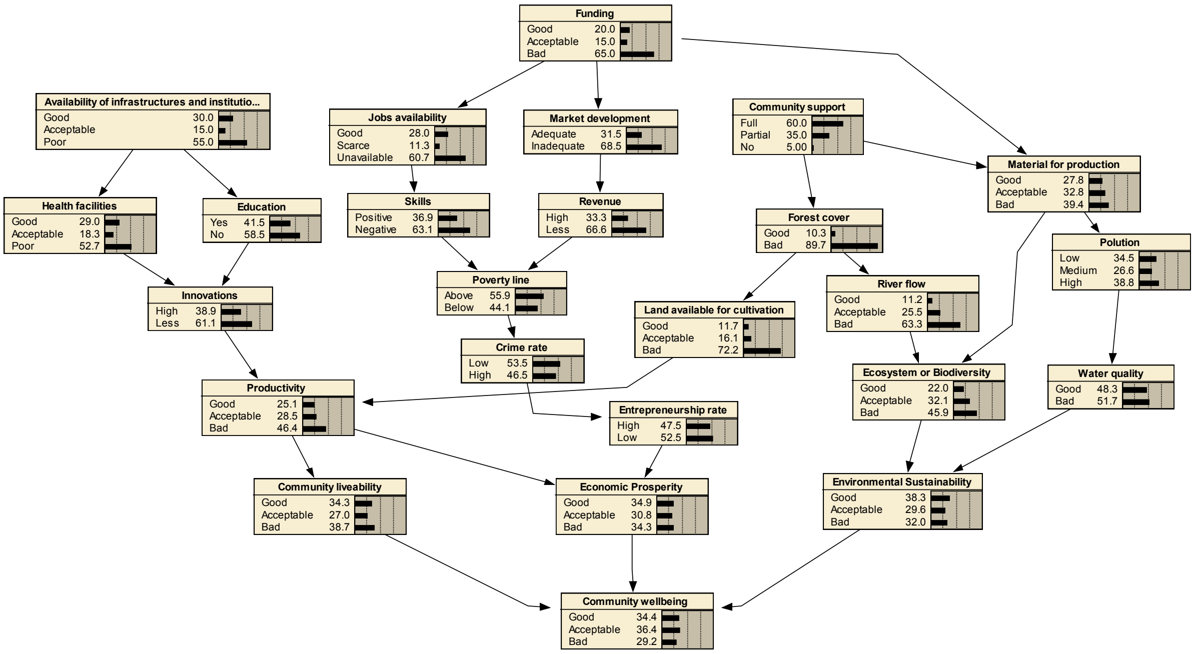

Figure 5: Bayesian Belief Network showing the current agricultural development indicator system affecting community wellbeing in Ghana

However, because GDP reflects only the amount of economic activity, regardless of the effect of that activity on the community's social and environmental health, GDP can go up when overall community health goes down. For example, when there is a ten-car pileup on the highway, the GDP goes up because of the money spent on medical fees and repair costs. On the other hand, if ten people decide not to buy cars and instead walk to work, their health and wealth may increase but the GDP goes down.

Monitoring and Evaluations

The BBN in Figure 5 was used as a simulation model to monitor, measure and evaluate the possible outcomes of different sustainable development indicators by observing what would happen to the system as a whole when a particular strategy or combination of strategies was implemented to alter its indicator. If community wellbeing is within an acceptable level (Figure 5), then we would expect significant positive effects on the rest of the indictors within the network. With this information, the intervention can be adapted to encourage positive feedbacks.

For example in Figure 5, the probability for forest cover is 10.3%. It is evident from the discussion above that improving farmers' market development, forest cover, and ensuring infrastructure availability are key leverage points for ensuring community wellbeing and sustainable agriculture. These interventions will have positive impact on the other indicators.

The BBN model (Figure 5) indicates that the probability of the current level of revenue is 33.3%, the percentage of Ghanaian population living below the international poverty line $1.25 (in purchasing power parity terms) a day is 44.1 (Olinto *et al.*, 2013; UNDP, 2012) with the probability of community prosperity as 34.9%. Developing market as intervention strategies, revenue increased from a probability of 33.3% to 95%, farmers below the poverty line reduced from 44.1% to 7.93% (Figure 6) and the probability of the prosperity of the community increased from 34.9% to 46.8%.

The expected outcomes are presented in Figure 6. This simulation provides added opportunity to test possible strategies that can impact on any indicator before any time or money is invested in actual implementation.

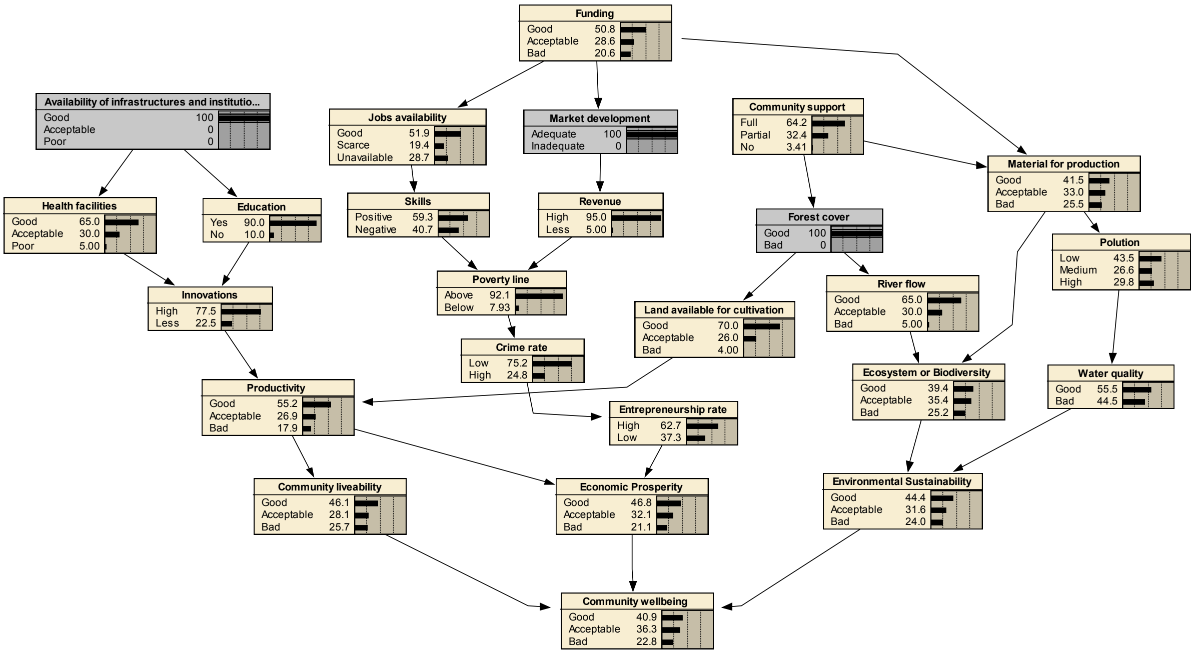

Figure 6: Bayesian network showing the agricultural development indicator system related to community wellbeing in Ghana *(With intervention: Market development, infrastructural development and improving forest cover)*

As a result of altering forest cover as a systemic intervention (Figure 6), amplify a ripple impact on the other indicators such as river flow, ecosystem/biodiversity and environmental sustainability. This has been graphed (Figure 7) using percentage change tabulations (Equation 1) to calculate the state of the indicator (x) while varying percentage change (y) and depending on the project scope, time, and budget, growth rate of each indicator can be tabulated using Figure 7.

$$x = \left(\frac{y}{100}\right) \times Current\,Value \quad + Current\,Value \qquad \text{----- (1)}$$

Where ' x ' is the state of the indicator at a percentage-change ' y '.

Figure 7 indicates that when forest cover is improved at a time "t" it will cause ripple positive effect on river flow improving the ecosystem or biodiversity to enhance environmental sustainability to impact on community wellbeing.

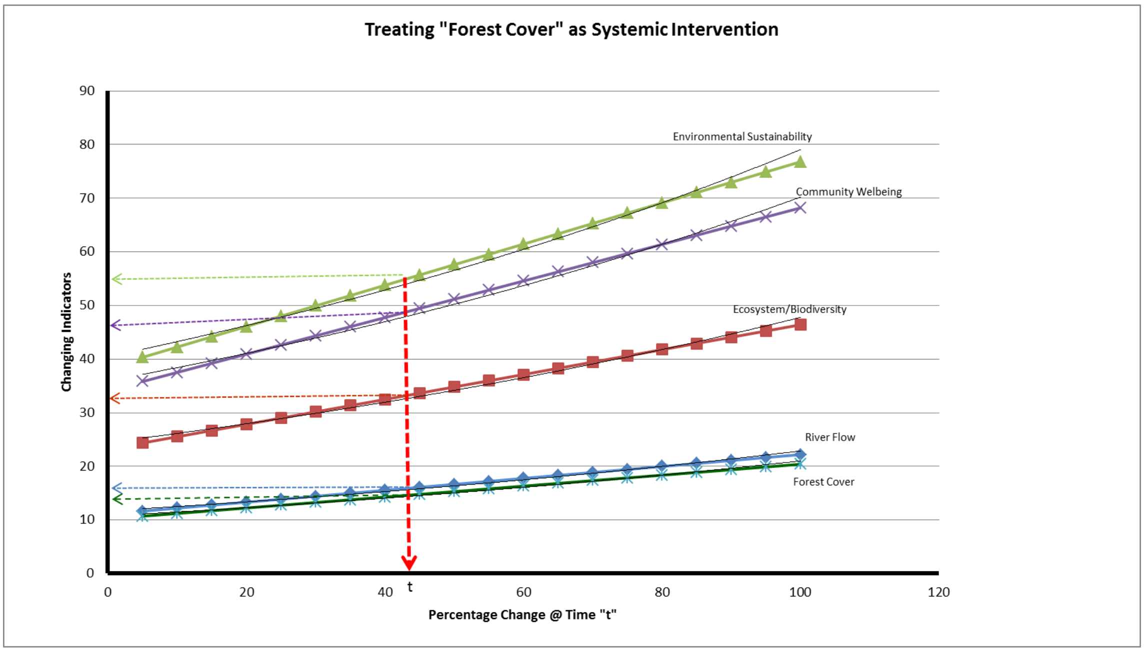

Figure 7: Graphical presentation of the impact of improving forest cover as systemic intervention

These indicators can be tabulated as a proportion of their actual SI units to get the measure of their value. For example, according to (FAO, 2002), forest and wildlife reserves occupy 18,000 km^2 or 22 per cent (Figure 5) of the forest zone of Ghana. In order to measure the impact of improving forest cover as a systemic intervention, it can be deduced from Figure 7 as a percentage change on forest and wildlife reserves at time ‘t’ as expressed below.

$$x = (\left(\frac{45}{100}\right) \times 18{,}000) + 18{,}000 = 26{,}100 km^2 .$$

Meaning with systemic intervention to improve forest cover at a period ‘t’ will increase forest and wildlife reserves by 8,100km2.

CONCLUSION

We live in an interdependent world where social, environments, political and economic problems soon collide, and therefore systemic approaches and networks of cooperation to deal with complex issues will be the dominant mode of success to catalyse effective investment to protect global commons and increase resilience. Only by applying systemic knowledge can we sustain our communities and derive benefit from an increasingly complex future. This paper has demonstrated how a systemic approach as a management tool can be applied to agricultural development to increase it competiveness. Systems thinking gives rise to a new art of thinking required in business, management and finance as well the technical aspects of managing economic development for the “Greater Push” effects. The “Greater Push” model” assumes holistic thinking and interrelationships to the extent that any small impact of productivity on one sector has impact on the whole system, as proposed otherwise by the adapted "Big Push model". It has also shown that u*sing a systems thinking approach,* a sector's productivity would be much higher per investment through leverage points with positive cascading effects on the other sectors compared to the traditional approach. This can complement the "Big push" model as a concept in development economics or welfare economics should a nation require increasing productivity and economic development in this complex world.

ACKNOWLEDGEMENTS

Funding for this study is sourced from the Australian Agency for International Development (AusAID) and the University of Adelaide Business School. The authors would like to express great attitude to all the agricultural experts and relevant stakeholders from Africa for their time and contribution to this study. Special appreciation also goes to the Ghana Atomic Energy Commission and The Biotechnology and Nuclear Agriculture Research Institute for their support during the conduct of this study.

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