

Digital Knowledge Ecosystem to Reduce Uncertainty and Coordination Failure in Agricultural Markets – Study of “Govi Nena” Mobile–Based Information System

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Abstract This paper presents how Digital Knowledge Ecosystem such as “Govi Nena” (translates as agriculture intelligence) can be used to provide a more effective and practical solution to eliminate the inefficiencies in agricultural markets and achieve higher productivity and price stability. In order to establish the framework to analyze the system, this paper uses a set of hypothetical scenarios faced by value chain actors based on a review of the literature, established knowledge and recent developing country experiences. The scenario analysis reveals that “Govi Nena” enables farmers to make effective production decisions, deepens the level of value chain integration, and enhances the level of welfare for the society as a whole.

Keywords Actionable information, coordination failure, uncertainty, digital knowledge eco system, mobile-based information system

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1 Introduction

The rapid rise in food prices and the shortage of basic food commodities experienced in recent years has created renewed interest towards efficient production of agricultural commodities around the world. Two of the main causes of low efficiency in agricultural production are coordination failure and uncertainty which will be explained shortly below. A key condition for producers to be included in successful value chains is that they have access to market information and possess the ability to translate it to market intelligence (Trienekens, 2011). Thus in order to improve efficiency agricultural sector needs to transform itself from fragmented production and marketing relationships towards an integrated market system.

Unlike in any other industry production lag associated with the seasonality of agricultural crops has created a unique problem for market actors. The synchronization of different activities carried out by different actors, from the time of cultivation to time of selling, has to be well coordinated (Ginige & Ginige, 2011; Varian, 1992). Failure to do so would result in either an oversupply or undersupply of commodity to the market. In economics coordination failure describes a situation where inability of agents to coordinate their behavior (choices) leads to an outcome (equilibrium) that leaves all agents worse off than in an alternative situation that is also an equilibrium (Smith & Todaro, 2015). However, coordinating such a massive operation comprised of thousands of independent actors in a timely manner is beyond the ability of human coordination. Hence the coordination failure prevails in the agricultural markets.

The second main cause of inefficiency in the agricultural markets this paper focuses on is the uncertainty. Uncertainty

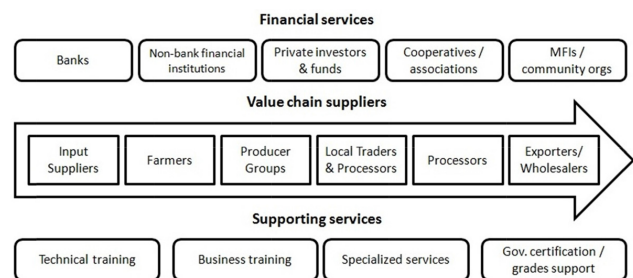
is present when the likelihood of future events is indefinite or incalculable (Knight, 1921). Uncertainty affects production decisions. Thus higher uncertainty leads to lower production. Lack of access to actionable information can also increase the level of uncertainty in the agricultural markets. The remainder of the paper is organized as follows. Section 2 presents brief overview of the Gove Nena system. An analysis of scenarios is described in Section 3. Section 4 summarizes the approach and concludes the paper.

2 Overview of the System

Govi Nena is mainly comprised of two components: real-time mobile-based information system and a management dashboard. A mobile application will be the front-end for farmers to monitor the aggregate production level in near real-time. Once a farmer is signed up, the mobile application will detect the corresponding agro-ecological zone of the farm location and display a list of viable crops to grow (Ginige, Silva, Ginige, Giovanni, Walisadeera, & Mathai, 2014). Farmers communicate their production decisions (varieties and their extent) back to Govi Nena in exchange for a variety of support and advisory services on fertilizer, pesticides, crop insurance, agricultural loans, cultivation advice, buyer contacts, and labor supply information critical for the cultivation process (Silva, Ginige, Giovanni, Mathai, Goonetillake, & Wikramanayake, 2016). The second component, management dashboard is a graphical terminal customizable according to other value chain participants' (i.e. banks, agrochemical companies, government agencies, etc.) specific information needs. They provide information to Govi Nena to receive information which is vital for their business activities. The conceptual idea is to create information dependency among different value chain agents so that these networks of information relationships would evolve into a digital knowledge ecosystem resembling a natural ecosystem (Briscoe, 2010; De Silva L. N., Goonetillake, Wikramanayake, & Ginige, 2014). In this digital knowledge ecosystem each agent produces information that might be an input for another agent to produce information. The incentives (profits or reduced uncertainty gained by participation) and punishments (losses or increased uncertainty incurred by not participating) would ensure the sustainability of this digital knowledge ecosystem. The role of the Govi Nena is to aggregate and disaggregate information to generate actionable information for each of the user (De Silva L. N., Goonetillake, Wikramanayake, & Ginige, 2014; De Silva, Goonetillake, Wikramanayake, & Ginige, 2012).

3 Scenario Analysis

The scenario analysis in this paper uses a generic value chain to conduct the analysis (see Figure.1). The value chain comprises of six main actors: input suppliers, farmers, producer groups, local traders and processors, processors, and exporters and wholesalers. These actors are instrumental in moving the product from farm-to-table. The function of the input suppliers is to provide factors of production to the farmers. Financial services play a key role in each link facilitating movement of funds/credit and risk sharing while support services enhance the business outcomes of core value chain activities (i.e. activities of six main value chain actors) by improving efficiency.



Source: Miller & Jones (2011)

Figure 1 Agricultural Value Chain

At this point it is worthwhile to explore market linkages in order to analyze the scenarios in light of these contexts. These linkages are: farmer to domestic trader, farmer to retailer, linkages through a leading farmer, linkages through cooperatives, farmer to agro processor, farmer to exporter, and contract farming (Shepherd, 2007). Farmer to domestic trader, linkages through a leading farmer, and linkages through cooperatives are traditional models where the farmer interacts one-to-one with the other party for a limited range of value transfers. Often in the traditional models farmers adopt “grow and sell” production approach. The growths of agribusinesses have necessitated value chain actors to go beyond these traditional linkages and form much sophisticated market linkages. In some of the modern marketing relationships the value transfers are much broader. For example it could encompass a range of activities such as making credits available, supplying input, assisting throughout the growing phase, monitoring quality, buying the harvest, collection and transport. In these non-traditional models farmers frequently adopt “grow to order” production approach. The complex nature of global conglomerates have created the need for agribusiness to integrate value

chains in different combination of activities just described depending on the nature of the crops and the market dynamics. This implies that the broader the value transfer greater the required level of value chain integration. The success of these value chains heavily depends on availability of actionable information and transaction cost between the links. If there is little actionable information the uncertainty would prevail and if there is higher transaction cost coordination failure would prevail. Impending section analyses few selected hypothetical scenarios to understand how the Govi Nena system improves performance of the value chains by facilitating information flow and reducing transaction cost.

3.1 Farmer Planning to Maximize Profits by Attempting a New Crop Variety

Let us consider a hypothetical scenario where a rural farmer is interested in finding a suitable crop to maximize the revenue. Let's assume that he is familiar with the operations and features of Govi Nena. One of the greatest advantages of using Govi Nena is, the farmer is able to see what major agribusinesses are willing to pay for certain export quality varieties which is not possible under usual circumstances. This reduces the uncertainty by ensuring a guaranteed price for future production for farmers and also helping farmers to transform to low risk "grow to order" model from traditional production approaches.

If the farmer feels that the expected price is substantially higher than the average cost, farmer will decide to produce the intended crop. Average cost calculation requires factor prices (fertilizer, seeds, pesticides wages, rents, interest etc.) to consider. If the margins are relatively thin (which is usually the case when it comes to agricultural commodities), this step becomes crucial in determining the likely profitability of the interested crop. Once again the accuracy of the calculation depends on the quality of information. If there is information cost (i.e. travelling and processing) this will effectively increase the average cost which under normal circumstances the farmer may fail to include. Often the farmer intuitively calculates the average cost using the past experience. Govi Nena contains a cost calculator module (with up-to-date factor pricing) in which once the farmer inputs the planned extent then the system will display the estimated cost of cultivation. This allows farmer to calculate the estimated profits with the minimum amount of processing and cost. Thus the farmer would know how much profits he can make by growing this crop in his farm (De Silva L.

N., Goonetillake, Wikramanayake, & Ginige, 2013; Ginige, Richards, & Hitchens, 2014).

The next thing the farmer is interested in knowing is whether this particular crop grows in his farm. In the absence of Govi Nena, the farmer would be required to visit nearest state agricultural office which involves time and a travelling cost (physical visit is relatively less expensive than calling). At the office farmer receives generic information relating to the cultivation of the crop (leaflets, manuals, and verbal instructions). This standard information does not answer the question "does this particular crop grow in my farm?" To answer this question the farmer has to consider several variables such as soil type, rainfall, temperature etc. Further processing of information (cost of processing) could be a barrier for a rural farmer. With Govi Nena the farmer is able to find out answers to above problem in the least expensive and time consuming manner (Ginige & Richards, 2013). Govi Nena system will indicate a list of crops that grows in farmer's land from which the farmer would be able to know whether the crop under consideration grows in his land with certainty.

3.2 Contract Farmer Management

Consider a situation of an agribusiness company serving a foreign customer who has adopted "made-to-order" production approach. The company must fulfill the delivery with the quality standards set by the customer within the given timeline. In order to acquire the goods required to fulfill the delivery, the company may resort to contract farming. The challenge faced by the agribusiness company is to maximize the output while ensuring the quality of the produce.

Traditionally the company train farmers, provide inputs, and monitor activities to ensure meeting of the production targets. Due to higher uncertainty level associated with the quality of output, company provides agricultural extension services through agricultural extension officers (AEOs). The primary role of the agricultural AEOs is to ensure farmers engage in the right agricultural practices. However there are few issues with this approach: first, the company is not able to directly observe the activities of AEOs; second, the communication between the base and the AEOs could be time consuming; third, the limitations in manpower. Consequently the performance of the overall process is not optimum.

In order to resolve above issues, Govi Nena system has a special version for AEOs which could be installed on a tablet computer. AEO can accompany the device

to the field and upload information. The information gets updated and the base can track AEO activities in real-time. In developing countries AEO reporting happens in the form of periodic meetings or paper based reports. This form of correspondence is relatively slow paced for time critical crops. Therefore Govi Nena presents a faster and effective way of monitoring and communicating with AEOs. Principles can use customized version of Govi Nena mobile- based information system to impart company specific best practices to contract farmers. Thus the system is capable of guiding the farmers through each phase of the cultivation cycle step-by-step giving specific instructions. In other words the system replaces some of the functions of the AEO with a much greater efficiency. This resolves the issue having to allocate limited number of AEOs to a vast network of contract farmers. Thus Govi Nena effectively reduces the costs associated with monitoring activities of farmers and AEOs.

3.3 Finance Institution Planning to Provide Agricultural Loan Products to Farmers

Consider a case of input supplier credit where agrochemical company offering a deferred payment sales to smallholder farmers. The smallholder farmers are able to access bank finance using the forward sales contract with the agribusiness companies. Agricultural finance is considered to be high risk due to heightened uncertainty (Miller & Jones, 2010). The risks need to be compensated either through obtaining collateral or demanding a higher interest. Many smallholder farmers lack physical assets and cannot afford higher interest rates. This results in coordination failure between two agents.

In this scenario as a way to reduce the risk the bank may be interested in tracking the progress of the farming activities to ensure the funds are being utilized for the intended purposes and farmer is taking the best cause of action to minimize losses. The bank needs to incur an additional cost of monitoring the farmer. In addition, to evaluate the credit worthiness the bank would lack information regarding the farming history (farmer rating) of a particular farmer.

Govi Nena offers banks with an opportunity to expand finance to smallholder farmers and improve recovery rate via its features. The banks can monitor the activities through management dashboard and furthermore they can access the farmer's farming history to evaluate the consistency of his/her agricultural practices. This would be an important criterion in determining the credit

worthiness of the farmer.

3.4 National Cultivation Planning by the Government

Governments of the developing countries have often faced the challenges when it comes to national cultivation planning. Matching the demand and supply for agricultural commodities is essential to ensure reasonable farm gate price for farmers and to food security. In order to achieve this government agency must organize production, but the question is how to go about this.

Traditionally governments administer their plans through agencies such as departments, institutes, boards etc. Often these agencies carry out grass-root level operations through shared resources in local government offices. These offices may be operating large distances away from the base offices and their responsiveness is extremely low. This creates an issue at national cultivation planning as between the back and forth information flow, a greater degree of uncertainty exist due to information lag and distortions or losses in information.

In a scenario where there is a substantial Govi Nena user base spread across the country, the coordination of the cultivation activities can be done with greater effectiveness and speed. The relevant government agency would estimate the annual demand and set the target production levels in Govi Nena. Individual cultivation information is captured at the source using a reward mechanism where Govi Nena assists farmers to plan cultivation in exchange for farmer's cultivation information. This is a much effective mechanism to capture individual information at the source. Then the system dynamically updates and sends signals to farmers to plan their cultivation, discouraging (warning signals; red light) crops that are already near the target level while encouraging crops that are below the target (green light) (Giovanni, Romano, Sebillo, Tortora, Vitiello, & Silva, 2010). The central agency can monitor the crop dynamics at different levels and predict the output with a greater precision. With this Govi Nena also allows central agency to take action in case if there is a likelihood of deviating from the target production levels.

3.5 Research Organizations Disseminating Latest Agricultural Practices.

Agricultural research organizations are a critical link in the agricultural value chain. Their primary role is to improve the efficiency. Usually the knowledge is created and disseminated via paper material (leaflets, manuals,

bulletins etc.) or instructors (trainings or verbal instructions). Let us consider a scenario where a research institute which has recently made a discovery on an innovative cultivation practices that would increase the yield of a certain crop. Their problem is how to disseminate this information from lab to farm.

In the traditional setting, directly reaching thousands of geographically scattered farmers is costly for a research organization. Instead, in addition to their publications they may use government agencies as proxies (officers trained by the research institute) to impart knowledge from lab to farm. However these resources are limited and could be counterproductive as many variables (time available, communication skills etc.) determine their ability to transfer knowledge to farmers. On the other hand publications are a costly way of imparting knowledge and fail to fulfill its mission if the farmers do not have necessary skills (literacy or comprehension) to process them. This creates a coordination failure between the farmers and research organizations.

Govi Nena bridges this gap by facilitating knowledge transfer directly to farmers. The research institute uses the Govi Nena expert console to insert knowledge. Once the knowledge (ontology based knowledge base) is updated, it will be incorporated to the routine agricultural practices via automated instructions given by the system (Walisadeera, Ginige, & Wikramanayake, 2014; Walisadeera, Ginige, & Wikramanayake, 2014; Walisadeera, Wikramanayake, & Ginige, 2013; Walisadeera, Wikramanayake, & Ginige, 2013). Thus the knowledge is imparted to the farmers seamlessly as and when the knowledge is created by the research bodies.

4 Conclusion

A necessary condition for the market efficiency in agricultural markets is the integration of the entire value chain. Govi Nena platform offers a great opportunity to consolidate linkages in the value chain by eliminating coordination failure and uncertainty. Uncertainty prevails when there is lack of actionable information for actors. Govi Nena reduces uncertainty by aggregating and disaggregating information acquired from various actors and transforming them into actionable information. In developing countries, agricultural markets experience relatively high transaction costs. This creates friction for value chain to operate efficiently often leading to coordination failure between markets. Govi Nena is capable of coordinating activities of many independent

actors in the most cost effective manner.

At broader level this study reveals several policy implications. Likely success of the system at the macro level hinges on the level of penetration. This means the number of users must be substantially high enough in order to see improved national agriculture productivity and stable commodity prices. Thus support from the policy makers to promote the programme at the national level is necessary. This will also have an impetus towards technology adoption among rural farmers in developing countries. Furthermore Govi Nena can greatly enhance agricultural diversification improving the export prospects for exotic crops.

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