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On the Development of I-Community to Improve Production of Off-season Longan

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Abstract: Longan is one of the most important Thai economic fruits, accounting for more than 120 million USD of market value yearly. Alternative to typical seasonal longan, off-season production can increase marketing potential to the agro-industry where price is more attractive. However, problems exist within the industry where information sharing is limited within and between supply chain members. Therefore, it is the aim of the study to develop i-Community where news, knowledge and information can be easily accessible. Highlighted information includes the forecasted production output in terms of harvesting period, quality and quantity of the crop by the developed fuzzy neural network engine.

Key words: I-Community, information technology, longan, fuzzy neural network, supply chain management.

INTRODUCTION

Longan is one of Thailand's major export fruits. In year 2010 alone, Thailand has exported more than 120 million USD worth of longan (Customs Department, 2011). 298,000 tons of longan are reported as the volume of export, whilst 45,000 tons are consumed domestically. Longan are demanded in the market in various types; fresh, dried, frozen and processed. China and Hong Kong are among the top importers, accounted for 75% of total export. As China prefers to consume dried longan, more than 55% of longan products in Thailand are processed as dried longan.

Longan major production base is in the northern region of Thailand, which currently accounts for more than 85% of gross production. Fig. 1 illustrates longan crop and tree. Chiang Mai and Lamphun are among the top cultivation areas suitable for longan production. More than 580,000 rais (230,000 acres) are related to the longan industry.

Fig. 1: Longan fruit and longan tree.

The industry is big. However, there are several issues in longan production. The climate changes result in underproduction in some years and overproduction in others. Production rate went down from the average of 583 kg per rai in 2009 to 462 kg per rai in 2010. Price of the longan also varies due to the production capacity each year. In 2009, fresh longan was priced at less than 0.3 USD per kg. Compared to year 2010, it was priced at almost 0.9 USD per kg. (1 USD = 30 Thai Baht, exchange rate on 1 August 2011).

Not only the change of weather that results in the uncertainty of the production, but also the production technique and implemented knowledge that lead to the success of the production. Market demand in terms of volume and period are also affected the pricing factors. Therefore, it is necessary that the farmers can meet the demand at the right time, right place and right price.

However, from the study by Sopadang (2006), it was observed that most farmers are lack of knowledge and understanding of the proper technique. There is also limitation of the information sharing within the supply chain where farmers cannot access to suitable information for the production such as market demand and weather. This results in the unsatisfied fluctuation in production of the longan.

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Off-Season Longan Industry:

Off-season longan industry has become a popular alternative to farmers in Thailand where they can manage the production of the longan usingchemicals. Chemicals such as $KClO_3$ can expand the harvesting period from seasonal longan in June to August to the more satisfied period such as Chinese New Year period during December and January, or Qing Ming Festival during March and April. This can increase the opportunity to sell according to the market demand.

The study by Yangyuen (2000) concluded that the economic impact of the industry as the off-season longan production is more efficient than the seasonal longan production. Hence, the off-season longan farmer would have more product surplus than those during the season.

The study by Janthasri *et al.*, (2005) summarized the practical methods of producing off-season longan in Thailand, including the application of chemicals to induce flowering. Concentration, stage of development and time related to the application of Potassium chlorate were also studied.

The price of off-season longan is 2-5 times higher than the in-season. However, the production of the off-season longan requires sophisticated techniques and understanding. Information is also the key for success of the industry.

The off-season longan farmers gain on average 2 times income more than those in-season longan farmers. The well-planned and well-understood farmers can gain up to 5 times of the average in-season longan (Manochai, 2004).

The supply chain of the off-season longan (illustrated in Fig. 2) is comprised of farmers, middle-men (as most of the time, exporters) and the distribution overseas. Middle-men mainly collect the product from the farmer and sell it directly to the buyer from oversea. Within the country, longan products were transported via small size and when exporting and moving over countries, it mostly uses ship, truck or container, depending on the destination. Most of the time, farmers do not understand the requirement of the end consumer overseas. The demands of the market are also unreachable by the farmers. This is a serious problem within this industry's supply chain.

The public agencies, such as the Department of Agricultural Extension, Ministry of Agricultural and Cooperatives, play significant role in educating, promoting and supporting supply chain members such as farmer, middle man, processing bodies. Yet, the activities are limited to each individual, not to the supply chain as a whole.

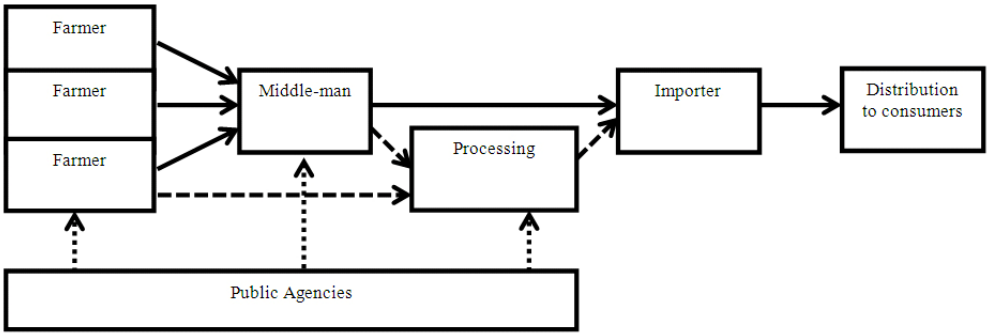

Fig. 2: Typical supply chain of an off-season longan in Thailand.

Khamwang and Intaruccomporn (2010) concluded that personal characteristics, socio-economic factors, knowledgeable about off-season longan production system and area size strongly related to success in off-season longan production. It was recommended that there should be wider public relations about the production technique. The support for gathering farmers should also be done. Related units should regularly and continuously follow up and monitor the farmers in order to guide and give knowledge and motivate the farmers to realize the importance of problems.

Forecasting to Off-Season Longan Production:

Today, the production capacity and period of harvesting can be predicted, easily by estimating from the application date of the chemical. However, such prediction is very rough. In fact, there are several more factors that relate to the production. These factors include wind, temperature, humidity, cutting technique, distance between trees, irrigation system, soil condition, etc. Therefore, after consulting to the off-season longan experts, 40 factors related to the production capacity and period are summarized. Such factors are categorized into 4 groups:

1. General information (14 factors), e.,g., age, experience in the production, education of the farmers, production area, density and distance of plants, age of plants, height and diameter of plants.
2. Production technique (12 factors), e.g., chemical application volume, continuity, and date, irrigation system, convalesce period.
3. Farm environment (10 factors), e.g., soil, temperature, air and soil humidity.
4. Product (6 factors), e.g., harvesting date, average production capacity per plant, longan size (grade), efflorescence rate and type.

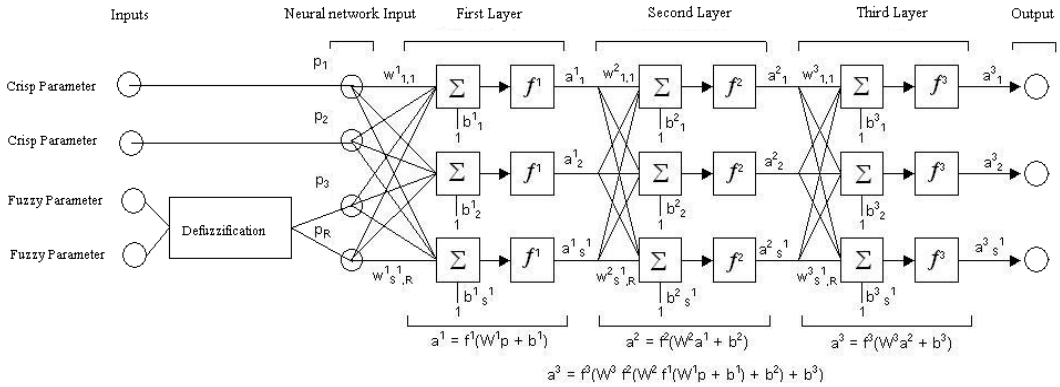

Fig. 3: Typical architecture of fuzzy neural network.

After collecting data from 69 farmers involved to the project, the database was made. The forecasting is based on fuzzy neural network (FNN) techniques. FNN is a learning algorithm that finds the parameters of a fuzzy system by exploiting approximation techniques from neural networks. FNN is academically used for solving a mathematical problem. It can observe a large amount of examples, the black box is trained with extraction of comprehensible rules from the neural network's structure. Here, a fuzzy system demands linguistic rules instead of learning examples as prior knowledge. (Kruse, 2011) Fig. 3 illustrates a typical architecture of FNN.

FNN is widely used in a variety of application. Erfani and Farsangi (2010) demonstrated the use of FNN in the prediction of compressive strength of slag-cement based mortars. The results showed that the trained FNN system has strong potential capability to predict compressive strength of mortars. Ghavidel *et al.*, (2011) confirmed the success of FNN in the study evaluating Iran labor market where thesupply and demand are both fuzzy. In the study, the algorithm from the cost function of the fuzzy neural network was presented.

There are crisp parameters and fuzzy parameters, 3 FNN forecasting processes were designed, i.e., (i) training (with back propagation neural network), (ii) verifying (with learning back-propagation neural network) and (iii) forecasting (with learnt and verified back-propagation neural network). There are 40 input notes with 20 hidden notes and finally 1 output node. Here, the forecasting process provides estimated quality, quantity and date of the production due to 40 production factors.

I-Community:

With the developed FNN forecasting engine, it is then possible to forecast the output of the off-season longan production. The engine is then attached to other information technolgy in order to input, process and output for easy access.

The concept of I-Community is of interest to the project as it can overcome those weaknesses and limitation for the off-season longan industry. Information and knowledge are published and available. The farmers are able to promote for ease of access and understanding.

I-Community introduces linkage to information and knowledge to the member of the supply chain of off-season longan industry via suitable information technology, i.e., website, mobile technology; short message service (SMS), global positioning system (GPS) and geographical information system (GIS). This allows members of the chain to access and use the information according to their preference. The farmer can access to the information via website and SMS, e.g., related news, oversea demand, requirement and trend of prices, weather forecast. Therefore, they can plan their production accordingly. Middle-man can access the website, SMS and GIS that will help them to foresee what the production capacity is in advance. It can be the channel to distribute their requirement to the farmers. The related public agencies, such as the Department of Agricultural Extension, Ministry of Agricultural and Cooperatives can observe the production of the area with the available farmer database and GIS. They will have information supporting any policy making or decision makings if required. Fig. 4 illustrates the linkage between each member of the off-season longa industry supply chain.

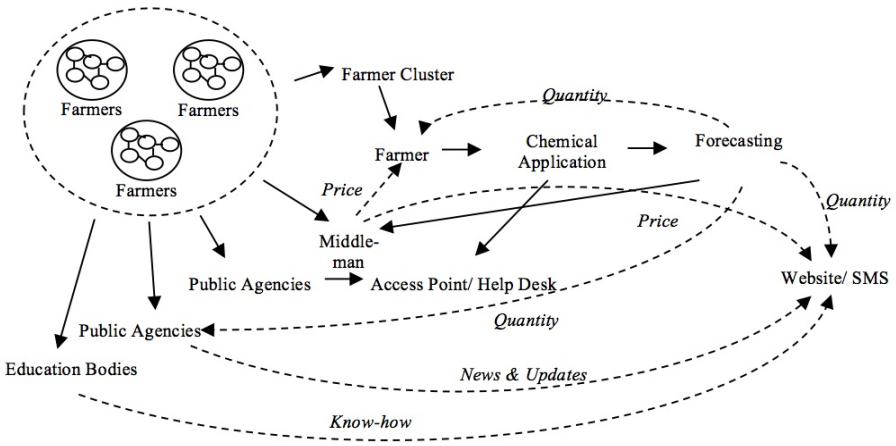

Fig. 4: Off-season longan i-Community framework.

***Website*:**

It is full of information needed by the supply chain members and related government agencies. Fig. 5 illustrates the i-community website. The structure of the website includes:

1. Input – e.g., farmer information, farm information, news and knowledge by the system administrator
2. Database of the production – comprising of 40 production factors (Fig. 6 illustrates the structure of the developed database.)
3. Processing engine – e.g., forecasting engine
4. Output – e.g., production estimating, farmer information, geographic information of farm, forecasted production, news and knowledge.

Fig. 5: Off-season longan i-Community website.

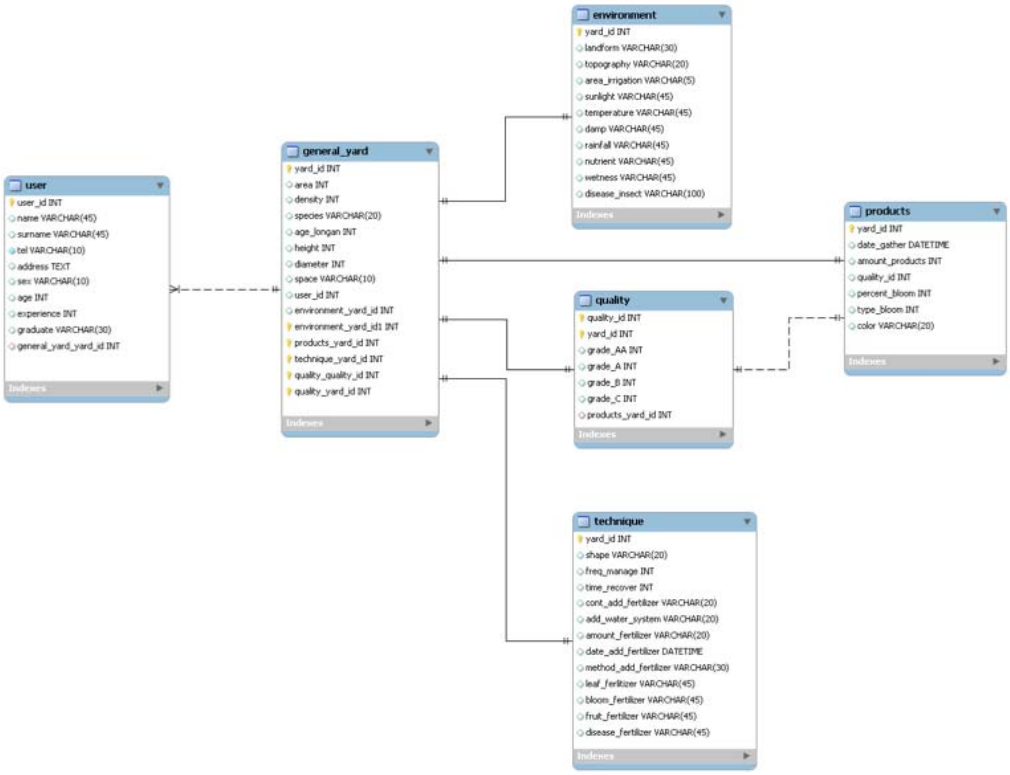

Fig. 6: Database Structure.

SMS - As an easy way to communicate with farmers, SMS technology is used. Based on the quicktext messaging service, the standardized communication protocols allow the system to exchange information by short text messages. The exchange information includes chemical application input from farmers, news, and information from the system.

GIS and GPS - The technologies were used to locate off-season farms. Together with the collected database of the farms, the status of the farms can be observed, such as how many farms have applied the chemicals, which farms are ready to harvest, and how many kilograms and grade are expected from these farms. The current and future status can also be illustrated via GIS map (see Fig. 7).

Fig. 7: GIS Data.

Conclusion:

The common problem within the off-season longan industry is known as the lack of information sharing. In this work, the i-Community has been developed where several information technologies, i.e., SMS, website, GIS and GPS were used. Together with FNN forecasting engine, this i-Community framework can increase accessibilities of the farmers to news, knowledge and key production information, as well as the product estimation in terms of time, quantity and quality. The information is also accessible by related supply chain members such as middle-man and public agencies.

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