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The Impact of Contract Farming on Banana Supply Chain Performance in East Java, Indonesia

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ABSTRACT

Pisang Mas (Musa acuminatacolla or banana) is one of the important commodities in East Java. This study discusses the impact of contract farming to the improvement of banana supply chain performance.The performance measurements of banana supply chain are revenue, oversupply, lost sales, and availability. Two models of supply chain are developed based on two types of contract farming, plasma-nucleus contract farming (Model 1) and sub-contract contract farming (Model 2). Those two modelsaresimulated using Vensim PLE software for 52 weeks (computer time). The simulation shows that the performance of the Model 2 is better than the Model 1.

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INTRODUCTION

Farming is one important sector in Indonesia economic and banana is one of the important commodities in East Java Indonesia. However in recents year's number of imported bananas increasing. Local bananas have characteristics easy to decay and the price difference with imported bananas and local bananas are not significant. To improve competitiveness of local banana some efforts to reduce delivery time and logistic cost have to be conducted.

An appropriate supply chain strategy can be used to improve the local banana competitive advantage. Some countries have used a supply chian strategy to improve their competitiveness. Sopadang *et al*. (2012) concluded that 25% waste reduction of Longan in Thailand can be achieved by implementing best practice of supply chain. Wilson (1996) showed co-ordination in the supply chain for fresh product sector increase the competitive advantage of the products in Northern Europe. One of supply chain strategies for fresh foods is a partnership. Hughes and Merton (1996) mentioned that partnership give benefit for the consumer, retailer and supplier. One of partnership strategies is contract farming. Glover (1987) stated that contract farming has potential benefit for small farmers. Patrict (2004) stated that contract farming is one mechanism to improve the livelihood of rural smallholders and provides them with the benefits of economic liberalization. He analyzed some cases in Indonesia. Arumugam *et al*. (2010) examined factors that lead farmers to participate in the contract farming and Man and Nawi (2010) concluded that there are many improper contract farmings between farmers and hypermarkets.

In this paper we analyzed the impact of contract farming in banana supply chain in East Java Indonesia. Data are collected from field research and the supply chain system of existing conditions are developed using Vensim PLE then the existing supply chain model is validated. Two supply chain models with contract farming are introduced and analyzed using Vensim PLE.Vensim is simulation software for developing, analysis, and packaging system dynamic models. Vensim Personal Learning Edition (PLE) is a configuration of Vensim for classroom use and personal learning of system dynamics.

This paper is divided into four sections. The first section shows contribution of this research. The research methodology is explained in Section two. Result and discussion are explained in Section three and the conclusion is derived in Section four.

Research methodology:

Multi echelon supply chains for Pisang Mas are commonly used to meet customer demand. Such a supply chain network must satisfy buyers' demands at the lowest possible cost. In this research, we study and design an existing model of supply chain and causal loop for pisang mas from farmers of Lumajang city and the big

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plantation in Malang to retail/traditional market/ fruit store. The data used in this model are from (Sanada *et al*., 2014), interviews, and secondary data of the National Economic and Social Survey (SUSENAS).

An existing model is designed in a dynamic system. Daellenbach andMcNickle (2005) stated a dynamic system is a condition in which the behavior of the system is continuously changing / sustainable within a certain time. The depiction of a dynamic system through a diagram can be done by using a causal loop diagram to determine the behavior of a complex system.

Next, verification and validation of the current model are applied in order to obtain the right model. Then, the proposed model based on causal loop is designed in order to give the best result. In this research the models are solved using qualitative and quantitative approaches. Qualitative and quantitative approaches are acquired from causal loop diagram and simulation using VENSIM PLE, respectively.

RESULT AND DISCUSSIONS

Causal loop diagrams are marked with a "+" and "-" for the two connected variables. The sign "+" describes the positive impact relationship if one variable increased in value and vice versa will have a negative impact for the "-"signs.In this model, we use farmers in Lumajang and the big plantation in Malang as producers, PT Sewu Segar Nusantara (PT SSN) as a distributor. They are major players in the distribution of banana to all areas of Indonesia, especially East Java. The farmers are clustered in Groups of farmer. Groups of farmes could sell their products to PT. SSN or Banana Farmers Association Seroja (APP Seroja). The traditional market, fruit store and retail are the suppliers of end customers. The retail of this research is PT Carrefour. Since there are price and demand mechanism, we compare the price using additional retails such as Hypermart, Ranchmart, and Hero. Data from SUSENAS shows that the demand of customer in Surabaya for pisang mas weekly as 12,230 kg up to 13,000 kg (SUSENAS, 2010). The *Causal Loop*of supply chain for Pisang Mas from Lumajang and Malang can be seen in Appendix 1. We use dummy retail to accommodate the demand after reducing the Careefour's demand fulfillment. The range of retail pisang mas' demand is from 9,430 kgs to 9,500 kgs weekly to meet consumption rate in Surabaya. The harvest and actual demand data of the Farmers and Big Plantation of the model can be seen in Table 1.

Table 1: The Harvest and Actual Demand of Farmers and Big Plantation.

Variable	Distribution Type	*Distribution Input* (kgs)
Harvest	Uniform Distribution	Minimum value: 1.000 Maximum value: 2.000
Actual retail Demand in Surabaya	Uniform Distribution	Minimum value: 2.800 Maximum value: 3.500
Actual traditional market/fruit store Demand in Surabaya	Uniform Distribution	Minimum value: 1.200 Maximum value: 1.500
Harvest	Uniform Distribution	Minimum value: 7.700 Maximum value: 8.800
Actual dummy retail Demand	Uniform Distribution	Minimum value: 9.430 Maximum value: 9.500

The value of rejection rate for each business player is different as shown in Table 2. It depends on the policy of each business player. Table 3 provides the production cost from each producer and the profit margin from each player.

Table 2: The Rejection Rate of Supply Chain.

Variable	Distribution Type	Distribution Inputs
The rejection rate of Plantation	Uniform distribution	Minimum value: 0.8% Maximum value: 1.2%
The rejection rate of distributor	Uniform distribution	Minimum value: 1% Maximum value: 3%
The rejection rate of retail	Uniform distribution	Minimum value: 2% Maximum value: 3%
The rejection rate of fruit store	Uniform distribution	Minimum value: 5% Maximum value: 7%
The rejection rate of traditional market	Uniform distribution	Minimum value: 5% Maximum value: 7%
The rejection rate of farmers	Uniform distribution	Minimum value: 3% Maximum value: 5%
The rejection rate of processing	Uniform distribution	Minimum value: 1% Maximum value: 3%

Australian Journal of Basic and Applied Sciences, 8(14) Special 2014, Pages: 90-95

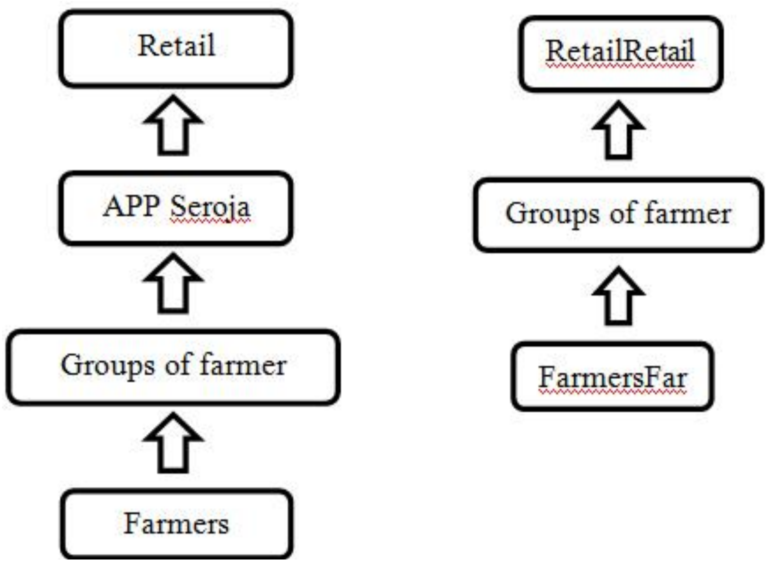
Table 3: Production Cost and Profit Margin of Supply Chain.

Variable		The Input for Simulation
Production cost/kgs		Rp 1,375
Profit margin of plantation		300%
Profit margin of distributor for retail		100%
Profit margin of distributor for fruit store		80%
Production cost/kgs (farmer)		Rp 1,250
Profit margin of farmers to local traditional market		50%
Profit margin of farmers		200%
Profit margin of groups of farmers		20%
Profit margin of APP Seroja		20%
Profit margin of retail	(Uniform distribution)	Profit margin of retail
Profit margin of fruit store	(Uniform distribution)	Profit margin of fruit store
Profit margin of traditional market	(Uniform distribution)	Profit margin of traditional market

Contract Farming on Banana Supply Chain Model:

This research develops two models of banana supply chain based on two types of contract farming. Those two types are plasma-nucleus and sub-contract. Plasma-nucleus involves an agricultural enterprise (the nucleus) who provides seed and the other needs of farmers or a group of farmers (plasma) and then buys their products. The nucleus also provides technical expertise that relevant to the commodity being produced. The nucleus in this model is Banana Farmers Association Seroja (APP Seroja). APP Seroja becomes an agent of supplier which has partnership with retail. Model 1 as shown in Appendix 2 is developed based on plasma-nucleus contract farming.

Sub-contract partnership is simpler than plasma-nucleus. Sub-contract involves groups of farmers having a contract to supply commodities directly to retail. The key player of this model is retail which has partnership with groups of farmers. The retailer does not provide any technical or management assistance to the farmers. The retailer guarantee to buy a specific volume of product in a specific time period such as daily or weekly at a specified quality standard. Model 2 as shown in Appendix 3 is developed based on sub-contract contract farming. Figure 1 shows the distribution flow of those two types of contract farming.



(a) Plasma-nucleus (Model 1)(b) Sub-contract (Model 2)

Fig. 1: Two types of contract farming.

Performances of Banana Supply Chain:

Model 1 and 2 are simulated using Vensim PLE software for 52 weeks (one year). The performance measurements of banana supply chain are revenue, lost sales, oversupply and availability. Table 4 and 5 show the performance of supply chain model 1 and2 for each criteria. Performance measurement from those tables show that model 2 has better performance than model 1 in the criteria of lost sales, oversupply and availability, but not in revenue. Model 1 shows that retail get the biggest revenue, but in model 2, the farmers get the biggest revenue. Although the overall revenue of supply chain in model 1 is higher than model 2, however in model 2 farmers get the biggest revenue. This is very reasonable since the farmers are the most important player in banana supply chain. Also, if the farmers gain higher revenue, they will be motivated to plant more bananas and will not be switched to other commodities.

Table 4: Performance of Supply Chain Model 1.

Player	Performance			
	Revenue (Rp)	Lost Sales (Rp)	Over supply (Rp)	Availability (%)
Farmers	955,116,000	494,215,000	29,559,300	0.657073
Group of farmers	287,477,000	157,950,000	4,515,140	0.646982
APP Seroja	339,288,000	197,624,000	8,084,300	0.631925
Retail	1,059,700,000	491,666,000	37,390,700	0.683076
Supply Chain	2,643,581,000	1,341,455,000	79,549,440	0.654764

Table 5: Performance of Supply Chain Model 2.

Player	Performance			
	Revenue (Rp)	Lost Sales (Rp)	Over supply (Rp)	Availability (%)
Farmers	843,840,000	175,547,000	30,763,500	0.824527
Group of farmers	267,447,000	62,311,800	4,447,870	0.811038
Retail	640,816,000	100,911,000	13,913,400	0.863951
Supply Chain	1,743,103,000	338,769,000	49,124,770	0.833172

Conclusion:

This research resulted in two supply chain models that are developed based on two types of contract farming. The first model of Banana supply chain (Model 1) is builded from plasma nucleus contract farming. The second model (Model 2) is based on sub-contract contract farming. The simulation using Vensim PLE software shows that the performance of the second model is better than the first model. Thus, it can be concluded that the method of contract farming will give positive results if they are only few players in the supply chain.

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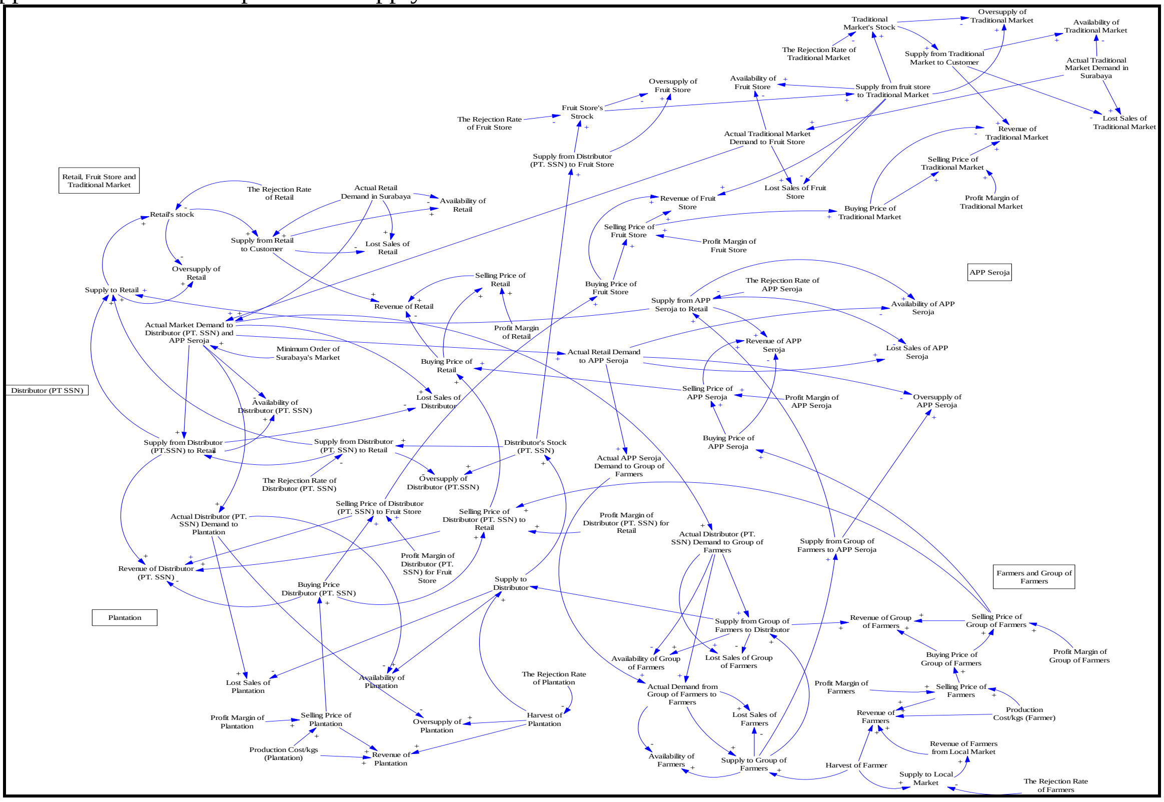
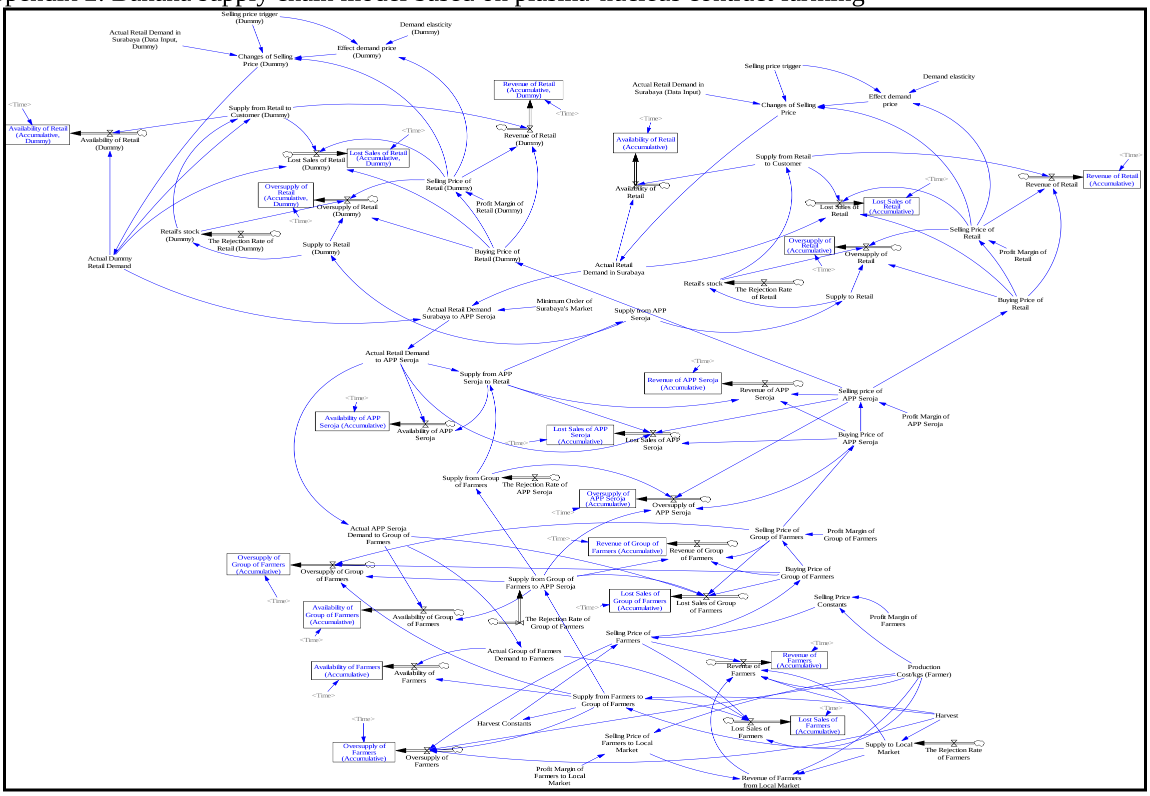
Australian Journal of Basic and Applied Sciences, 8(14) Special 2014, Pages: 90-95

Appendix 1: Causal Loop Banana Supply Chain Model



Appendix 2: Banana supply chain model based on plasma-nucleus contract farming



Australian Journal of Basic and Applied Sciences, 8(14) Special 2014, Pages: 90-95

Appendix 3: Banana supply chain model based on sub-contract contract farming