Agricultural production optimization : the impacts of agricultural cooperative and blockchain-based information sharing

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1 Introduction

Food freshness is an important problem to public health and a major concern to consumers. Traditionally, to verify the high quality of a product, the product should pass the identification of the government and some associations. With the identification, consumers will be likely to pay a high price for the food. Now, the blockchain has been used widely in agriculture to show the freshness of agricultural products. For example, *Axéréal Group* uses a blockchain solution, Connecting Food, to support the company's traceability needs. The implementation of Connecting Food achieves the transparency of the whole supply chain. As a result, *Axéréal Group* has an increase in productivity and selling price. However, real-time information sharing is a double-side sword for the provider. On the one hand, real-time information sharing by blockchain technology benefits the supplier by decreasing the demand uncertainty [1]. On the other hand, the downstream buyer can monitor the real freshness of product and has the right to select the fresh food, which negatively affects the profit of the provider. Thus, one research question is : when will a farmer trade with a buyer in the blockchain-based transaction system ?

A method to deal with the threat from real-time information sharing for small farmers is to improve the freshness of product by joining a cooperative. Since the cooperative have advanced inventory and high technology to detect producing environment (e.g., temperature and moisture), small farmers joined the cooperative can use these tools to adjust input and improve the freshness of products and the cooperative can sign a sell out contract with the buyer. Therefore, another research question is : when will a farmer join the cooperative faced with the threat of real-time information sharing ?

2 Model

We consider the transaction in a supply chain under two systems-with and without the blockchain-based platform supported by a buyer. Each system includes a farmer (she), a co-operative, and a buyer (he). Farmers joined a cooperative can sell all her products to the downstream buyer. A non-cooperative farmer cannot sell products to buyer in the traditional transaction system and can sell products to buyer in the blockchain-based transaction system if her product freshness satisfies the requirement of the buyer. A farmer who want to join a cooperative would have a higher cost. We show the two systems detailed in the following. As shown in Figure 1, in the first system, the buyer supports a blockchain-based transaction system. If a farmer joins a cooperative, the farmer sells all her products to the buyer. If a farmer does not join the cooperative, the farmer can sell her products to the buyer if the freshness of her product surpass the requirement of the buyer. As shown in Figure 2, in the second system, transactions in the supply chain take place in a traditional system. If a farmer joins a cooperative, the farmer sells all her products to the buyer. If a farmer does not join the cooperative, the farmer sells her products to consumers directly instead of selling to the buyer.

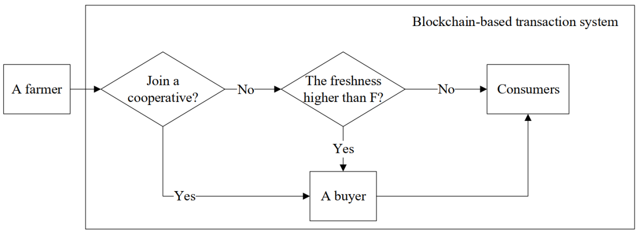

FIG. 1 – Trading in the blockchain-based transaction system

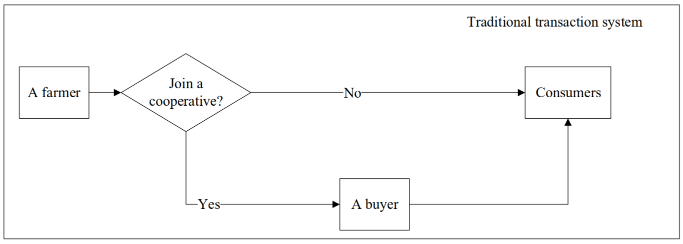

FIG. 2 – Trading in the traditional transaction system

We consider that the farmer faces with random consumer demand that depends on product freshness [2]. Recognizing that consumers enjoy higher utility from fresher products, we suppose that the random demand is $D = A + \beta X + \epsilon$, where A is the potential demand level, β is the sensitivity of demand to the freshness, X represents the freshness state of the offered products, and ϵ is a random demand shock. If the buyer adopts the blockchain technology, the farmer faces with the demand distribution conditional on $X = x$. If the buyer does not adopt the blockchain technology, the farmer faces with the demand based on the distribution of X. In every purchasing cycle, leftover fresh products are disposed of. The unit production cost is $c > 0$; the unit selling price is $p > c$; and the unit salvage value is $s < c$. The unit storage cost is c_1. The retailer's objective is to maximize her expected profit. Hence, this setup is essentially a newsvendor model, which focuses on single-period decision-making.

3 Conclusions

Blockchain technology causes the critical ratio to increase and reveals the real market demand. If the real demand is higher than the expected demand, the farmer produces more products under joining than non-joining. If the real demand is lower than the expected demand, the farmer adjusts production quantity according to the purchased price by the buyer.

Références

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