MIT SCALE RESEARCH REPORT

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The Global SCALE Network allows faculty, researchers, students, and affiliated companies from all six centers around the world to pool their expertise and collaborate on projects that will create supply chain and logistics innovations with global applications.

This reprint is intended to communicate research results of innovative supply chain research completed by faculty, researchers, and students of the Global SCALE Network, thereby contributing to the greater public knowledge about supply chains.

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Research Report: ZLC-2011-7
Bulk Storage: Postponement of Agricultural By-Products
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KEY INSIGHTS

1. Dependency on agricultural farms to supply the raw material needed for production create a huge planning challenge.

2. In order to prevent stock outs when using agricultural by-products as supply, companies tend to increase their inventory.

3. Packaging postponement of such perishable products can reduce significantly the level of inventory and improve service level.

Introduction

Today's competitive environment and increasing variation of consumer preferences is generating enormous challenges to meet those specific demands in a competitive manner. The proliferation of SKU's (Stock Keeping Units) is furthermore fueling the implied uncertainty of demand and taking power from the supplier when it comes to deciding in what specific product and production process they want to specialize. The need to accommodate each demand requisite is continuously decreasing the ability, as a supplier, to operate in an efficient and effective manner.

In the agricultural by-products industry supply chain, customer specific requirements, mandatory quality as well as fierce competition create that these types of companies comply with every request increasing their number of SKU's to an "infinite" number of options. Although in this industry, companies try to provide the best customer service not only to priority customers, but also to small mom and pop stores, they sometimes lack the ability of providing such a consistent service due to the fact that they do not control the availability of supply. This causes that in any given period of high supply availability companies try to build up inventory to guard themselves from the lack of supply that could possibly happen in the near future. This of course creates high levels of inventory produced based on a forecast that may be wrong leaving us with the wrong inventory at the wrong time.

In order to deal with this complex supply chain and complicated business model, this thesis examines the feasibility of the concept of postponement onto such supply chain. Specifically this thesis examines the viability of packaging postponement, where the by-product will be stored in bulk tanks as work-in-process waiting for the demand signal to be packed and finished.

First, we investigate and analyze the concept and applications of postponement in different industries as well as some real examples with actual results.

Summary:

This thesis studies one possible solution for companies using agricultural by-products as supply. The dependency on agricultural farms to supply, the raw material needed for production create a huge planning challenge since agricultural products depend on nature creating volatility in the quantity and quality received. We review the concept of postponement and apply it to their business process and found an impressive decrease in inventory and a formidable improvement of 19% in fill rate.

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Bulk Storage: Postponement of Agricultural By-Products
Then we introduce Fruit International, the case company, where we performed the study. After that we execute some statistical analysis to understand the distribution of the supply. Subsequently we introduce our selection criterion corresponding to our SKU selection. Following we created a simulation model in ARENA software in order to replicate the current and postponed scenarios.

Industry Case

Fruit International is one of the world leading marketers of fresh fruits and vegetables. As a food conglomerate their name will always be linked to the banana’s long and successful history as a market leader in production and trade.

As a leading fresh products and fresh produce products manufacturer and trader they are divided into six main activities/departments: Whole Fruit, Bananas, Healthy Food, Processed by-products (PP), Shakes and Salads. With more than two hundred customers spread around the globe having in place an optimal, if not perfect, production plan is one of the main concerns of the company.

The thesis focus is on the Processed by-Products (PP) division. The division offers more than 250 fruit ingredients products in a very extensive variety of packaging types and sizes. Products ranging from frozen chunks, dried pieces, purees, concentrates, juices, extracts, essences, powders and flakes can be found in the manufacturing plants of the company.

The supply chain of these products can be quite extensive and complex. Its distribution can be made directly to strategic customer or to company owned warehouses located in US or Europe. The constant dependency on agricultural farms to supply the raw material needed for production create a huge planning challenge as a problem in getting high quantity and quality of supply.

Production Process

The PP division is in charge of further processing “industrial fruits”, fruit that doesn’t meet the quality standards to be exported. We refer to quality standards not in terms of edibility, but in terms of shape, weight and appearance.

The industrial fruit is “created” every time farms are harvested. There are several fruits used by the division that range from (but are not limited to) banana, mango, pineapple, peach and watermelon. There is some seasonality in the production and availability of the fruits used. There are products that can only be made during certain seasons of the year. We will focus more on bananas since it is the best selling product as well as the fact that it is produced all year round.

Banana production is very volatile since it depends on many factors like weather temperature, amount of fertilizer applied, Sigatoka Negra (a banana disease) control, amount of water supplied to the plant, and many others. Since the quantity harvested of fruit is so volatile, accordingly this creates a very unstable and varying environment for the production of industrial banana.

The process starts at the farms. Every week the banana is harvested and industrial fruit is created. The process of picking this industrial fruit is, most of the times, made by truck drivers that will then sell the banana to manufacturing plants like Fruit International or to local informal markets.

When the fruit is processed for puree, the puree has to pass through several pipelines in which it is subject to very high temperatures that will sterilize the puree and eliminate any bacteria. At the end of these pipelines there is a filling section in which depending on the packing required by the order, the puree is then put into a vacuum-pack sterile bags. There are several packaging presentations of the puree, in pallets, in drums, in small sterile bags or with different special packaging features required by the order. These different combinations of packaging are available for the different combinations of the puree.

When the product is finished it is momentarily stored for at least five to seven days for observation. Given the nature of the product and the importance of a clean and secure process, packed puree must be monitored in case there were some bacteria’s left or the bag is not vacuum-packed containing oxygen that in the end will help in the process of bacteria creation.

These kind of products are exported on a daily basis via container ships either to direct customers or to privately owned warehouses.

Postponement

In order to maximize the benefit of postponement it was important to perform an extensive study of the more than 250 SKU’s produced by the company.

We evaluated fruits and product families due to the nature of their manufacturing process and
proliferation of packaging. We chose banana as a fruit to focus on in our analyses. Although there are several products deriving from this fruit like flakes, chunks, extracts, frozen pieces, within this family of products the one that fitted best was the puree.

We will create a modular puree; a basic puree that needs small extra processing to create all other kinds of purees. It will permit a more efficient use of the facilities. We have three types of banana supply X, Y, Z we will have three bulk tanks that will store the modular purees corresponding to each raw banana type (organic, regular or rainforest alliance banana).

Purees X, Y, Z will be stored in the tanks in their more modular stage. Further processing will be needed to cope with special kinds of purees, but the company considered that this extra processing would take only a small amount of extra effort. Then again we will also postpone the packaging stage until demand realizes. This process means that we will have more work-in-process inventory but less finished goods inventory.

Simulation Model

ARENA software was chosen to perform the simulation of the current scenario and the new situation. By doing this we are going to be able to compare the current scenario (W/O postponement) with different postponement scenarios.

We choose to simulate 10 of the most selling products that represent almost 75% of the total volume sold during a period of two years. The macro level study gave us some operational results.

The complicated business model posed by the company push us to make several assumptions that, even when not able to completely represent reality, they somehow provide a good understanding of the current situation.

Results

We observed some of the following results. Please note that we didn’t focus on any cost effectiveness analysis but rather more a performance base study.

Scenario 1 - Postponement Under Constant demand

The arrival rate and the volume required by each order were set as constant across the simulation.

Inventory

The figure above shows the level of inventory by SKU W/O postponement. It also shows the inventory with postponement. Please note the difference between these two measures. In the current scenario (W/O) inventory is finished products inventory, while in the postponement scenario inventory is work-in-process inventory held as modular puree in the bulk tank.

The result was a spectacular reduction of Finished Product inventory formed if there is extra supply available, of 81%. The main reason why this new strategy has this effect on the inventory level is because now we are able to store WIP inventory in the tank rather than having finished products; we don’t need to PUSH production of finished products any longer. Then again we have the ability to pool the demand of each SKU and produce one modular puree reducing the risk of obsolesce or producing the wrong SKU when extra supply is available.

Fill Rate

This result is one of the most important ones because as we know from the literature, by applying postponement customers may need to wait longer for their order to be fulfilled. Indeed our manufacturing process, which needs to be reengineered, will take longer, but even so it is important to note that the average “Fill Rate” increases by 19%, improving our performance.
Scenario 2: Postponement Under Stochastic demand

The arrival rate (time between arrivals) of the orders from each SKU was set as random. The volume of each demand order stayed untouched and constant.

Inventory

Inventory level at the tank increased, but the total level of inventory was low, meaning again that the postponement strategy under demand randomness is still better than the current scenario.

From the literature we know that one of the major benefits of postponement may be present when the variation between customer orders across SKU’s is greater. This is what we tried to simulate in this scenario. The pooling of the variation of the demand is done under postponement meaning that the whole system bears less variation compared to the variation felt by the system in which we managed the SKU’s independently. This precise concept of pooling is what prevents us from producing the wrong inventory at the wrong time.

Fill Rate

Fill Rate improved. We prove that with postponement we have a higher level of responsiveness with less inventory on hand.

Finally, variation in the demand arrival rate prove that it was not an excuse to not implement the new strategy since even with randomness the postponement scenario is better than the current one.

<table>
<thead>
<tr>
<th>W/O Postponement</th>
<th>W/O Postponement RND</th>
<th>With Postponement</th>
<th>With Postponement RND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill Rate</td>
<td>Fill Rate</td>
<td>Fill Rate</td>
<td>Fill Rate</td>
</tr>
<tr>
<td>Min</td>
<td>52%</td>
<td>52%</td>
<td>84%</td>
</tr>
<tr>
<td>Max</td>
<td>98%</td>
<td>97%</td>
<td>84%</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>13%</td>
<td>13%</td>
<td>0%</td>
</tr>
</tbody>
</table>

We can observe the difference between the performances during random demand arrival rate (RND) and constant demand. As expected there was going to be some decrease in performance in both cases, but overall the postponement scenario continues to be better than the current situation.

Conclusions

In our research we have analyzed the benefits and drawbacks of applying postponement in an agriculture related industry. We have also studied the effects of the new strategy on key performance indicators.

Inventory is the most affected (positively) measurement when we applied postponement. We were able to demonstrate that inventory level of finished products will decrease significantly. On the hand there are some non quantified benefits of the reduction in inventory such as: risk pooling of demand, less risk of obsolesce, less risk of producing the wrong inventory, a decrease in holding cost, decrease in warehousing cost and some financial savings.

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