

GT-Panama Thesis Series

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Mapping the Flow of Resources, Products, and Information in the Agricultural Cold Chain of Panama

Capstone Final Report

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In partial fulfillment of the requirements for the degree
Master of Science in Supply Chain Engineering



Acknowledgements

We would like to thank our advisors, Dr. John Bartholdi and Dr. Donald Ratliff, for giving us the best guidance throughout the project and the master's program. Thank you for your time and knowledge. We enjoyed learning from you!

Thank you, Georgia Tech Logistics Innovation & Research Center personnel, for supporting us to give our best to finish this program. Your hospitality and willingness made it comfortable to work on this project.

To Eng. Fernando Duque, Eng. Carlos García and the Cold Chain personnel whom supported and believed in this project. We would like to thank the personnel in the PHCs in Chiriqui, especially to Clementina Rojas for the help provided to successfully finish the research.

Our deepest gratitude to SENACYT and The Georgia Institute of Technology for trusting in our potential and giving us the opportunity to grow our knowledge in such a prestigious institution.

Abstract

This project started from the need of having a clearer understanding of how the vegetables produced in Chiriqui get to the consumers. So, it assesses a well-defined problem: the lack of visibility of product moving towards the market once it leaves the farm.

This paper documents, through supply chain mappings, all the processes and variants that a product has to go through from the planting until it gets to the final customer. The products considered in this study are the most valuable and most temperature sensitive products: tomato, pepper, lettuce, potato and onion. Thus, to have a very detailed and informative paper the mappings include timing of decision-making, amounts and allocation of scarce capacities, such as farm labor, specialized equipment, and transportation assets, and all the possible channels of distributions from Chiriqui to Panama City and/or to other regions.

An data collection and analysis was performed to accomplish this project. This knowledge will make it possible to identify where the product is at greatest risk and at what points it makes most sense for the government to offer assistance.

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Acronyms and definitions

Caballito: kind of an intermediary that collects cargo from several producers to deliver to other intermediary in order to fulfill the intermediary's demand in exchange for a payment per amount of product. Also, it can deliver to several intermediaries.

Colonos: landowners that work directly with producers with an agreement for producing any kind of product required by the producer.

Commercial spot: it is a place where retailers and customers trade merchandise, most of the times agricultural products. They are more common outside the province of Panama in areas without supply markets.

Final customer: it is the last stakeholder in the supply chain and it is the one that consumes the product.

Final retailer: is the party that buys to a wholesaler and sells the product to final customers. It can be a Chinese seller, grocery stores, restaurants and hotels.

M.A.C.: stands for "Mercado Agrícola Central", which means Agricultural Central Market. It is located in Panama City and it is the biggest supply market in Panama.

M.I.D.A.: stands for "Ministerio de Desarrollo Agropecuario", which means Ministry of Agricultural Development.

PHC: stands for Post Harvest Center. It is a collection center from the Cold Chain Secretariat that provides value added services to producers in order to have homogeneous and innocuous products. Some of the services include are cleaning, drying, packing, temperature controlled warehousing, etc.

Pitufo: is the name that light trucks received in Panama. This classification of truck has a maximum cargo capacity of 7,000 pounds.

Local distribution: distribution of cargo within the same province.

Regional distribution: distribution of cargo within different provinces.

Unforgivable project: A proposed project by a presidential candidate that, if elected, the project should be executed otherwise the people would lose trustfulness on the president.

Introduction

According to Wikipedia, a cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. It is used to help extend and ensure the shelf life of products such as fresh agricultural produce, seafood, frozen food, photographic film, chemicals and pharmaceutical drugs.

In 2009 there was a change of government in Panama and a whole set of new projects to execute. One of the most important and ambitious project was The Agricultural Cold Chain of Panama. It started with an initial investment of around 287,448,307.62 U.S. dollars and has become one of the first State-owned project of this type in the world.

Nowadays there are 4 PHCs and a market in David operating and a new market in Panama - Merca- soon to begin operations. With these operating and new markets on the way the Cold Chain wants to offer a logistics platform for agricultural producers with services to reduce the high wastes and improve the quality of the products.

Most of the people -producers, intermediaries and wholesalers/retailers- believe that these wastes are high because of quality of the product since the beginning of the chain, however, they believe these can be reduced. The stakeholders believe that if you have a good-quality product from the beginning of the chain you can have a good-quality product at the end with a proper process, however, if the quality of the product is bad at the beginning of the chain it cannot be good at the end.

As the implementation of the cold chain is totally new for Panamanian producers, drivers, intermediaries and sellers, lack of information and visibility is presented along the entire process. The flow of goods is uncertain once the products depart the producer's farm. So, It was necessary to study this situation and document all the activities during the entire cold chain in order to have a clearer understanding of the processes to facilitate and support decisions that could benefit the stakeholders.

To support this study the data was collected at the beginning of the chain in Chiriqui and at the end of the Chain in the M.A.C. This data was analyzed from an engineering perspective with the main goal of filling all the gaps along the process by putting together and corroborating the observations, interviews and a set of statistics given from previous studies.

Future steps or opportunities of improvements were also assessed in this study.

Cold Chain Secretariat

The Cold Chain project was created under the government of the President Ricardo Martinelli as one of his unforgivable projects of his proposal. This project have as a finality the creation of a logistic system to handle properly the comestible products from its origin to the distribution points and commercialize in order to reduce high costs caused by the waste, offering at the same time a product with better quality to the Panamanian population.

The project began in 2009. In order to have a direct relationship with the Presidency it started as a Secretariat. Currently, the Engineer Fernando Duque is the Executive Secretary of the Cold Chain.

After the census performed by the Cold Chain Secretariat, 24 vegetables were selected as the most temperature and humidity sensitive. These products are: sweet pepper, chayote, short bean, long bean, pepper, celery, cilantro, culantro, lettuce, beet, watercress, cauliflower, mustard green, cabbage, broccoli, potato, industrial tomato, table tomato, onion, spinach, carrot, cucumber, chives and parsley.

The project is divided in two components. The first one consists of the development of four collection centers called PHC and they were strategically located considering the main productive regions to process the products assigned. Three of them were positioned in the province of Chiriqui, one in Dolega, another one in Volcán and the third in Cerro Punta (according to the M.I.D.A. data 82.5% of the national production is harvested in these areas); and a fourth one in the province of Los Santos in El Ejido (according to the M.I.D.A. data 14.1% of the national production is are harvested in this region).

The second component is based on the creation of a national retailer markets network and a main supply unit in Panama City. This will improve the preservation of the products, and the distribution and commercialization of them. The network is being developing with the construction of six markets out of Panama City.

The integrated logistic system will create a directed relationship between producers and final customers allowing the population to acquire quality products. The ideal system begins when producers receive the services from the PHCs. The center will provide different kind of treatments to each product depending on the producer's needs including brushing, cleaning, drying, temperature control and storage once the product is cleaned. Then the products will be transported to the markets in proper vehicles to not break the cold chain. Finally the products will arrive at the network of markets, where they will receive an adequate handling and temperature to maintain the freshness and shelf life of them. At these selling stations, the products end their flow once the final customers acquired them.

Methodology

The methodology followed consisted of interviews, inspections, research, validations and calculations, in order to analyze as consistent as possible the information collected.

Data collection and sampling

The initial phase for data collection started by visits to the M.A.C., in order to interview wholesalers and retailers, to have an initial understanding on how the product arrives, is processed and sold and get experience on how to conduct meaningful interviews. Then, a travel to Chiriqui moving upstream in the supply chain in order to seek for the main reasons and events causing the products to arrive in current conditions at destination. For a better appreciation of these “current conditions” here are some pictures presented in the appendix.

Key stakeholders were visited and interviewed. Two of the three PHCs in Chiriqui were visited, however, the data collection was mainly performed at the Cerro Punta PHC where employees, producers, drivers, and intermediaries gathered to do their businesses or chores.

The Cold Chain Secretariat explained their processes and services, helped on scheduling visits to main producers, and provided an initial contact with some drivers and intermediaries. Producers were interviewed to understand and document the way they operate; drivers were interviewed to determine the transportation capacity and conditions in order to identify the popularity of the vehicles and their current utilization; and intermediaries were interviewed to have a better understanding of all the possible channels of distributions that a product can follow.

6 producers, 12 drivers, 1 intermediary were interviewed in Chiriqui and are listed in the references. 15 wholesaler/retailers were interviewed at the M.A.C. and some of them are listed in the references. The interviews did not follow a strict pattern. They were mostly performed as a dialogue and the surveys presented in the appendix A were used as a guide. The four of us participated when interviewing each producer and the intermediary; however, we split into two groups to interview the drivers and the wholesalers/retailers. This system allowed the collection of more information and better observations.

Context

The land in Chiriqui is very expensive and to get the most out of the investment the producers alternate the crops within the plots to avoid diseases. The planning of what, when and how much to seed includes basically a consideration of their experience or knowledge, weather factors and an estimate of the demand. The producers try to have all

of the products at all times, but they said that this was actually impossible due to weather factors. So, instead of having all the products all-year round they usually have each product for about 8 months in a year. Here is where planning plays a role and gives a competitive advantage to the producers that have the products in time of scarcity. They get paid a better price and all of their production sold.

Panama has two seasons, the dry season from December to April and the rainy season from May to November. All the producers that were interviewed stated that the dry season favors the agricultural activities, because the amount of product harvested is greater than in the rainy season even though they seed less amount of plants during the dry season. This happens because the plantations are less attacked by fungus or ruined by excess of water. During the rainy season they incur in higher costs of production. For instance, if they fumigate a plot and it rains within a few hours after they have to reapply the herbicide. Also, if they just planted the seeds and it rains they may have to plant everything again.

Stakeholders

The identified stakeholders along the supply chain are the producer, caballito, stevedore, driver, intermediary, retailer/wholesaler and final customer.

Types of producers

There are two types of very well defined producers that follow different approaches when it comes to using their lands. The producers that work under a production plan that account for 50% of them all -according to Clementina Rojas, a 25 years expert in the field- and the producers that do not.

The plan-based producers have strong relationships or partnerships with big supermarket chains to whom they sell around 80% of their production. These supermarket chains tell the producers their weekly needs of each of the products a reasonable time in advance. Generally, these weekly needs remain the same over time and the only changes are on seasonal products. So, to meet this demand the producers plan the timing of seeding and the amount. For example, one of the producers seeds 10000 lettuce plants every 10 days. These producers, obviously, work mostly on a pull system, however, the excess of production is sold as a second-class product on a push system.

The other producers work under a less rigorous planning system and most of the time they seed considering only their experience and weather conditions. These producers have no strong partnership with their customers and most of the times these customers are intermediaries or sellers at the M.A.C. So, in this case part of the product is based on a pull

system where customers call the producers or an intermediary in Chiriqui to ask for some amount of product and the other part is pushed somehow.

Often, the big producers negotiate an agreement with “Colonos”. In this agreement, the big producer or “main producer” is responsible for providing the “Colonos” with the seeds, fertilizers, herbicides, etc. and the “Colonos” are responsible for the workforce and they also own the land. The “Colonos” later deliver the product to the “main producer” who sells the products and pays 50% of the profit to the “Colonos”.

Land processes

Tomato

The tomato seeds are germinated in seedbeds for 45 days. Then the plants are transplanted to the soil, cared and fertilized. After 75 more days the plants begin producing the fruits and remains productive for 5 to 6 months after the first production. The fruits are harvested time to time according to the physical aspect of the fruit, the plan if they have one or the needs of the customer. The harvester cuts the fruit when they are mostly green with some red pigmentation and also the ripe ones. Then the fruits are placed immediately in a plastic tote that is taken to the sorting and packing area. In this area the ripe product, considered waste, is separated and not commercialized and the rest of the product is sorted to meet the needs of the customers. Then the totes are taken to a collection center in a pickup truck. The tomato once harvested can last for 12 to 15 days.

It is worthwhile to mention that:

- Most of the tomato grown in Chiriqui is produced in greenhouses.
- All the work is done manually.
- The producers believe that there is no optimal temperature for harvesting so it can be performed at any time.
- Each producer has its own frequency for harvesting but the most popular one is from 2 to 3 days per week.
- A plant produces on average 28 pounds of tomato.

Pepper

The production process of the pepper takes place in mesh greenhouses. Starts when the pepper seeds are germinated in seedbeds for 40 days. After this germination, the plants are transplanted to the soil and receive during 90 consecutive days all the fertilizers, insecticides and fumigations that are required. Then the plants begin producing fruit and remain productive for 3 more months after the first production. During this harvested period, operators work daily according to the physical aspect of the fruit, the current planning or the needs of their customers. The harvester removes the fruit when they present an intense green color and are placed immediately in a plastic tote to be sorted

depending on orders and then packed. Once the product is ready for being delivered is loaded in pickup trucks and goes to the respective collection center. The pepper shelf life is around 5 days.

It is worthwhile to mention that:

- All the work is done manually because peppers are a delicate product.
- The temperature does not affect the harvesting so it can be performed at any time.
- A plant produces on average 15 pounds of pepper.

Lettuce

The lettuce seeds are germinated in seedbeds during 22 to 25 days. Then the plants are transplanted to the soil, fertilized and fumigated. Approximately 20 plants can fit per square meter of soil (the producer can plant more lettuces in the same space, depending on the size of lettuce he wants). Around 50 to 55 days after the plantation the lettuce should be ready to be harvested. The exterior leaves are removed from the lettuce, as few as possible, to protect the product and minimize wastes during the transportation. Then the lettuces are placed in plastic totes -some producers use plastic carpets under the totes to avoid contact with the soil once the vegetable is harvested-. The associates put the totes in a truck or pickup vehicle to take the product to either their processing plants, PHCs or any other place to meet customers immediately.

It is worthwhile to mention that:

- During the dry season the crops are more productive than during the rainy season, because the rain favors the growth of fungus in the plants and delays the activities.
- The collection is made manually.
- Each producer has its own frequency for harvesting but the most popular one is from 2 to 3 days per week.
- The plant dies after the harvest.

Potato

The potato is produced using imported seeds or the small potato, which results from previous harvests. The production is based on a sowing plan according to the needs of the customer. Seeds are planted directly into the soil just in the dry season because during rainy season they are not productive due to fungus. On the other hand, the small potato can be used for sowing during the whole year. One Ha of soil preparation takes around 1 week with human labor and one day with machinery, once the seeds are planted, both type of seeds are cared, fertilized and fumigated with pesticides during a period of 120 days involving 3 stages: emergency stage, wilting stage and harvesting stage. The emergency stage is just at the beginning when the plant is born, after 65 days the potato starts to wither, and after 120 days it is ready to harvest. It is harvested from time to time according

to the physical aspect of the product and customer demand. The harvester takes out the potato when they have a diameter of 35-135mm. Then the product is sorted at the field to meet the needs of the customers and placed immediately in bags. The small potatoes (less than 60mm) are taken to a warehouse at the field for a 2 months drying period until ready to be used as seeds, while the broken/damaged product is separated as waste and not commercialized. Once the bags of commercial potatoes are full, they are moved in pickup vehicles to the producer's plant or PHC for cleaning, brushing, classification and packing in the same bags.

It is worthwhile to mention that:

- Small potatoes resulting from previous harvests can be sown 3-4 times again. Later, the quality of the product is not good.
- Once the product is sown, it is not sown again on the same area until six months or next year.
- Machinery is used for sowing/harvest in flat terrain, while human labor does it on the hills.
- The producers believe that there is no optimal temperature for harvesting so it can be made at any time.
- Each producer has its own frequency for harvesting but they usually do it almost every day.
- The potato once harvested can last 3-5 months in a warehouse.
- During July and August the product is stored in a warehouse because harvest is not possible due to the rain.
- Production is around 12 potatoes per seed, with 6-8 in good conditions for selling. There is just one type of commercial potato produced right now.
- Potato seeds are usually imported from Netherlands, Germany and USA.

Onion

The process to produce onion can be started by seed or bulb. These two methods differ mainly on the germination phase and the production quality at the end. The seed method requires 50 to 60 days in seedbeds to germinate until the plant gets ready to be transplanted. While in the other method, bulbs are placed in plastic totes in the shade during 30 days. After the germination, the plants or bulbs are sowed and remain around 100 days in the soil, which is fertilized and fumigated to improve the quality of the product. Then the plants start to bend the stem, which is considered a signal: time to harvest. When 80% of the entire production is bending, all the plants are pulled out. The final phase at the producer site is drying the onions. It consists in a kind of small greenhouse to concentrate the heat that the producers make and they use sawdust or a similar product in the ground to absorb the humidity and accelerate the process. The drying takes approximately a

month. After this, onions are sorted depending on customers needs and then packed to be delivered in pickup trucks to the respective collection centers. The onion shelf life is around 30 to 60 days.

It is worthwhile to mention that:

- The seed method is considered a better-quality product and is useful in the plains. Each seed produces one onion.
- Bulbs are used to be sow in slopes and the fruits obtained have irregularities in shape and size. Each bulb produces 4 to 5 fruits.
- All the work is done manually.
- The only aspect that affects the harvesting is the rain.

Distribution channels

During November and December when demand is very high, due to many national holidays in November and mother's day and Christmas time in December, sometimes the products are sold to other producers to fulfill their customer demand. These other producers are responsible for picking up the product at the farm and supplying their customers according previous agreements. Either the buying producer and/or his customer face the waste. The customer pays the complete shipment (including waste), but the producer can offer discounts to face part of it. The buying producer usually pays to the selling producer 90-120 days after receiving the product.

As soon as the product is sold, it belongs to the buyer, however, the responsibilities of delivery/pickup and waste, may vary depending on the negotiations.

There are several ways for distributing the products to final customers, depending on the producer type and agreements.

The most common distribution channels and agreements observed are shown below.



Plan-based producers sell around 80% of total production to supermarket chains like El Rey, El Machetazo, Riba Smith, Super 99 and to Mcdonalds. Producers that sell their products to El Rey are responsible for delivering to the consolidation center of the grocery store located in Cerro Punta, Chiriquí with the standards of size, texture and quality agreed previously. These deliveries are done with the producer's own transportation (either pickup vehicles or trucks).

The producer is responsible for the regional distribution to Riba Smith and Super 99 and delivering the product to the different branches of the grocery stores directly. In the case of McDonalds the products are delivered to a consolidation center in Panama City. Value added services like washing, drying and packing are performed at the producer's plant before delivering the products. In these cases, the producer includes the freight cost in the product price.

El Machetazo is responsible for picking up the product at the post-harvest center and moving it to the consolidation center in Panama for local distribution.

These grocery stores require high standards of product quality, so producers have the perception that sometimes the product in good conditions is not accepted or considered too heterogeneous. The request for homogenous product is evident, but it does not match the reality of agriculture, so producers have a different selling price when trading the products with the supermarkets due to having more labor, care and waste than usual. In this case, the supermarkets take a sample of the products on the truck and if it has 20% or more of waste or not qualified product the producers have to make discounts or even return the whole shipment.

As soon as the product is sold, the invoice is made and the payment is usually received 1 month after delivery, but it could take up to 120 days.



This distribution channel has two variance: according to the interviewed intermediaries, between 80% to 90% of the times the product goes directly to the M.A.C. and the remaining can have another destination to fulfill the needs of the other cities in Panama.

In the first scenario all the product in a vehicle is delivered to a wholesaler/retailer at the M.A.C. by the intermediary. The owner of the product can be the intermediary or the wholesaler/retailer at the market. The wholesaler/retailer is the owner when he contacts an intermediary in Chiriqui to place an order and the intermediary contact the producers to supply the wholesaler/retailer demand -pull system-.

On the other hand, the intermediary can be the owner of the product when he buys products from producers in Chiriqui and tries to sell them to wholesalers/retailers at the M.A.C. -push system-.

The intermediary is responsible for picking up the product at the origin (farm, PHC, etc.) and paying the transportation freight either owned or through a third party. Most of the

time intermediaries pick up more products in Chiriqui to supply several customers (around 2 to 3 wholesalers/retailers).

In this distribution channel the final retailer usually faces the waste and the wholesaler/retailer at the M.A.C. pays for the shipment. Sometimes, the intermediary can offer discounts to face part of the waste. As soon as the product is sold, the invoice is made and the payment from the intermediary is received 8-15 days after delivery.

The remaining 10% to 20% of the times the product in a vehicle is delivered to other cities in a multistop or a single stop system. The most popular stops are in Santiago, Divisa, Azuero (Herrera and Los Santos) and Chorrera, and sometimes Panama City is the final stop.

The delivery to Azuero could be considered a special case because it requires a detour so, the shipments are either sent directly from Chiriqui to Azuero or left in Divisa where another vehicle picks it up to take it to the destination. The following picture illustrates this situation.

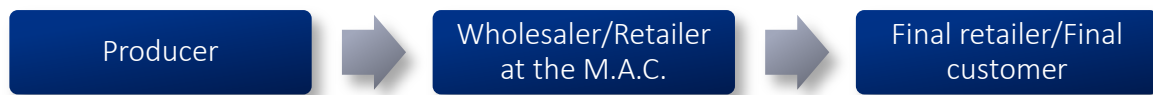


Figure 1. Movement of product from Chiriqui

It is important to mention that the intermediary can be:

- Party who buys directly from the producer and sells to the wholesaler/retailer in any province.
- Party who buys directly from the producer and sells the product to a final retailer.
- Party who buys directly from the producer and sells to another intermediary.
- Party who buys from an intermediary and sells to a wholesaler/retailer in any province.
- Party who buys from an intermediary and sells to a final retailer.
- Party who buys from an intermediary and sells to another intermediary.

Plan-based producers use this distribution channel for 20% of their production.

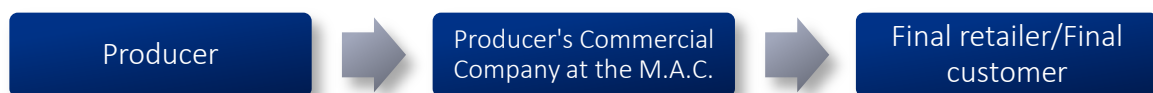


Not plan-based producers usually distribute directly to the M.A.C. trying to sell the product to wholesalers/retailers -push system-. Producers pay the freight cost to a third party responsible for transportation. Even though most of the time the final destination is the M.A.C., the producers also try pushing the product locally.

Plan-based producers may sell the product directly to the wholesaler/retailer at the M.A.C. if there is a long-term relationship with constant demand or a surplus in production. The producer is responsible for delivering the product at destination by paying his own transportation freight (either owned or through a third party).

As in previous distribution channels, the wholesaler/retailer pays for the shipment and faces the waste but the producer can offer discounts to face part of the waste. As soon as the product is sold, the invoice is made and the payment from the wholesaler/retailer is received 7 days after delivery.

When the wholesaler/retailer sells the product to a final retailer, the payment can be received until 1 month after sale, however, if the product is sold to the final customer, payment is received immediately.



Some of the plan-based producers have a vertical integration by managing the production company, their own transportation fleet and a commercial company in charge of selling the product at the M.A.C. The production company and commercial company are managed independently, even though both belong to the same owner. The commercial company usually sells the product to the final retailer (Chinese seller or restaurants) and the final customer as well. As soon as the product is sold to the commercial company, the invoice is made and the payment is usually received 15 days after delivery. When the commercial company sells the product to a final retailer, the payment can be received until 1 month after sale, however, if the product is sold to the final customer, payment is received immediately.



Producers can supply final customers directly by the Free Trade Fairs or by selling the product at their own site. The fairs allow producers to sell (either by themselves or by hiring a seller) the product directly to final customers and eliminate the intermediary. Some of the producers consider this is unfair competition with the grocery stores because they are saving taxes and expenses that the grocery store has to pay to the country. The producer is responsible for transporting and selling the product at the free trade fairs. As soon as the product is sold to the final customer, the invoice is made and the payment is received immediately.

Production quantity and amount of product transported

Based on the Dichter & Neira census in the document Elaboración de Pliego de Cargos, the production of the 24 products selected in Chiriqui was of 83,885,485 lbs. for the year 2010 in a total of 3,856 has. From this amount the pounds corresponding to each of the five products studied in this research, as in the table elaborated from the data in the census.

Table 1. Production in Chiriqui

| Product | Quantity of product (lbs) | Area of production (has.) | Percentage out of the total production |
|---------|---------------------------|---------------------------|--|
| Potato | 17,991,109 | 457 | 21% |
| Onion | 10,407,471 | 288 | 12% |
| Lettuce | 7,829,259 | 222 | 9% |
| Tomato | 14,317,333 | 800 | 17% |
| Pepper | 3,443,872 | 178 | 4% |

In order to know the volume of product that entries the M.A.C., the Cold Chain Secretariat made a study from April 2013 to March 2014 called “Análisis del Abastecimiento de Productos al MAC”, where they collected the amount of product per vehicle. A total of 58,379,424 lbs. of the 24 products coming from Chiriqui entered the M.A.C. during that period. From this total, the amount of each of the five products is shown on the table.

Table 2. Volume of product that entered the M.A.C. from Chiriqui

| Product | Quantity of product (lbs) | Percentage out of the total |
|---------|---------------------------|-----------------------------|
|---------|---------------------------|-----------------------------|

| | | entry volume |
|---------|------------|--------------|
| Tomato | 22,310,251 | 38.2% |
| Potato | 9,139,300 | 15.7% |
| Lettuce | 4,983,606 | 8.5% |
| Onion | 3,851,300 | 6.6% |
| Pepper | 945,441 | 1.6% |

Assuming that the production in Chiriqui did not have a significant variation from 2010 to 2013, which is a reasonable assumption, from the 24 products the 69.6% goes to the M.A.C. and the remaining goes somewhere else, mainly to other cities. And out of the five products 91.81% goes to the M.A.C. The detailed information is in the following table.

Table 3. Movement of the products

| Product | Goes to the M.A.C. | Goes to other destinations |
|---------|--------------------|----------------------------|
| Tomato | 100.0% | 0.0% |
| Lettuce | 63.7% | 36.3% |
| Potato | 50.8% | 49.2% |
| Onion | 49.2% | 50.8% |
| Pepper | 27.5% | 72.5% |

Observation: the analysis indicates that the production of the tomato in Chiriqui is less than the amount of product that entered the M.A.C. This could be because of some variation in the production from 2010 to 2013.

Transportation

The transportation of the merchandise is by truck departing Chiriqui usually during the afternoon. The journey can take at most around 2 days in total. This time includes the round trip, inspections and selling arrangement with the wholesaler (producer's client). According to the interviewed drivers, each vehicle makes two to three round trips per week.

The transit time varies according to the destination and the kilometers to go, as it is shown in the following table which takes into consideration the road conditions, geography and traffic.

Table 4. Distances and transit times from David to other regions

| | Santiago | | Divisa | | Chitre | | Penonome | | Chorrera | | Panama | |
|-------|----------|------|--------|------|--------|------|----------|------|----------|------|--------|------|
| David | km | h | km | h | km | h | km | h | km | h | km | h |
| | 193 | 2.85 | 227 | 3.22 | 263 | 3.72 | 292 | 4.03 | 405 | 5.43 | 441 | 6.05 |

Also depending on where in Chiriqui trucks depart the transit time can take longer. Most of the times it is from Cerro Punta located at 70.8 kilometers (1.2 hours) from David or Volcan at 55.1 kilometers (0.9 hours).

Based on the measure of entrance to the MAC during the period from April 2013 to March 2014 in the Cold Chain census, 25.40% (5,476 units) of the vehicles were from Chiriqui. Out of that percentage each type of vehicle had different movements, as in the following figure.

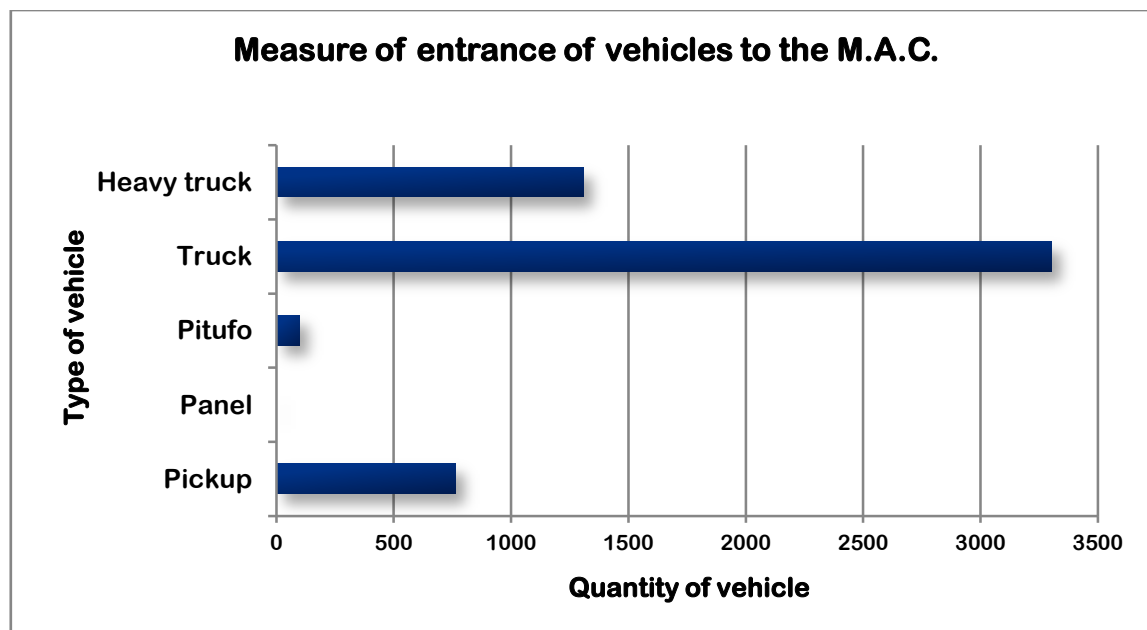


Figure 2. Measure of entrance of vehicles to the M.A.C.

Trucks were the most popular vehicle category in the transportation of vegetables from Chiriqui with a 61% of participation during the study. The type C3 is the more used while under the second popular category (24%), the type T2-S3 was the most seen.

The regulated specifications and dimensions of the types of vehicles in Panama are present in the appendix.

M.A.C.

Trucks usually arrive to the M.A.C. between 1 a.m. – 4 a.m. The employees from the delivering party are responsible for unloading, and delivering to the selling stations. Unloading is done manually; the baskets are placed on pallets and moved to the stations with jack pallets. The actual market does not have space for forklifts; the aisles are very narrowed.

The products are sold and distributed to the selling stations owned by wholesalers and/or retailers. The products are classified and cleaned with different methods at the selling stations. For example, in the case of the tomato and pepper employees use a dirty towel to remove impurities, for the lettuce they remove manually the spoiled leaves and the dirt with water, and onions and potatoes do not go through a cleaning process at the market.

Then, when the products are “clean” and classified to be sold, they are packed for either wholesaling or retailing. In the case of retailing, the product is placed in plastic totes or bags and in the case of wholesaling the product is packed in sacks of 50 pounds and often stored on the floor.

All of the products are commercialized per pound, while sometimes the potato and onion are commercialized per sacks and the lettuce per basket. Value added is not quite common in the M.A.C. but depending on the customer requirements, these products can be washed with chemicals, dried with fans and packed according to customer standards. In case of the onions sometimes they are peeled, especially for restaurants.

In current conditions, the products have different shelf life. The tomato stays at the selling stations for about 1 to 4 days, the pepper for about 7 days, the lettuce stays at most 2 days, the potato from 8 to 15 days, and the onion can last until one month at the selling stations if there is low demand. After these periods the products become waste and is thrown away in a common dumpster. The responsible for this waste is the wholesaler/retailer.

Mappings

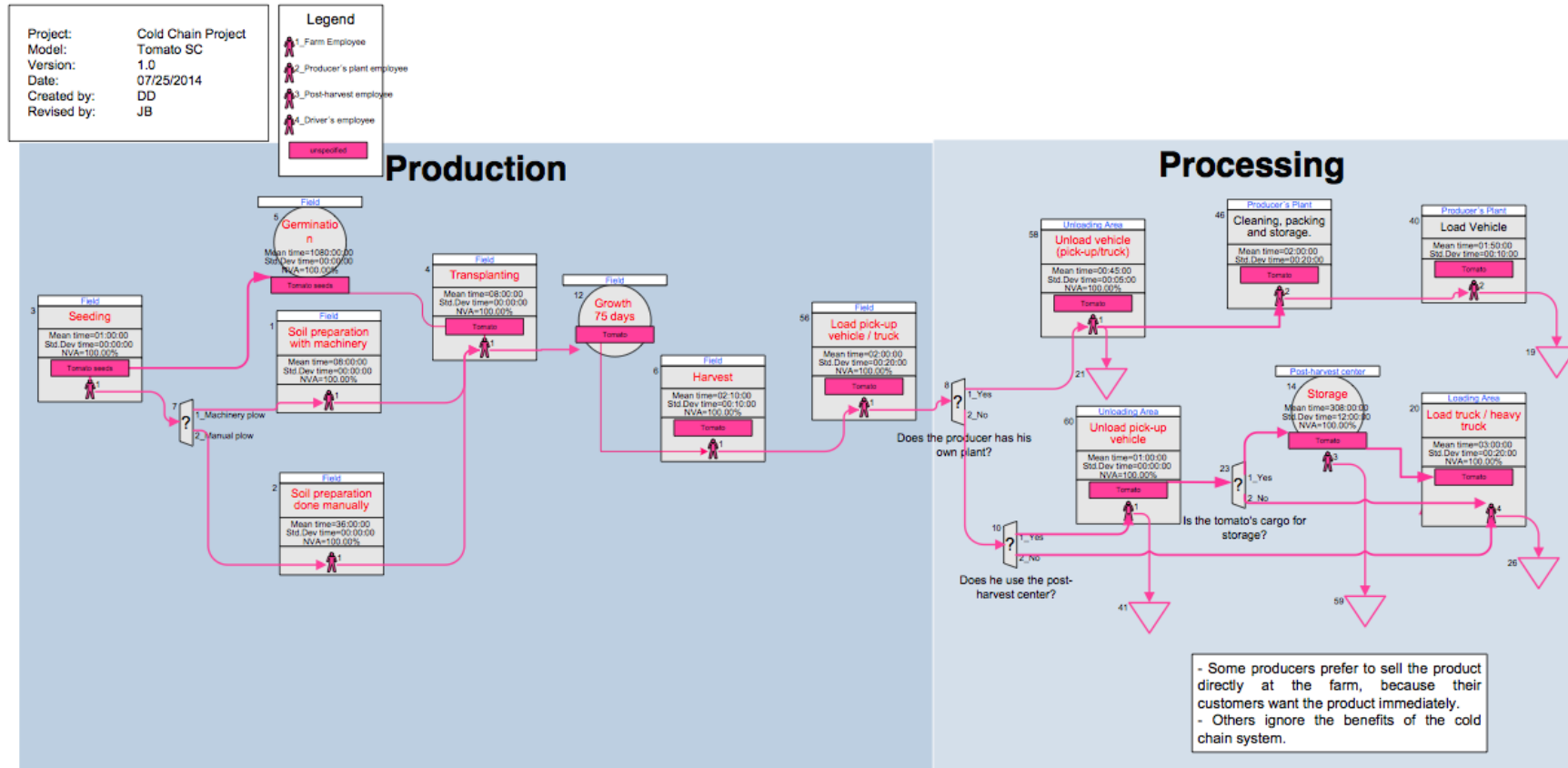


Figure 3. Process mapping of the tomato

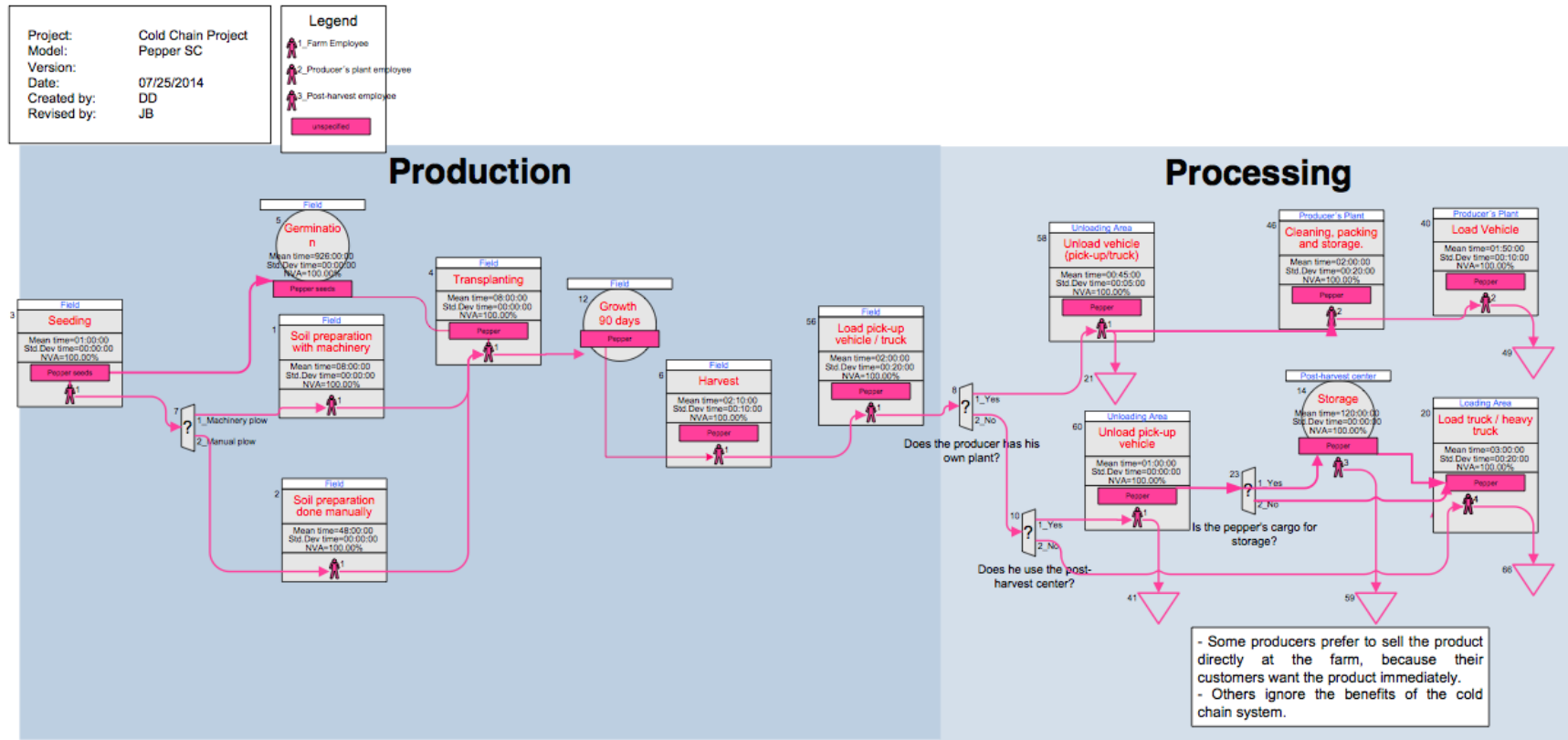


Figure 4. Process mapping of the pepper

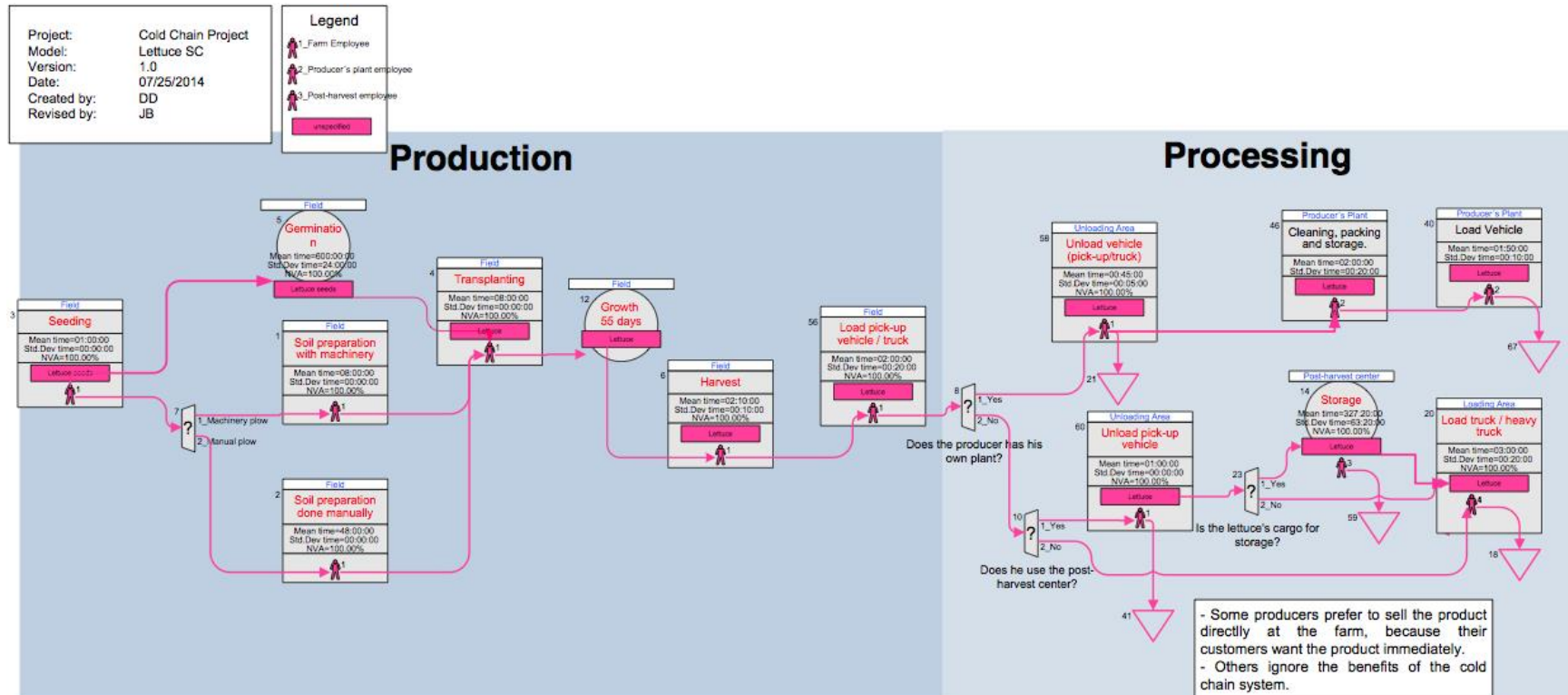


Figure 5. Process mapping of the lettuce

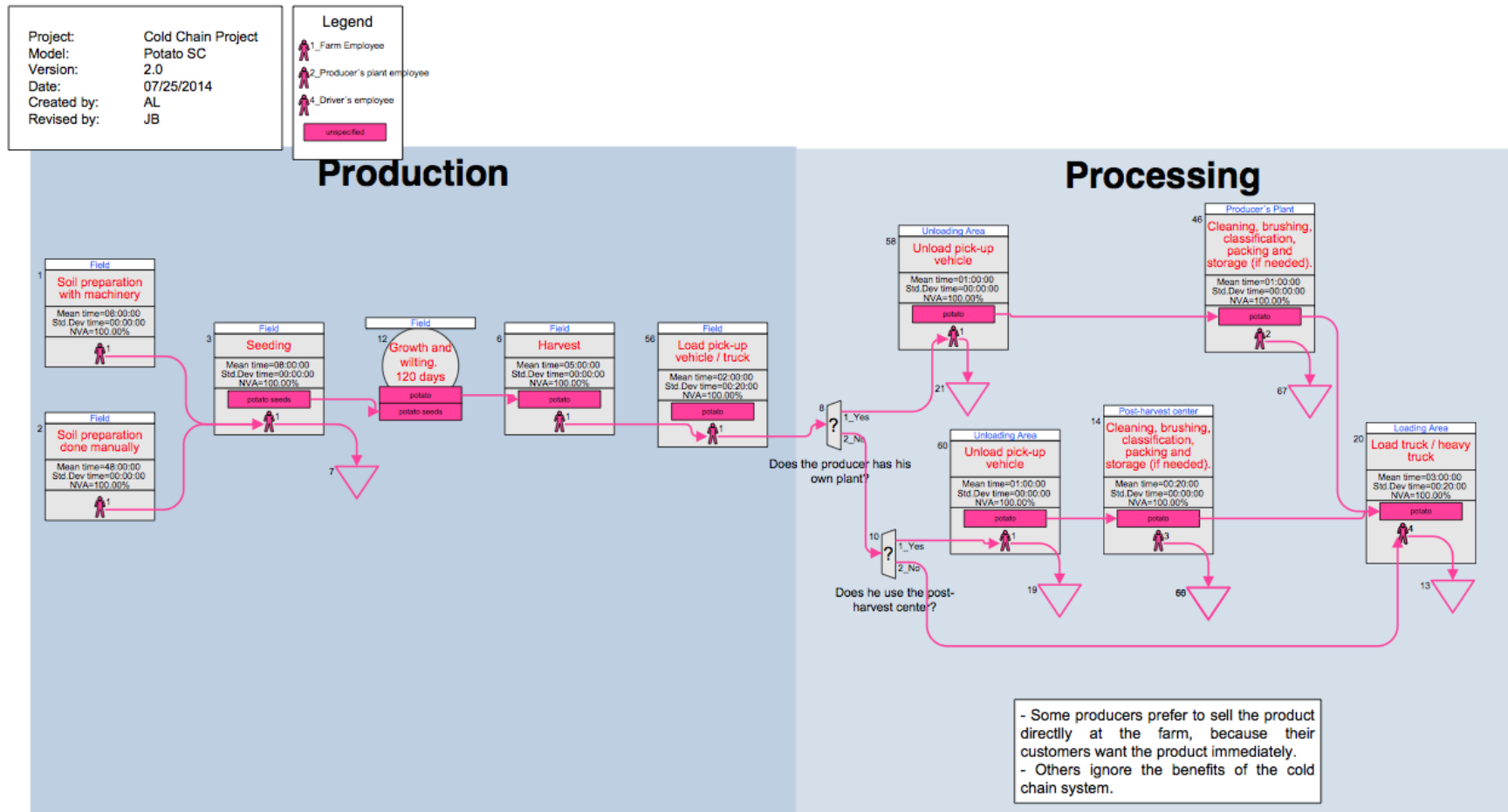


Figure 6. Process mapping of the potato

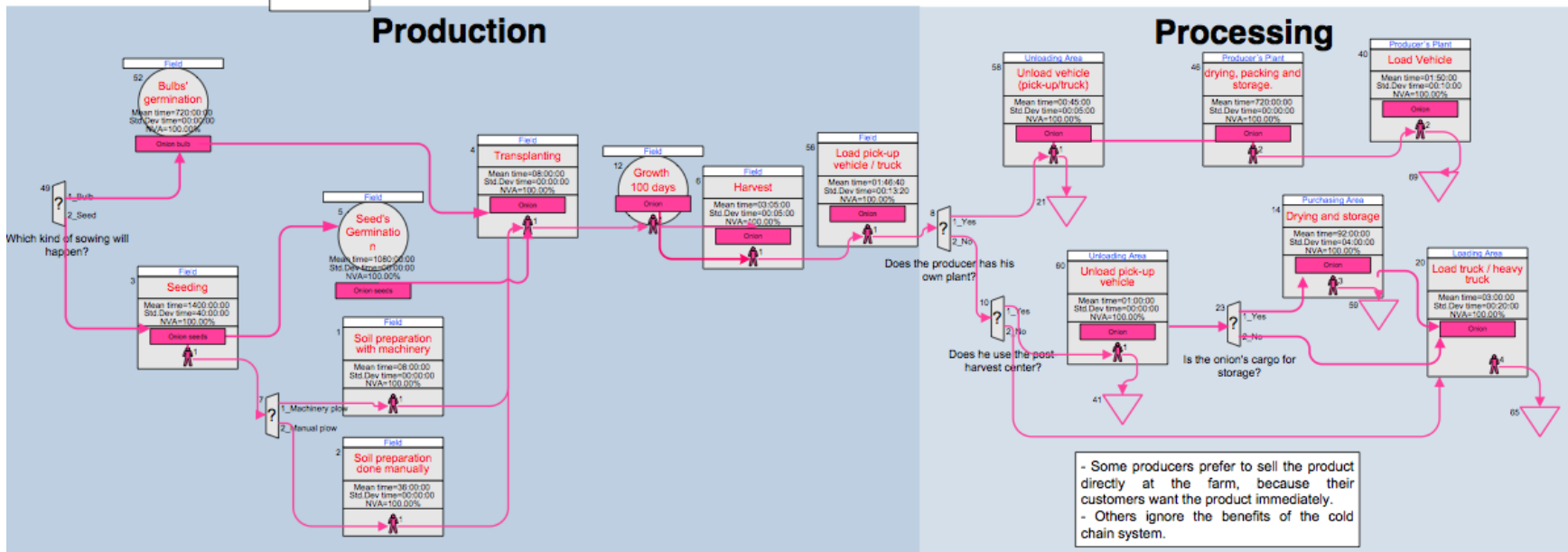
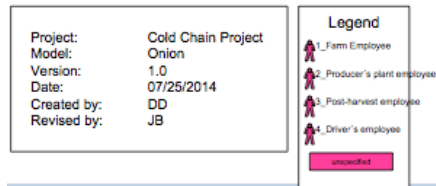


Figure 7. Process mapping of the onion

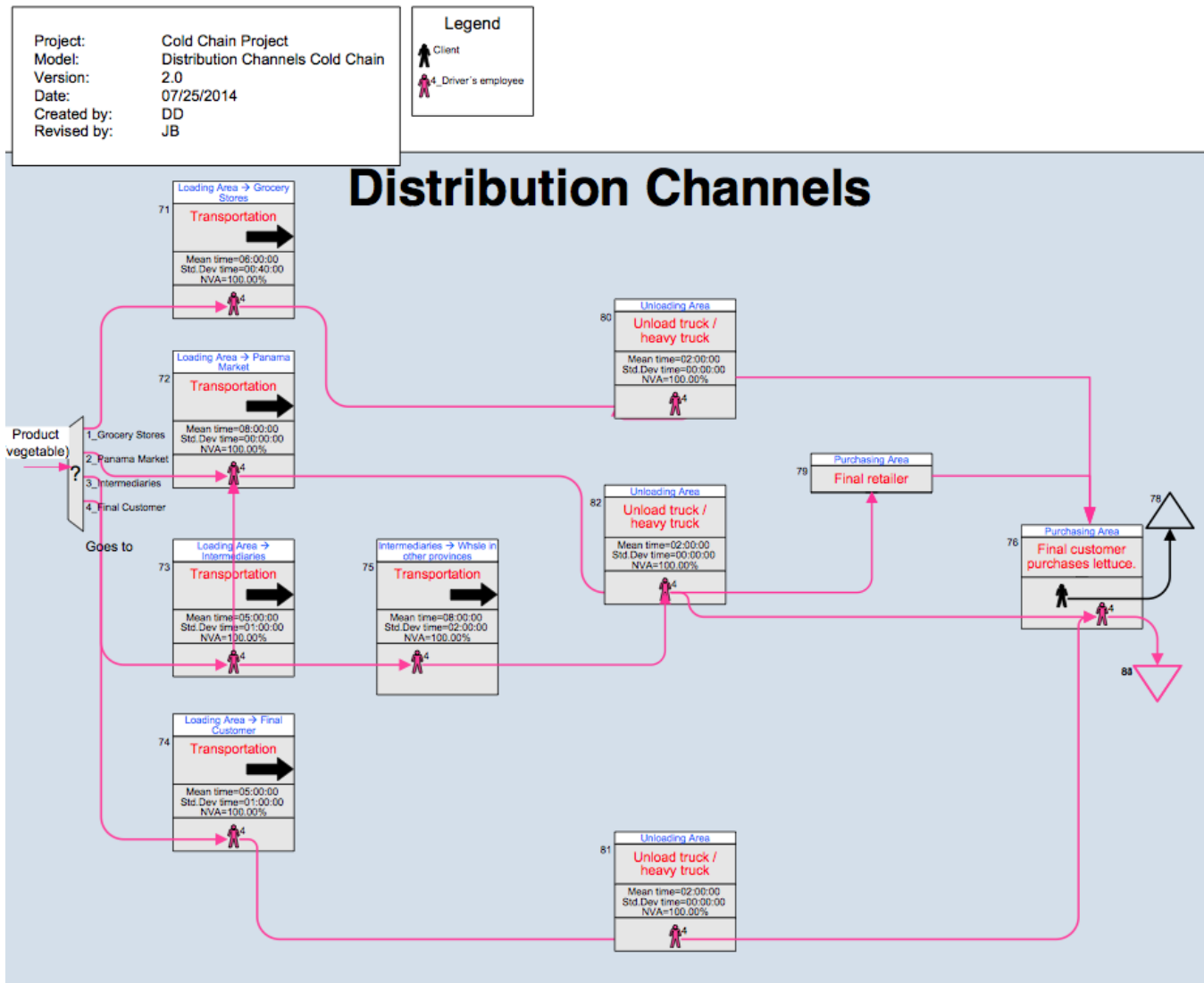


Figure 8. Mapping of the distribution channels

Costs and prices

According to the producers in the area the costs involved in an agricultural production are usually high. A high investment is required even if producers own the land. This investing involves raw materials, maintenance products and human labor. The costs varies depending on the type of products due some of them are imported products which requires a higher inversion and handling.

The following table shows the average cost per hectare and the selling price per pound for each product as the producers mentioned.

Table 5. Costs and selling prices of the products

| Product | Cost per has | Selling price per pound | |
|---------|--------------|-------------------------|---------|
| | | Minimum | Maximum |
| Tomato | \$27,750 | \$0.30 | \$0.60 |
| Pepper | \$24,000 | \$0.65 | \$0.70 |
| Lettuce | \$6,500 | \$0.20 | \$0.65 |
| Potato | \$14,500 | \$0.20 | \$0.55 |
| Onion | \$12,000 | \$0.18 | \$0.64 |

The population demand is fluctuant and the production changes across seasons, so selling rates needs to change too. When the production is high, the prices are low in order to reduce waste, and vice versa. So the producers reach agreements with the selling rates considering costs involved, earnings, and the free supply and demand.

Waste

The producers interviewed stated that in the field they do not have a significant percentage of waste. In fact, they consider they have normal levels of waste under regular conditions. Instead, the producers agreed that the one who assumes the greater percentage of waste is the retailer except when the product is sold to a supermarket chain.

The following table shows the average percentage of waste during the production for each product as told by the producers.

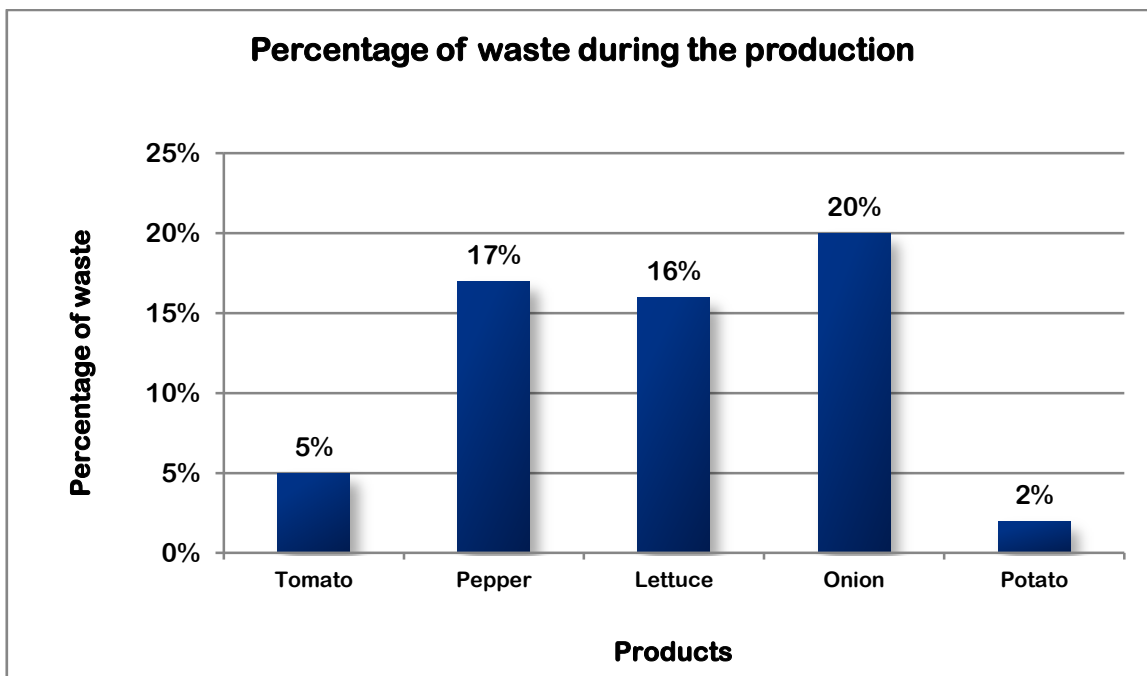


Figure 9. Percentage of waste during the production

An exercise was performed by the four of us and the intermediary Ivan Morales to corroborate this statement. The lettuce was chosen because it is the one that presents more waste once it gets to the final seller, in this case the retailer. The practice consists on removing the spoiled leaves of the lettuce, which is the cleaning process that the retailers do.

The sample included 3 wood boxes of lettuce that weighed 109 pounds in total (34, 35 and 40 pounds respectively). After the cleaning process, the removed leaves were placed in a sack and weighted. The waste was of 13.05 pounds or 12%.

Observations

Waste

For producer the percentages of waste are measured by the quality of the product. To have a great product it is required quality during the production, mainly in aspects as raw material and handling.

Despite weather conditions cannot be controlled by the producers, it is an important factor in humidity sensitive products as the onion. The rainy season increases significantly the waste due to the humidity makes the plantation vulnerable to fungus and other diseases.

On the other side of the supply chain when the retailer/wholesaler becomes the owner of the product, the percentage of waste can be higher. This increase is due to the handling and conditions during the transportation. Stevedores consolidate the product into the vehicles in a disorganized way without caring about how they do it. Their task is to load the truck as much as possible and close the container doors.

On June 19th, during the inspection at the PHC in Cerro Punta, the observed way of how the product is loaded was not the most appropriate one. For example, on one occasion the stevedores were loading a truck exceeding its capacity as much as they could, so they were not able to close the container doors. Some onion sacks were misplaced and the doors did not fit well. So, two stevedores started kicking the sacks of onions and pushing strongly the doors but it did not work. They tried this many times in order to close the door. Finally, they were able to close the doors but the product was mistreated, getting at the end a spoiled product prone to become waste.

Transportation

Drivers load the vehicles not taking into consideration the regulations regarding maximum weight allowed. Instead, they only consider the volume or the physical capacity of the container. This can be supported as eleven of the drivers interviewed said that 80% of the time they exceed the maximum capacity (weight). The Transit Authority of Panama has regulations to penalize drivers who excess the weight with a fine of \$50 per each ton exceeded. Obviously, the corruption takes place and drivers have green light if they pay a reasonable amount of money at the weighing stations.

Despite the infraction, this practice also affects the quality of products because they are carelessly stowed and consolidated leading to spoiled vegetables at the end of the chain. According to 9 wholesalers/retailers at the M.A.C. around 20% of the cargo suffers this deterioration.

Another aspect that may affect the quality of the products is the age of the vehicles. In the case of heavy trucks, the owners renew more often the truck unit than the container part. But the container is the unit that carries the cargo and the one that needs to be more cared about. Based on the comments of the drivers and corroborated by our observations, 50% of the truck units were relatively new in the range from the year 2000 to the 2012 while 75% of the containers were old in the range from the 1960 to the 1999. On the other hand, in the case of a single unit trucks, 80% of the trucks were in the range from the year 2000 to the 2008. From the entire sample only 17% of the vehicles were refrigerated (2 out of 12), this was seen on the newest ones. Furthermore, through one week of observation the information above could be confirmed.

One of the aspects that are less important during the transportation is the sanitation of vehicles. Drivers always want to earn more, so 90% of the time they return with the container loaded. 95% of these trips are loaded with poultry manure and the remaining with construction materials or sometimes with empty totes.

Once the freight is unloaded at its destination, the container's cleaning process is not the most proper. According to nine of the drivers, the method used by the vehicles' owners consists in throwing coffee all over the container to remove the smell but this is just when they have time. In the cases when the producer also owns the vehicle, the containers are washed with pressurized water to remove impurities but the probabilities of contaminating the products are still high.

Reception/dispatch operations (PHC)

The PHCs have docks assigned for reception and dispatch of the products, but there is no scheduling for reception or dispatch at this moment. Most of the time the trucks are served in the order they arrive. Nevertheless, right now the center is mostly used as a transshipment point where producers deliver the product in pickup trucks to fill a truck immediately, without processing the product, using any available dock.

Usually trucks occupy the docks available for receiving, to do the transshipment operation. A pickup truck takes the parking beside the loading truck and then the movement of products begins; the products is unloaded from the pickup truck, weighed and loaded into the departing truck. This is an obstacle for a producer that is coming to leave product at the same time generating a delay. Even sometimes when docks are occupied, heavy trucks and pick up vehicles perform the transshipment activity on the street, in the area available for maneuverability. Nowadays, the PHCs are not functioning at full capacity; however, they should reorganize the way they allow transshipment operations to avoid delays.

Opportunities for improvements

The opportunities for improvement shown below are not presented in any special ordering.

Waste

Handling procedures performed during production have improved in recent years, but waste after production until arrival of the products at destination is still significant.

After harvest, the whole chain is generating waste because workers are careless with the products. Handling training is needed on this regard to avoid products spoiled due to people pushing, throwing or kicking the bags and baskets.

If products arrive in bad conditions to the PHC, the outcome will include just the product in good conditions that was processed successfully. The processes performed at the center are intended to keep the good quality of the products, not to improve the quality of the product in bad condition, so special care must be taken into consideration while handling products at all stages.

Transportation

The trucking industry has no regulations to monitor deterioration of containers or vehicles, however, as in other logistics industries it is responsibility of the shipper to inspect the status of the unit before loading. It is important to create awareness among the related parties -shipper and consignee- about the necessity of inspecting the transportation units. If the equipment belongs to the shipper, he must repair the anomalies (i.e. holes) and replace the unit if necessary. If the transportation unit belongs to a third party, it is necessary to communicate the requirements of the service and conditions of the vehicles beforehand. The related parties must agree previously that if the unit shows anomalies that can spoil the product, it will not be loaded.

Promote even more the use of refrigerated vehicles by telling stakeholders on the advantages of maintaining the cold chain from origin to destination. The potential increase in sales by reducing waste while using refrigerated vehicles and loading according regulations are important topics to emphasize.

The cleaning process of the vehicles or containers on their returning trip must be standardized considering that the most popular cargo is the chicken manure that may represent a threat to human health. A fumigation point in Chiriqui can be established to fumigate the outer part of vehicles and containers. Once it arrives to destination on its

returning trip and the freight has been unloaded, the internal cleaning process should begin by sweeping the transportation unit to remove solid residues, then a wash with pressurized water including disinfectants and biodegradable surfactants. The temperature of the water should be approximately 55 °C to attack infectious agents -according best practices implemented in other countries like Uruguay- and finally the equipment must remain with open doors for drying at least one day. The boots and implements of the staff should be washed with the same water solution. This procedure must be done every time the transportation unit returns with chicken manure or construction material, in order to protect the new products that will be loaded from contamination.

Logistics order for reception/dispatch operations

The PHCs should implement a scheduling system to assign producers specific time frames to receive, deliver or perform transshipment at the PHC, in order to avoid having a transshipment truck occupying one dock the whole day until all the products that will be loaded arrive. This will also require close communication between the party organizing the loading of the truck and his suppliers to have the products ready for loading during the assigned period.

The docks could be assigned a specific operation of receiving, dispatch or transshipment, so that each operation does not disturb the product flow of the others. As just few producers are using the PHC for processing, the dock 5 can be assigned for receiving, the docks 2 to 4 for transshipment and the dock 1 for dispatch. This arrangement follows the logic of having more docks assigned to the most common activities at the center, so considering the transshipment activity as the one that takes longer and requires more space to be accomplished, it has been assigned more docks than the others. The receiving dock is close to the processing area and the dispatch dock is close to the storage rooms. Most of the time the receiving is done from 7:30am to 1:00pm, so dock 5 along with the available empty space next to it, can be used for transshipment after this period.

If there exists the need to perform another activity the dock can be used to expedite other operations, if available.

The diagram below shows the interaction between the different areas of the PHC. The numbers 1, 2, 3, 4 and 5 stand for each one of the available docks to serve non-refrigerated vehicles. The brown, orange and green arrows refer to the activities of reception, transshipment and dispatch suggested in this context respectively.

Product Flow – The five Cs

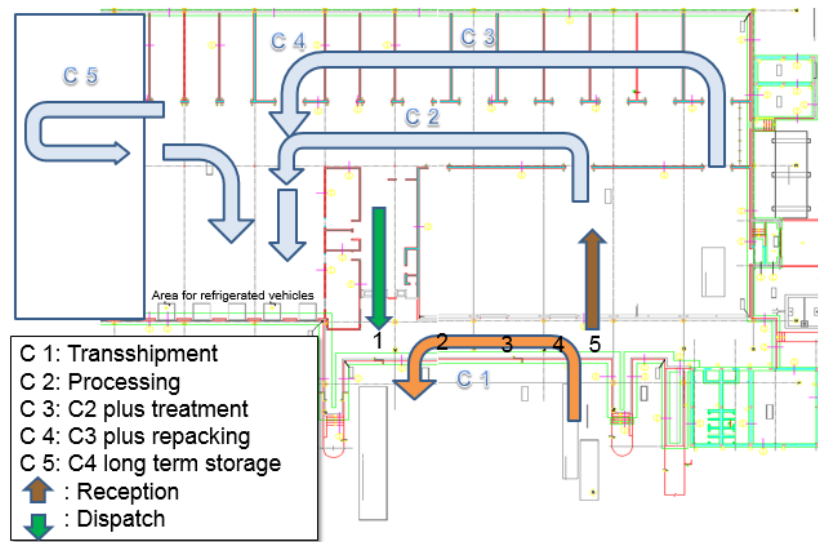


Figure 10. Product flow in the PHC

Source: Cold Chain Secretariat. UP marketing presentation. May 13, 2014.

It's worthwhile to mention that the area intended to serve refrigerated vehicles is not facing this challenge because few vehicles are using this area.

Cold Chain System

Even though most producers are aware of the benefits from using the cold chain system, intensive training is still needed because PHC employees stated that producers are reluctant to use it. One of the reasons for having this situation is lack of trust in the system administration because it is managed by the government and producers stated they had bad experience working previously with government institutions. Another reason is the uncertainty of unknowing the cost of using the system in the future. More agricultural engineers must be assigned for training in order to expand their knowledge and convince related parties the system is reliable.

On the other hand, cultural changes must be promoted because Panamanian people are used to buy products without caring too much about their quality. Customers must require products of better quality and ask for the use of the PHC as part of the process to extend product's shelf life. Some customers want the product immediately after harvest but is important to create awareness of the related disadvantages, so that more stakeholders support the use of the cold chain system.

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Appendix

Appendix A. Data collection templates

Template for Data Collection PRODUCERS

PRODUCER: _____ Date/Time: _____
 LOCATION: _____

| | | | | |
|-----------------------------------|---------------------|--------------------------------|--|----------------------|
| 1. Farm Size (Ha): _____ | | Sowing Area (Ha): _____ | | Notes |
| Product: | | Production Rate (lb/Ha): _____ | | Temperature |
| Sowing Ha: | | Harvest frequency: | | Time between baskets |
| <div>General</div> | | | | |
| Production time: | | Productive life: | | Harvested basket? |
| Starts (time): | | Ends (time): | | |
| Harvest: | Manual / Automation | Production waste | | Baskets/person-day |
| When is harvest? | Visual / Time | Journey waste | | Quantity of workers |
| Origin | | | | Quality (conditions) |
| Destination | Panama | Azuero | | |
| | Chorrera | P.Centrales | | |
| <div>Cost</div> | | | | |
| Production cost: | | Transportation (%) | | |
| Selling rate: | | Labor (%) | | |
| Truck availability (filling time) | | | | |
| Predefined routes? | | | | |
| General process info: | | | | |

2. Who is responsible for transportation and handling? _____ Producer / Buyer
 Comments: _____ Who?

| | | |
|-------------------|---------------|----------------|
| Transportation: | Private fleet | For-hire fleet |
| Cost | | |
| How it works? | | |
| Contract? | | |
| Duration/Validity | | |
| Agreements | | |
| Fleet size | | |

| | | | | |
|------------------------------------|----------|------------------|------|--------------|
| Fleet type, quantity, generalities | | | | |
| Pitufu: | Truck: | Pick-up: | Van: | Heavy truck: |
| Refrigerated: | Yes / No | | | |
| Capacity: | | Utilization (%): | | Year: |

3. It is difficult to obtain transportation services?
 Comments: _____

4. Need to use smaller vehicles? Why and when?

Comments:

5. Who decides if the product goes through the cold chain system?

Producer

Buyer

Comments:

6. Flow of money (payments)

7. When and when are the arrangements done?

8. What type of anomalies or bad situations have you faced on your processes?

9. How often do you have those bad situations?

10. What things worry you the most?

11. Causes to firing workers?

12. What type of training workers received/needed?

12. What are the hardest decisions you need to make?

13. What things in the supply chain cause the biggest disruptions to you?

Template for Data Collection: POST-HARVEST CENTERS

PHC: _____
Worker: _____

Date/Time: _____
Product: _____

1. SC Process (steps) including time window (when and duration)

Labor

DOC/INFO, when and who receives it?

Equipment

2. What is the destination of the product (%)?

3. What percentage of the product is stored (%)?

4. Frequency of shipping:

Output average amount (pounds):

5. What percentage of the product is wasted (%)?

6. What is the storage capacity?

How long does the product can stay, how does it affect its shelf life?

7. What type of anomalies or bad situations have you faced on your processes?

8. How often do you have those bad situations?

9. What things worry you the most?

10. What may cause you to get tired?

11. What are the hardest decisions you need to make?

12. What things in the supply chain cause the biggest disruptions to you?

Template for Data Collection: DRIVERS

Product: TOMATO ~~PEPPER~~ ~~LETTUCE~~ ~~ONION~~ ~~POTATO~~

Driver: _____ Date/Time: _____
Origin: _____ Destination: _____

Type of vehicles: ~~Pitufu~~ ~~Pick-up~~ ~~Van~~ ~~truck~~ ~~Heavy truck~~

License plate: _____ Year: _____

Refrigerated: Yes ~~No~~

Capacity: _____ Utilization (%): _____

You own the product? Yes ~~No~~

Charge fleet? _____

Frequency of trips: _____

Output amount of product per vehicle: _____

Packing: _____

Template for Data Collection: M.A.C.

MARKET: PANAMA

PRODUCT:

PRODUCER:

Date/Time:

1. **SC Process (steps) including time window (when) and duration**

Labor DOC/INFO, When and Who receives it?

Types of equipment for storage and handling

2. **What percentage of the product is wasted (%)?**

3. **Are the trucks returning empty?**

4. **How frequent do you have replenishments?**

5. **Who do you sell the products to (%)?**

6. **What is the price of the product?**

7. **What type of anomalies or bad situations have you faced on your processes?**

8. **How often do you have those bad situations?**

9. **What things worry you the most?**

10. **What may cause you to get tired?**

11. **What are the hardest decisions you need to make?**

12. **What things in the supply chain cause the biggest disruptions to you?**

Inspection

Product:

Producer: **Date/Time:**

License plate:

Origin: **Destination:**

Type of vehicles:

Pitufu ☐ Truck ☐ Pick-up ☐ Van ☐ Heavy Truck ☐

Refrigerated: Yes ☐ No ☐

Year:

Utilization (%):

Frequency:

Input amount per vehicle (in pounds):

Packing:

Appendix B. Supporting tables

















| LIMITS OF WEIGHTS AND DIMENSIONS FOR FREIGHT TRANSPORTATION IN PANAMA | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|----|------|-------|---|------|----|-------|------|-------|----|------|-----------------------|--------------|---------|------|--------------|-------|---------|--------|--------|-------|
| TYPE | VEHICLE | Maximum Weight per axle or group of axles allowed | | | | | | | | | | | | Maximum Weight (Tons) | Maximum Size | | | License Type | | | | | |
| | | 1 | 2 | 2-3 | 2-3-4 | 3 | 3-4 | 4 | 3-4-5 | 4-5 | 4-5-6 | 5 | 5-6 | | 6 | 4-5-6-7 | 7 | | 5-6-7 | 5-6-7-8 | Length | Height | Width |
| C-2 |  | 4 | 10 | | | | | | | | | | | | | | | | 14 | 11 | 4.15 | 2.5 | F |
| C-3 |  | 5.5 | | 16.4 | | | | | | | | | | | | | | | 21.9 | 12 | 4.15 | 2.5 | F |
| C-4 |  | 5.5 | | | 22 | | | | | | | | | | | | | | 27.5 | 12 | 4.15 | 2.5 | F |
| C-4-E |  | 5.5 | 10 | | | | 16.4 | | | | | | | | | | | | 31.9 | 12 | 4.15 | 2.5 | F |
| C2-R2 |  | 4 | 10 | | | | | 8 | | | | | | | | | | | 30 | 16.7 | 4.15 | 2.5 | G |
| C2-R3 |  | 4 | 10 | | | | | 8 | | | 14.5 | | | | | | | | 36.5 | 16.7 | 4.15 | 2.5 | G |
| C3-R2 |  | 5.5 | | 16.4 | | | | | | | | 8 | | | | | | | 37.9 | 16.7 | 4.15 | 2.5 | G |
| C3-R3 |  | 5.5 | | 16.4 | | | | | | | | | 8 | | | 14.5 | | | 44.4 | 16.7 | 4.15 | 2.5 | G |
| T2-S1 |  | 5.5 | 10 | | | | 10 | | | | | | | | | | | | 25.5 | 16.7 | 4.15 | 2.5 | FG |
| T2-S2 |  | 5.5 | 10 | | | | | | | 16.4 | | | | | | | | | 31.9 | 16.7 | 4.15 | 2.5 | FG |
| T2-S3 |  | 5.5 | 10 | | | | | | | | | | 22 | | | | | | 37.5 | 16.7 | 4.15 | 2.5 | FG |
| T3-S1 |  | 5.5 | | 16.4 | | | | 10 | | | | | | | | | | | 31.9 | 16.7 | 4.15 | 2.5 | FG |
| T3-S2 |  | 5.5 | | 16.4 | | | | | | | | | 16.4 | | | | | | 38.3 | 16.7 | 4.15 | 2.5 | FG |
| T3-S3 |  | 5.5 | | 16.4 | | | | | | | | | | 22 | | | | | 43.9 | 16.7 | 4.15 | 2.5 | FG |
| T2-S1-R2 |  | 5.5 | 10 | | | | 10 | | | | | 8 | | | | | | | 41.5 | 16.7 | 4.15 | 2.5 | FG |
| T2-S2-R2 |  | 5.5 | 10 | | | | | | 16.4 | | | | | | | 8 | | | 47.9 | 20 | 4.15 | 2.5 | FG |
| T3-S1-R2 | | 5.5 | | 16.4 | | | | | | | | 10 | | | | | | | 47.9 | 20 | 4.15 | 2.5 | FG |
| T3-S2-R3 | | 5.5 | | 16.4 | | | | | | | | | | 16.4 | | | 14.5 | | 60.8 | 20 | 4.15 | 2.5 | FG |

Figure 8 - Limits of weights and dimensions for freight transportation in Panama. Source: <http://logistics.gatech.pa/en/services/trucking/components-and-operations>

Appendix C. Pictures



Figure 11. Land in Chiriqui

The land in Chiriqui have a mixture of plains and slopes, where slopes are the most predominant.



Figure 12. Lettuce process - Application of the substrate



Figure 13. Lettuce process - Seeding and fertilizing



Figure 14. Lettuce process – Germination at the greenhouse



Figure 15. Lettuce process - Plants ready to be transplanted



Figure 16. Lettuce process - Growing phase



Figure 17. Lettuce process - Harvesting



Figure 18. Lettuce process - Harvesting



Figure 19. Lettuce process - Weighing at the PHC



Figure 20. Comparison of harvesting quality



Figure 21. Physical aspect of tomato for optimal harvesting



Figure 22. Ripe tomatoes are considered waste



Figure 23. Potato seed from previous harvesting



Figure 24. Potato plants



Figure 25. Onion plants



Figure 26. Traditional method for drying the onions



Figure 27. Lettuce exercise – Cleaning the lettuce



Figure 28. Lettuce exercise - Leaves considered waste



Figure 29. Weighing stations in the PHC



Figure 30. Loading and unloading area



Figure 31. The products obstructing the area while waiting for being loaded



Figure 32. Flammable product waiting to be loaded



Figure 33. Deteriorated container



Figure 34. Deteriorated tire



Figure 35. Non-refrigerated cargo loading



Figure 36. Refrigerated cargo loading



Figure 37. Stevedores trying to close the door of an overloaded container



Figure 38. Tomato cleaning process at a selling stations in the M.A.C.



Figure 39. Waste and classified product for selling in the same area (M.A.C.)



Figure 40. Onion cleaning and peeling process at the M.A.C.



Figure 41. Loading and unloading area at the M.A.C.



Figure 42. Weighing station at the M.A.C.



Figure 43. Selling stations at the M.A.C.



Figure 44. Storage of product on the ground at the M.A.C.