PLANNING SYSTEM IN TOMATO PLANTING FOR PROCESSING FACTORY

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรบัณฑิต
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วิทยานิพนธ์ฉบับนี้เป็นการศึกษาเกี่ยวกับระบบการวางแผนการเพาะปลูกมะเขือเทศสำหรับโรงงานแปรรูป โดยการประยุกต์ใช้เทคนิค MRP (Material requirement planning) ซึ่งเป็นเทคนิคที่ช่วยในการควบคุมและวางแผนการผลิต ที่คำนึงถึงเวลาและปริมาณ เพื่อที่จะให้ได้มาซึ่งผลผลิตที่ต้องการ วัตถุประสงค์ของงานวิจัยนี้ เพื่อพัฒนาระบบการวางแผนการเพาะปลูกมะเขือเทศสำหรับโรงงานแปรรูป

จากการวิเคราะห์ปัญหาพบว่า การวางแผนที่ไม่เหมาะสมจากการทำงานของฝ่ายไร่ เพื่อตรวจสอบการเพาะปลูก ทำให้เกิดปัญหาในการหาวัตถุดิบป้อนโรงงาน ไม่เพียงพอต่อความต้องการ จากการประยุกต์ใช้แนวความคิดของ MRP แผนการเพาะปลูกถูกแบ่งออกเป็น 4 เฟส เพื่อใช้ในการแก้ปัญหาและให้ได้แผนงานที่มีประสิทธิภาพมากที่สุด โดยเฟสที่ 1 คือ แผนงาน ตารางการเพาะปลูกในแต่ละพื้นที่การเพาะปลูกจะถูกคำนวณออกมา เฟสที่ 2 สัญญา พนักงานส่งเสริมจะออกหาพื้นที่เพาะปลูกให้ได้ตามตารางในเฟสที่ 1 และเซ็นสัญญาการเพาะปลูกกับเกษตรกร ซึ่งถ้าพื้นที่ที่หาได้ไม่เพียงพอก็จะต้องมีแผนรองรับต่อมาในเฟส 4 เฟสที่ 3 ลงปลูก พนักงานส่งเสริมที่ดูแลพื้นที่ในแต่ละเขตและผู้ตรวจสอบจะทำการสำรวจความแตกต่างของเวลาในการลงปลูก ระหว่างเฟส 2 และ 3 และมีการปรับปรุงแผนงานให้ถูกต้องตามเวลาที่ลงปลูก เฟสที่ 4 ก่อนเก็บเกี่ยว พนักงานส่งเสริมที่ดูแลพื้นที่ในแต่ละเขตและผู้ตรวจสอบจะทำการประมาณการผลผลิตที่น่าจะเก็บได้เป็นเปอร์เซ็นต์ ซึ่งในบางพื้นที่ที่ได้ผลผลิตดี อาจจะมีเซ็นสัญญาเพิ่มในการส่งมอบผลผลิต ถ้าพื้นที่ที่หาได้ในเฟส 2 มีไม่เพียงพอ

จากการประยุกต์ใช้พบว่า ปัญหาในการหาวัตถุดิบเพื่อป้อนโรงงาน ให้เพียงพอต่อความต้องการนั้นได้ลดลงจากเดิม วัตถุดิบที่ส่งเข้าโรงงานมีมากขึ้นจาก 51 เป็น 71 เปอร์เซ็นต์เมื่อเทียบจากเป้าหมายที่ตั้งไว้ตอนต้น

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ลายมือชื่อนิสิต.....
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This thesis aims to study the planning system in tomato growing for processing factory by applying MRP (Material requirement planning) technique which this technique provides precise control to operations personnel regarding the amounts and timing of deliveries to produce end items. The objective of this research is to develop the system of plantation planning and scheduling in tomatoes planting for processing factory.

The analysis of the causes had found that there was no proper plan for work procedure of farming department to monitor the growing of tomatoes which lead to problem in acquiring fruits to meet with plan. By applying MRP concept, the plantation planning is divided into 4 phases to eliminate the problem and obtain the most effective plan. Phase 1 is the planning, the plantation schedule is obtained. Phase 2 contracting phase, staffs or zone controllers look for the growing areas as scheduled in phase 1 and get farmers to sign contract. If the areas signed in the contract is not enough, there will be some more action in phase 4. Phase 3 planted phase, zone controllers and monitors check the discrepancy of timing in planting from phase 2 and there might be a corrective action. The last phase is pre-harvesting, staffs and monitors evaluate the percentage in acquiring of product. The contract for more amount of product might be signed again if there is not enough growing areas signed in phase 2.

After implementing MRP concept, the result of this research showed that there is an increasing in percentage of acquiring products from 51 to 71 percent when comparing between the actual fruits delivered and forecasting demand.

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Student's Signature……..
Advisor's Signature……..

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CONTENTS

Pages

Pages

LIST OF TABLES

Pages

LIST OF FIGURES

Pages

CHAPTER I

INTRODUCTION

1.1 Background of the Research

Tomatoes have been largely grown in the upper Northeastern (I-Sarn) of Thailand. Tomatoes processing firms are also located in this part. At first, farmers still lacked knowledge in growing tomatoes. Thus, these processing firms have come to play an important role in providing knowledge and training to farmers from soil preparation to the practical way in harvesting in order to attain the better quality of raw materials for processing. Besides that, there are supporting services by giving credit such as seeds, fertilizers, insecticides and herbicides. Tomato's growing period is about 3 months and then it will be ready to harvest. When the time of harvesting have come, sponsors will set up the purchasing spot in each of the growing area to buy product from farmers. The growing areas of tomatoes are illustrated in Figure 1.1.

Figure 1.1 Growing areas of Tomato in The North East of Thailand

However, in the beginning of the supporting service in the past, growing tomatoes with farmers had no contract involved because there was only one factory in tomato processing industry in Thailand. Next, the demands of tomato processing products in the markets increased which lead to the higher growth in tomato processing industry. More processing firms had been established and the problem occurred due to the total production capacity for all processing firms. The agricultural products were not enough to support that high production capacity.

The lack of raw materials and the high competitive conditions had given rise to the snatches of raw materials purchasing and higher cost in raw material. Therefore, contract farming has begun as an agreement between farmers and processing firms for the production and supply of agricultural products. The agreement frequently defines the farming areas, the quantity of agricultural products supply to the firm, and predetermined prices. Prices may vary according to the market prices in each harvesting period.

The result from doing contract farming gives sponsors advantages in organizing a reliable supply of products of the desired quality. The problem of raw material lacking has reduced. However, the firms still face the difficulty in forecasting the quantity of raw materials in each harvesting period. The production schedule could not be obvious and the delivery of finish goods cannot be planed properly. The management system in planting plan, monitoring the results and harvesting plan still need an improvement to be more efficient in order to be able to plan the procedure schedule for every division.

1.2 Company Background

The company, ABC Industry Co. Ltd., was established in 1978. The factory is located in the North-East of Thailand, which is the first tomato factory in the uppermost area in Thailand. At the beginning, tomato-processing products (tomato paste and tomato canning) were produced to supply food industries such as sardine in tomato sauce manufacturer and tomato ketchup manufacturer. After that, the company had tried to gain more profit by producing chili product, which are Pickle Chili and Chili Puree.

Since the most important factor of the business is raw materials, the company must have enough raw materials for production to support the capacity each year. Thus, the Contract Farming systems were developed to reach higher quality in raw materials by educating farmers' knowledge and planting supplement. At present, 4,000 families or 20,000 people are in the contract farming within the responsibility of company.

Within the year 2001, SAI is the first tomato and chili product facility that certified by standard quality systems: HACCP, GMP, HALAL. SAI has been keeping the satisfaction of both domestic and international customers.

1.2.1 Vision

"The biggest tomato and chili manufacturer in South East Asia with the international standard and the leader market both in Thailand and international."

1.2.2 Mission

1. To be fully tomato planting supplement to reach the good quality product and enable support the capacity each year
2. To develop product and service continuously to reach the customer satisfaction
3. To have the international standard quality system to compete with the liberal trade world
4. To be a part of the country to supply foods to the foreign countries
5. To increase the value added of the raw material in the country and gain more income from the foreign countries
6. To help farmers to get the stable income

1.3 Statement of Problem

For many years, the processing products were not enough to meet the customers orders which lead to unreliable, lower demand, and profit loss. The production department could not arrange the production schedule and also the marketing section could not plan the delivery of finish goods to customers. The root of the problems caused from raw material lacking. The lack of raw material occurred due to many factors.

- Corruption of Staffs
- Farmers sell outside the contract (extra-contractual marketing)
- Ineffective planting plan
- Inaccuracy of agricultural product analysis
- Price competitiveness in purchasing raw material

Most of problems are internal factors. The management of farming department is not well enough to control and coped with the come up situation. The procedure to check up and follow the result in planting and harvesting were quite not in a proper way. There were no actual data used to analyze the quantity of products. For external factor, the price competitiveness is related to the weather condition, quantity of product per rai in each year, fresh tomatoes market and etc. The problem within the company should be solved first to create more strength to the company and has more potential to cope with external problem.

1.4 Objective

The objective is to develop a system of plantation planning and scheduling in tomatoes planting for processing factory.

1.5 Scope of the Research

The research focus on raw material management system for tomato processing industry. The demand of tomato processing product is assumed as known. The raw material management system is the system of a logical approach to the problem of planning in tomato planting and supporting procedure. It is also the schedule specifying when each of these stages should be developed and monitored.

1.5.1 Stages for Growing Tomatoes

1. Production of Seedling

2. Land Preparation, Fertilizer usage I

3. Transplanting, Fertilizer usage II

4. Weed control, Fertilizer usage III

5. Fertilizer usage IV


6. Harvesting


1.5.2 Tomato Planting and Supporting Procedure

1. Survey the planting area

Survey the old planting area that farmers still want to plant tomatoes and survey for the new area that could be possible to plant tomatoes.

2. Farmers meeting

Call farmers for meeting and the meeting will be about how to make more profit from tomato planting provide some basic knowledge

3. Select farmers to sign the contract farming

Farmers who are interested in tomato planting will sign the contract.

4. Training

New farmers will be trained how to plant tomato from the soil preparation until the harvesting in the planting area. For both new and old farmers will be given advices when the problem occurs.

5. ***Supply Chemicals, seeds and fertilizers***

   Seeds, fertilizers, insecticides and herbicides will be supplied to farmers as needed.

6. ***Monitor planting area***

   Monitor tomato growing in each planting period in order to get the most productive products. By the time it sets fruit, staffs will forecast the quantity and time to harvest.

7. ***Harvesting***

   Farmers will harvest their products and put them into the plastic box which provided by sponsors. Tomatoes for fresh market will be harvested while fruit is green-orange with stem. Tomatoes for processing are harvested while fruit is red without stem.

8. ***Purchase products from farmers***

   Staffs will set up a purchasing spot in each planting area. Farmers will bring their products to the purchasing spot to sell the product.

9. ***Deliver products to the factory***

   Workers will put plastic basket which full of tomatoes into the trucks. Then, they will be ready to deliver to the factory.

This research will develop planning, monitoring and controlling system for each stage by adopting MRP concept.

1.6 Expected Results

Obtain the planning, monitoring and controlling system in each period of tomato planting

1.7 Research Procedure

1. Study all related information about the tomato planting
2. Collecting data for the area will be planted
3. Create and apply the plan and schedule in planting
4. Monitor loss in planting and solve the problems in planting
5. Study the problems occurred during planting and harvesting
6. Analyze and summarize the results
7. Thesis preparation

Table 1.1 Research Schedule

Activities	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1 Study all related information									
2 Collecting data about growing tomatoes									
3 Create and apply the plan and schedule									
4 Monitor loss and solve problems									
5 Study the problems									
6 Analyze and summarize the results									
7 Thesis preparation									

CHAPTER II

THEORY AND LITERATURE SURVEYS

This chapter describes the theories and literatures applied for completion of the thesis. Theories and literatures regards cultural practices of tomatoes and Material Requirements Planning (MRP). How MRP can assist in managing production schedules and ordering items so that tomatoes will be available in a cost-effective, timely manner. The concept of the tool (MRP) will be applied for planting support in term of planning, scheduling.

2.1 Cultural Practice of Tomatoes

The cultural practice of tomatoes was explanined by Asian Vegetable Research and Development Center. Tomato is one of the most widely grown vegetables in the world. The popularity of tomato among consumers has made it an important source of vitamins A and C in diets.

2.1.1 Varieties

Tomato varieties are normally grouped into one of three market classes.

Figure 2.1 Processing tomatoes

- ***Fresh market****:* fruit are usually red but vary in color, shape, and size
- ***Cherry****:* a small-fruited (less than 30 g) fresh market type borne on long clusters
- ***Processing****:* fruit have intense red color and high solids content suitable for making paste, catsup, or sauce.

In Thailand, Processing tomatoes are also use for fresh market

Plant habit: Tomato varieties are also classified according to plant habit: determinate, semi-determinate, or indeterminate. Determinate and semi-determinate varieties produce stems that end with a flower cluster. Determinates are short and bushy while semi-determinate varieties grow slightly taller. Determinate and semi-determinate varieties are widely grown in Thailand.

Indeterminate varieties continually produce new leaves and flowers, and can grow very tall. Indeterminate varieties set fruit over a longer period. This longer harvest period is an advantage if market prices fluctuate, because income tends to even out. Indeterminate varieties should be staked and pruned and usually require more labor.

Hybrid or Inbred: Hybrid varieties are gaining popularity because they often produce higher yields and more uniform fruit compared to inbred lines. However, a hybrid is not always superior to an inbred variety. Hybrid seed is usually more expensive than inbred varieties, and seed cannot be harvested for future planting. Seeds of inbred can be harvested and saved for future planting.

All tomato varieties grow in Thailand are hybrid. They could tolerate more to hot weather condition and disease.

2.1.2 Climate and Soil Requirements

Tomatoes grow best in temperatures 20–27°C. Fruit setting is poor when average temperatures exceed 30°C or fall below 10°C. Tomatoes prefer well- drained soil because they are sensitive to water- logging. Optimum soil pH is 6.0–7.0.

2.1.3 Seedling Production

Seedling tray method: Fill the holes with a medium that drains well, such as peat moss, commercial potting soil, or a mixture of sand, compost, and burnt rice hulls. Place the trays in a sheltered place. Sow 1-2 seeds per hole and thin the seedlings 2–3 days after the first true (noncotyledon) leaves appear. (*1 tray has 72 holes, 45 trays use for 1 rai, 3,240 plants/rai)*

Seedbed method: Choose a well-drained area not recently cropped with a solanaceous crop. Burning a 3–4 cm layer of rice straw on the seedbed before sowing, and forming a raised seedbed of 15 cm or higher to improve drainage, can reduce soilborne disease problems.

Sow the seeds in rows 6 cm apart at a rate of 750–900 seeds/m2. Cover the bed surface with a thin layer of compost or rice straw mulch. Do not allow the soil to dry and form a crust on the surface that might hinder seedling emergence. Water the seedbed regularly so that it is moist but not waterlogged. Thin the seedlings 2–3 days after the first true (non-cotyledon) leaves appear.

2.1.4 Transplanting

Harden the seedlings by slightly reducing water and exposing them directly to sunlight 6-9 days before transplanting. Thoroughly water the seedlings about 12 hours before transplanting to the field. A good seedling is in the four or five-leaf stage (about 4 weeks old), vigorous and stocky.

Figure 2.2 Healthy Seedling

Transplant in the late afternoon or on a cloudy day to minimize transplant shock. Insert the seedling in a hole so the cotyledons are above the surface. Tall, thin (spindly) seedlings should be buried deeper. Press soil firmly around the root, and water around the base of the plant to settle the soil. Irrigate the field as soon as possible after transplanting.

2.1.5 Field Preparation

Shaping the land into beds and growing tomatoes on top of the bed facilitates furrow irrigation of the crop and drainage after heavy rain. Beds can be prepared in many ways. At AVRDC, beds are made with a mechanical bed shaper and are about 1 m wide with furrows (ditches) 50 cm wide. Bed height varies with the season: 20 cm in the dry season and 35 cm in the wet season.

A mulch of rice straw, thin polyethylene plastic sheets, or other material is used to cover the soil surface. Mulches reduce fertilizer leaching, conserve moisture, and reduce weeds. If average air temperatures exceed 28°C, plastic mulch should be covered with rice straw to prevent it from getting too hot.

2.1.6 Water Management

Insufficient water at any growth stage will reduce yield and fruit quality. Tomato is most sensitive to water deficit during flowering, somewhat sensitive immediately after transplanting and during fruit development, and least sensitive during vegetative growth. Because indeterminate varieties flower and form fruit continuously, they are always sensitive to water deficits.

Tomato grows well in moist but not soggy soil, and well-timed furrow or drip irrigation is effective. Wilting in the late morning indicates that the crop should be irrigated.

As a general rule in the dry season, irrigate weekly for the first month after transplanting, and then every 10 days until crop completion. The root zone of young transplants is shallow so irrigation should be frequent and just enough to recharge the root zone. As the crop develops, the root zone enlarges and less frequent but heavier irrigation is required. Tomato plants are sensitive to waterlogging and flooded fields should be drained within 1-3 days.

2.1.7 Staking

Staking or trellising tomato plants with bamboo poles, wood stakes, or other sturdy material provides support and keeps the fruit and foliage off the ground. Staking can increase fruit yield and size, reduce fruit rot, and make spraying and harvesting easier.

Indeterminate varieties should be staked to facilitate pruning, pinching, harvesting, and other cultural practices. Determinate varieties should be staked in the wet season to prevent fruit contact with the soil.

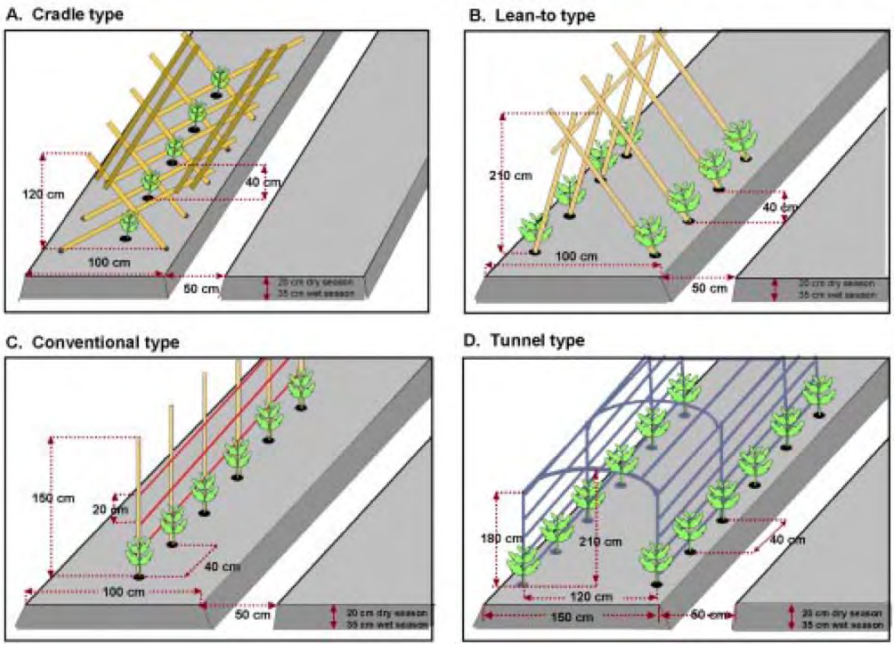


Figure 2.3 Tomato trellising arrangements

Many staking arrangements are possible (Figure 2.3). Plants should be fixed securely to the stake or string supports, beginning about two weeks after transplanting. Rice straw, plastic strips, horticultural fixing tape, or other material can be used for fixing. Fixing should be done so fruit clusters are supported.

2.1.8 Harvest

Tomato can be harvested at different stages, depending upon the time needed to market the fruit. For long distance transport or fresh market, fruit can be harvested at the breaker stage (not more than 10% of the surface is tannish-yellow, pink, or red). Fruit for local sale or processing can be harvested at later ripening stages.

Poor care of fruit after harvest will lead to poor fruit quality. Avoid fruit injury and do not mix damaged and undamaged fruit. Harvest during cool periods, such as late afternoon or early morning. Shade the harvested fruit and avoid exposing fruit to temperatures above 25°C. If possible, store the fruit in a ventilated place with a relative humidity of 85–90% to slow water loss.

2.2 Material Requirement Planning

2.2.1 Overview

The concept of MRP was developed and refined by Joseph Orlicky, at IBM, and Oliver Wight, a consultant, in the 1960s and 1970s. It is a mathematical planning tool, driven by the master production schedule, for determining the needs of dependent component such as raw materials, parts, subassemblies, or modules principally in manufacturing but also a warehousing/distribution environment. Knowing the current inventory level and the bill of materials that go into particular product, then specifically the MRP indicates:

- The types of material, and the quantity that has to be purchased from outside, taking into account current inventory levels.
- The types of material that need to be manufactured internally, and in what quantity, taking into account current inventory levels.
- As what time to place these orders, either by purchasing outside, or manufacturing inside, taking into account the lead times for materials.

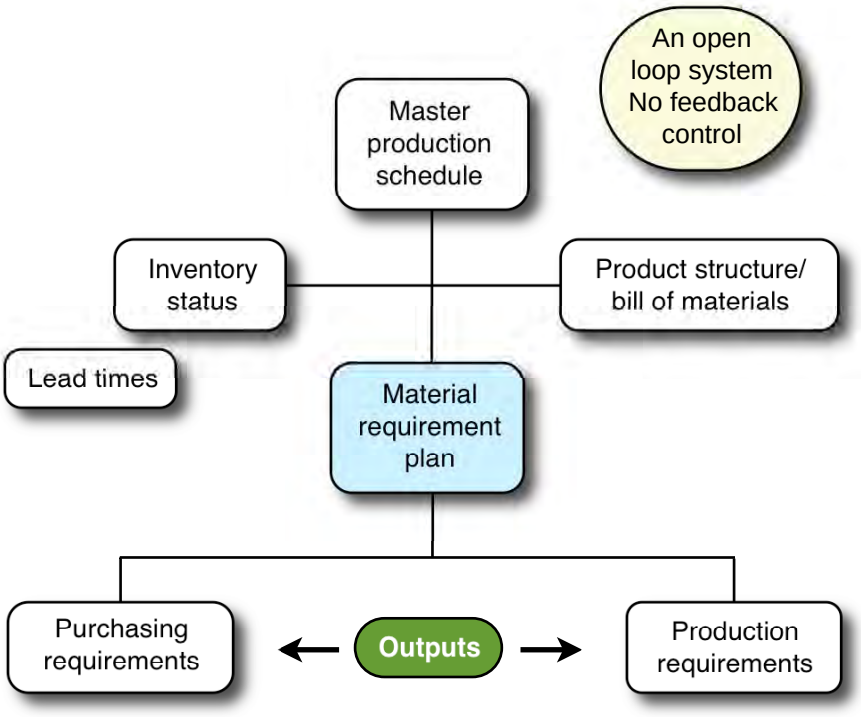


Figure 2.4 Needs and outputs of a material requirements plan [1]

The MRP, as a planning tool, provides precise control to operations personnel regarding the amounts and timing of deliveries if materials necessary to produce end items indicated by the master production schedule. This control helps to avoid inventory stockouts, minimize excessive levels of inventory, and to optimize the utilization of labour and machines.

2.2.2 MRP Inputs

Master Production Schedule (MPS)

The master production schedule indicates the quantity of finish goods and the time period that they are needed. The MPS is derived from the aggregate production plan based on demand forecasts, customer orders, and capacity limitation. This information then provides a basis for establishing component needs for the end product thus making the MPS the driving wheel for the MRP.

Bill of Materials (BOM)

Bill of materials, or product structure, is a listing for each end product all assemblies, sub-assemblies, components, all materials, and quantities required to produce the product, or end items.

Inventory Record File

The inventory record file is a complete record of the quantity of each material held in inventory. A detailed file would know transactions receipts, disbursements, scrapped materials, planned orders, order releases, projections of delivery dates, quantities of each materials to order, and when to place orders. Also within the inventory file would be the lead times, or the time required to produce a production lot in-house, or to receive a lot purchased from a supplier. To take into account the lead time, a requirement in one time period will necessitate the release of the order in some earlier period according to established delay or lead time.

2.2.3 MRP Logic and Mechanics

MRP logic is to use the product structure and lead time information to determine the time to purchase and press order for production so that materials are obtained when they are needed.

Exploding the Product

Explode the product into a production time chart, begins with the time the end product is needed and the works through each production or purchasing activity that must be done to make each succeeding item.

Developing the Material Requirements Plan

A material requirement Plan is a production or purchase schedule for an item that makes up the end product. The procedure begins by converting the gross product requirement in the MPS into net product requirements. The *gross requirements* are the number of units actually required at the beginning of each time period. The *net requirement* are the gross requirement less any available inventories, where that available inventories are total inventories for the item at the beginning of the period less any desired safety stock (in MRP, available inventories are normally labeled as projected on hand):

$$(\text{net requirements})_t = (\text{gross requirements})_t - (\text{projected on hand})_t$$
$$(\text{projected on hand})_t = (\text{total expected inventory})_t - (\text{safety stock})_t$$

Gross product requirement are transferred from MPS to material requirements plan for the end product, and the net requirements are computed. The next line in material requirements plan is the amount of product or material planned to be received through production or from a vendor at the beginning of the time period, which is called the *planned order receipts*. Under **lot-for-lot ordering (production)**, items are ordered and produced when needed in a time period so that the planned order receipts will equal the net requirements.

The final line in the material requirements plan for an item is the *planned order releases.* This is the amount that must be ordered (internally through production or externally from a vendor) at the beginning of the time period so that the planned order receipts occur when needed. Therefore, the planned order releases equal the planned order receipts, except that they are offset by the lead time.

Consolidating Requirements

Many items may be common to several end products. Rather than ordering or producing an item separately for each end product in which it is used, the material requirements plans for the item for all the end product in which it occurs should be merged into one master material requirements plan. This way a more coherent and efficient production or procurement plan can be devised.

2.2.4 MRP Outputs

When the data from the master production schedule, the inventory record file, are fed into the MRP programme, then for the given product structure, the MRP will generate the output requirements. These would include outside purchasing needs and production requirements for those material produced internally. They are generated as the following reports and documents:

- ***Order and production release schedules***, which specify the amount and timing of future orders and production runs for each item.

- ***Order release***, which authorize the purchase or production of items.
- ***Change reports***, which highlight changes to the previous production and purchase plans.
- ***Load reports***, which indicate the amount of each major production resource or department capacity that is to be utilized with plan.

The input/output relationship is shown in Figure 2.1. The information produced by MRP system can be combined with other company data to produce various financial, production, and delivery performance reports, as well as exception reporsts that highlight deviations from plans.

2.3 Literature Review

Stanley Crosby (2003) detailed the development process for and MRP system within a SME electronics company by using tools that are available to most SMEs. The stages to develop the system are found as planning, data collection and analysis, drafting of the overall system design specification, system design, programming and testing. The MRP system helped SMEs to solve problems in production planning. Thus, materials and products would be available for production and delivery to customers.

Khompee Limpadapun (2005) developed the production information system to improve the efficiency in production planning and control for a screen printing machine plant. The databases were created to collect data by using Microsoft Access. The program to support the decision making in production planning was created to calculate lead-time in production, forecast the trend of sales, examine the material requirements, issue the production orders, make the production formula, issue reports for the production department and monitor the status of production by using Visual Basic software. This production information system had advantage in reducing the production planning time. Plus, the production plan could be more efficient with the accurate data. Subsequently, the delivery of the finish goods could be planned and deliver on time.

Sittipoom Phrompoo (2001) explored a management information system for production planning, scheduling and control. A Data Flow Diagrams (DFDs) is created as a tool for developing a database system using Microsoft Access as Khompee Limpadapun’s work. The modules include order entry, production planning, capacity requirement planning, and inventory control. The result from applying the information system shows that working time for report preparation, the number of operator, the amount of storage papers are reduced; the production capacity is increased; the delivery delay has improved; and the inventory level is reduced.

Kanokporn Sripathomswat (2000) had proposed a decision supporting system for production planning and scheduling in a kraft paper industry. The decision supporting system is developed on a personal computer with Microsoft Visual Basic 6.0 and Microsoft Access 97. The system is used to schedule production grouping by paper grade which aimed to minimum loss. The result shows that the decision supporting system can reduce the total production cost which comes from planning. In addition, it increases the reliability of the information in the decision making; and also reduces planning time and facilitates to change a plan promptly.

Udomrat Laichuthai (2002) developed the production scheduling system for a packaging printing factory. This factory had faced problems with production planning due to to the unknown actual production capacity, no production planning section and responsible person, and inefficient in raw material management. The production scheduling system were developed to solve these problems by applying the practical production planning and control, production scheduling and computer software (Borland Delphi 5) to set up database. The system is easy to revise for the production plan and thereby the decision making can be prompt and more effective.

Bureau of Agricultural Economics Canberra Australia (1971) presents the results of a Bureau of Agricultural Economics survey of farms producing tomatoes for processing. It also detailed the farming practises of tomatoes in Australia. The practises decribe the procedure and important information in growing tomatoes which are crop season, varieties, production of seedling, land use, tomato operations, harvesting, marketing and miscellaneous.

Office of Land Management Research and Development had done a research on vegetable planting by reducing the chemical usage. This research also provides details in growing vegetables including tomatoes. The details about growing tomatoes are about varieties, the suitable weather, land use and land preperation, production of seedling, plantation, irrigation, fertilizer usage, weed control, and harvesting.

CHAPTER III

DATA ANALYSIS

This chapter focus on data analysis of controllable factors which are significant variables in making effective plan to acquire targeting amount of product. Varieties of tomatoes, growing areas and crop cycle are important factors. Choosing varieties must be suitable for climate and growing areas. However, the major problem is not about varieties or growing areas. It is more about the plantation planning of farming department of the case study company that is not concise enough and leaving the gap for corruption. The inaccurate in forecasting amount of tomatoes had cause the incorrect in taking orders, normally with too high amounts which lead to the insufficient amounts of processing product to deliver to customer. The work procedure in a crop cycle is studied in detailed to help in creating the new managing plan in the next chapter.

3.1 Factors in growing tomato

3.1.1 Varieties of tomatoes

Varieties chosen for growing are all the suitable varieties for processing and some can also be used for fresh market. The maturity days which is the day after transplanting, are very close for all varieties but still vary to the climate. The statistic from past year, the average of maturity days is about 80 days or 11 weeks. Table 3.1 shows tomato varieties of the case study company

Table 3.1 Tomato varieties of the case study company

Varieties	Maturity Days	Yield (kg/ rai)	Fruit			
			Shape	Firmness	Weight (g)	Use
Siam Ruby	70 - 75	6000	round	fair	75 - 85	P
Pang Dang	75 - 80	7000	oblong	excellence	65 - 75	P
BT-2	70 - 75	7000	round	poor	70 - 80	P
Extra-390	80 - 85	6000	oblong	fair	70 - 80	F/P
Delta	80 - 85	6000	oblong	good	75 - 85	F/P
Perfect-89	80 - 85	6000	oblong	fair	65 - 75	F/P
Perfect-58	80 - 85	6000	round	good	75 - 85	P
Red Gem	80 - 85	6000	oblong	good	75 - 85	F/P

P: Processing, F: Fresh Market

The shape, firmness and weight are almost the same in all varieties. Therefore, when calculating the number of plastic basket used for circulation per day, the average weight per a plastic basket is 28 kilograms.

Production yield is about 6,000 - 7,000 kilograms per rai and vary to the growing area. In Maekong riverside field, it is the most suitable area in growing tomato. The yield could reach the highest with 12,000 kilograms per rai. The production yield of each areas will be discussed more in the next section.

3.1.2 Growing areas

There should be 100,000 rais of tomatoes growable areas in the upper Noretheastern of Thailand (Nongkhai, Sakonnakorn, Udonthani, Nakornpanom, and Kalasin). However, only 30,000 rais or about 30 percent are planted for tomatoes, and the rest are either idle or used for some others especially tobacco, and chilli.

At the present, there are 4 factories in the upper Northeastern of Thailand. The factory here had snatched in purchasing tomatoes with the limited amount from time to time. Besides the snatch of each factory, there are also snatching of traders for fresh market who goes not support in growing tomato.

Table 3.2 Yield (Kg/Rai) and Percentage of Fresh market in Each zone

Planting Areas	Start Period	Product (Kg/Rai)		% to Fresh market
		Yield	Contract**	
Nearby zone				
Riverside field	Oct - Nov	10,000 -12,000	5,000	40 - 60%
Rice field	Nov - Dec	5,000 - 8,000	5,000	10 - 30%
Sakonnakorn zone				
Rice field	Nov - Dec	5,000 - 8,000	5,000	10 - 30%
Maekong side zone				
Riverside field	Oct - Nov	8,000 - 10,000	5,000	30 - 50%
Rice field	Nov - Dec	5,000 - 8,000	5,000	10 - 30%
Konkean zone				
Rice field	Dec	5,000 - 7,000	5,000	0%

** contract farming made with farmers to delivers product for processing

In general, growing areas can be easily divided into two kind of field, riverside field and rice field. The riverside field normally start growing tomatoes early in late September until November. The rice field can start to grow tomatoes in November until December after the rice had been harvested.

Tomatoes grown in October until November can be harvested in late December until late January which is in the celebration period for Christmas, New Year, Chinese New Year. The demand of tomatoes in this period of time is very high for both fresh market and processing. There are snatches of product purchasing and high competitiveness in price. The case study company has to make sure that the quantity of fruits obtained will not be to much different from plan. Therefore, the quantity of fruits that sign in the contract with farmers is 5,000 kilograms per rais. The early product mostly go to fresh market for about 30 to 60 percent and the rest will be use for processing. Vice versa, the rest of crop season, most product will be use for processing. Only about 10 to 30 percent of all product will go to fresh market.

Growning areas in the upper Northeastern of Thailand supported by the case study company are divided into four zones. The areas are divided in order to be easily to sustain farmers in growing tomatoes. The zone ratio of each growing zone to the total areas is shown in Figure 3.1. Figure 3.2 shows the map of tomato planting areas supported by the case study company. For quota, there is no specified zone. Quota's are also growing tomatoes in these four zone.

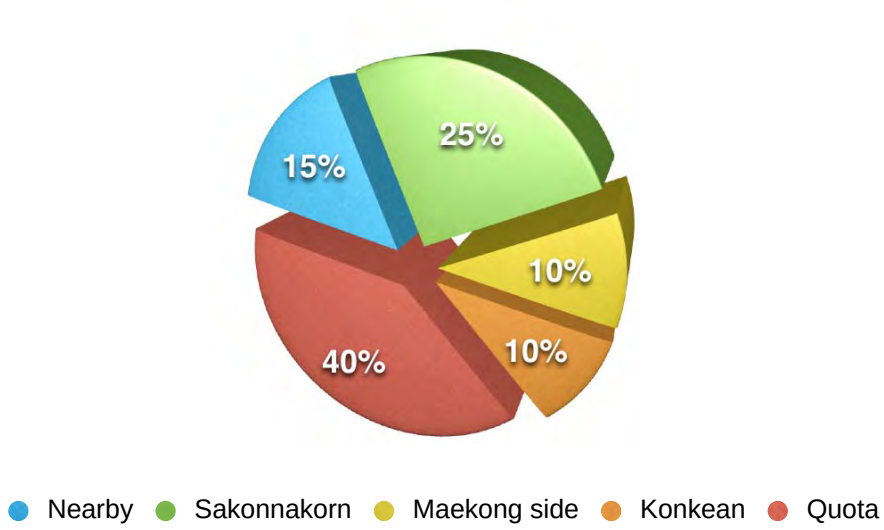


Figure 3.1 Zone ratio of each growing area to the total areas

Nearby zone

This zone covers the some part of Nong-Khai and Udon-Thani Province. Production yield in riverside filed of this zone is the highest one with the production of 10,000 to 12,000 kilograms per rai. It is also the highest competitive in price. 40 to 60 percent of product go to fresh market. Yield of the rice field in this zone is about 5,000 to 8,000 kilograms per rai. 70 to 90 percent of product go to processing firm.

Sakonnakorn zone

Sakonnakorn zone covers some part of Sakon-Nakorn privince. There is no riverside field in this zone. Production yield of rice field in this zone is the same as nearby zone about 5,000 to 8,000 kilograms per rai. Percentage of product go to processing firm is about 70 to 90 percent.

Maekong side zone

Maekong side zone covers some part of Sakon-Nakorn city and Nakorn-Panom province. The production yield in the riverside field is not as high as Nearby zone. The product quantity per rai is about 8,000 to 10,000 kilograms. However, There is still high competitive in price. 30 to 50 percent of product go to fresh market. For the rice field, production yield and percentage to get product are the same as nearby zone and maekong side zone.

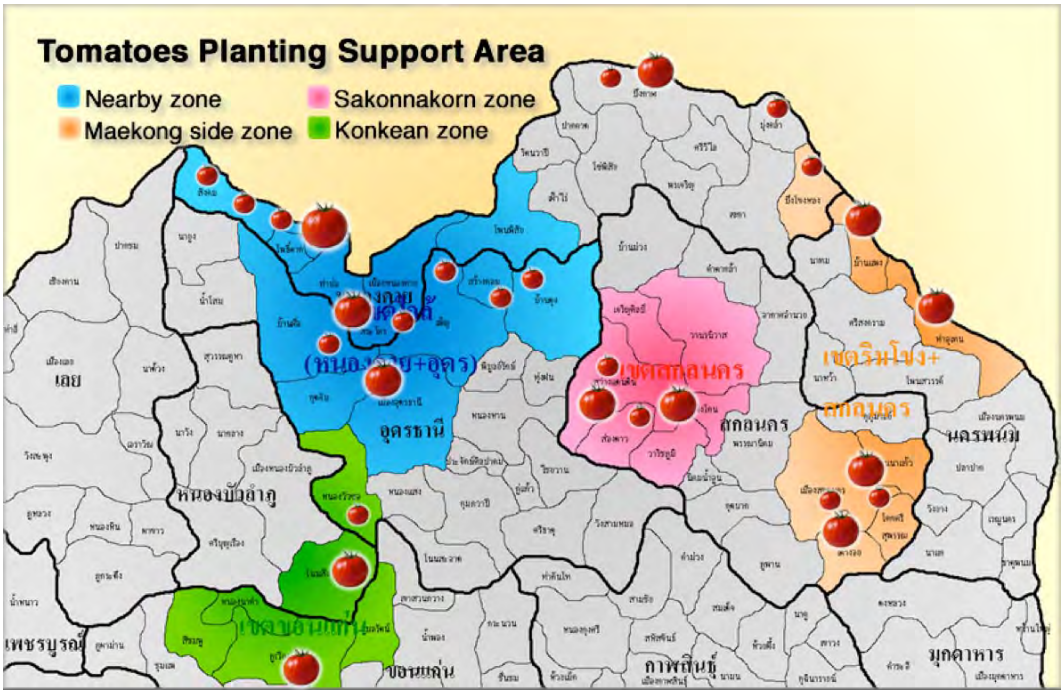


Figure 3.2 Map of Tomatoes Planting Support Zones

Konkean zone

This zone cover some part of Konkean province. Some farmers still new in growing tomatoes. Production yield of the rice field in this zone is about 5,000 to 7,000 kilograms per rai. There is no snatches of product purchasing in this zone at all. 100 percent of product is for processing.

3.1.3 Crop cycle

Tomato production of the case study company start with seedling production in house by using seedling tray method as shown in Figure 3.3. One tray can produce 200 seedling. Seedling production usually take 25-30 days (about 4 weeks) to be ready to deliver to farmers for transplanting to the field.

Figure 3.3 Seedling tray method

The interval between transplanting and harvesting varies according to the season and variety. Crop production in Thailand grow during winter months take an average of 10 to 11 weeks to reach the mature fruit stage. The first transplanting usually start at the end of September and the latest transplanting start at the end of December. Table 3.3 shows time period of seedling production, transplanting and harvesting in a crop cycle.

Table 3.3 Time period of seedling production, transplanting and harvesting

Procedure	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Seedling production								
Transplanting								
Harvesting								

Tomatoes that is grown in September can be harvested in the late December. Harvesting period begins in December and will be finished in April. The fruit can be harvested for about 4 times in four weeks period. The first to forth time harvested can be determined into percentage of a total production as shown in table 3.4. The first week can harvest 15 percent of a total production. The second to the forth week are 30 percent, 40 percent and 15 percent respectively.

Table 3.4 Harvesting ratio from the first to the forth week

Week in harvesting	Harvesting ratio
1st week	*0.15*
2nd week	*0.30*
3rd week	*0.40*
4th week	*0.15*

The studied of the important factors in achieving production target in this chapter is significant to design the managing program for planning system in growing tomatoes. All factors will be applied in the program by adopting MRP concept in the next chapter to obtain the most effective plan.

3.2 A Study of Work Procedure

The work procedure normally start by specifying fruit requirement for current planning year which forecasting from the areas of growing tomatoes previous year. The main problem is how to achieve the certain amount of product by forecasting from growing area. This section is the study of the work procedure of farming department to be able to adjust for more effective work. Working procedure is usually broken into 7 stages for a crop production illustrate in Figure 3.4. Time line of working procedure of the case study company is shown in Table 3.5.

3.2.1 Survey the planting area

Around July of every year, Farming Department staffs go out to survey for growing area. The survey for growing areas is to estimate the areas for the coming year crop. Staff first look at the previous year growing area to see the farmers who still wants to grow tomatoes and then look for the new area that could be possible to grow tomatoes and report back to the department.

From the four growing zones, there are only one or two staffs to monitor and control in each zone. At the beginning, they only know how many areas they need to find for the planning year. There was no plan to tell them, in which week how many areas they have to find in their working zone. The unclear target had lead to the ineffective work and inaccurate results in estimating products.

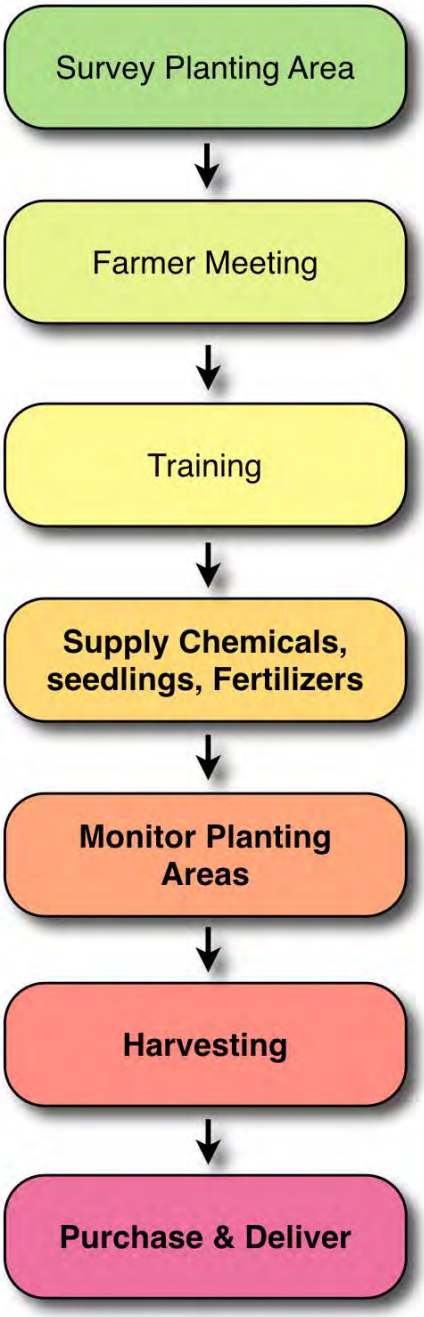


Figure 3.4 Working Procedure of the department

3.2.2 Farmers meeting

In August, There will be Farmers meeting. This meeting is to give the prize the great farmers in the past year. The new farmers are invited to learn basic knowledge in growing tomatoes and how to make more profit in growing tomatoes. Farmers who are interested in growing tomatoes will get to sign the contract.

The meeting is normally done in the growing areas in order to get use to with farmers. The contract farming made with farmers deal with the quantity and quality of product, number of areas, start planting and delivery date.

3.2.3 Training

Staff is out to the new growing areas to train the farmers on how to grow tomatoes from the soil preparation to the harvesting. For both new and old farmers will be given advices when the problem occurs. Pests and plant diseases has to be treated in the different way depend on the type of the pest and disease.

3.2.4 Supply chemicals, seeds and fertilizers

Seeds, fertilizers, insecticides and herbicides will be supplied to farmers as needed. Some farmers have grown tomatoes for along time from generation to generation. They do not need seedlings produced from the factory. They will do the seedling production themselves to save cost in growing tomato.

3.2.5 Monitor planting area

Monitor tomato growing in each growing period in order to get the most productive products. Moreover, when the farmers needed help to cope with the disease problem, staff could help them in time to avoid to the loss in production. By the time the fruit come close to the maturing stage, staffs in each zone will forecast the quantity and time to harvest.

Table 3.5 Work Procedure Timeline

Activity	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1. Survey										
2. Meeting										
3. Training										
4. Supply needs										
5. Monitor										
6. Harvest										
7. Delivery										

3.2.6 Harvesting

Farmers will harvest their products and put them into the plastic basket which provided by sponsors with the average weight of 28 kilograms. Tomatoes for fresh

market will be harvested while fruit is green-orange with stem. Tomatoes for processing are harvested while fruit is red without stem.

3.2.7 Purchase and deliver products

Staffs set up a purchasing spot in their growing zone. Farmers bring plastic baskets full with harvested fruit to the purchasing spot to sell their product. Workers will then weigh the product on the scale to make sure that fruits in the basket is in the acceptable weight. After that plastic basket will be delivered to the factory on the truck. One truck can carry tomatoes about 8,000 kilograms.

3.3 Team Set up

This research involves with the whole planning process to support tomato planting of farming department. Therefore the team work is necessary. There are six participants including author (experiment conductor), four staffs of growing area and two monitors. Figure 3.5 illustrates Organization chart of Farming department which focussing on farming support section.

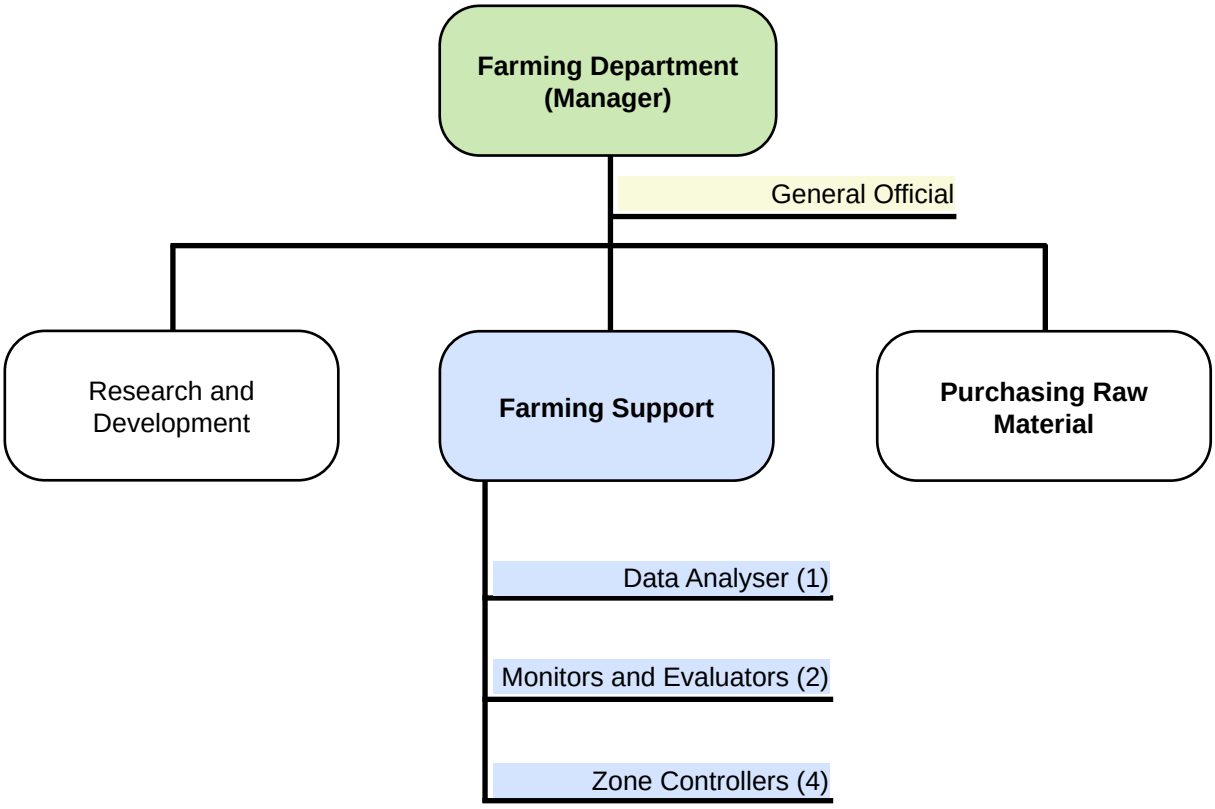


Figure 3.5 Organization Chart of Farming Department

3.3.1 Roles of Farming Department

Farming department is divided into 3 sections which are Research and Development section, Farming Support section, and Purchasing Ramaterial section.

Research and Development section

This section is to studies, conducts research and development on farming support system as well as on technical knowhow to increase production yield and fruit healthy.

- Test varieties for the suitability in growing
- Develop the growing procedure to provide knowledge to farmers
- Field experiment in growing other crops
- Give advices to farming support staffs
- Test the new field in growing for the suitability in farming support
- Seedling production

Farming Support section

The role of this section is to support tomato planting to be able to obtain fruits as planned

- Survey for the suitable areas in growing tomato
- Choosing farmers for tomato growing and make contract.
- Provide knowledge in growing tomato to farmers and evaluate the situation in planting
- Purchasing fruits from farmers to deliver to the factory

Purchasing Raw Material section

This section is the logistic management to supply components in delivering fruits from the growing areas to the factory.

- Cooridinate with farming support to plan for utilisation of truck and plastic basket
- Contact with transporting company

3.3.2 Individuals Roles of Farming Support Section

Zone Controllers

The staffs who in charge of each growing zone, Their role is to survey the plantable area and choosing farmers to make contract. They also have to provide knowledge in growing tomato to farmers and evaluate the situation in each planting stage. Normally, the official report will be sent to that factory when the contract is made and again before it gets to the harvesting period.

For this research, the official report must be sent the factory for one more stage that is the planting time of each area.

Monitors

Monitors or evaluators have set up for this research to check up on the report of the zone controllers. They have to monitor and evaluate each growing area for 2 stages of planting; transplanted and pre-harvesting. The information of timing in transplanted and percentage in acquiring product will be reported to the factory.

Data Analyser

Data analyser is also set up especially for the research. The data collected from zone controllers and monitors is analysed to see the discrepancy in timing, number of areas, and quantity of fruits in acquiring product. This will be summarised and reported to the manager of the department. If there are inadequate number of planting areas or amount of fruits, the plan to take more action is also reported to the manager to be approved.

CHAPTER IV

SYSTEM DESIGN BY APPLYING MRP CONEPT

The problem in lacking of raw material for processing in the past years has led to losses in production. The forecasting of fruits for the whole crop season was incorrect due to the ineffective planning system, follow up the work procedure, and forecasting the amount of product. This chapter, MRP concept will be applied to obtain to most effective plan and to be able to forecast the amount of product more accurate. At the end, the acquiring of product will be recorded to compare with the plan.

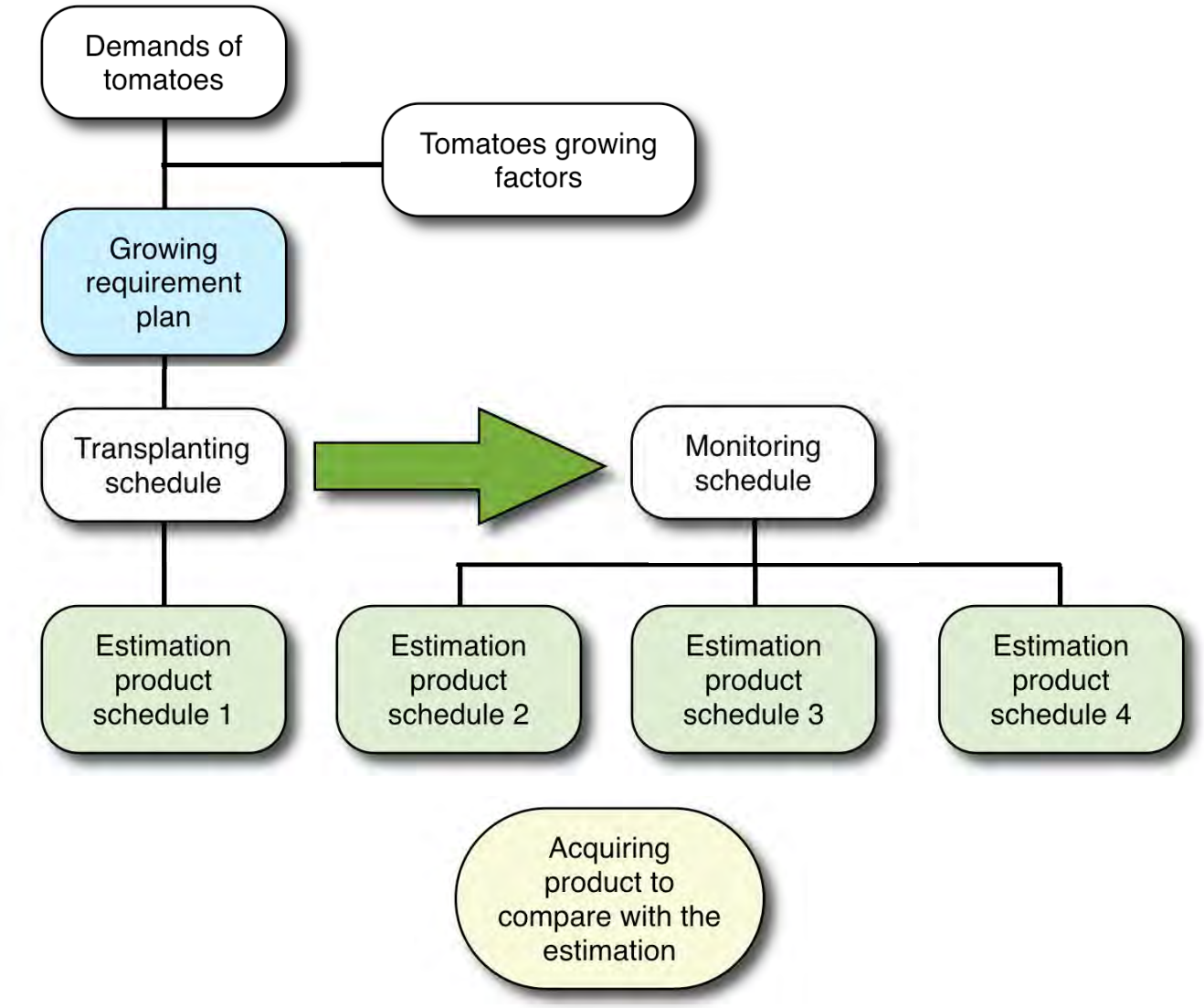


Figure 4.1 Needs and outputs of growing requirements plan

By applying MRP concept, therefore, it will be called Growing requirement plan in this thesis. The growing requirement plan is a mathematical tools, driven by demand of fruits, for determining the needs of dependents component such as area for planting, number of growing areas in order to be able to estimate the amount of products. In Figure 4.1 show needs and outputs of growing requirement plan

4.1 Inputs

4.1.1 Demand of tomatoes

The demand of tomatoes is forecasted from the year 2007 customer order and growing area. Base on the year 2007 order, the order is about the same or a little bit higher. Therefore, the demand will be determined from the amount of tomatoes obtained in the year 2007 plus the amount of fruits should be obtained rom the new growing field. However, the demand of tomatoes in this thesis is assumed as known as 33,000 tons per year or about 2,357 tons per week from week 52 to week 13.

4.1.2 Growing factors

Tomato growing factors is the informations in growing tomatoes that need to be concern to develop this growing requirement plan for the case study company. The factors below is described as follow.

- **The contract amount** is the amount of product that sign in the contract with farmers per rai (5 tons). It is used to calculate number of areas from the total amount of product of each zone.
- **Harvesting ratio** is the ratio of harvesting product in 4 weeks. It is used to calculate the amount of product that can be harvested for each week from the the number of areas of each zone in week.
- **Zone ratio** is the ratio of area in the growing zone to the total area. It is used to calculate the total amount of product of each zone from the known total demand of tomatoes
- **Growing ratio** is the ratio of areas in week for different growing zones to the total area of that zone. It is used to calculate the number of areas of growing zone in week from the total areas of each zone.

4.2 Logic and Mechanics

Growing requirement planning logic is to use growing factors and lead time information in a crop cycle to determine the time to transplant and monitoring the growth so that the estimation of products are more accurate and obtained when they are needed.

According to the total demand of the crop in 2008 which assume as known in this thesis, therefore, to develop the growing requirement plan the decision must be made for timing and quantity.

- **Timing** - when to start transplant

For a crop cycle, the transplanting period can be varied due to the weather condition. The time period to start transplanting is normally start from week 39 to week 52 of the year 2007. And it takes about about 11 weeks to reach its harveting stage which normally start from week 50 to week 14. To be able to calculate the transplanting time, the total demand of product will be exploded into a growing time chart with the average amount from week 52 to week 13 because the production will reach its highest amount at 40 percent in third week of harvesting period as mentioned in Table 3.4 of Chapter 3.1.3.

- **Quanity** - the requirement of areas per week for each zone

Table 4.1 Timing for Growing and Harvesting period

Year Calendar	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14
	General Crop Cycle																											
Growing																												
Harvesting																												
	Growing Requirement plan																											
Demand																												

The number of areas per week for each zone is calculated from the requirement of fruits in each week which derive from the total demand of tomatoes. From the growing factors; harvesting ratio and signed amount, the average number of growing areas for each week to meet the requirement of fruits can be determined step by step as below:

1. Demand for each week (tons) can be calculated form the total demand of the year divided by the number of week in harvesting that is 14.

$$\text{Demand of each week} = \frac{\text{Total demand}}{\text{No. of week in Harvesting}}$$

Table 4.2 Demand of each week

Week of Year	wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14
Demand			Demand of each week = Total Demand / 14														

2. Then, number of areas for transplanting in each week are determined from demand of each week divided by contract amount (5 tons per rai) which *t* is the week of the year. The growing period is about 11 weeks so the week for transplanting is the week to harvest minus 11. Therefore,

$$\text{Number of area for each week}_{(t)} = \frac{\text{Demand of each week}_{(t+11)}}{\text{Contract amount}}$$

Table 4.3 Period for transplanting in each week before shift

Week of Year	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 1	wk 2
Area need			Area for each week = Demand of each week / 5													

3. The percentage of fruits production in each week or harvesting ratio will reach its highest amout at 40 percent in third week of harvesting period. Therefore, the week to start transplanting will be shifted for two weeks ahead as shown in Table 4.4.

Table 4.4 Number of areas for transplanting in each week after shift

Week of Year	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 1	wk 2
Area need	Area for each week = Demand of each week / 5															

Due to the percentage to be able to harvest is different from the first week to the forth week thus, the number of fruit obtained in each week can be recalculated. A, B, C and D are number of fruits in each week of each harvesting period

Table 4.5 Calculation of number of fruit obtained in each week

	Harvest ratio	wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14
1st	0.15	A_{50}	A_{51}	A_{52}	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8						
2nd	0.30		B_{51}	B_{52}	B_1	.....												
3rd	0.40			C_{52}	C_1	C_2	.....											
4th	0.15				D_1	D_2	D_3	.....										
Total Fruits		F_{50}	F_{51}	F_{52}	F_1	F_2	F_3	F_4	.....									

$$A_{t+11} = \text{Number of Area}_t \times 0.15 \times \text{contract amount}$$
$$B_{t+12} = \text{Number of Area}_t \times 0.30 \times \text{contract amount}$$
$$C_{t+13} = \text{Number of Area}_t \times 0.40 \times \text{contract amount}$$
$$D_{t+14} = \text{Number of Area}_t \times 0.15 \times \text{contract amount}$$

Thus, total number of fruit obtained in each week is determined as follow which t is the week of the year

$$T_t = A_t + B_t + C_t + D_t$$

From the calculation above, it can be seen that the number of fruits obtained for each week is much the same as demand in the first step.

4. Next, the total number of area for each zone will be calculated from the zone ratio, total demand of fruit and contract amount. So that, the number of growing area for each zone in each week can be calculated in the next step. The zone ratio was mentioned in Chapter 3.1.2, Figure 3.1.

$$\text{No. of areas in zone A} = \text{zone ratio of zone A} \times \frac{\text{Total demand}}{\text{Contract amount}}$$

5. From the area for transplanting in each week in step 3, it is difficult to adjust this number of ares to match with the each zone area because the type of growing field and the cutural practice of growing zone as mention in Chapter 3.1.2. Therefore, the growing ratio will be specified to match with the cultural prctice of growing zone. Table 4.6 shows the example of growing ratio.

Table 4.6 Example of Growing ratio

Areaa		wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 1	wk 2
Nearby	**1**	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*						
Sakonnakorn	**1**								*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.20*	*0.20*	*0.10*	
Maekong side	**1**		*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*					
Konkean	**1**												*0.30*	*0.20*	*0.20*	*0.30*	
Quota	**1**	*0.08*	*0.08*	*0.08*	*0.10*	*0.10*	*0.10*	*0.10*	*0.07*	*0.07*	*0.07*	*0.10*	*0.05*				

After, the growing ration is specified, the number of area for each zone can be calculated. Then, total number of area for each week will be calculated to estimate the amount of fruit as step 3. This estimation is to be able to see that the amount of fruit is not over the production capacity of the factory.

4.3 Outputs

When the demand of tomatoes are fed into the growing requirement planning programme, then for the given growing factors the growing requirement planning will generate the output requirements, that are the transplanting schedule, monitoring schedule and the estimation of product amount.

Next, from the work procedure of farming department of the case study company, it will be divided into 4 phases to monitoring the growth of tomato in order to estimate the amount of product more accurately. In Figure 4.2 shows the procedure of different phases. Timeline for different phases is show in Table 4.7. A team will need to be set up to monitor the growth of tomatoes to check with the staffs who in charge of each zone.

Table 4.7 Timeline for different phases

Week of Year	August				September				October				November				December				January				February				March			
	wk 33	wk 34	wk 35	wk 36	wk 37	wk 38	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12
Phase 1																																
Phase 2 (1st)																																
(2nd)																																
Phase 3																																
Phase 4																																

4.3.1 Phase 1: Planning

The transplanting schedule and the estimation of product amount is obtained from the growing requirement planning. The transplanting schedule will tell staffs who in charge of each zone to find number of areas to be transplanted in each week. The estimation of product is to be able to compare with the actual acquired product at the end and to see the spread of product amount in each week. The product amount would not be too high for production capacity of the factory. If the production amount is too high, the growing ratio will be adjusted to get the suitable amount. The flow idea of phase 1 can be seen in Figure 4.2.

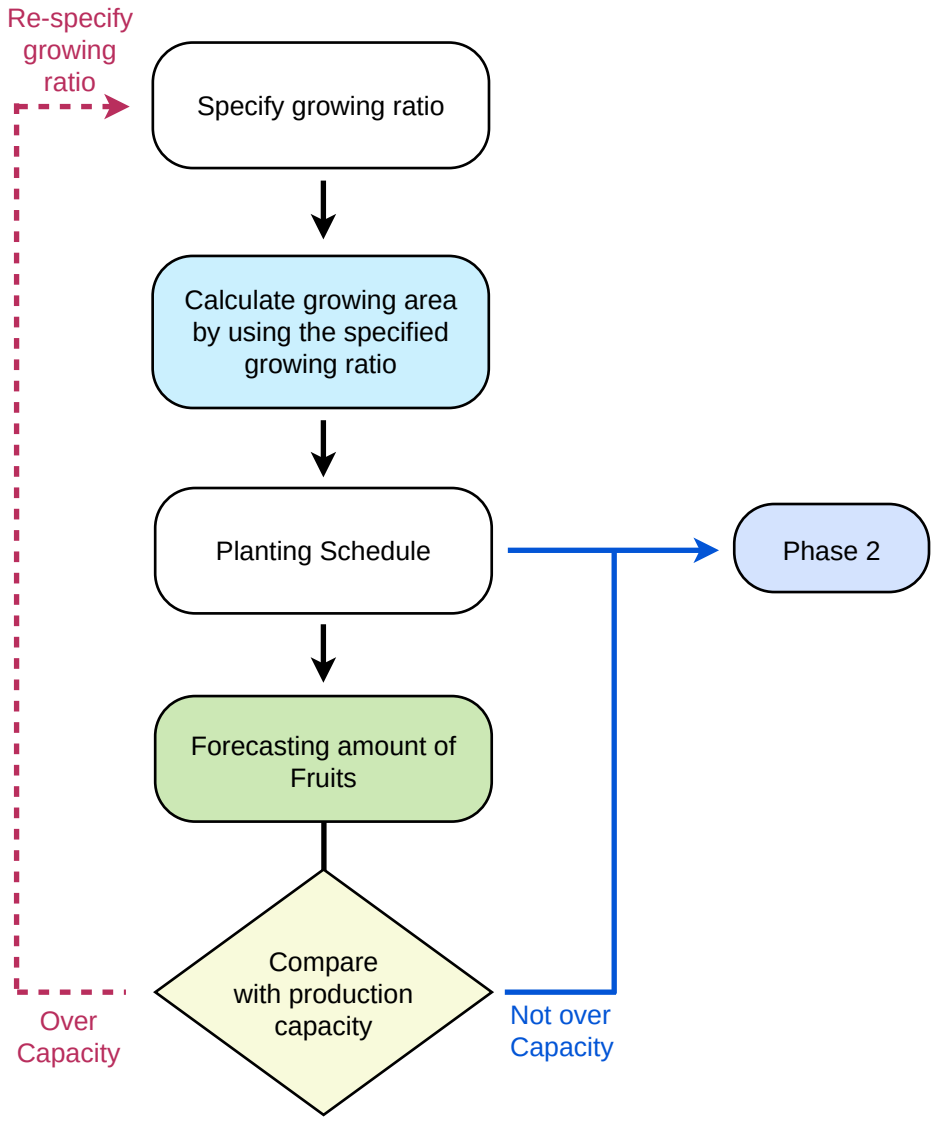


Figure 4.2 Phase 1 Procedure

4.3.2 Phase 2: Contracting

Continue from phase 1, after staffs had found number of areas to be transplanted. The contract had been signed by farmers of each zone. During the contracting procedure, the signed contract will be reported back to the factory week by week. Until the end of September, staffs will summarize the total number of areas for each week transplanting in their zone. This summary is then recorded and compares with plan in phase 1.

After comparing with plan, if the total number of growing areas are insufficient. Staffs will have to look for areas again and summarise by the end of November. This is because when the pre-harvesting time (Phase 4) start at the end of November (week 48) as can be seen in Table 4.7. At this time, if the areas are still not enough when compare with the plan, there will be some more action in phase

4. The amount of product will be estimated to compare with phase 1 to see the different period and amount in acquiring products to be able to plan to take more action in phase 4. The flow idea of phase 2 is illustrated in Figure 4.3.

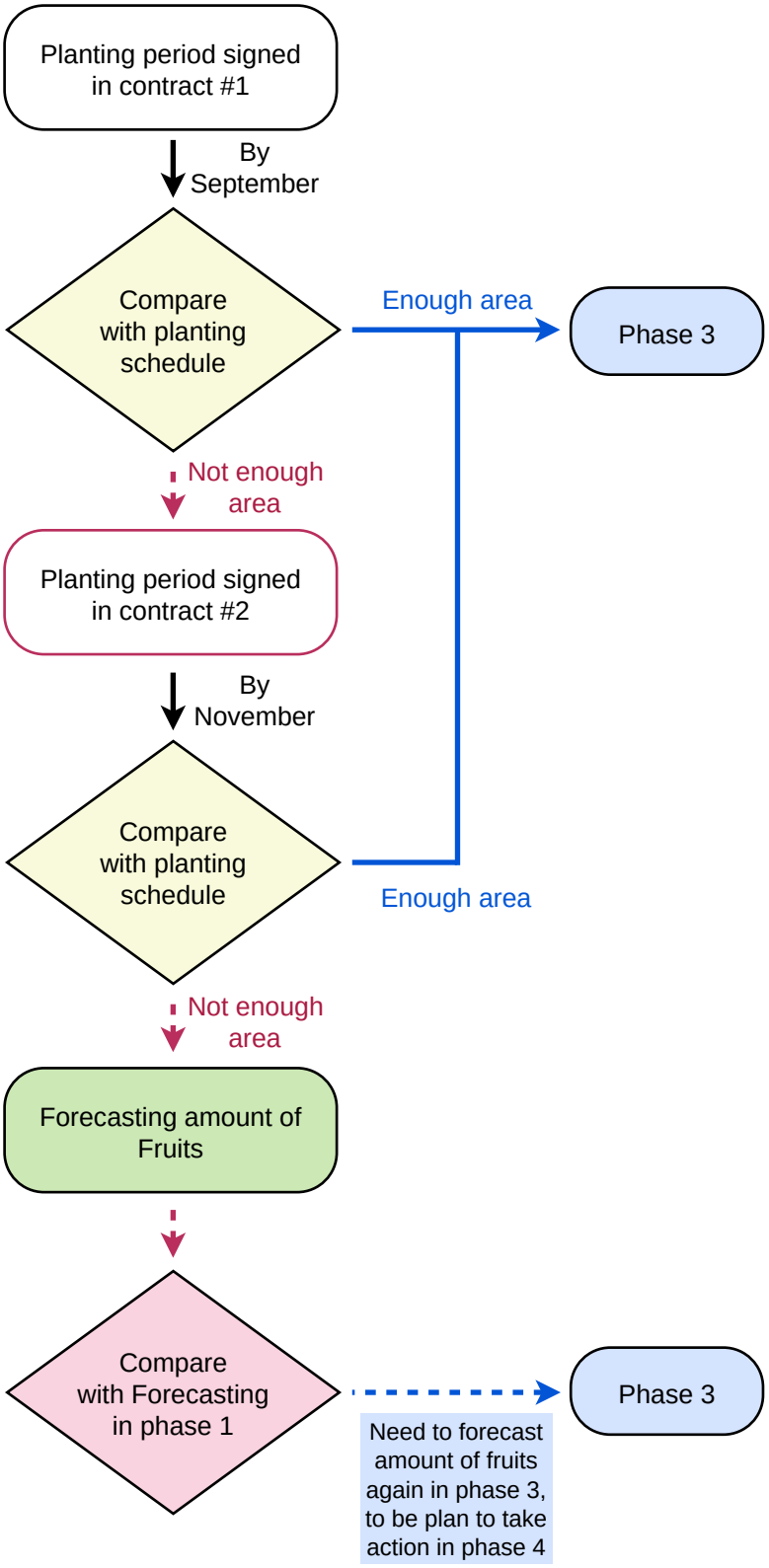


Figure 4.3 Phase 2 Procedure

4.3.3 Phase 3: Planting

From phase 2, this phase is to check that farmers had transplanted in the week signed in the contract or not. It could be a time shifting for one to two week for some reason such as off-season raining. The transplanted time will be reported back to the factory by monitoring team to check up on report from staffs in all zone. From this report, the harvesting period can be forecasted. Again with the estimation of product, if there is a shifting of time in transplanting, the harvesting time will be shifted also. From the estimation of product in this phase, the plan from phase 2 will be adjusted a little bit to sign contract for more amount of product. The flow idea of phase 3 is illustrated in Figure 4.4.

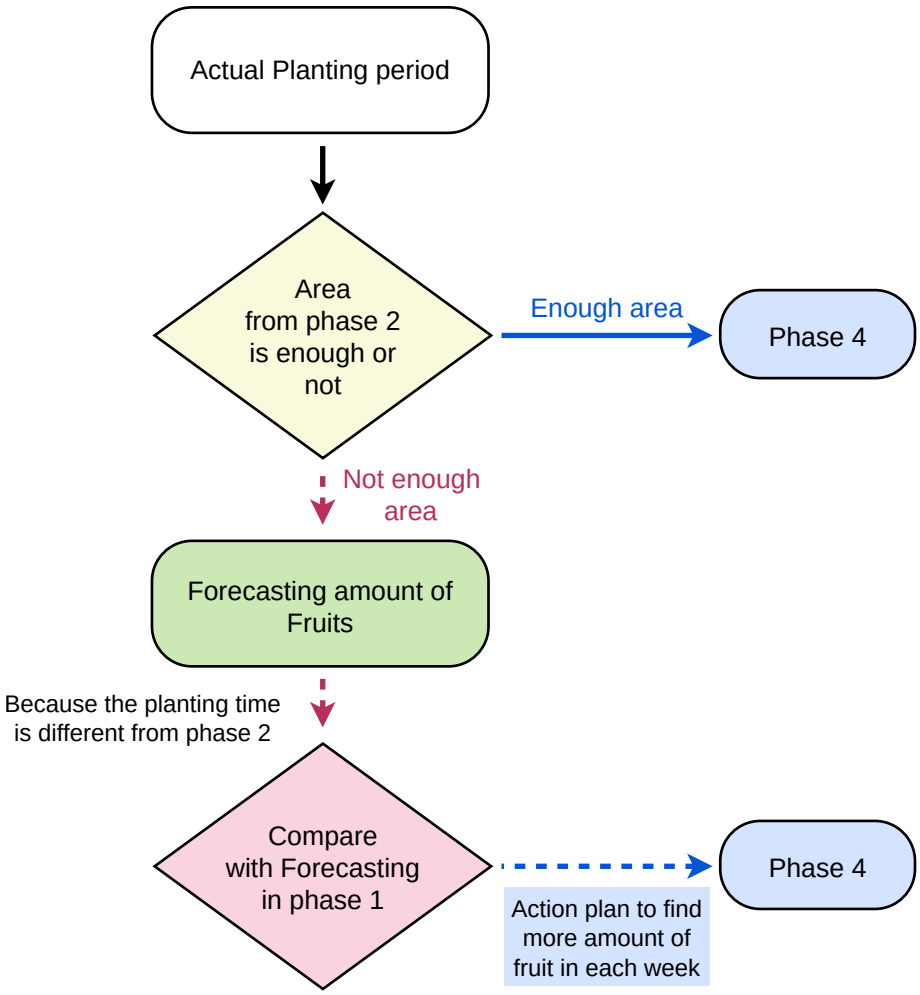


Figure 4.4 Phase 3 procedure

4.3.4 Phase 4: Pre-harvesting

Before harvesting period forecasted in the last phase for about two weeks, Staffs and monitoring team have to observe the amount of product in each area. The percentage in acquiring product will then be reported back to the factory. For some areas that are very productive, staffs could do contract for more amount of fruits if there are in sufficient growing areas from phase 2. Moreover, the contract could also be done with the farmers of the competitor's company if the fruits in that area are very productive. The flow idea of phase 4 is illustrated in Figure 4.5.

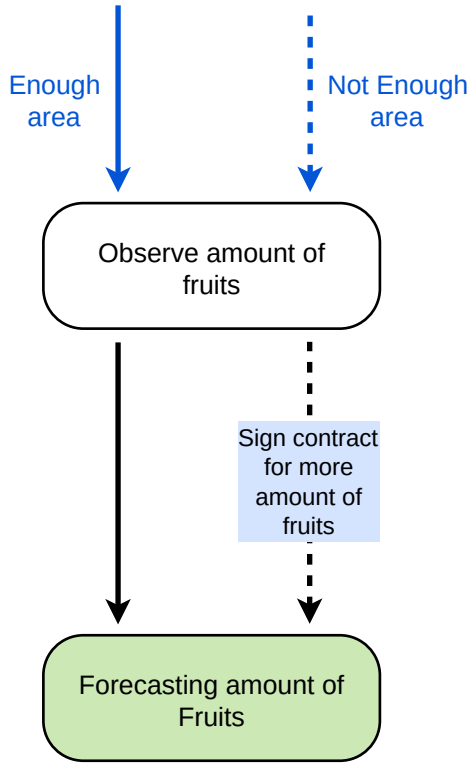


Figure 4.5 Phase 4 Procedure

In addition, for long term planning if the growing areas are not enough. The company could ask for the cooperation with the Provincial Agricultural Extension Offices to develop more income for farmers by providing more information to farmers on how to earn more money in tomato growing. Furthermore, the Provincial Agricultural Extension Offices should give an extension support for tomato to be industrial crop of the province to create confidence to farmers.

From the this effective planning system, the company will have more than enough products in the future. What if the products are too many for the production capacity of the factory, the company could rent the cooling storage to keep tomato's fresh longer for one or two weeks.

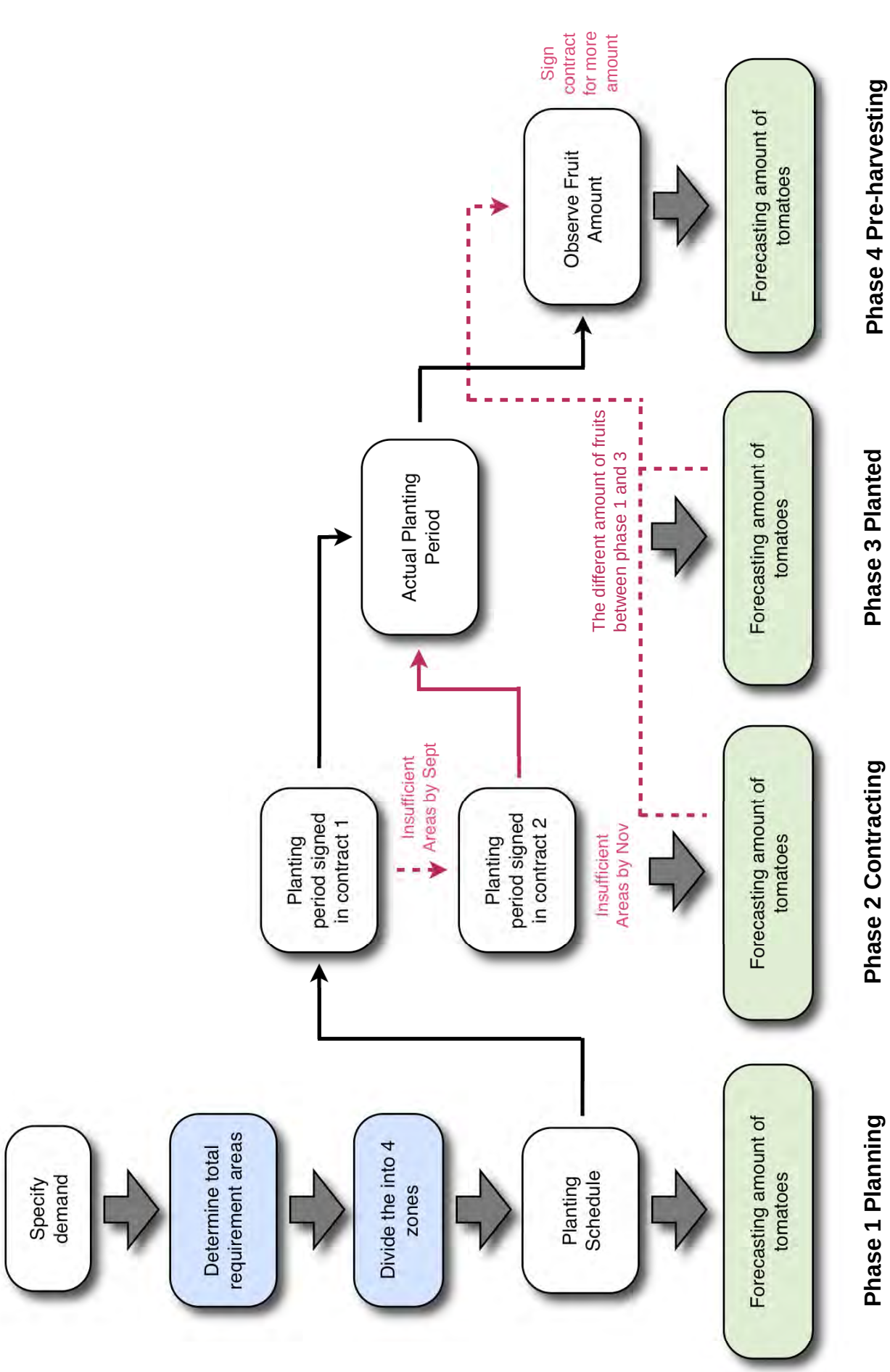


Figure 4.6 Procedure of different phases

4.4 Extension for production of the factory

From phase 4, The total amount of fruits can be compare with the plan in phase 1 to see the differences in quantity and timing to acquire fruits. These differences will be reported to the production department to take further action. Production department could adjust the production plan for labour needs, machine and other requirement to save cost in production. Figure 4.7 shows The flow in reporting the discrepancy in timing and quantity to production department.

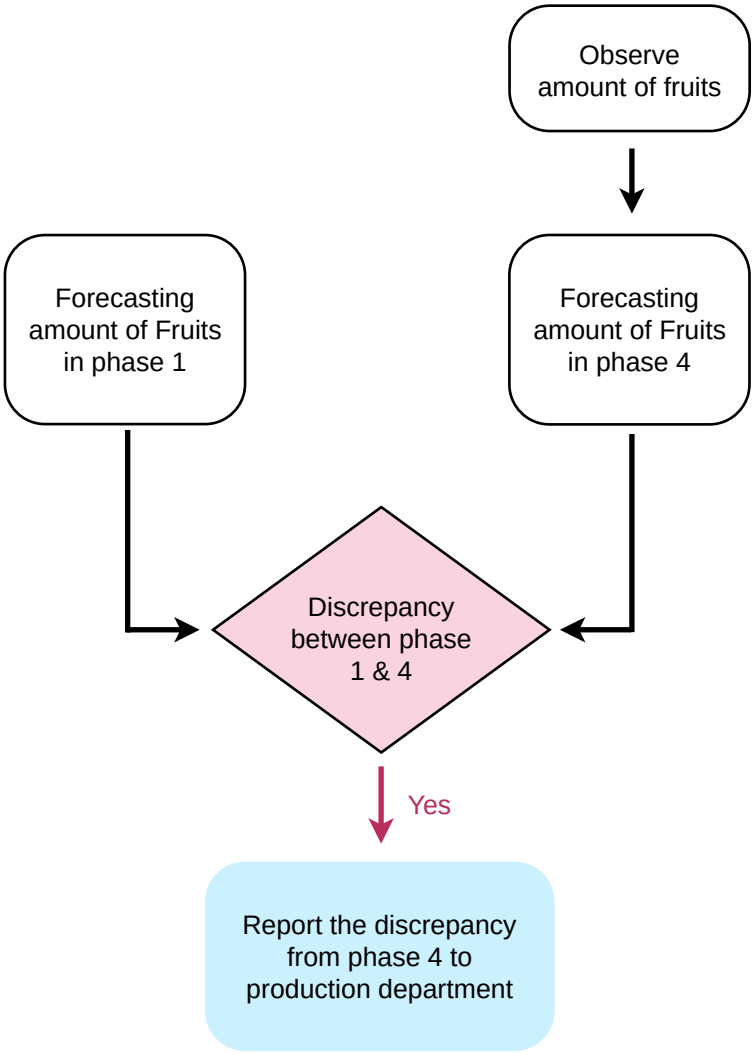


Figure 4.7 Flow in reporting the discrepancy to production department

CHAPTER V

IMPLEMENTING AND EVALUATION

5.1 Implementation of growing requirement planning

5.1.1 Inputs and Logic

Demand of tomatoes

The demand of tomatoes in this thesis is assumed as known as 33,000 tons per year or about 2,357 tons per week, from week 52 to week 13. The Table 4.1 below show total demand of 33,000 tons divided into 14 weeks period of time.

Table 5.1 Demand of fruits in each week

Demands	Total (tons)	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	Wk 6	Wk 7	Wk 8	Wk 9	wk 10	wk 11	wk 12	wk 13
Total Demand	33,000	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357

Growing factors

From the demand of fruits in each week, the number of area will be determined by considering these growing factors.

- **The contract amount** is the amount of product that sign in the contract with farmers per rai (5 tons). It is used to calculate number of areas from the total amount of product of each zone.

From Table 5.1 the number of areas for transplanting can be calculated by,

$$\text{Number of areas}_{\text{wk(t)}} = \frac{\text{Demand in week}_{\text{wk(t+11)}}}{\text{Contract amount}}$$

Therefore, with the 11 week period of growing, Number of areas from week 41 to week 2 can be calculated as follow, and results show in Table 5.2.

$$\text{No. of area}_{\text{wk 41 to wk 2}} = \frac{2,357_{\text{wk52 to wk13}}}{5} = 471$$

Table 5.2 Number of areas calculated from demand of each week

	Contract amount	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	Wk 1	Wk 2
# Areas	5	471	471	471	471	471	471	471	471	471	471	471	471	471	471

- **Harvesting ratio** is the ratio of harvesting product in 4 weeks time period, shown in Chapter 3, Table 3.4. It is used to calculate the amount of product that can be harvested for each week from the the number of areas of each zone in week.

Because the fruits cannot be harvested in the one week time period and each period of harvesting, fruits get to the ripening stage with different amount. Therefore, harvesting ratio must be concerned. It is seen that in the first week of harvesting period, fruits can be harvested for only 15 percent of its production. In the third week, the product will reach its highest amount of 40 percent in production.

Thus, the transplanting time will be shifted for 2 weeks in advance. So, the average of product amount still meet with the demand. The shifting of transplanting time is shown in Table 5.3.

Table 5.3 Shifted transplanting time by considering harvesting ratio

	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52
# Areas	471	471	471	471	471	471	471	471	471	471	471	471	471	471

From Table 5.3, the amount of product will be determined by using harveting ratio as shown on the next page. The result of calculation is shown in Table 5.4.

$$\begin{aligned}\text{Product amount}_{\text{wk(t)}} = {} & \text{No. of area}_{\text{wk(t-11)}} \times \text{Contract amount} \times \text{Harvesting ratio}_{\text{(1st)}} \\ & + \text{No. of area}_{\text{wk(t-12)}} \times \text{Contract amount} \times \text{Harvesting ratio}_{\text{(2nd)}} \\ & + \text{No. of area}_{\text{wk(t-13)}} \times \text{Contract amount} \times \text{Harvesting ratio}_{\text{(3rd)}} \\ & + \text{No. of area}_{\text{wk(t-14)}} \times \text{Contract amount} \times \text{Harvesting ratio}_{\text{(4th)}}\end{aligned}$$

For example,

$$\begin{aligned}\text{Product amount}_{\text{wk(1)}} = {} & 471_{\text{wk(42)}} \times 5 \times 0.15 + 471_{\text{wk(41)}} \times 5 \times 0.30 \\ & + 471_{\text{wk(40)}} \times 5 \times 0.40 + 471_{\text{wk(39)}} \times 5 \times 0.15 \\ = {} & 2,357\end{aligned}$$

Table 5.4 Amount of product determined from shifted time by using harvesting ratio

Harvest' Period	ratio	wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14
week 1	0.15	354	354	354	354	354	354	354	354	354	354	354	354	354	354			
week 2	0.30		707	707	707	707	707	707	707	707	707	707	707	707	707	707		
week 3	0.40			943	943	943	943	943	943	943	943	943	943	943	943	943	943	
week 4	0.15				354	354	354	354	354	354	354	354	354	354	354	354	354	354
Sum	33,000	354	1,061	2,004	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,357	2,004	1,296	354

- **Zone ratio** is the ratio of area in the growing zone to the total area. The ratio is shown in Table 5.5. It is used to calculate the number of areas in each zone from the known total demand of tomatoes. The numeber of areas for different zone can be calculated as follow and results show in Table 5.5.

$$\text{No. of areas in zone A} = \text{zone ratio of zone A} \times \frac{\text{forecasting demand}}{\text{contract amount}}$$

For example,

$$\text{No. of areas in Nearby} = 0.15 \times \frac{33,000}{5} = 990$$

Table 5.5 Zone Ratio and total number of area in each zone

Area	Zone Ratio	areas (rai)
Nearby	*0.15*	990
Sakonnakorn	*0.25*	1,650
Maekong side	*0.10*	660
Konkean	*0.10*	660
Quota	*0.40*	2,640

According to the zone ratio in Table 5.5 and the start period of transplanting in each zone in Table 3.2, it is difficult to adjust the equally number of 471 rai for each week to match with the zone ratio and transplanting period of each zone. So, the growing ratio has to be concerned.

- **Growing ratio** is the ratio of number of areas in week for different growing zones to the total area of that zone. This growing ratio is considered from the appropriate transplanting period of each zone so the number of area will be rearranged to get the acceptable out come.

Table 5.6 Growing ratio

Areaa		wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 1	wk 2
Nearby	1	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*						
Sakonnakorn	1								*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.20*	*0.20*	*0.10*	
Maekong side	1		*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*					
Konkean	1												*0.30*	*0.20*	*0.20*	*0.30*	
Quota	1	*0.08*	*0.08*	*0.08*	*0.10*	*0.10*	*0.10*	*0.10*	*0.07*	*0.07*	*0.07*	*0.10*	*0.05*				

5.1.2 Outputs

After considering the total demand for tomato crop in 2008 and all growing factors, the schedule for transplanting in Table 5.7 and also the estimation of product in Table 5.8 will be obtained for phase 1.

By going through working procedure of farming department, the number of area is recorded for each phase and product for each phase can be estimated.

Phase 1: Planning

The transplanting schedule and the estimation of product amount is obtained from the growing requirement planning. Staffs are now knowing there target to find number of areas in each week for transplanting in their zone. The transplanting schedule of phase 1 is shown in Table 5.7. The spread out of product quantity for each week is satisfied as shown in Table 5.8. The fruits amount is acceptable for the factory. It is not too high for the production capacity.

Table 5.7 Transplanting schedule of phase 1

Area	Total (rai)	September		October				November				December				January	
		wk-39	wk-40	wk-41	wk-42	wk-43	wk-44	wk-45	wk-46	wk-47	wk-48	wk-49	wk-50	wk-51	wk-52	wk-1	wk-2
Nearby	990	99	99	99	99	99	99	99	99	99	99	0	0	0	0	0	0
Sakonnakorn	1,650	0	0	0	0	0	0	0	165	165	165	165	165	330	330	165	0
Maekong side	660	0	66	66	66	66	66	66	66	66	66	66	0	0	0	0	0
Konkean	660	0	0	0	0	0	0	0	0	0	0	0	198	132	132	198	0
Quota	2,640	211	211	211	264	264	264	264	185	185	185	264	132	0	0	0	0
Total (rai)	6,600	310	376	376	429	429	429	429	515	515	515	495	495	462	462	363	0

Table 5.8 the estimation of product in phase 1

Area	Total (tons)	December			January				February				March				April			
		wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16
Nearby	4,950																			
1st		74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	0.0	0.0	0.0	0.0	0.0	0.0			
2nd			148.5	148.5	148.5	148.5	148.5	148.5	148.5	148.5	148.5	148.5	0.0	0.0	0.0	0.0	0.0	0.0		
3rd				198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	0.0	0.0	0.0	0.0	0.0	0.0	
4th					74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	0.0	0.0	0.0	0.0	0.0	0
Sakonnakorn	8,250																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	123.8	123.8	123.8	123.8	123.8	247.5	247.5	123.8	0.0			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	247.5	247.5	247.5	247.5	247.5	495.0	495.0	247.5	0.0		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	330.0	330.0	330.0	330.0	330.0	660.0	660.0	330.0	0.0	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	123.8	123.8	123.8	123.8	123.8	247.5	247.5	123.8	0
Maekong side	3,300																			
1st		0.0	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	0.0	0.0	0.0	0.0	0.0			
2nd		0.0	0.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	0.0	0.0	0.0	0.0	0.0		
3rd		0.0	0.0	0.0	132.0	132.0	132.0	132.0	132.0	132.0	132.0	132.0	132.0	132.0	0.0	0.0	0.0	0.0	0.0	
4th			0.0	0.0	0.0	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5	0.0	0.0	0.0	0.0	0
Konkean	3,300																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.5	99.0	99.0	148.5	0.0	0.0	0.0	
2nd		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	297.0	198.0	198.0	297.0	0.0	0.0	0
3rd		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	396.0	264.0	264.0	396.0	0.0	0
4th			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.5	99.0	99.0	148.5	0
Quota	13,200																			
1st		158.4	158.4	158.4	198.0	198.0	198.0	198.0	138.6	138.6	138.6	198.0	99.0	0.0	0.0	0.0	0.0	0.0	0.0	
2nd		0.0	316.8	316.8	316.8	396.0	396.0	396.0	396.0	277.2	277.2	277.2	396.0	198.0	0.0	0.0	0.0	0.0	0.0	0
3rd		0.0	0.0	422.4	422.4	422.4	528.0	528.0	528.0	528.0	369.6	369.6	369.6	528.0	264.0	0.0	0.0	0.0	0.0	0
4th			0.0	0.0	158.4	158.4	158.4	198.0	198.0	198.0	198.0	138.6	138.6	138.6	198.0	99.0	0.0	0.0	0.0	0
Total (tons)	33,000	232.7	747.5	1,466.9	1,871.1	1,999.8	2,105.4	2,145.0	2,209.4	2,338.1	2,509.7	2,559.2	2,529.5	2,465.1	2,400.8	2,260.5	1,815.0	1,072.5	272.3	0

Phase 2: Contracting

Farmers in each growing zone had signed contract for number of areas to grow tomatoes. The number of growing area was insufficient fron the summary in September 2007. Staffs had to look for more areas again and summarised in November 2007 that the number of areas was still insufficient. Therefore, they will have to take more action in phase 4. The summary of areas for both time is shown in table 5.9. The estimation of product of this phase is shown in table 5.10. From this estimation and comparison with the estimation in phase 1, the week that fruit amount is insuffient will be plan to take action in phase 4.

Table 5.9 Contracting area for each zone of phase 2

Area	Total by area (rai)	September		October				November				December				January	
		wk-39	wk-40	wk-41	wk-42	wk-43	wk-44	wk-45	wk-46	wk-47	wk-48	wk-49	wk-50	wk-51	wk-52	wk-1	wk-2
Nearby	629	0	0	0	48	80	84	78	0	0	0	180	159	0	0	0	0
Sakonnakorn	1200	0	0	0	0	0	0	0	150	161	102	143	157	141	242	104	0
Maekong side	473	0	0	50	60	80	30	0	70	75	68	40	0	0	0	0	0
Konkean	453	0	0	0	0	0	0	0	0	0	0	0	0	119	157	177	0
Quota	2098	0	0	0	0	85	200	290	290	310	325	220	168	150	60	0	0
Total (rai)	4853	0	0	50	108	245	314	368	510	546	495	583	484	410	459	281	0

Table 5.10 the estimation of product in phase 2

Area	Total (tons)	December			January				February				March				April			
		wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16
Nearby	3,145																			
1st		0.0	0.0	0.0	36.0	60.0	63.0	58.5	0.0	0.0	0.0	135.0	119.3	0.0	0.0	0.0	0.0			
2nd			0.0	0.0	0.0	72.0	120.0	126.0	117.0	0.0	0.0	0.0	270.0	238.5	0.0	0.0	0.0	0.0		
3rd				0.0	0.0	0.0	96.0	160.0	168.0	156.0	0.0	0.0	0.0	360.0	318.0	0.0	0.0	0.0	0.0	
4th					0.0	0.0	0.0	36.0	60.0	63.0	58.5	0.0	0.0	0.0	135.0	119.3	0.0	0.0	0.0	0.0
Sakonnakorn	6,000																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.5	120.8	76.5	107.3	117.8	105.8	181.5	78.0	0.0			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	225.0	241.5	153.0	214.5	235.5	211.5	363.0	156.0	0.0		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	300.0	322.0	204.0	286.0	314.0	282.0	484.0	208.0	0.0	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.5	120.8	76.5	107.3	117.8	105.8	181.5	78.0	0.0
Maekong side	2,365																			
1st		0.0	0.0	37.5	45.0	60.0	22.5	0.0	52.5	56.3	51.0	30.0	0.0	0.0	0.0	0.0	0.0			
2nd			0.0	0.0	75.0	90.0	120.0	45.0	0.0	105.0	112.5	102.0	60.0	0.0	0.0	0.0	0.0	0.0		
3rd				0.0	0.0	100.0	120.0	160.0	60.0	0.0	140.0	150.0	136.0	80.0	0.0	0.0	0.0	0.0	0.0	
4th					0.0	0.0	37.5	45.0	60.0	22.5	0.0	52.5	56.3	51.0	30.0	0.0	0.0	0.0	0.0	0.0
Konkean	2,265																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.3	117.8	132.8	0.0			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	178.5	235.5	265.5	0.0		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	238.0	314.0	354.0	0.0	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.3	117.8	132.8	0.0
Quota	10,490																			
1st		0.0	0.0	0.0	0.0	63.8	150.0	217.5	217.5	232.5	243.8	165.0	126.0	112.5	45.0	0.0	0.0			
2nd			0.0	0.0	0.0	0.0	127.5	300.0	435.0	435.0	465.0	487.5	330.0	252.0	225.0	90.0	0.0	0.0		
3rd				0.0	0.0	0.0	0.0	170.0	400.0	580.0	580.0	620.0	650.0	440.0	336.0	300.0	120.0	0.0	0.0	
4th					0.0	0.0	0.0	0.0	63.8	150.0	217.5	217.5	232.5	243.8	165.0	126.0	112.5	45.0	0.0	0.0
Total (tons)	24,265	0	0	38	156	446	857	1,318	1,746	2,146	2,486	2,654	2,637	2,571	2,365	2,082	1,647	906	211	0
Need more	8,735	233	747	1,429	1,715	1,554	1,249	827	463	192	23	-95	-108	-106	36	178	168	166	62	0

Phase 3: Planting

From phase 2, Staffs had reported the transplanting period of farmers in their zones. The monitoring team had also observed the planted area to check up with the staff's report. After the check up, the report is shown in Table 5.11. The estimation of product is shown in table 5.12 to adjust plan from phase 2 to aquire more fruits.

Table 5.11 Planted area for each zone of phase 3

Area	Total by area (rai)	September		October				November				December				January	
		wk-39	wk-40	wk-41	wk-42	wk-43	wk-44	wk-45	wk-46	wk-47	wk-48	wk-49	wk-50	wk-51	wk-52	wk-1	wk-2
Nearby	629	0	0	0	11	42	20	42	0	14	14	0	360	115	11	0	0
Sakonnakorn	1200	0	0	0	0	0	0	0	0	131	216	0	30	152	501	171	0
Maekong side	473	0	0	55	82	66	13	0	11	54	109	84	0	0	0	0	0
Konkean	453	0	0	0	0	0	0	0	0	0	0	0	0	90	175	163	26
Quota	2098	0	0	0	0	90	212	286	308	329	345	233	178	53	64	0	0
Total (rai)	4853	0	0	55	93	197	245	328	319	527	684	317	568	409	751	334	26

Table 5.12 the estimation of product in phase 3

Area	Total (tons)	December			January				February				March				April			
		wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16
Nearby	3,145																			
1st		0.0	0.0	0.0	8.6	31.2	15.0	31.2	0.0	10.7	10.7	0.0	269.7	86.0	8.6	0.0	0.0			
2nd			0.0	0.0	0.0	17.2	62.3	30.1	62.3	0.0	21.5	21.5	0.0	539.4	171.9	17.2	0.0	0.0		
3rd				0.0	0.0	0.0	22.9	83.1	40.1	83.1	0.0	28.7	28.7	0.0	719.3	229.2	22.9	0.0	0.0	
4th					0.0	0.0	0.0	8.6	31.2	15.0	31.2	0.0	10.7	10.7	0.0	269.7	86.0	8.6	0.0	0.0
Sakonnakorn	6,000																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.9	162.0	0.0	22.5	113.6	375.8	128.3	0.0			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	195.8	324.0	0.0	45.0	227.3	751.5	256.5	0.0		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	261.0	432.0	0.0	60.0	303.0	1,002.0	342.0	0.0	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.9	162.0	0.0	22.5	113.6	375.8	128.3	0.0
Maekong side	2,365																			
1st		0.0	0.0	41.0	61.4	49.2	9.8	0.0	8.2	40.1	81.9	63.1	0.0	0.0	0.0	0.0	0.0			
2nd			0.0	0.0	81.9	122.9	98.3	19.7	0.0	16.4	80.3	163.9	126.2	0.0	0.0	0.0	0.0	0.0		
3rd				0.0	0.0	109.2	163.9	131.1	26.2	0.0	21.8	107.1	218.5	168.2	0.0	0.0	0.0	0.0	0.0	
4th					0.0	0.0	41.0	61.4	49.2	9.8	0.0	8.2	40.1	81.9	63.1	0.0	0.0	0.0	0.0	0.0
Konkean	2,265																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.4	130.9	122.2	19.2			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	134.7	261.8	244.5	38.5		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	179.7	349.1	326.0	51.3	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.4	130.9	122.2	19.2
Quota	10,490																			
1st		0.0	0.0	0.0	0.0	67.6	159.1	214.8	230.7	246.6	258.5	175.0	133.6	39.8	47.7	0.0	0.0			
2nd			0.0	0.0	0.0	0.0	135.2	318.2	429.6	461.4	493.2	517.1	350.0	267.3	79.6	95.5	0.0	0.0		
3rd				0.0	0.0	0.0	0.0	180.3	424.3	572.8	615.2	657.6	689.4	466.7	356.4	106.1	127.3	0.0	0.0	
4th					0.0	0.0	0.0	0.0	67.6	159.1	214.8	230.7	246.6	258.5	175.0	133.6	39.8	47.7	0.0	0.0
Total (tons)	24,265	0	0	41	152	397	708	1,078	1,369	1,713	2,187	2,558	2,666	2,307	2,550	2,620	2,328	1,269	302	19
Need more	8,735	233	747	1,426	1,719	1,603	1,398	1,067	840	625	323	1	-137	158	-149	-360	-513	-197	-30	-19

Phase 4: Pre-harvesting

From phase 3, with the actual transplanting time and 11 week period to harvest, the time to obseve the growing areas is 2 weeks before harvesting. So, from transplanting week plus 9 weeks, it is time to observe and find more products by sign more contract with our farmers and competitor's farmers for more amount of product. Then, it will be reported back in percentage of product amount that can be harvested. Becasue, there might also be some losses during the growth. Table 5.13 is the remaining area that can be harvested which determined from the mentioned percentage.

Table 5.13 Pre-harvesting area pearcentage which converted to no. of areas for each zone of phase 4

Area Percentage	September		October				November				December				January	
	wk-39	wk-40	wk-41	wk-42	wk-43	wk-44	wk-45	wk-46	wk-47	wk-48	wk-49	wk-50	wk-51	wk-52	wk-1	wk-2
Nearby	0	0	0	0.80	0	0	0.58	0	1.00	1.00	0	1.06	1.00	0.80	0	0
Sakonnakorn	0	0	0	0	0	0	0	0	0.92	1.13	0	1.20	1.11	1.07	1.20	0
Maekong side	0	0	0.50	0.52	0.70	0	0	1.00	1.08	1.15	1.20	0	0	0	0	0
Konkean	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1.00	1.00	1.00
Quota	0	0	0	0	0.68	0.50	0.73	0.78	1.00	1.00	1.05	1.00	1.10	1.13	0	0

Area	Total (rai)	September		October				November				December				January	
		wk-39	wk-40	wk-41	wk-42	wk-43	wk-44	wk-45	wk-46	wk-47	wk-48	wk-49	wk-50	wk-51	wk-52	wk-1	wk-2
Nearby	397	0	0	0	6	0	0	17	0	10	10	0	267	80	6	0	0
Sakonnakorn	872	0	0	0	0	0	0	0	0	80	162	0	24	112	357	137	0
Maekong side	376	0	0	25	39	42	0	0	10	53	115	92	0	0	0	0	0
Konkean	353	0	0	0	0	0	0	0	0	0	0	0	0	70	136	127	20
Quota	1736	0	0	0	0	58	100	196	226	310	325	230	168	55	68	0	0
Total (rai)	3733	0	0	25	45	100	100	213	236	453	612	322	459	317	567	264	20

Table 5.14 the estimation of product in phase 4

Area	Total (tons)	December			January				February				March				April			
		wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16
Nearby	**2,187.7**																			
1st		0.0	0.0	0.0	28.8	0.0	0.0	21.3	0.0	7.5	7.5	0.0	192.3	60.0	10.8	0.0	0.0			
2nd			0.0	0.0	0.0	57.6	0.0	0.0	42.6	0.0	15.0	15.0	0.0	384.5	120.0	21.6	0.0	0.0		
3rd				0.0	0.0	0.0	76.8	0.0	0.0	56.8	0.0	20.0	20.0	0.0	512.7	160.0	28.8	0.0	0.0	
4th					0.0	0.0	0.0	28.8	0.0	0.0	21.3	0.0	7.5	7.5	0.0	192.3	60.0	10.8	0.0	0.0
Sakonnakorn	**5,673.0**																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	129.0	121.5	0.0	104.4	125.6	267.7	102.8	0.0			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	257.9	243.0	0.0	208.8	251.2	535.5	205.5	0.0		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	343.9	324.0	0.0	278.4	334.9	714.0	274.0	0.0	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	129.0	121.5	0.0	104.4	125.6	267.7	102.8	0.0
Maekong side	**2,369.3**																			
1st		0.0	0.0	18.8	29.3	44.1	0.0	0.0	7.5	39.7	38.8	177.3	0.0	0.0	0.0	0.0	0.0			
2nd			0.0	0.0	37.5	58.5	88.2	0.0	0.0	15.0	79.3	77.6	354.6	0.0	0.0	0.0	0.0	0.0		
3rd				0.0	0.0	50.0	78.0	117.6	0.0	0.0	20.0	105.8	103.5	472.8	0.0	0.0	0.0	0.0	0.0	
4th					0.0	0.0	18.8	29.3	44.1	0.0	0.0	7.5	39.7	38.8	177.3	0.0	0.0	0.0	0.0	0.0
Konkean	**2,190.0**																			
1st		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	116.3	102.0	95.3	15.0			
2nd			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	232.5	204.0	190.5	30.0		
3rd				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	310.0	272.0	254.0	40.0	
4th					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	116.3	102.0	95.3	15.0
Quota	**9,172.5**																			
1st		0.0	0.0	0.0	0.0	43.1	75.0	147.0	169.5	232.5	243.8	172.5	126.0	115.5	51.0	0.0	0.0			
2nd			0.0	0.0	0.0	0.0	86.3	150.0	294.0	339.0	465.0	487.5	345.0	252.0	231.0	102.0	0.0	0.0		
3rd				0.0	0.0	0.0	0.0	115.0	200.0	392.0	452.0	620.0	650.0	460.0	336.0	308.0	136.0	0.0	0.0	
4th					0.0	0.0	0.0	0.0	43.1	75.0	147.0	169.5	232.5	243.8	172.5	126.0	115.5	51.0	0.0	0.0
Total (tons)	**21,592**	**0**	**0**	**19**	**96**	**253**	**423**	**609**	**801**	**1,286**	**1,869**	**2,440**	**2,628**	**2,607**	**2,743**	**2,597**	**1,979**	**990**	**238**	**15**

Record of Acquiring product

This is the record when there are product delivered to the factory. The table 5.15 is the summary of product amount delivered in each week for each area. The record is used to evaluate the planning system in tomato growing.

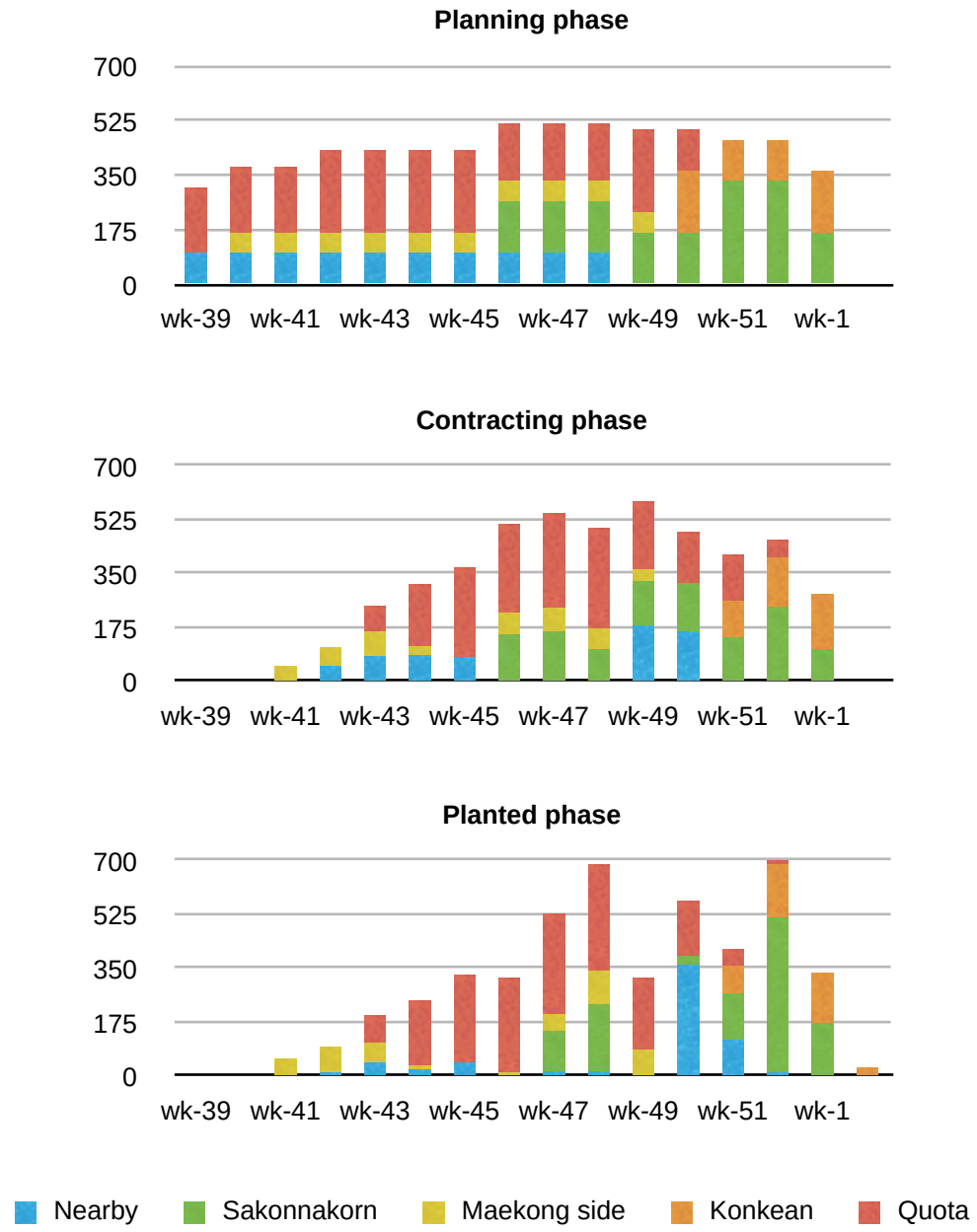
Table 5.15 Record of Acquiring product

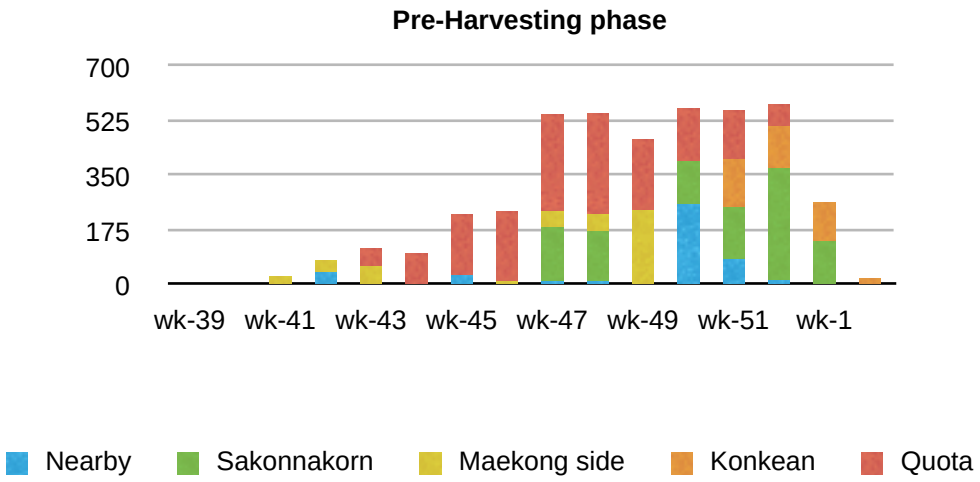
Areas	Total (tons)	wk 50	wk 51	wk 52	wk 1	wk 2	wk 3	wk 4	wk 5	wk 6	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16
Nearby	2,879.93	*0.0*	*0.0*	*0.0*	*32.7*	*113.3*	*123.3*	*201.5*	*194.5*	*112.4*	*62.9*	*38.4*	*238.6*	*547.6*	*740.6*	*373.2*	*88.9*	*12.0*	*0.0*	*0.0*
Sakonnakorn	5,990.52	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*61.1*	*219.7*	*580.1*	*750.6*	*590.3*	*504.5*	*853.1*	*989.9*	*882.1*	*426.1*	*133.1*	*0.0*
Maekong side	2,462.97	*0*	*0*	*0.0*	*119.3*	*237.7*	*146.7*	*145.3*	*74.0*	*45.5*	*135.1*	*351.7*	*483.7*	*546.0*	*177.8*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Konkean	2,330.04	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*148.4*	*402.5*	*618.2*	*550.0*	*343.7*	*210.5*	*56.7*
Quota	9,907.15	*0*	*0*	*0.0*	*0.0*	*55.0*	*123.3*	*379.9*	*702.5*	*905.9*	*1,583.5*	*1,633.8*	*1,533.4*	*1,328.4*	*909.6*	*503.3*	*208.4*	*40.1*	*0.0*	*0.0*
# delivered	23,570.61	0.00	0.00	0.00	152.08	405.99	393.37	726.72	1,032.1(	1,283.5{	2,361.7(	2,774.4:	2,846.0{	3,074.7!	3,083.5{	2,484.6:	1,729.4!	821.90	343.53	56.74

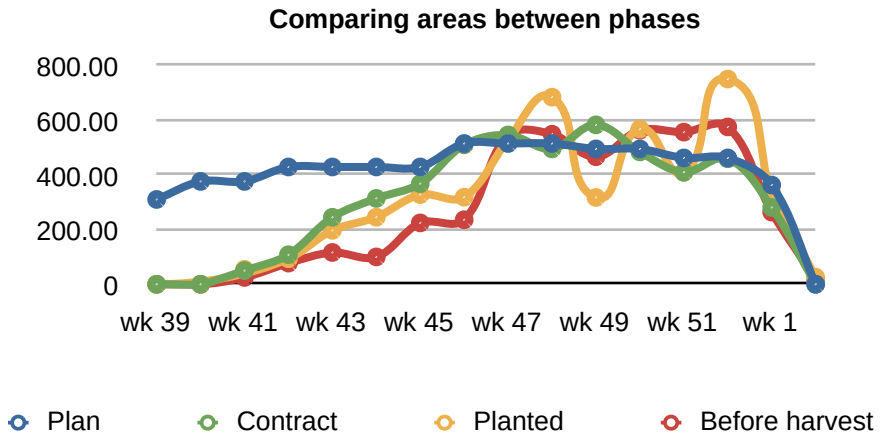
5.2 Evaluation

From the record of acquiring product, the results can be evaluted in different aspects.

5.2.1 Total Transplanting areas in different phases







- **Comparison between phase 1 and 2**

The transplanting of contracting phase starts later than planning phase for two weeks. The planning phase start at week 39 and contracting phase start at week 41. The staffs could not reach the objective of looking for areas. It is seen obviously that from week 39 to week 45, the contracting area was not so many compare to planning area.

- **Comparison between phase 2 and 3**

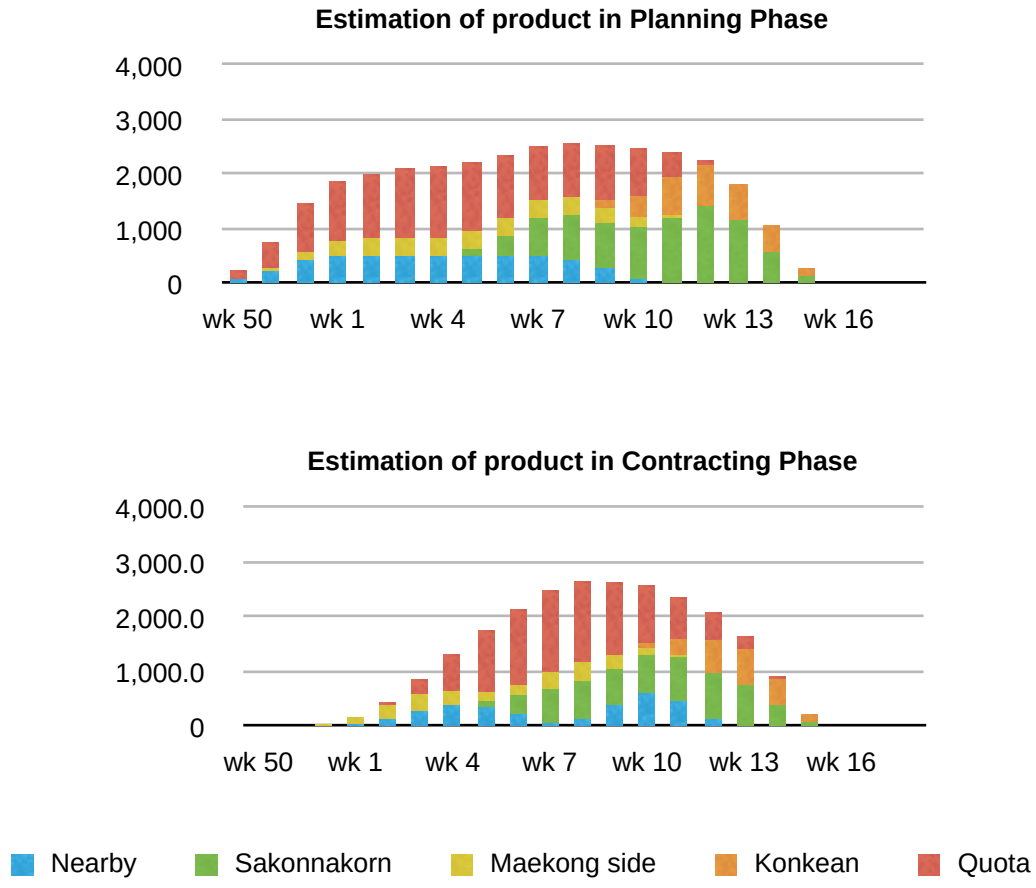
There is fluctuation of the graph in this phase due to time shifting in transplant. Farmers had shifted time in transplanting for one to two weeks so the area that should be planted in week 46 was shifted to week 48, there were shifting of time since that. The areas that should be planted in week 49, 50, 51 had shifted to week 50, 51, and 52. the areas of planted phase was increased a little bit. And also, in week 1 some areas are shifted transplanting time to week 2.

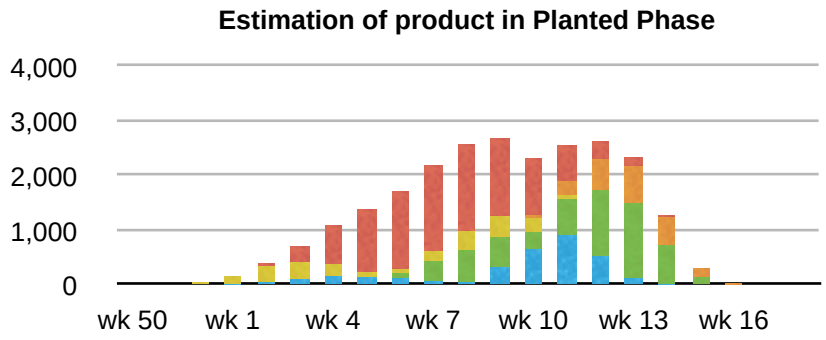
- **Comparison between phase 3 and 4**

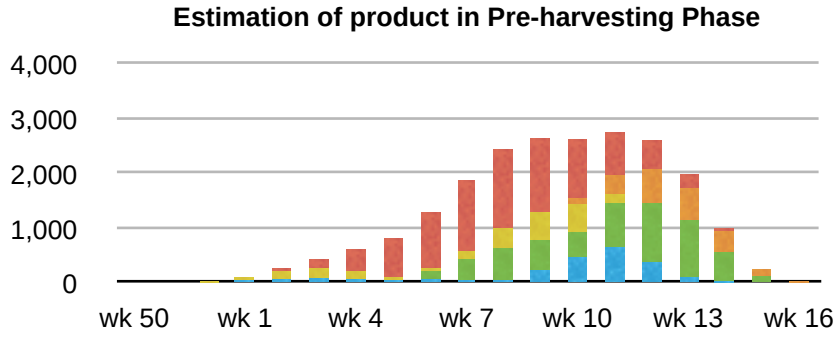
Due to the report of pre-harvesting was back in percentage of probability in harvesting of each area for each week. So, number of areas was the same as planted phase but amount of product is different. To be able to compare, it is converted back into number of areas to see the differences. From week 41 to week 46, percentage in harvesting of pre-harvesting period was very low. This will be discussed more in the estimation of product between phase 3 and 4.

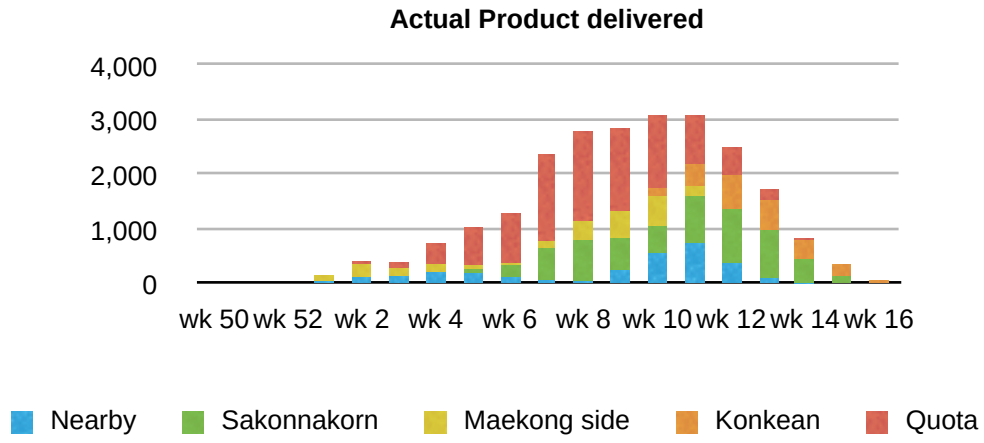
Analysis: before the starting of the crop in 2008, there was flooded in August. It had causes a lot of losses for people who live by Maekong riverside and also the field for growing tomatoes (nearby zone). This occurence affected the start time of crop season for two weeks late and the reducing in number of growing areas inevitably. From the contracting phase, it can be seen clearly that farmers attempted to do as what they sign in the contract although there are the shift of time in some areas.

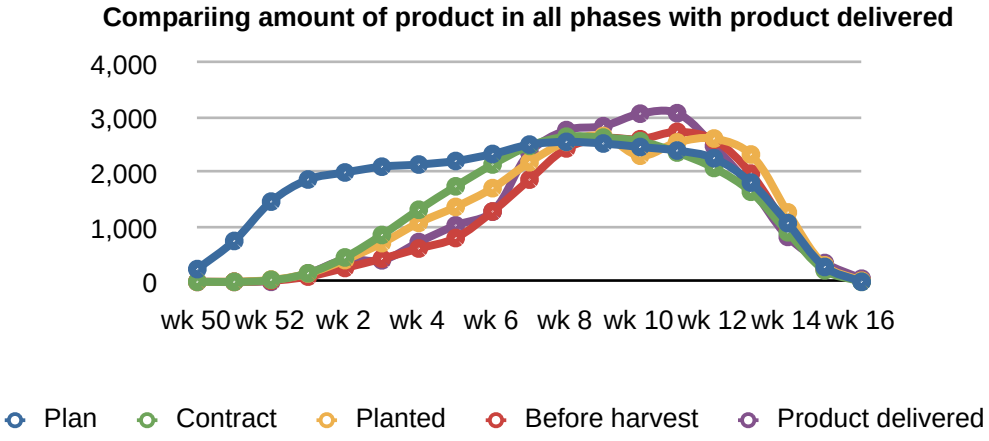
5.2.2 Total Product estimation in different phases




Estimation of product in Planted Phase
4,000
3,000
2,000
1,000
0
wk 50
wk 1
wk 4
wk 7
wk 10
wk 13
wk 16


Estimation of product in Pre-harvesting Phase
4,000
3,000
2,000
1,000
0
wk 50
wk 1
wk 4
wk 7
wk 10
wk 13
wk 16


Actual Product delivered
4,000
3,000
2,000
1,000
0
wk 50
wk 52
wk 2
wk 4
wk 6
wk 8
wk 10
wk 12
wk 14
wk 16
Nearby
Sakonnakorn
Maekong side
Konkean
Quota


Compariing amount of product in all phases with product delivered
4,000
3,000
2,000
1,000
0
wk 50
wk 52
wk 2
wk 4
wk 6
wk 8
wk 10
wk 12
wk 14
wk 16
Plan
Contract
Planted
Before harvest
Product delivered

- **Comparison between phase 1 and 2**

From week 50 to week 5, the estimation of product in contracting phase is a lot lower than planning phase especially in week 1 is lower for almost 2,000 tons. For the rest of this crop season, week 6 to week 16 is about to be equal.

- **Comparison between phase 2 and 3**

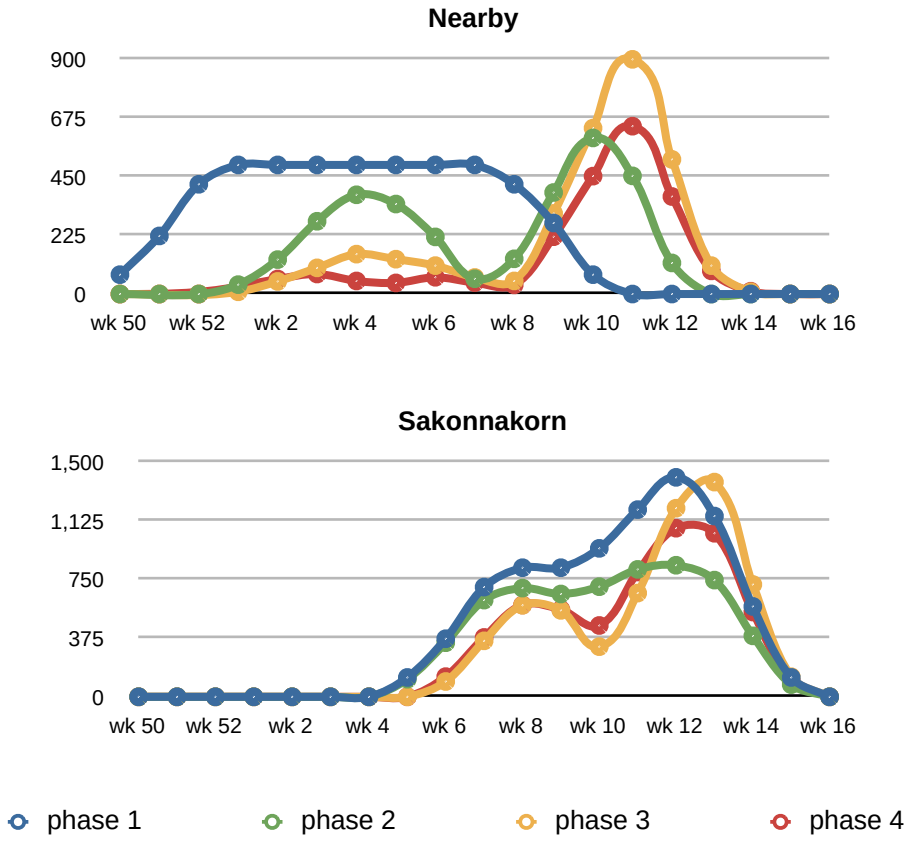
The amount of product between contracting and planted phase is about the same. There is only slightly different between week 11 to week 13.

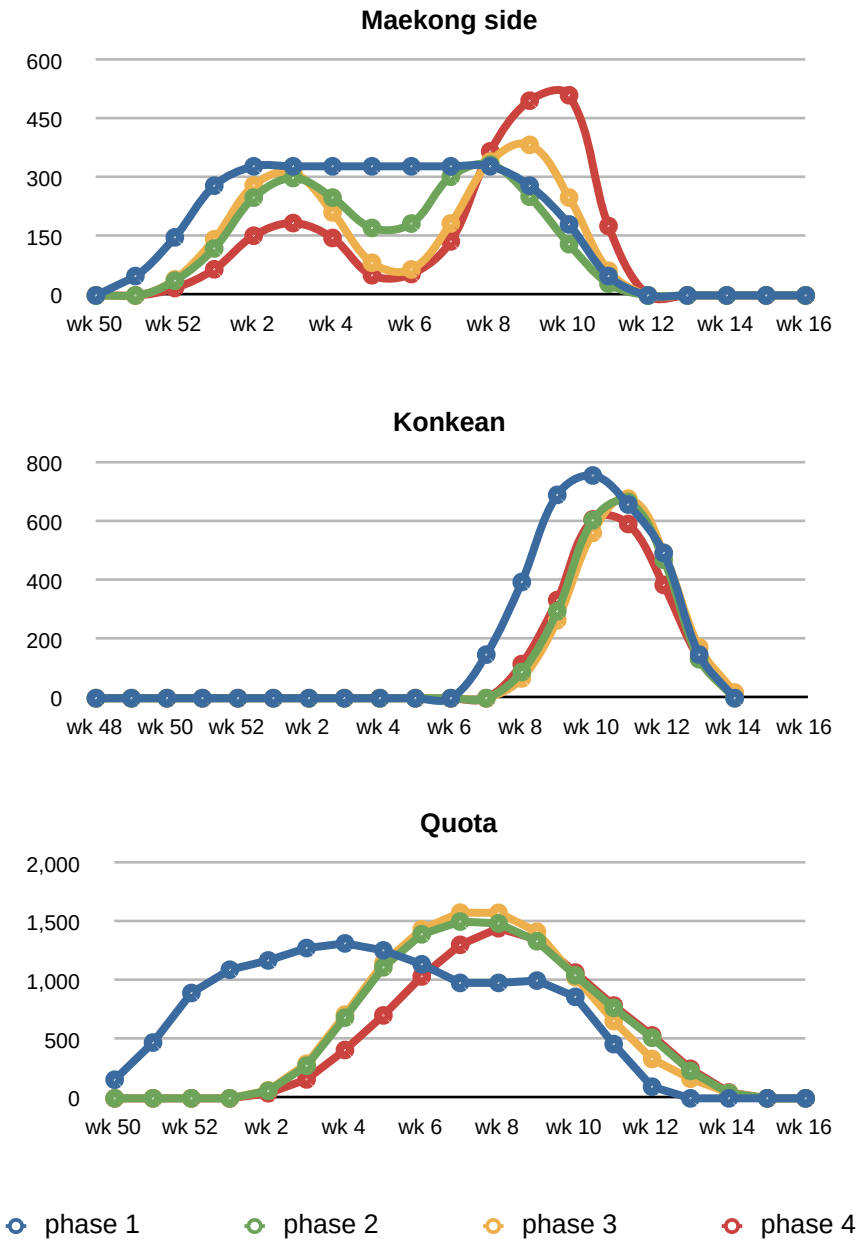
- **Comparison between phase 3 and 4**

Between week 3 to week 7, the product amount in pre-harvesting phase was estimated to be lower than planted. And it is likely to be the same from week 8 to week 16.

Analysis: For the crop in 2008, the early crop was taking longer than usual to get to the harvesting stage. This is because the unusual weather condition that the winter was longer than every year.

5.2.3 Production Estimation in different zone for all phases





Nearby zone

It is seen clearly that the effect of flood had caused a lot of damage in this zone for the early of the crop season. The growing areas that close to the flooded areas are also affected. There were plant diesease in theses areas which lead to the lower amount of product.

Sakonnakorn zone

There was time shifted in tranplanting as seen in Figure above that the estimation of product of week 10 in planted and pre-harvesting phase is lower than the estimation of product in contracting phase. And week 12 and 13 is reversed, the estimation of product in contracting phase is higher than planted and pre-harvesting phase.

Maekong side zone

This area also had been affected from the flood but less than nearby zone, lead to the lower amount of product estimation in pre-harvesting phase between week 52 to week 3. Between week 9 to week 11 the estimation of product in phase 3 and 4 is higher than phase 2 because the shifted time in transplanting.

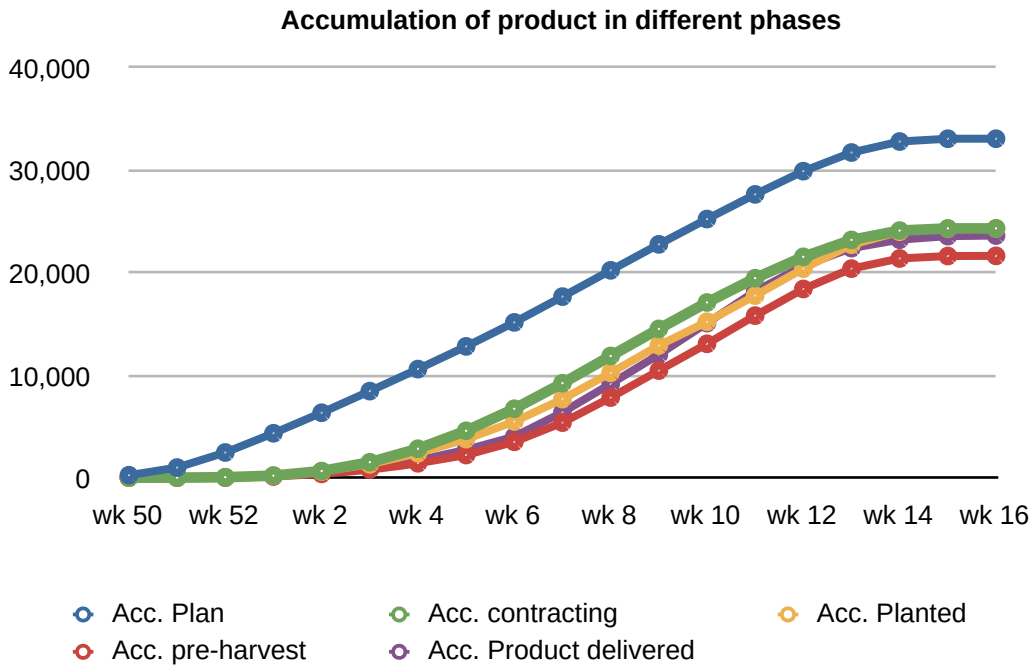
Konkean zone

There is not much different in this zone between phase 2, 3 and 4. Staffs could not get farmers to sign contract as plan. There was also some losses during the growth so the estimation of product in pre-harvesting phase is lower than planted phase

Quota

Growing zone can not be specified for quota because they are in every zone. For this phase it can be seen clearly that, because of the winter in the year 2008 is longer than the other year. The acquiring of product was late for about 1 week. At the early of growing season. In addition, Staffs can not get quota group to sign contract as plan.

5.2.4 Accumulation of product in different phases



In the graph above, the accumalation of product in phase 2, 3 and 4 are stick together which means from the contract, the products are acquired as sign in the contract. However, these phases are a lot different from the accumulation of product in planning phase about 10,000 tons

5.3 Comparison before and after implementation of planning system

After implementation, it was found that the quantity of products is increased. As can be seen in Table 5.16, percentage of product amount signed in contract before implement the planning system was 62 percent and 51 percent for product delivered by comparing with plan. The implementation of planning system have reduced errors in planning for about 12 percent from the contract signed and 21 percent from product delivered when comparing with crop in 2007 which the demend is similar. A significant increase in percentage in acquiring product is observed. The percentage of product amount signed in contract after implement the planning system is 74 percent and 72 percent for product delivered by comparing with plan.

Table 5.16 Comparison before and after implementation of planning system

	Comparison		
	Plan	Contract	Delivered
Crop in 2007 (tons)	32,000	19,726	16,334
Compare with plan	100%	62%	51%
Compare with contract		100%	83%
Crop in 2008 (tons)	33,000	24,265.00	23,570.61
Compare with plan	100%	74%	71%
Compare with contract		100%	97%

Although, the product acquired does not meet with plan due to the loss of growing areas from flooding but the comparison between product delivered and product signed in the contract is increased from 83 to 98 percent which higher than year 2007 for about 15 percent. Therefore, the planning system by applying MRP concept can be used to for developing growing plan to meet the forecasting demand if there was in normal condition.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The objective of this research is to develop the system of plantation planning and scheduling in tomatoes planting for processing factory. The problem in lacking of raw material for processing in the past years has led to losses in production. The analysis of the causes had found that there was no proper plan for work procedure of farming department to monitor the growing of tomatoes, which lead to problem in acquiring fruits to meet with plan. The analysis of growing factors is briefly explained in Chapter 3.1. The work procedure of farming department is analyzed in details in Chapter 3.2. Therefore, the new planning system by using MRP concept is implemented to identify and eliminate the problem in lacking of raw material of the case study company by increasing percentage in acquiring fruit product to meet with plan.

MRP (Material requirement planning) is a planning tool, provides precise control to operations personnel regarding the amounts and timing of deliveries. The application of MRP concept is mentioned in Chapter 4. The plantation planning is divided into 4 phases to obtain the most effective plan. Phase 1 is the planning, the plantation schedule is obtained. Phase 2 contracting phase, staffs or zone controllers look for the growing areas as phase 1 and get farmers to sign contract. Phase 3 planted phase, zone controllers and monitors check the discrepancy of timing in planting from phase 2 and there might be a corrective action. The last phase is pre-harvesting, staffs and monitors evaluate the percentage in acquiring of product. The contract for more amount of product might be signed again if there is not enough growing areas signed in phase 2.

The plantation planning has been applied for farming department to work through a tomato crop season from August to April of 2008/2009 as mentioned in Chapter 5. After implementation, the results have indicated that there are increasing in percentage of acquiring products. As can be seen in Table 5.19, the percentage of product delivered by comparing with plan was increased from 51 percent to 72 percent, which is 21 percent more accurate to the plan. The percentage of product delivered comparing with the contract is also increased from 83 to 98 percent, which is very accurate. The new set up team for monitoring the growing field is vital for plantation planning. The corruption problem of staffs is reduced obviously by this observation.

Although the objective of this thesis has been achieved, there are still some issues that can be developed in the future in order to improve the process further. These issuses are discussed in the following section

6.2 Limitation

There are limitations found in this research. The time period used to evaluate the result after implementing growing planning system is only From August 2008 to December 2008. The amount of fruits from January 2009 to April 2009 are the forecasting amount which might not be enough yet to absolutely to confirm the result. However, due to the time limitation of this study the researcher cannot further analyse the result in long term.

The other difficulty the researcher has found is that basic knowledge of Thai farmers. Since some Thai farmers have low level of education, it is difficult to use the contract farming because they are afraid to be obligated and might be deception.

6.3 Recommendation

6.3.1 Extension for logistics management to deliver fruits

According to this research has covered only plantation planning to achieve the customer demands. The process on how delivering fruits to the factory could be continued for the future development. For example, the calculation in using plastic basket to contain fruits and six-wheeled truck or ten-wheeled truck to carry those basket back to the factory. These logistics management is important to keep quality of fruits and to save cost in transportation.

6.3.2 Staff training

Human error is one of the failure modes occurred in the case study company. Staffs do not follow the schedule strictly and sometime misunderstanding of information due to the mistake in communication. Therefore, training is an important factor to overcome this problem. Traning should be carried out for several aspects. As sugguested, general training should be provided to all staffs of the factory. Then particular trainings that appropriate for each job should be specially designed and provided for all staffs. For example, staff who survey for the new growing field, other than knowledge about tomatoes, they also need to be train about marketing strategy to obtain more areas in growing tomato.

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