A Suitable Schedule For Harvesting And Delivering Of Sugar Cane (Application Using Remote Sensing And GIS)

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ABSTRACT: Sugar cane is one of the major upland crops cultivated in the Northeast of Thailand. Recently, sugar factories have been required to have a better plan and to make important decision in regards of sugar cane production, transportation, quota system, and fair queue arrangement.The study is aimed to identify an appropriate schedule for harvesting and delivering sugar cane to sugar factories, applying Remote Sensing and GIS. Selected site is one of the sugar factories located in Khon Kaen Province, Northeast of Thailand. Using data from Indian Remote Sensing Satellite (IRS), the sugar cane plantation area - within 50 kilometers radius distance from this sugar factory - was identified. Each area sugar cane plantation was identified according to database of soil group, distance from the sugar factory, and quota commitment between farmers and the sugar factory. The criteria to judge which plantation area will get priority in harvesting and delivering their products to the factory are:1) soil fertility, 2) distance from the sugar factory, and 3) quantity of quota commitment. From the study, the Remote Sensing data and GIS could estimate the plantation area at 342,103 rai. The production capacity of sugar factory is 24,000 tons per day. Therefore, the farmers must supply sugar cane from 3,000 rai each day. The map has shown that all of the sugar cane plantation were classified and arranged their harvest and delivery within 16 weeks.

1. Introduction

Most of the sugar factories nowadays are encountering the difficulty in arranging queue for sugar cane farmers who deliver sugar cane to the factory. There are several factors lead to this problem. Only one farmer can not afford a big-enough land to be a counter party with the factory. This leads to the group of many farmers with unequal land. At the time of harvest to deliver their products to the factory, the counter party farmers can usually not achieve the specified amount. Some farmers have to harvest their crops before their queue due to problems in terms of economic. In addition, there are also problems in labor, road condition and transportation, and size and condition of the truck. As a result, the management and development of all database concerned with the sugar cane system since the plantation to the harvest is necessary. It is vital that all database of number of farmers, land each farmer owns, geography and location of plantation land, accessibility and distance from the factory, amount of lands surrounded the factory in which sugarcane can be delivered and the queue can be arrange fairly must be noticed.

This study has interpreted and analyzed data from IRS (Indian Remote Sensing Satellite) to evaluate plantation area of sugar cane in Khon Kaen, Chaiyaphum, and Maha Sarakam. This study is aimed to develop the database system leading to appropriate management. In this study the main purpose is to rearrange order of sugar cane plantation area in terms of priority in harvesting and delivering to the factory, using high and effective technology : Geographic information system and satellite images.

2. Methodology

2.1 Soil database processing

Soil database was done to rank effectiveness of each type of soil that would be appropriate in growing sugar cane. Soils would be categorized into 17 types and they would be weight since 1 up to 13 respectively, according to their appropriateness – the most appropriate type would be weight high then lowered down to the least appropriate. The most appropriate type of soil is "fine loam soil in upland" with the score of 13. The next is "coarse loam soil in upland" with score of 12 respectively until the least appropriate with the score of 1 – "rock out crop".

2.2 Distance of sugar cane plantation land to factory database processing

This database was based on road way used to transport sugar cane to the factory. The data of roads and plantation areas were overlaid to measure distance from the land to the factory. If there was no accessibility of road in some area; the distance could be measured through Geographic Information System (GIS). In some areas the position was measured by GPS (Global Positioning System) and then the distance from the factory was calculated by GIS. After that the land would be weighted according to their distance from the factory. The farest land would be scored 10 and lowered down to the least close at the point of 1, respectively.

2.3 Quota commitment database processing

In the time of sugar cane processing in the factory each group of farmer in each area will be encouraged to sign contract of quota of crop they will send with the factory. This contract will be in different amount by each farmer and is called "quota commitment". The amount depends on the co-operatives of farmers, ability in finding labor for the harvest, and number and size of the trucks used in delivery. The factory has divided the area in support of its to 9 areas. The rest will be considered as an area of no support. The weighting scale is from 1 to 10. The most quota commitment will be scored 10, correspondingly lowering to 1 for the lowest.

2.4 Mapping of schedule to harvest and delivery order processing

The data of soils groups and land of sugar cane plantation were overlaid and updated. The weight of soils, distance, and quota commitment would be multiplied to find out the result of the total score that had been weighted. After that the weights would be grouped according to the sugar factory that could accept sugar cane to process at 24,000 tons per day. Generally, sugar cane farmers in the northeast region are capable of producing 7-10 tons of sugar cane per one rai (1 rai is 1600 m2). In this study the average amount of sugar cane production was determined at 8 tons per rai. In delivering sugar cane 24,000 tons farmers have to harvest sugar cane from 3,000 rai per one day. From the analysis of plantation land of sugar cane in the area of 50 kilometers radius from the factory, 342,103.16 rai of sugar cane plantation land was found. To harvest all the sugar cane from this area, the time of 16 weeks will be consumed. So the delivery of sugar cane to the factory is divided to 16 groups or 16 weeks.

3. Results

3.1 The appropriate sugar cane plantation land to delivery to sugar factory

The case study of the sugar factory is located in Amphur Phuwiang, Khon Kaen province which begins the operation in the middle of December and carries on within 120 days or more, depending on the amount of sugar cane of each year. The factory is capable of squeezing 24,000 tons of sugar cane per one day. Farmers in the area of Khon Kaen and Chaiyaphum can produce 7 to 10 tons of sugar cane per rai. The factory has 9 areas of sugar cane planting support within the distance radius of 50 kilometers from the factory. The whole area is 342,103.16 rai covering the area of two provinces – Khon Kaen with the area of 202,908.78 rai and Chaiyaphum with the area of 139,194.38 rai. The plantation area in Maha Sarakham is found far from the factory more than 50 kilometers. The plantation area in Maha Sarakam is closer to other factories and more convenient and safer to deliver the products to those

factories. Somehow some areas that are not too far from 50 kilometers are counted to be in the area of plantation support.

3.2 Processing and developing soil database

Soil information was used in forming the database. Soils were divided according to the criteria of the Department of Land Development by which potential in high production sugar cane plantation. The soils could be categorized by 17 groups. The best group consisted of fine loam soil in upland (26.19 %), coarse loam soil in upland (9.94 %), soil on levee (upland near by the river) (2.08%), clayey soil in upland (6.59%), and sandy soil in upland (6.06%). The average appropriate group consisted of fine loam soil in lowland (21.55%), coarse loam soil in lowland (0.89%), clayey soil in lowland (10.03%), and silty soil in lowland (0.01%). The least appropriate group consisted of sandy soil in lowland (0.55%), saline soil in lowland (1.10%), shallow soil (5.77%), slope complex (0.0001%), and rock out crop land (9.24%). Figure 1 shows sugar cane plantation area on various types of soils.

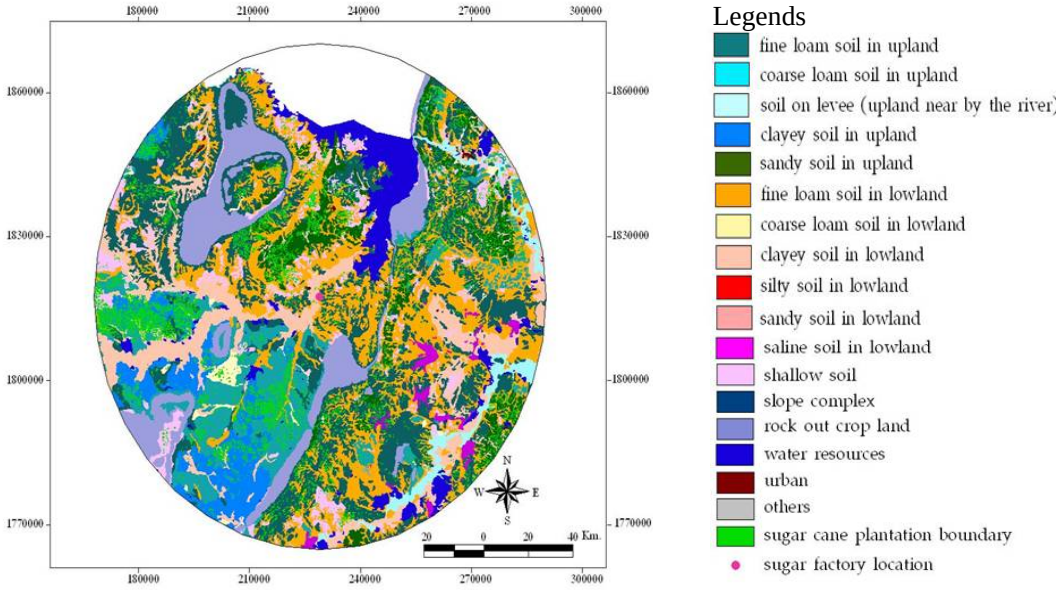

Figure 1: Sugar cane plantation lands in different types of soils.

After weighting soils according to its group, information of sugar cane plantation land and information of soil were overlaid and updated to get new data. This brought data of plantation land and soil to the same table which made it easier for further study.

3.3 Investigation of distance of sugar cane plantation land

To organize the database of how far was each plantation land from the sugar factory, the information of sugar cane plantation land was overlaid with the road way then measured the distance and organized in groups. The lands that were closed together would be counted as the same group. The crops from group of far distance would be harvested and transported before those with close distance to give a chance to the farmer of far distance to do the harvest and transportation first. The groups could be divided by 10 groups – 1) 1-5 km. (0.07 %), 2) 6-10 km. (1.44 %), 3) 11-15 km. (1.93 %), 4) 16-19 km. (6.42 %), 5) 20-25 km. (13.49 %), 6) 26-30 km. (12.49 %), 7) 31-35 km (23.26 %), 8) 36-40 km (9.73 %), 9) 41-45 km. (19.86 %), 10) 46-55 km. (11.30 %). From the study most sugar cane plantation lands were in the far area

from the factory. Figure 2 shows sugar cane plantation land divided according to distance from the factory with road way.

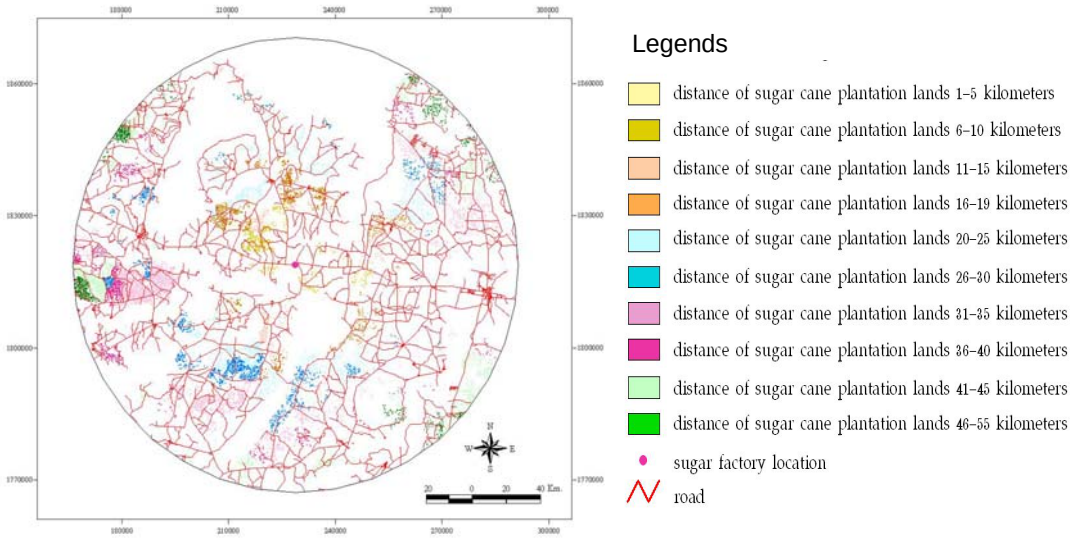

Figure 2: Groups of sugar cane plantation lands and their distance from the sugar factory

3.4 Specification of area of quota commitment to deliver sugar cane to the factory

There was specification of area of quota commitment according to agreement the farmers have done with the factory. In this study there were 9 groups of quota commitment according to the area under support of the factory. The rest that was not in 9 groups was considered out side the support area because they somehow were in the radius of 50 km. From this specification it was found that most of the lands were far from the factory and the farmer cooperative with more quota commitment would have first queue of harvest and delivery. Figure 3 shows the organization of quota commitment group as follow; quota commitment of 354,860 tons (0.36 %), quota commitment of 329,510 tons (0.47 %), quota commitment of 301,850 tons (2.21 %), quota commitment of 289, 642 tons (0.74 %), quota commitment of 164,830 tons (0.53 %), quota commitment of 117, 530 tons (0.42 %), quota commitment of 78,600 tons (0.43 %), quota commitment of 49,100 tons (0.25 %), and quota commitment of 2,000 tons (94.59 %).

3.5 Evaluation, organization and mapping of order for plantation land to deliver sugar cane to the factory

Data of sugar cane plantation land was overlaid with data of soils, distance of land from the factory, and quota commitment. This would form a new data with more details consisting land area, soil type, distance from factory, support area, and quota commitment. Weighting was gained from the multiplied score of each data. The total score would be used to organized appropriateness of sugar cane plantation land to deliver the crop to the factory. The criterion had been discussed in 2.4. Sugar cane farmers must harvest their crops by the area of 3,000 rai per day, in other words, 21,000 rai per week. The harvested product would be delivered to the sugar factory within the distance radius of 50 kilometers. It was found that the whole area is 342,103.16 rai which took 16 weeks to finish. So the groups of appropriateness could be divided by 16 groups or 16 weeks, arranging by place the group with highest weight at the first week respectively lower to the lowest weight at the sixteenth week. The highest score meant it will get the before queue to harvest and deliver their products to the factory because they were on the appropriate soil, capable to give high quality product, situated far from the factory, and

situated in the support area with high quota commitment. Figure 4 shows organization of groups according to appropriateness of order in harvest and delivery to the sugar cane factory.

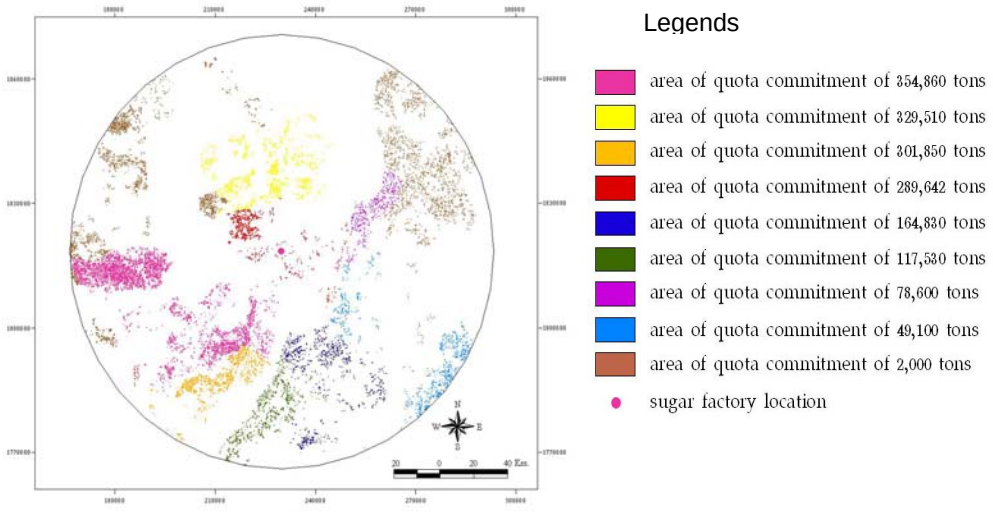

Figure 3: Organization of quota commitment groups

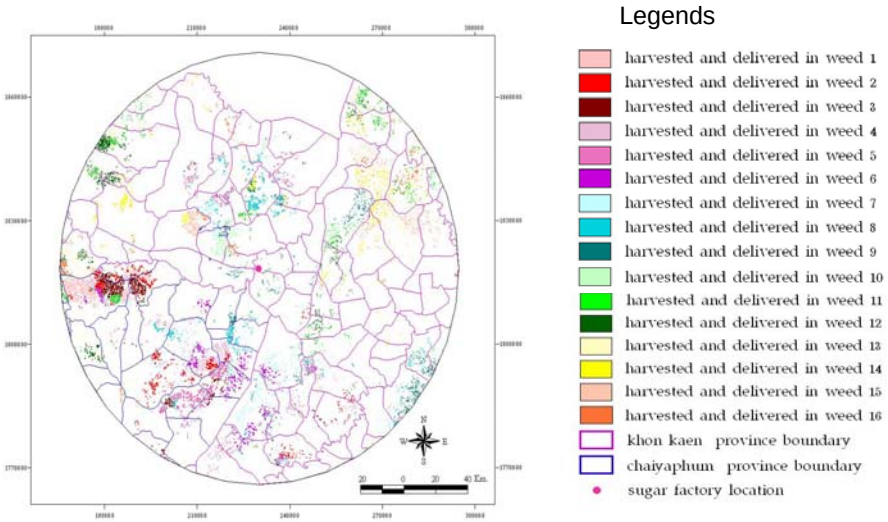

Figure 4: Mapping of groups of sugar cane plantation lands according to appropriateness of order in harvest and delivery to the sugar cane factory.

4. Conclusion

The study of sugar cane plantation within the distance radius of 50 kilometers from the case study factory revealed that the most appropriate soils to cultivate sugar cane were on upland which was 56.04 %. The average appropriate soils were on lowland which was 36.00 %. The inappropriate soils were 8.17 %. Most of the areas that were studied were on the upland and appropriate for sugar cane plantation. For those land that was inappropriate if they were desired to grow sugar cane on, there should be fertilization of soil.

Most of plantation areas were far from the factory (20-25 km.) which made 90.13 % of all areas, and area of 1-19 km. distance which made 9.86 % - considered very small amount of

sugar cane plantation land. So, there should be an expansion of plantation area that was near the factory for convenience and safe cost of transportation and other operation.

The study revealed that most of plantation areas were far from the sugar factory. From the organization of order of appropriateness it was found that the plantation areas which harvested and delivered in the first week were in Amphur Manjakiri, Khon Kaen and Amphur Phukiaw and Amphur KaengKraw, Chaiyaphum. The soil type was fine loam soil on upland, coarse loam soil on upland, and clayey soil on upland. The distance was around 31-52 kilometers with high quota commitment. The plantation areas that harvested and deliver at the sixteenth week were in King Amphur Koge Phochai, King Amphur Nongnakhum, Amphur Muang, Amphur Ban Phang, Amphur Hnong Rue, Amphur Phu Wiang, Amphur Manjakiri, Amphur Ubonrat, Amphur Sri Chompoo, Amphur Namphong, and Amphur Chumphae, Khon Kaen; and Amphur Kasetsomboom, Amphur KaengKraw, Amphur Konsan, and Amphur Ban taen, Chaiyaphum. The soil types were sandy soil on upland, fine loam soil in lowland, clayey soil in lowland, sandy soil in lowland, and saline soil in lowland which consisted of inappropriate soil too. As a result, there should be fertilization for soil. The distance was around 6-50 kilometers – all the land are scattered around.

The result showed that the most of the plantation lands were far from the factory. So it led to waste of time and expense in transportation. So there should be more support for farmers to grow sugar cane in the area near the factory and along with that there should be the supporting system to increase the production, for example, soil fertilization, water reservation, and irrigation.

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