

Mapping and Analyses of Post Harvesting Supply Chain Entities of Mango Using GIS - A Case Study for Krishnagiri District, Tamilnadu, India

*Krishnaveni M. and Kowsalya M.

Centre for Water Resources, Anna University, Chennai- 600025, India.

Email: [*mkveni@annauniv.edu](mailto:mkveni@annauniv.edu), kowsiaie@gmail.com

Abstract

Mango, being the most perishable fruit, is facing the highest post harvest losses in India. An emphasis should be given to develop the post harvesting supply chain entities like cold storage units, food processing units and market outlets. This should be done because they are mostly concentrated in and around the consumer markets which provide very little facilities to the marginal farmers during harvesting. Hence a scientific approach is needed to evolve a methodology to identify the existing Supply Chain Management (SCM) problems and enhance the overall efficiency of SCM network. This study mainly deals with the creation of a scientific database for mango supply chain in the study area. This could be used for checking the adequacy of all entities involved in the supply chain of mango and for finding the suitable measures to enhance the efficiency of the supply chain using Geographical Information System (GIS) technique.

Keywords: Mango, Post Harvest, Supply Chain Management, Physical Entities, GIS Analysis.

Introduction

Mango, the major tropical fruit grown worldwide, is of economic, social and political significance to the country. In Tamilnadu, the second largest mango producing district is Krishnagiri which contributes with an annual production of 2, 00,000 tonnes. It has exported mango based products worth of Rs. 100 crores in the year 2003-2004 [8]. But 15% of the overall production is lost during the post harvesting. Post harvest losses in mango are caused due to the problems existing in the supply chain network entities like processing units, cold storage units, and market outlets [5]. The evolution of efficient supply chain management with GIS would handle these problems in a realistic manner. Hence a study was conducted to assess the post harvest losses in different entities of the supply chain network and to suggest the suitable measures to enhance the overall efficiency of supply chain of the mango. The questionnaire survey depicts the real scenario to find out the secondary factors that affect the supply chain of mango.

Study Area

The largest Mango growing Krishnagiri district covers a geographical area of 5,143 sq. km, (Source: www.krishnagiri.tn.) The intensive study carried throughout the district involved the entire entities in the Supply Chain of Mango. The major entities involved in mango production are the Mango growing fields, Mango mandis (godown), Processing units, Cold Storage units and Market outlets like Uzhavar Sandhai (Special markets exclusively for farmers), Local market, and Export centers which are shown in Figure 1.

Materials and Methods

Satellite Remote Sensing data of IRS P6- RESOURCESAT LISS III (23.5m resolution) acquired on 2007 is used for the delineation of Mango growing area. The administrative and road network maps of the district are collected from corresponding government authorities. The geographical co-ordinates (Latitude & Longitude) of the physical entities are also taken as a primary data using handheld GPS (Geographical Positioning System). The questionnaire survey is conducted with the various stake holders to draft the factors like production, transportation, processing capacity that influences the supply chain network. The statistical data are collected from the Department of Horticulture, Krishnagiri, Tamilnadu.

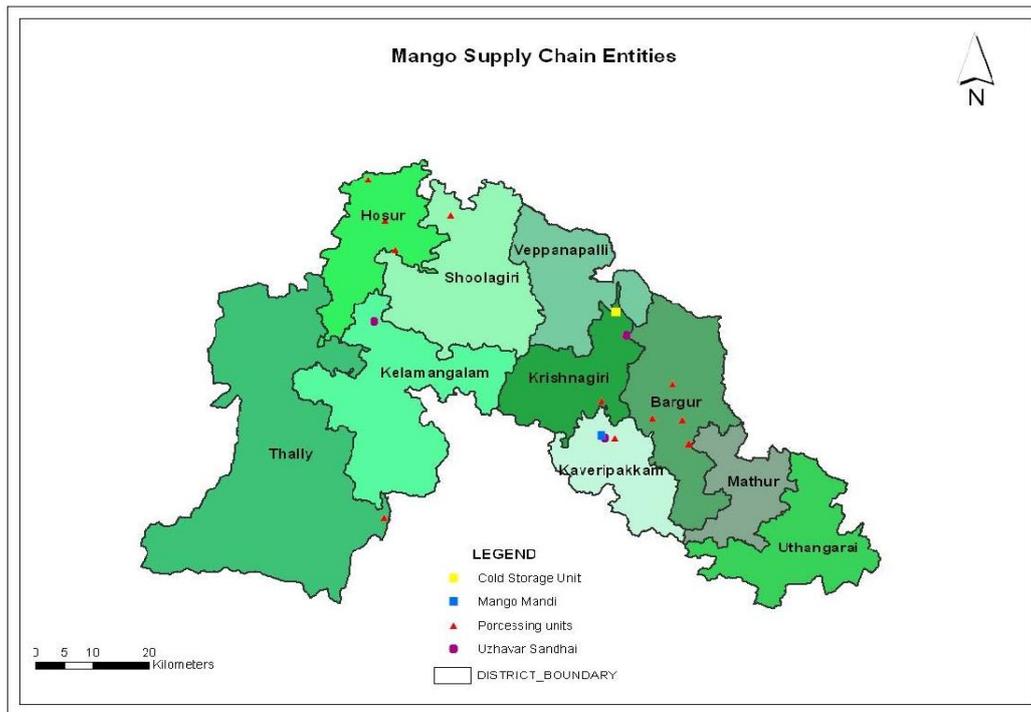


Figure.1 Location Map of Krishnagiri District showing Existing Mango Supply Chain Entities

There are about 42 major processing units existing in the district. But the weak spatial distribution of processing units in the study area is the major reason for the study of SCM. Market outlets are the ultimate end point of any supply chain. Nearly more than 100 mandis, 5 Uzhavar santhais and 2 major exports centre are there that ease the export of mango in terms of raw fruit as well as processed pulp. The lack of the cold storage units is found to be the main reason for the major losses of mango during the post harvest period for the marginal farmers. The connectivity of the road infrastructure between the village and the district headquarters is less adequate than the existing road network. The Figure 2 depicts the overall methodology of the study.

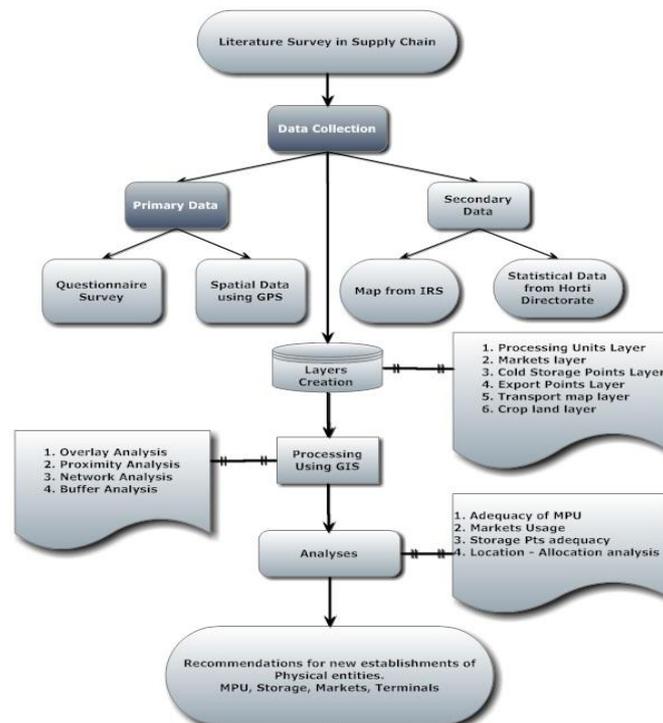


Figure.2 Methodology of the study in the form of flowchart

GIS Processing and Analyses

The complexity of the Supply Chain Management shall be reduced with the introduction of GIS technology [2]. The spatial database of physical entities namely processing units, cold storage units, mandis and uzhar santhais are created using ArcGIS 9.1 software. Different map layers like road network, administrative boundary are created and given as the input to the GIS system for further analysis. The following analyses are carried out to find out the existing problems in the supply chain of mango.

1. Overlay Analysis

The map layers of Administrative boundary and the Landuse- Landcover are overlaid to find out the spatial spread of mango growing areas in the study area. This map is further overlaid with the processing units' distribution layer. The resulted map shows the spatial distribution pattern i.e., the distance between the mango fields and the processing units.

2. Network Analysis

The network analysis has been done to analyze the mango supply chain network through which the product is transported from production field to the end user in order to reduce the transportation losses in terms of cost as well as time. The analysis involves finding out the shortest path to transport the mango in the form of raw fruit from growing field to the markets and cold storage units or as pulp from processing units to the retails and export terminals.

3. Buffer Analysis

The buffering analysis has been done to minimize the transportation losses by finding out the proximity of roads [7] to the processing units, farmer fields and storage units. From the analysis, the potential influence of existing entities (nearness of the fields and processing units to the roads) is well drawn and projected to find an optimum location for new establishment of cold storage units.

Results and Discussions

1. Mango Supply Chain in Krishnagiri

The questionnaire survey was conducted separately to the farmers, government officials and the processing units which helped in drafting the average percentage of supply of the mango from the producer to the end user. This was cross checked with the results from Tamilnadu State Agricultural Extension Department, Bulk buyers and the processing units. The Figure 3 gives an overall picture about the supply chain of Mango in the form of flow chart. This flowchart depicts that the highest percentage of mango is supplied in the form of pulp to the consumers. So, the pulp producing and storing units are given more importance in this study.

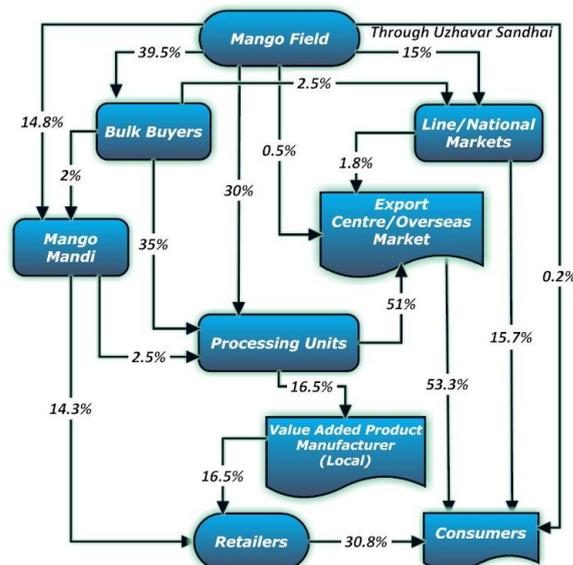


Figure.3 Flowchart shows the Supply Chain of Mango

2. Processing Units' Distribution

The buffer and overlay analyses reveal that the processing units are clustered in a single block, Kaverippattinam which has the 35 units out of the 42 units in the whole district.. The Figure 4 shows the processing units distribution in the Krishnagiri district. This is due to one of the following reasons.

1. Higher water table by the intervention of a canal,
2. Located to the nearby highway which in turn reduces the transportation cost.

Thus, it is very clear that the processing units are more than adequate in the major mango producing blocks like Kaverippattinam, Bargur, Krishnagiri, Kelamangalam. The remaining units serve to the other blocks for pulp production. However, the increment of mango cultivation in other blocks may automatically emerge the new processing units.

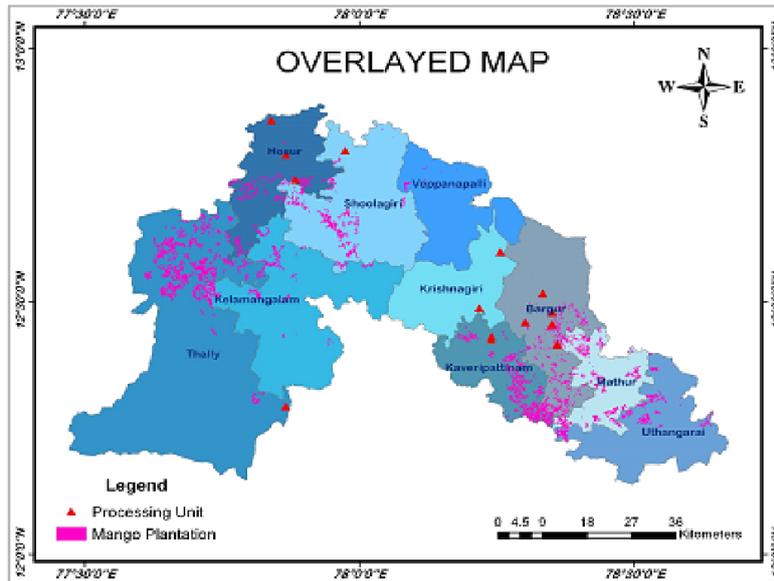


Figure.4 Map shows the spatial distribution of processing units with the mango growing area

- **Site for New Processing Unit**

From the overlay map shown in Figure.4, it is clear that the farmers in Thally block are isolated from the existing processing units and as a result, they have to spend more money and time to make their product reach the industries. Hence Thally block is in need of new processing units. A site has been suggested for establishing a new processing unit, which is shown in the Figure 5.

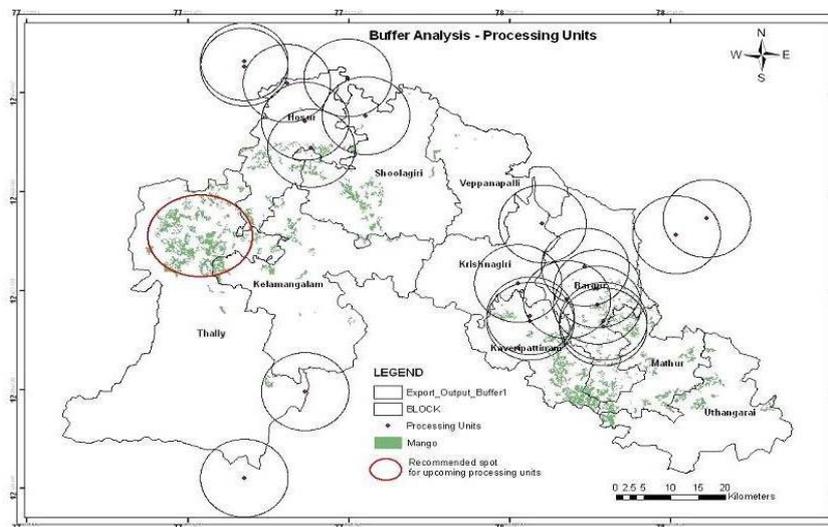


Figure.5 Map of Krishnagiri district showing the location for new processing unit establishment

- **Transportation Facilities**

To overcome the existing transportation problem, the network analysis would help to find out the shortest paths to transport the mango as a raw fruit and pulp. An exemplary map, shown in the Figure 6, depicts the shortest path from a mango field to the nearby processing unit. The NH 66, which is under construction, serves for the transportation of over 20% of the total product transported. It should be completed in a stipulated span of time and maintained in order to reduce the post harvest losses happening due to transportation.

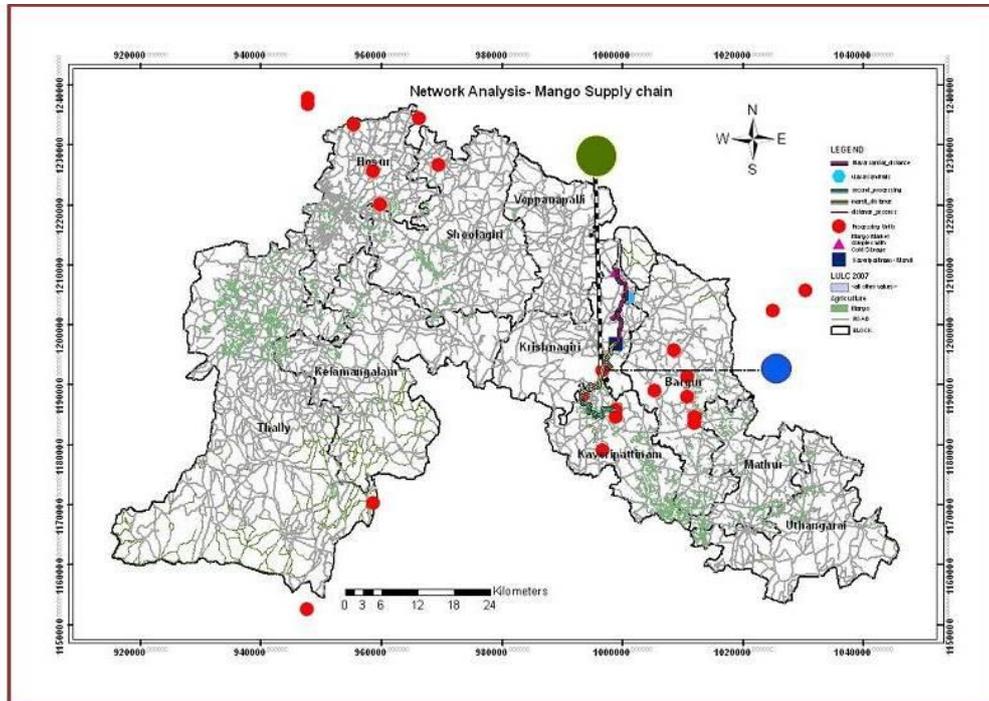


Figure.6 Map showing the network analyses for finding out the shortest path from mango growing field to processing units

- **Storage Facilities**

The scope of the cold storage has very less influence on mango for two major reasons that resulted from the questionnaire survey:

1. Mango as a pulp, need no cold storage as their shelf life is around 2 years,
2. Mango as a fruit can be preserved in cold storage but it is costlier than its profit.

Agriculture Marketing and Business Centre in Krishnagiri District is establishing a cold storage unit for Mango as a fruit. This unit construction is started in the financial year 2011- 2012. This will be done on trail basis in their office complex. Then it will be accompanied by a ‘Mango Market Complex’, where the mango farmers can directly sell their products. A map showing the location of the upcoming mango market complex with the cold storage is shown in Figure 1. The incorporation of Wax coating technology also improves the shelf life of the mango fruit upto 7% and thus increasing the national market export scope. This is given as the recommendation in addition to Mango Market Complex proposal.

- **Expansion of Production Area**

In the supply chain of agricultural commodity, the supply-demand gap is increasing as the production area is depleted or it is being shifted to some other crops. But in Krishnagiri, even though the mango cultivable area is increasing by 20% in every decade, the productivity finds ups and downs. The shortage of irrigation water is the main factor for the increase in mango production area as other crops requires more amount of irrigation than mango. The most favorable climate (Temperature: 24°C and 27°C, low relative humidity) satisfies the

requirement and thus mango is chosen as an alternative crop for other field crops, which also paves the way for increase in the production area.

- **Market Outlets**

Export markets more likely demand the pulp (varieties: Totapori, Neelam, Naati) rather than the fruit. Even though the present demand gap is filled by adequate supply in the district, the more production will increase the overall revenue in turn.

Summary and Conclusion

Incorporating new technologies like GIS and Remote Sensing would pave a way for easy analysis of supply chain study of any horticultural crops with considerable reduction in effort, time and resources. The supply chain network study, conducted for Mango fruit in Krishnagiri district of Tamilnadu is drafted and presented here. The overlay analysis, buffer analysis and network analysis are done in GIS with respective layers to obtain the expected output.

This study deals with the mapping and analyses of the mango supply chain entities exclusively for Krishnagiri district using the Geo-spatial technologies like remote sensing and GIS. The secondary information has been collected by questionnaire survey which offers existing real time problems in the supply chain of Mango fruit throughout the district. The questionnaire survey derived flowchart gives the brief overview of the present scenario and aids in analyses of issues related to supply chain itself. Based on the GIS analyses, the recommendations are given which are further classified as primary and secondary recommendations based upon their relative importance and necessity.

This study can be created as a dynamic one by incorporating the techniques using interfaces and database. Though it involves more complexity and cost of creation, it can be utilized for multipurpose issues related to supply chain management. The wide ability (large area coverage) of this study at national level will explore a different perception and unknown issues that are behind the major problems in SCM. Thus incorporation of GIS in SCM analysis clearly depicts the effectiveness and the simplicity of the methodology.

References

- [1]. Andrew Daily, Geographic Information Systems as a Supply Chain Risk Management Tool, *Continuity Central, Portal Publishing Ltd*, 1-4 (2007).
- [2]. Burrough P.A., Principles of Geographical Information System for Land Resources Assessment, *Clarendon Press*, 12, 1-3 (1986).
- [3]. Gouhar Ayub and Mahrukh Siraj, Mango Commodity Chain Study: Knowledge Gap and use of ICTs in the Chain in India, 5, 9 (2008).
- [4]. Prabakar K., Raghuander T., Parthiban V. K., Muthulakshmi P. and Prakasam V., Post Harvest Fungal Spoilage in Mango at Different Levels Marketing, *TNAU, Coimbatore*, 92, 42-45 (2005).
- [5]. Ray S.S. and Dutta S., A GIS and Remote Sensing based approach for siting Cold Storage Infrastructure for Horticultural Crops: A Case study for Potato Crop in Bradhaman District, West Bengal, *Journal of the Indian Society of Remote Sensing*, 28, 2&3 (2000).
- [6]. Skende D., The Study of Post Harvest Losses in Horticultural Crops in Albania with Main focus on Apple, *Kocara University, Albania*, 2, 173-177 (1996).
- [7]. Subramaniam Siva K.S., Remote Sensing and GIS based Services for Agriculture Supply Chain Management, *RMSI, North Indian States*, 6, 2-3 (2008).
- [8]. Xavier Susai A., Economics Analysis of Mango Pulp Agro based Industry in Krishnagiri District, Tamil Nadu, *Political Economy Journal of India*, 17 (1-2), 45 (2007).