

Geospatial technique for potato cold storage allocation

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Abstract: The present study was conducted to analyse the price and storages issue related to potato in Banaskantha district of Gujarat State, India. Banaskantha district is the major potato growing area which produces around 50 percent of the state's total production. It was observed that 80 percent of the potato in Gujarat is grown in winter and sold throughout the year. Hence, emphasis is given to develop post harvest infrastructure like cold storage. A stud most of the cold storages are concentrated in and around the consuming markets. A study was taken up to analyse the demand and supply situation, the effect on price variations and to evolve an optimum plan to locate cold storages using satellite remote sensing (RS) data and Geographic Information System (GIS). Resourcesat -1 and IRS 1C LISS-III (23 m resolution) images were taken for study purposes. The major factors which account for economics in potato pricing are weather, production, infrastructural such as service area and location of cold storages. All these factors directly or indirectly affect the prices. Farmers have to face huge losses due to inadequate storages facilities. Our analysis of data shows that there is a requirement to increase the number of cold storages and these needs to be located over a larger area nearer to farms rather than to concentrate them in a particular town. It would help in generating revenue for both the government and private sectors and circumvent losses due to transportation. In this study, we have evolved a plan for the location of new cold storages with the help of remote sensing and GIS, keeping in mind the existing ones.

Keywords: Cold storage, Potatoes, Geospatial, Marketing, Price fluctuation

1. Introduction

Potato is the world's fourth most important crop after wheat, rice and maize because of its great yield potential and high nutritive value (Hoffler and Ochieng, 2008; FAO, 2008). It is also one of the important cash crops grown by the farmers of Gujarat. The potato growers in India face various kinds of marketing problems like price instability, lower producer's share in consumer's price, storage problems, etc. The year 2008 witnessed bumper crop production of potatoes in Gujarat due to prolonged winter coupled with better seed varieties and utilisation of sprinkler and drip irrigation methods. The result was that the yield shot up by 30 percent. Instead of being a boon to the farmers it turned out to be a curse. The cold storage facilities were inadequate and farmers had to sell their crop for prices as low as 80 paise per kilogram or Rs.40 for a 50 kg bag. This incident brought forward the scarcity of cold storage facilities as a result causing huge fluctuation in prices. A study was conducted in Banaskantha district, a leading potato growing area of Gujarat, to investigate the demand and supply situation, its effect on price and develop a best possible plan to locate new cold storages using satellite remote sensing (RS) data and Geographic Information System (GIS). S.S Ray et al. (2000) had conducted a similar study on cold storage allocation in Bardhaman district, West Bengal using GIS and RS. The objective of this paper is to determine the most favourable cold storage locations using RS and GIS in Banaskantha district and find out the reasons for the price fluctuation.

2. Materials and methods

2.1 Study area

Banaskantha is a district in Northeast of Gujarat state of India. The region is named after the West Banas River that flows through the heart of the district. Banaskantha borders with Rajasthan state in the North, Sabarkantha district in East, Kutch district in South and Patan and Mehsana district in the South. The District is situated between 23.33 to 24.45 north latitude and 72.15 to 73.87 east longitude with an approx area of 10,757 sq. kilometres. There are about sixty eight cold storages in the study area.

2.2 Data used

Satellite based remote sensing data of Resourcesat -1 LISS-III, from Bhaskaracharya Institute for Space Applications and Geo-informatics (BISAG), Gandhinagar was used for potato crop map generation. To obtain the road network and settlement locations, high resolution remote sensing data of IRS 1C LISS-III (23 m resolution) and Survey of India toposheets were used. The information about the cold storage locations and statistics were collected from the cold storage association of Banaskantha district. Information related to production, productivity and net area under potato cultivation was collected from the District Statistical Office, Banaskantha and Krishi Bhavan Gandhinagar. Weather related information was collected from State Water Data Centre Gandhinagar, Gujarat.

2.3 Remote sensing and Geographic Information Systems analysis

The remote sensing data was georeferenced and the boundary mask of Banaskantha district were overlaid and the whole district area was clipped using ENVI (Environment for Visualizing Images) software. The extracted data was classified using paralleliped supervised classification to distinguish potato growing areas from the rest of the features. The supervised image was then converted to vector layer so that it could be used in Arc GIS for marking out the potato grown areas. Spatial database was generated for all the spatial features like, road network, settlement locations, and cold storage locations using Arc/Info GIS software. The database of the statistics of the cold storages was also linked to the spatial data.

2.3.1 Steps involved in selecting sites of cold storages

Figure 1 gives a brief outline of the methodology involved in selecting the cold storages. Resourcesat-1 LISS- III was used

for potato crop map generation. The data was georeferenced and data corresponding to the Banaskantha district boundary was clipped from the main satellite image. To identify and extract the potato growing areas from the district, Paralleliped Supervised Classification was carried out using ENVI for the years 2005 to 2008 for the months January and February. The potato cultivating areas map was overlaid with maps of roads, settlements and cold storage locations of the district. The sixty three existing cold storages were identified and located on the map. The total storage capacity was calculated and was used to estimate the total deficit capacity considering the fact that forty percent of the produce was likely to be stored in storage facilities by the farmers. The figure of forty percent was estimated by interviewing various farmers in Banaskantha district and cold storage association members. Using these estimates sixteen new cold storages were proposed and located on the map taking into account availability of electricity, distance from the main road, potato production of the area, and most importantly demand of the farmers in that area.

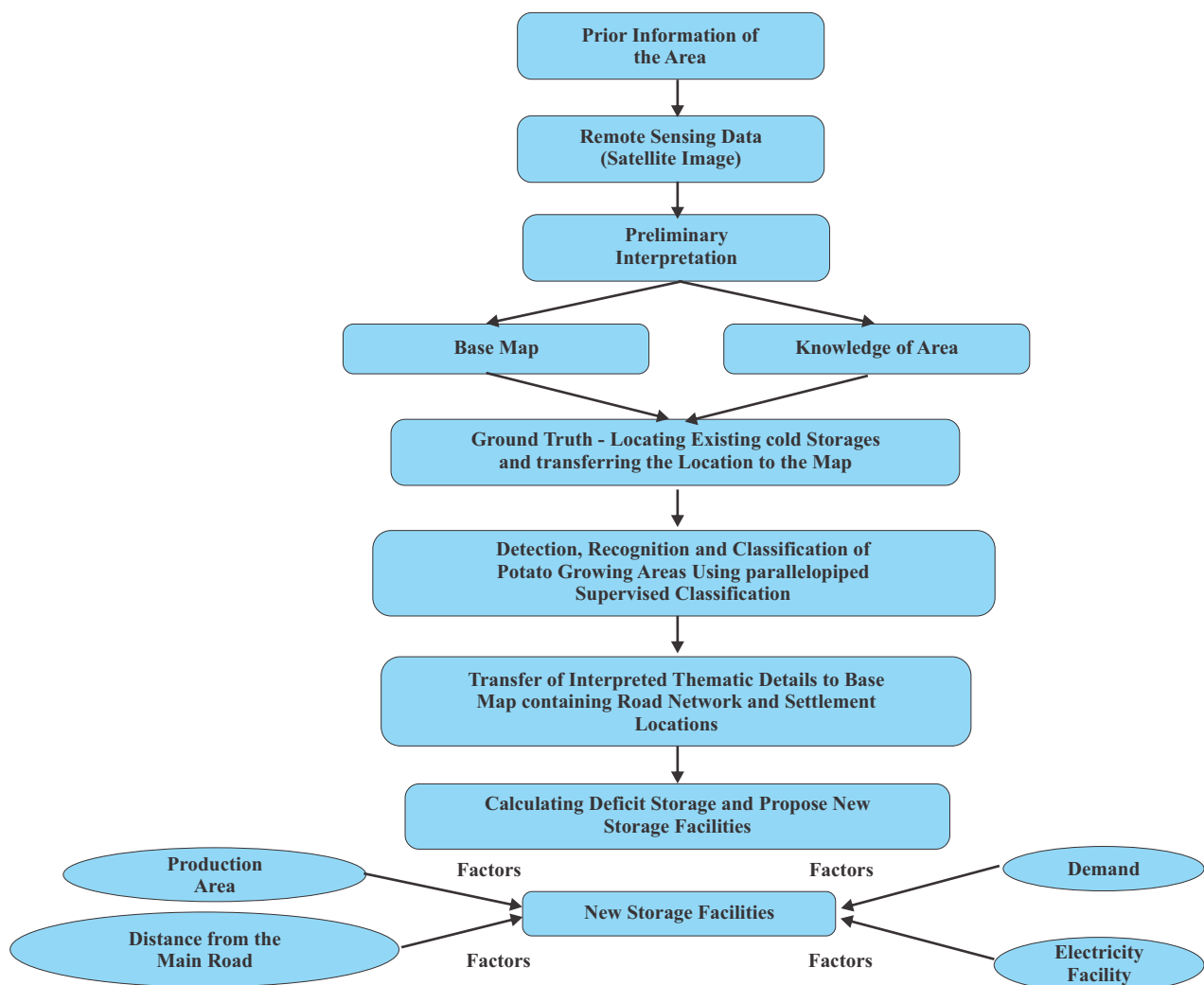


Figure1: Flowchart representing methodology involved in site selection of colds storages

3.Results and discussion

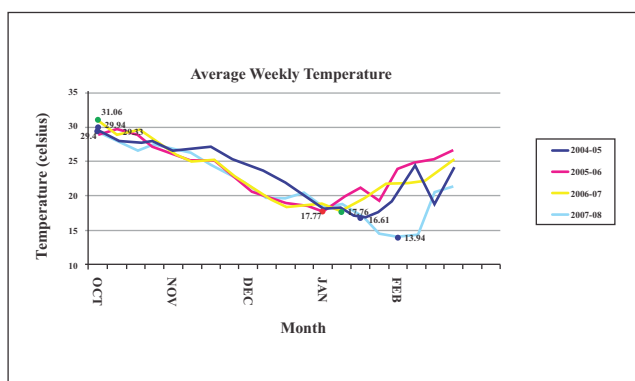
3.1 Other ancillary data analysis to understand the causes of price fluctuation

The analysis has been done based on four separate parameters

1. Relationship between weather and production
2. Price
3. Area and Productivity.
4. Cold storage
5. Transportation

3.1.1 Relationship between weather and production

The graph in figure 2 represents the average weekly temperature range during the potato growing season which starts from October and ends in February. Figure 3 represents the price trends of potatoes over a year. Figure 4 represents the productivity in Kilograms per hectare from 2004 to 2008. By comparing figure 2 and figure 4, one can clearly notice the relation between productivity and temperature. Extended winters in 2007-08 led to an increase in productivity of potatoes cultivation (Indian Express, Ahmedabad, Tuesday, March 22, 2008). Prolonged winters caused the acreage to increase as a result caused the production to further boost up by 10-15 percent. A correlation analysis was carried out between temperature and productivity, which was found to be -0.65, which indicates that temperature does have an effect on productivity.

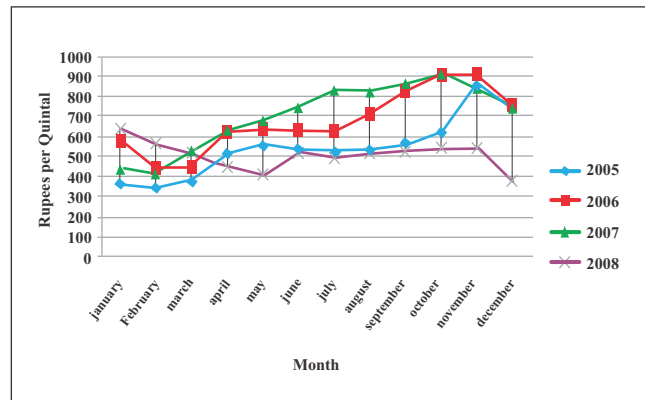


Source: Anand Agricultural University

Figure 2: Weather trends

3.1.2 Price

Prices of potatoes fluctuate every month but follow a similar pattern each year, which can be determined by looking at the graph in figure 3. Prices tend to remain high during October – November due to lean season along with limited availability of stocks in cold storages. The newly harvested potatoes start to arrive in the market from December. As more and more produce starts to enter the market, prices begin to fall. This is evident from February to March when prices remain low. By end of February the harvesting comes to an end and potatoes from cold storage are utilized till October.



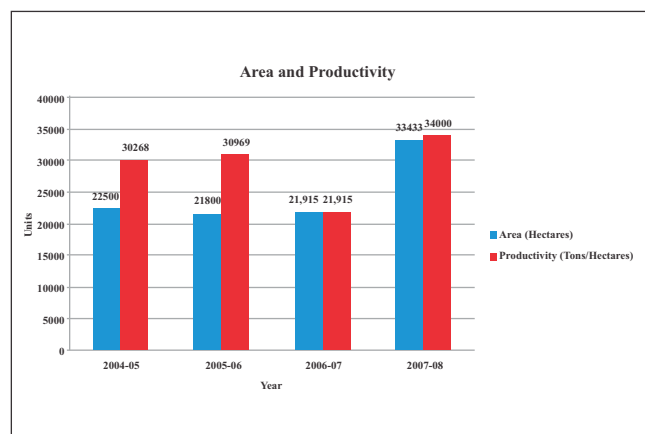
Source: <http://agmarknet.nic.in/>

Figure 3: Price trends

By looking at the graph in figure 3, one can notice an astonishing low market price for potato in the year 2008. This was due to the bumper crop production of potatoes during that year in Gujarat. This sharp decrease in the prices caused potato producers to sell most of their produce way below market rates. There were a large number of cases where farmers had to dump their produce in waste as there were no buyers and transportation cost was much higher than the price of potato itself.

3.1.3 Area and productivity

Over the past few years, potato cultivation has shown a steady increase both in terms of area under productivity except for 2006 where a decline in productivity could be noticed. 2007-08 indicates a bumper crop production resulting 62.4 percent increase in productivity compared to the previous year. Even the area under crop has shown a drastic increase compared to 2006 (Figure 4).



Source: Krishi Bhavan, Gandhinagar

Figure 4: Area and productivity

3.1.4 Cold storage

Banaskantha is considered the heart of potato growing area of Gujarat. There are total 68 cold storages in Banaskantha district. The average capacity of each of the cold storages is around 3270 tonnes and the total storage capacity is 222400 tonnes. Considering the total immediate demand for potatoes

is around 60 percent of the total overall production there is a demand for storage facilities to store 40 percent for the produce. It is evident from table 1 that there is a huge deficit in this respect.

Table 1: Cold storage information

Total number of cold storages in Banaskantha district	68
Average capacity of the cold storages 2007-2008	3270 MT
Total capacity of the cold storages	222400 MT
Average production 2004-2007	680698.66 MT
Total deficit 2004-2007	272279.46 MT
40 percent of total deficit 2004-2007	49879.46 MT
Total production 2007-2008	1136722 MT
Total deficit 2007-2008	454688.8 MT
40 percent of total deficit 2007-2008	232288.8 MT

Source: Cold Storage Association Banaskantha
*MT-Metric tonnes

3.1.5 Transportation

The transportation cost for 50 kilograms of potatoes is 10 rupees for approximately 50 kilometres. This means that per kilogram the transportation cost is 0.5 rupees. Most of the farmers would like to sell their produce in the nearby local market to increase their profits as the minimum support price of potato is Rs 4 per kilogram (in 2008) when procured by the government. But in most cases the farmers have to sell their produce in the open market at the rate of Rs 2-3 per kilogram. This is the reason why farmers are not ready to think about alternative markets.

3.2 Causes of price fluctuation

The focus will be on two major issues first on price fluctuation and second on the lack of cold storages in Banaskantha which has a direct impact on price fluctuations.

3.2.1 Price fluctuation

There are many direct and indirect factors responsible for the fluctuation in potato prices.

- a) Weather is one of the factors indirectly responsible for price fluctuation, for example the 2008, due to a prolonged winter and good monsoon a bumper production of potato was witnessed which caused a slump in the potato prices. An opposite effect was seen the previous year. Due to high humidity and low temperature, a disease called blight destroyed the crop

resulting (AndraNews.net, Tuesday March 11, 2008) in low productivity which caused the prices of potato to rise.

- b) The area under potato cultivation has been on a steady rise. More and more farmers of Banaskantha are cultivating potato as a major cash crop. There had been a 30 percent increase in area in 2008 as compared to previous year. Due to the use of improved variety seeds and good irrigation facilities, the production and productivity of potato had gone up tremendously. Instead of being a boon it became a curse as the demand for potatoes did not increase at the same rate. This has created a requirement to find new markets for farmers.
- c) Another major factor is transportation. Many times the transportation costs are much higher than the price of the potatoes itself. Affordable means of transportation to markets and cold storages are the major factors that influence the price of potatoes.

By providing better storage and marketing services one can improve the allocation of seasonal supplies and reduce seasonal price variability. Timely market information about total production, storage facilities, current prices and price forecasts, marketing services and weather information enable farmers to make better judgments about future market conditions and plan their marketing strategies accordingly.

3.2.2 Cold storages

One of the major reasons for the market price failure was the shortage of storage facility. Banaskantha district does not have adequate storage facilities, which are required specially after harvesting. The majority of the cold storages in Banaskantha district are distributed in and around Deesa taluka (Figure 5), which is the main market from where all the trade transactions take place. A good number of the farmers from other parts of the district were not able to afford to store their produce in the cold storages at Deesa due to the high transportation and labour costs. Ideally cold storages should not saturate around single area such as Deesa. To meet the growing demand for storage facilities, and make them accessible and affordable for farmer's new cold storage facilities should be opened around traditionally high potato producing areas.

Due to the lack of storage facilities the farmers were forced to sell their produce immediately after harvest. As the prices were low and demand was relatively low, the farmers had to incur huge losses. There are around 215 cold storages in Gujarat out of which Deesa alone has around 68 which is considerably less than required (Table 1).

It is clearly evident from table 1 that there is a deficit in cold storage facilities. Considering that 40 percent of the overall production needs to be stored in cold storages, there was still a deficit of 232288.8 tonnes in 2007-08. This figure clearly indicates that the requirement of cold storages capacity was

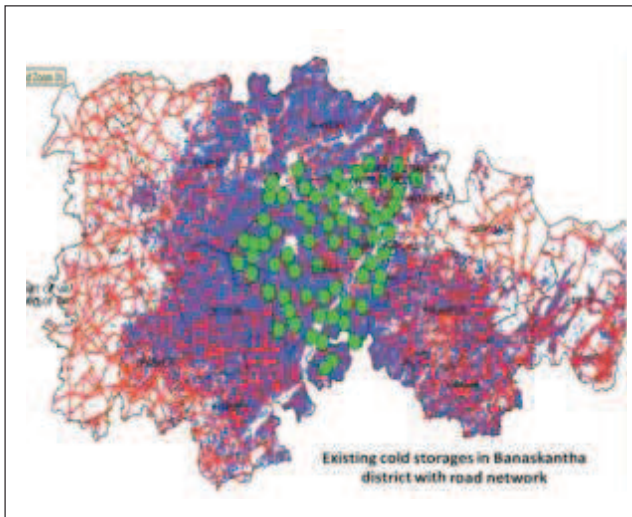


Figure 5: Existing cluster of cold storages around Deesa

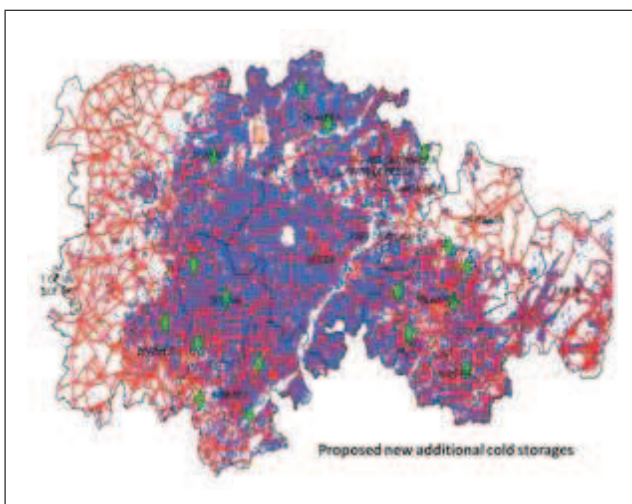


Figure 6: New proposed cold storages

almost double than what exists (222400 MT deficit). Statistics for 2007-08 for cold storage facilities weren't taken into consideration as it was a bumper crop production year. By taking into consideration the previous three years production, that is 2004-2007, it can still be seen that there was a deficit of 49879.46 tonnes which means that 22.42 percent additional storage capacity was required which amounted to an additional 16 cold storages (capacity: 3270 tonnes each) without taking into consideration the increase in area under production and productivity.

Figure 5 shows the clustering of cold storages around Deesa town. Distribution of cold storages over a large area, nearer to the farms gives incentive to the farmers to store their produce in cold storages and helps in reducing the cost of transportation and losses. Figure 6 shows the ideal location of the newly proposed cold storages. These cold storages were proposed taking into consideration the production around the area, productivity and road connectivity. Figure 7 shows the composite map of existing and proposed cold storages.

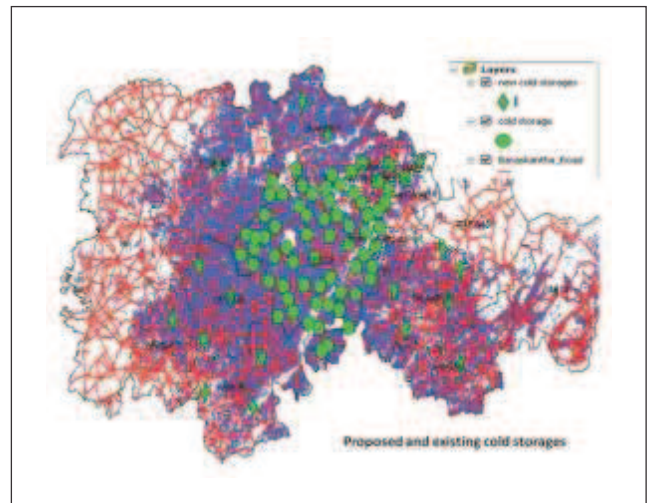


Figure 7: Proposed and existing cold storages

There is a need to look at some other issues that this paper does not discuss. One aspect can be the studies related to demand and supply, as production of potatoes does not remain the same every season. Another area is price estimation in the futures market based on previous year's data. Another consideration can be looking into alternate markets in case of bumper production to prevent losses.

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References

- Andhranews, Tuesday March 11, 2008, <http://www.andhranews.net/India/2008/March/11-Gujarat-bumper-potato-crop-36887.asp>
- FAO (2008). International Year of the Potato, 2008. www.potato2008.org
- Hoffler, H. and B.O. Ochieng (2008). High commodity prices – Who gets the money? Preliminary findings for World Food Day 2008. Heirich Boll Foundation.
- Indian Express, Deesa (Banaskantha), Sun Nov. 30, 2008, <http://www.indianexpress.com/news/lack-of-cold-storages-leaves-potato-farmers-in-the-cold/392419/0>.
- Indian Express, Ahmedabad, Tuesday March 22, 2011, <http://www.indianexpress.com/news/bumper-potato-crop-a-bane-for-deesa-farmers/765662/0>.
- Ray, S. S., S. Dutta, N. Kundu and S. Panigrahy (2000). A GIS and remote sensing based approach to develop cold storage infrastructure for horticultural crops: A case study for potato crop in Bardhaman district, West Bengal. *Journal of the Indian Society of Remote Sensing*, 28(2-3), 171-178.