

**SUITABILITY ANALYSIS FOR LOCATION OF POTATO SUPPLY CHAIN ENTITIES USING GIS AND REMOTE SENSIG IN NYANDARUA CUNTY**

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**Chapter 1: Introduction**

**1.1 Background Information**

Potato (commonly known as Irish potato) is the second major source of income and revenue after dairy production in Nyandarua County. Potatoes are fast growing and take much shorter period to mature compared to other food crops such as maize and wheat. This makes it more adaptive to the fluctuating climatic conditions of Nyandarua County that are usually cold and unfavorable for most food crops like maize and beans. Its production in Kenya has been constantly increasing following the call to farmers from the government to diversify their production.

The population of the County at the last population census of 2009 was 596,268 persons, comprising of 292,155 (49%) males and 304,113 females (51%) (Kenya National Population and Housing Census, 2009). The projected population in 2018 is 712,596 persons; comprising of 349,152 males and 363,443 females (CIDP2, 2017).

Despite the fact that there are other counties such as Nakuru, Bomet, Meru and Narok that grow potatoes, Nyandarua County produces about 33% of the total potato production in Kenya (Waithaka M. 2017). This is due to its cool and wet climate with well distributed rainfall all year round and potato varieties that mature fast thus enabling farmers to plant and make a harvest up to three times in one year. However, the residents face a challenge in the marketing of their produces because they sell directly to consumers majorly through brokers. This most of the time leads to exploitation and poor prices due to the perishable nature of the produces, resulting to great physical and financial loss. The prices also escalate during the recess period and become too expensive for traders and consumers. There is therefore a need for development of **value addition industries, storage facilities and modern market outlets** near the farmers which will ensure controlled and consistent supply that will create some balance and stability in the market price which in turn will ensure that farmers get good returns and traders get reasonable return for their investment and in turn generate more revenue for the county. This should be done because these facilities are mostly concentrated in and around the consumer markets which provide very little services to the marginal farmers during harvesting (Kanali C. 2017).

The industries will also increase the varieties of products obtained from the potatoes, both the food and non-food products.

This study aims at performing suitability analysis of site allocation on where the different supply chain entities can be established in an effort to reduce the post-harvest loss. The industrial allocation factors will be put into consideration so that the selected locations will have the highest economic value and rate of return.

**1.2 Problem Statement**

In Kenya, potato is the second most important food crop after maize. Its ability to grow in the high-altitude areas where maize does not do well, and its high nutritive value, make it an important food and cash crop for people living in these areas (FAO, 2008). In Nyandarua County, it is the leading cash and food crop.

Despite the high potential to contribute in improving welfare of many farmers, potato industry has faced a number of challenges ranging from production, processing, trading and wholesaling and marketing. Potato marketing in particular is poorly structured and farmers generally get very low marketing margin compared to other actors in the value chains. The industrial processing of potatoes is limited to the production of snack type foods such as crisps and other types of snacks specifically for Asian consumers (Kanali C. 2017). The available crisps enterprises are located in Nairobi, over 87km from the County.

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**1.3 Research Questions**

This study will be trying to answer the following questions.

1. What is the state of the current distribution of the supply chain entities in the county?
2. What is the effect of the available supply chain entities on post-harvest loss?
3. How can suitability analysis be used to locate new supply chain entities in order to reduce postharvest loss?

**1.4 Objectives**

The main objective of this study is to perform a suitability analysis for the allocation of additional post-harvest supply chain entities in Nyandarua County in an effort to reduce potato post-harvest loss. The specific objectives will be:

1. To analyze the spatial distribution of the available supply chain entities in county.
2. To determine the relationship between the available supply chain entities and post-harvest loss.
3. To identify suitable locations for additional supply chain entities.

**1.5 Justification of the study**

When implemented, this study will help to stabilize the prices such that there will be equitable benefit amongst all the stakeholders; that is farmers, traders and consumers.

This will be achieved by ensuring that the farmers and traders have a common trading ground that is easily accessible to all. It will also provide storage for the harvested products thus ensuring that these products reach market while still fresh thus higher returns. The consumers will also benefit from the fact that they will have access to a variety of potato products with an added value and longer shelf life.

**1.5 Scope**

This study will cover the confines of Nyandarua County. It will target both the small-scale farmers and large-scale farmers in order to determine how the two categories handle their products after the harvest, to who do they sell and how long do they store their potato after harvest before selling. This study will be carried out in samples with an assumption that the handling in uniform across different farmers and regions.

**2 Literature Review**

Potato industry faces challenges from production processing, marketing, and wholesaling. The poorly structured potato marketing makes the farmer to be the one earning the least among all the actors in the value chain. This leads to the loss of up to a third of the total harvest in terms of physical and financial loss (Kanali C., 2017). This loss is aggravated by the poorly structured supply chain entities such as the cold storage rooms, processing firms and market outlets that are not within the farmers’ reach. The available processors are only located in Nairobi and they only produce crisps thus the amount of potatoes they use for their daily production is way much lower than the amount harvested. Their facilities are also located far from the marginal farmer and he cannot benefit from their storage facilities so he ends up selling his products at a low price so that they don’t spoil in his hands.

One of the big four agendas is food security, potato has a high possibility in aiding the fight against food insecurity because it gives higher yields. However, according to GIZ (2014), per season, 19% of the produce is damaged. The damage occurs from the harvesting to packaging, storage and processing. This is facilitated by the lack of knowledge on the best practices during harvesting, packaging, transportation, storage and processing (Kanali C. 2017).

The supply chain entities that need to be improved are:

1. Establishment of specialized cold storage units- the potatoes are a vulnerable product, when exposed to heat and light, they lose a lot of water and lose the taste. Also, when stored in a dump location, they rot and tones of potatoes are lost.
2. Market Outlets- there is a need to create market outlets that are specialized to handle the potatoes. These platforms will create outlets for local and international trade of potatoes that are fresh and of high quality.
3. Processing units- The county needs processing units. This will increase the market base for potatoes needed for processing. This in turn will diversify the potato products in the market and increase the shelf life

Due to this fact, there is a need to perform land suitability analysis in order to determine the most suitable locations to set up these facilities.

Establishing food manufacturing industries should be treated as a rural development strategy because the value-added activity can increase farm incomes through backward linkages to agricultural production with increased commodity demand, in addition to employment opportunities they provide (Capps, Fuller, and Nichols; Kane and McNamara). Locating the potato processing industries in the rural areas will reduce the bulkiness of the commodity and thus cut on the cost of transportation.

Locations are chosen to gain access to labor, capital, business services, transportation, and technology while meeting procurement/distribution requirements of the firm (Henderson J. R., 2000).

Land suitability analysis is the process to determine whether the land resource is appropriate for some specific uses and to determine the suitability level by considering different factors such as land use and land cover type, landscape, and road infrastructure (Manlun 2003). Land suitability analysis is important in determining land resource for specific function in a given area. Locational analysis encompasses any spatial analysis of the area like proximity to the different services. Physiographic feature describes features and aattributes of the land surface (Mathias Tesfaye Abebe 2017).

Industrial location is an important factor at local, regional, national or even national level. It is influenced by a number of factors such as “transportation, labour, raw materials, markets, industrial sites, utilities, government attitude, tax structure, climate, and community.” (Badri M. A., 2007). Some other factors such as environmental impact of the industry, the supply of both agricultural and non-agricultural raw materials and availability of land and infrastructure (Sule Turhan, Basak Canan Ozbag and Bahattin Cetin, 2007).

**Conceptual Framework**



Research Design

**Chapter 3 Research Methodology**

This topic will cover details on the research design that will be used for this study, the study area where the research will be carried out, methods and tools that will be used in the data collection and the sampling techniques to be used during the study.

**3.1 Research Design**

According to Selltiz C. as cited by Kothari C. R. in *research Methodology*, “research design is the arrangement of conditions for collection and arrangement of data in a manner that aims to combine relevance to the research with economy in procedure.”

This study is going to use **diagnostic design** for it will be performing the suitability analysis of supply chain entities. It will be employing the multi-criteria evaluation in order to test and diagnose the suitability of selected areas for development.

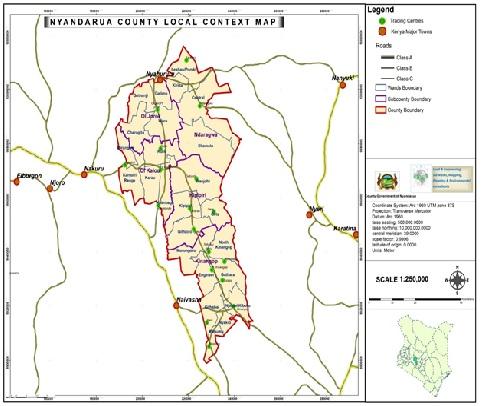
**3.2 Study Area**

Nyandarua county lies in the central part of Kenya between latitude 0°8’ North and 0°50’ South and between Longitude 35° 13’ East and 36°42’ West. Nyandarua borders Nyeri to the East, Laikipia to the North, Nakuru to the West, Murang’a to the South East and Kiambu to the South. The County is mainly linked to the major town centers in the region (Nakuru, Nyeri and Nyahururu) by road, the dominant mode of transport.

Nyandarua County covers an area of 3,245.2 Square Km lying between latitude 0°8’to the North and 0°50’to South and between 35° 13’East and 36°42’ West. Nyandarua County is divided into five Sub-Counties namely: Olkalou, Kinangop, Kipipiri, Ndaragwa and OljoroOrok and further into twenty-five wards. It had a population of 596,268 people, according to the 2009 National Census.

Nyandarua is one of the Kenyan Highlands. The topography of Nyandarua County constitutes of a mixture of plateaus and hilly areas. The County’s physiography was as a result of volcanism and faulting that created the major land. The highest point of the Aberdare Ranges is about 3,999 meters above sea level. The lowest parts include Lake Ol’Bolossat, Leshau and the northern part of Central Ward, lower Kaimbaga and the western parts of Kipipiri, Githioro and Murungaru Wards. The flat areas include Kinangop and Olkalou/OljoroOrok plateaus. The county has eight permanent rivers namely; Malewa, Ewaso Narok, Pesi, Turasha, Chania, Kiburu, Mkungi and Kitiri. Lake Olbolossat which is the largest water mass in the county is fed by streams and underground water seepage from the Aberdare and Dundori hills.

Nyandarua County has a cool and wet climate with reliable well distributed rainfall. In a typical year, the county experiences two rainy seasons: long rains from March to May with a maximum rainfall of 1,600 mm and short rains from September to December with a maximum rainfall of 700 mm. The average annual rainfall of the county is 1,500 mm (CIDP2, 2017).



Source: county integrated development plan 2017-2022 pg 26.

**3.3 Data Collection Methods to be used**

This study is going to collect data both from primary and secondary sources. The primary data source will be observation, interviewing, questionnaire administration and GPS coordinates recording.

The secondary data source will be the publications from other studies, google earth images, and remote sensing images from the internet.

**3.3.1 Observation**

Though observation is not a scientific tool, when it serves a formulated research purpose and systematically and recorded and subjected to checks and controls on validity and reliability, then it becomes a scientific method (Kothari C. R., 2004).

The observation method is used to collect data without getting it from any respondent. The researcher gathers the information by looking for themselves.

Due to the subjective nature of this method, this study will utilize the *structured observation*. This is because the structured observation provides guidelines on the selection of the data to be observed, units to be observed and the style of recording the observed data. The tools that will be used for this method are:

1. Camera- this will be used to take photographs for different locations and phenomena
2. Checklists- these will be used to countercheck whether all the information that was to be collected has been met.
3. GPS Receiver- this will be used to collect the geographic coordinates of the physical entities that will be observed at the ground.

**3.3.2 Interviewing**

This is a data collection method that involves the researcher gathers the information from the respondents orally. The interview can be *personal* where the researcher and the respondents meet face-to-face or *telephone interview* where the researcher communicates with the respondent over the telephone.

This study will use personal interview where I will interact with farmers, traders and authority personnel to obtain the key matters on the state of the supply chain entities under study. This method will help me get firsthand information on how they handle their products after harvesting and how insufficient supply chain entities contribute to the post-harvest loss.

This method will be used to obtain information from farmers and traders regarding the challenges they face in the supply chain entities. It will be also used to get their preference on the possible areas where these supply chain entities can be enacted.

**3.3.3 Questionnaire Administration**

A questionnaire constitutes of a set of structured questions that are either typed or printed. It is administered to the respondents and they fill in the questions therein thus giving the researcher the information. The questions can be either closed or open ended.

In this study, both open ended and closed questions are going to be administered in an effort to get information from the different stakeholders. There will be questionnaire that will be developed for the farmers and another one for the traders

**3.3.4 Secondary Sources**

The secondary sources of data that are going to be used for this study include:

1. Google Earth images

This will be used to collect data that will be used as the base map for the analysis. They will also serve as the data input for digitization.

1. Remote Sensing images

These images will be obtained from USGS website. They will also be obtained from the Natural Earth website. They will be used to provide topological data, elevation data, land use and land cover data.

1. Survey data

This study will also use shapefiles from Kenya Data that will be used to delimit boundaries of the different sub counties. This will also provide spot elevation data that will be used to develop digital elevation model (DEM). This data will also be obtained from the county land offices.

1. Journals and Publications

These materials will be used to give more information about the topic of the study. They will include the county policies and plans, publications on suitability analysis and on factors that influence industrial location. These will help in giving a detailed and informed decision why and where to locate the different supply chain entities.

These will be gotten from the different county departments as well as from the internet. Reference will also be made from the hard copy of some research books.

**3.4 Sampling Methods**

Sampling is the “selection of some part of an aggregate or totality on the basis of which a judgment or inference about the aggregate or totality is made” (Kothari C. R.).

Sampling enables the researcher to save on time and money. The study does not have to be carried out in the whole population but a section of the population may be used to represent the rest. This helps the researcher to conduct the study faster and with less resources.

In this study, Multi-stage sampling will be used. This will involve selecting a number of sub-counties from the county, then a number of wards from the sub-counties then a number of farmers from each ward.

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