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THE SPATIO-TEMPORAL DISTRIBUTION OF PERIODIC BANANA MARKETS IN MERU COUNTY, KENYA

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ABSTRACT

The spatio-temporal distribution of markets can influence the farmer's choice of a market channel. Assessing the effects of the spatio-temporal distribution of banana markets on the farmer's choice of a marketing channel is important in providing information that may guide rural planners and developers. This study examined the pattern of distribution of banana markets in space and time, and its effects on farmers' choice of market channel in Meru County, Kenya. The authors obtained data from field observations, measurements and questionnaires administered to 384 banana farmers. We analysed the data through Pearson correlation coefficient, nearest neighbour statistic and analysis of variance. The results revealed that banana markets are not: uniformly distributed, Rn = 0.31, $p < .0001$; synchronised, r = -0.530, p = .076; and distances between farms and markets significantly varied from location to location, F = 12.007, $p < .000$. The paper concludes that the periodic banana markets in Meru County are not spatially organised to adequately serve farmers with 47.4 % resorting to farm-gate selling. The study recommends that rural planners and developers reorganise the markets such that as spatial distance increase, the time distance decreases. This would ensure synchronisation and promote service delivery to farmers.

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INTRODUCTION

Unstructured rural markets impede farmers' meeting with buyers, amplifies post-harvest losses, and limits the assemblage of rural activities (Tracey-White, 2003). Studies examining the nature of rural markets reveal that markets have varied features (Abu *et al*., 2013; Mwithirwa, 2010; Wambugu, 1994, 2005). The features include: diverse spatial and temporal distribution patterns such as random (Abu *et al*., 2013), uniform (Wambugu, 1994); various week lengths including 7 day week length (Hill and Smith, 1972), 5 day week length (Abu *et al*., 2013); and poor infrastructure - prohibitive distances, poor roads, inadequate stores, toilets and piped water (Wambugu, 1994, 2005). Another key generalisation is that markets rarely concurrently meet the needs of buyers and sellers (Abu *et al*., 2013; Mwithirwa, 2010; Wambugu, 1994).

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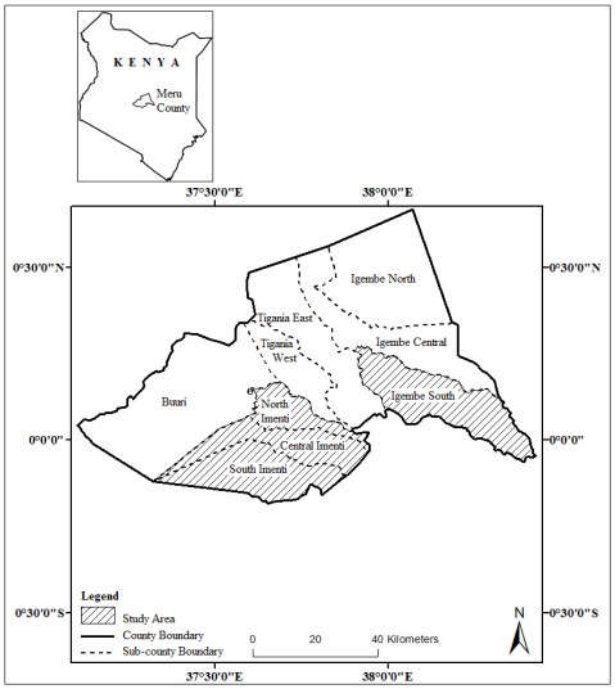
Such studies have also highlighted the factors influencing such markets' operations (e.g., Mwithirwa, 2010). Studies examining the nature of rural markets have not focused on the effects of periodicity and locational patterns of markets on farmers' choice of marketing channel. Thus, in this study, we seek to understand the spatio-temporal distribution of banana markets in Meru County, Kenya. The study also examines the effects of the prevailing spatio-temporal distribution of banana markets on farmers' choice of marketing channels.

MATERIALS AND METHODS

Study area

Geographically, Meru County is located in Eastern Kenya. The County straddles the equator and lies within 0° 6' north and about 0° 1' south, and latitudes 37° west and 38° east. It has a total area of 6,936.2 km^2 (Republic of Kenya, 2013). The County is made up of nine administrative sub-counties. These are; Imenti South, Imenti Central, Imenti North, Igembe South,

Igembe North, Igembe Central, Tigania East, Tigania West and Buuri (Figure 1). A wide range of crops for subsistence and commercial purposes including bananas are grown (Republic of Kenya, 2013).



Source: Mbuthia (2018)

Figure 1. Map of Meru County

Selection criteria

The data used in this study was based on a survey conducted between March 2015 and July 2015. Meru County has 49 trading markets, dealing with agricultural produce (Republic of Kenya, 2013). Out of the 49 markets, only banana markets were included in the sample. These markets are; Tiira, Maua, Kanuni, Kariene, Kanyakine, Gakoromone, Miruriiri, Mitunguu, Mujwa, Kamachege, Ntharene, and Mwichiune. In order to provide the actual locations of banana markets in Meru County, a reconnaissance visit to the twelve markets was done. During the visit, we used a Global Positioning System (GPS) – GARMIN: *GPSmap76CS* to map the actual location (latitude and longitudes) of every banana market. The data needed to achieve the objective of the study include; banana markets, their spatial locations, their temporal (days) separation, inter-market distances, banana sources and destinations, and distances between farms and markets. These data were generated mainly from the sub counties agribusiness officers and banana farmers. To capture the spatio-temporal patterns of periodic banana markets in Meru County, we first mapped the spatial locations of markets and then determined the inter-market distances using a measure line icon in QGIS version 2.10.1.

In order to determine the temporal distances (days) between periodic banana markets, we considered the days between nearest neighbour's market day or days. Where more than one market took place in a given market day, we picked the day closer to the market of interest. Questionnaires for farmers were designed to obtain data on location of banana farms, type of market channel and type of buyers. A total of 384 randomly selected banana farmers responded to the semi-structured questionnaires.

The researcher and three trained research assistants administered the questionnaires to the respondents. The respondents were drawn from Imenti South, Imenti Central, Imenti North and Igembe South sub counties of Meru because these regions produced 87.6 % of the total bananas produced in the entire County in the year 2013 (Ministry of Agriculture, Livestock and Fisheries, 2015).

Analytical Techniques

The nearest neighbour index (*Rn*) of the form (Henkel, 1984):

$$Rn = \frac{d_o}{d_e}$$

Where; N = number of banana market places in Meru County, d_o = observed mean nearest neighbour distance, d_e = expected mean nearest neighbour distance if points are placed randomly, A = area of the study region, was used to give a numerical spatial distribution of periodic banana markets. The *Rn* was further statistically qualified by converting it into Z-scores using the formula (Hammond and McCullagh, 1978):

$$\mathrm{Z} = \frac{d_o - d_e}{\delta_{d_e}}$$

Where; δ_{d_e} is the standard error of d_e and is calculated through the formula (King, 1969).

$$\delta_{d_e} = \frac{0.26136}{\sqrt{N(N/A)}}$$

The relationship between mean spatial distance and the temporal separation of banana markets in Meru County was determined through Pearson product moment correlation coefficient (*r)* of the form (Hammond and McCullagh, 1978):

$$r = \frac{1/n\sum(a - \bar{a})\ (b - \bar{b})}{\sigma_a \,.\, \sigma_b}$$

Where; n is the number of pairs (a, b) values, σ_a is the standard deviation for *a,* σ_b is the standard deviation for *b*, and $\bar{a}, \bar{b}$ are means for *a* and *b.* The statistical differences in average distances between banana farms and banana markets in different locations of Meru County were determined using the analysis of variance (ANOVA). The F-value calculated through the formula (Singh, 2007).

$$\mathrm{F} = \frac{\mathrm{E_o}}{\mathrm{E_w}}$$

Where; $\mathrm{E_o}$ is the estimate of population variance based on overall distribution and $\mathrm{E_w}$ is the estimate of population variance based on within sample variance

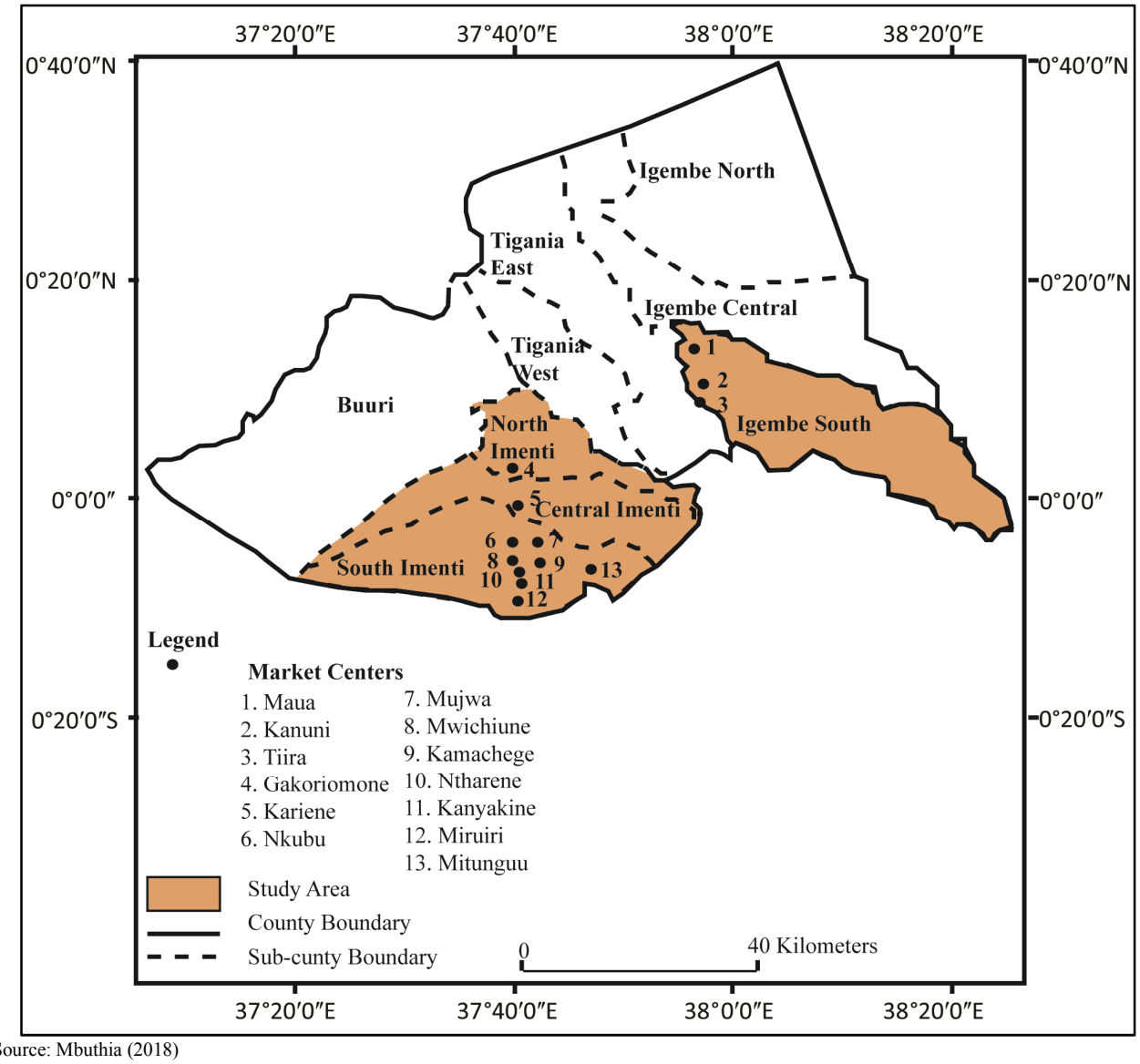
RESULTS AND DISCUSSION

The results of this study revealed that the distances between the twelve banana markets ranged from 0.9 kilometres to 68.1 kilometres (Table 1). As depicted in Table 1, while some markets are relatively closer together (e.g., Ntharene and Kanyakine), others are widely spaced (Gakoromone and Maua).

Table 1. A Matrix showing Euclidean Distances in Kilometres between Banana Markets

Market	1	2	3	4	5	7	8	9	10	11	12	13
1	0	7.9	9.4	68.1	67.3	61.6	63.8	65.9	62.6	62.5	61.8	62.3
2	7.9	0	2.5	67.2	67.1	61.2	64.5	64.7	62.8	63.0	62.5	60.8
3	9.4	2.5	0	64.8	64.6	59.0	62.3	61.9	60.7	60.7	60.5	58.5
4	68.1	67.2	64.8	0	4.5	7.0	7.8	5.1	10.8	10.2	12.9	9.6
5	67.3	67.1	64.6	4.5	0	5.6	4.0	9.2	6.9	6.4	9.0	13.2
7	61.6	61.2	59.0	7.0	5.6	0	4.1	8.9	5.9	5.2	7.6	10.8
8	63.8	64.5	62.3	7.8	4.0	4.1	0	11.5	3.3	3.2	1.8	15.7
9	65.9	64.7	61.9	5.1	9.1	8.9	11.5	0	14.1	13.5	16.2	4.8
10	62.6	62.8	60.7	10.8	6.9	5.9	3.3	14.1	0	0.9	2.1	16.4
11	62.5	63.0	60.7	10.1	6.4	5.2	3.2	13.5	0.9	0	1.8	15.7
12	61.8	62.5	60.4	12.9	9.0	7.6	5.1	16.2	2.1	1.8	0	18.2
13	62.3	60.8	58.5	9.6	13.2	10.8	14.3	4.8	16.4	15.7	18.2	0

Note. 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, and 13, forming the column and row headings represent Ntharene, Kanyakine, Miruriiri, Mwichiune, Mujwa, Kariene, Gakoromone, Kamachege, Mitunguu, Maua, Kanuni, Tiira, and Nkubu markets, respectively.
Source: Mbuthia (2018).



Source: Mbuthia (2018)

Figure 2. Spatial Distribution of Banana Markets in Meru County

Mapping of banana periodic markets in Meru County revealed that three markets are closely located within Igembe South while the rest are within Imenti South, Imenti Central, and Imenti North (Figure 2). Most (8) of the markets are in Imenti South perhaps due to its high gross banana production. Apart from Gakoromone, all the other markets operated along major all weather roads. Results on temporal distribution of periodic banana markets in Meru County revealed that the markets operated in six days of the week (i.e., Monday to Saturday) (Table 2). This incomplete market cycle may be explained with respect to the communities' religious beliefs. Majority of the farmers in Meru County considered Sunday a sacred day in which farming activities were barely undertaken. There was on average three markets operating on each day of the six-day week (Table 2). As Table 2 shows, there was disparity in the number of markets functioning in a given day with some having two and others five.

Table 2. Periodic Banana Markets and their Respective Market Days

Market Name	Market days					
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Ntharene	√	-	-	-	-	-
Kanyakine	-	-	-	-	√	-
Miruriiri	-	-	-	√	-	-
Mwichiune	-	-	√	-	-	-
Mujwa	-	-	√	-	-	-
Kariene	-	-	√	-	√	-
Gakoromone	√	-	√	-	√	-
Kamachege	-	-	-	√	-	-
Mitunguu	-	√	-	-	-	√
Maua	-	√	-	√	-	√
Kanuni	-	√	-	√	-	√
Tiira	-	√	-	√	-	√

Note. √ indicates the market's day(s)
Source: Mbuthia (2018)

Table 3. Time and Location Distance between Periodic Banana Markets in Meru County

Market name	Nearest neighbour market	Spatial distance (km)	Temporal distance (days)
Ntharene	Kanyakine	0.9	4
Kanyakine	Ntharene	0.9	4
Miruiiri	Kanyakine	1.8	1
Mwichiune	Kanyakine	3.2	2
Mujwa	Mwichiune	4.1	0
Kariene	Mwichiune	4.0	0
Gakoromone	Kariene	4.5	0
Kamachege	Mitunguu	4.8	2
Mitunguu	Kamachege	4.8	2
Maua	Kanuni	7.9	0
Kanuni	Tiira	2.5	0
Tiira	Kanuni	2.5	0
Total		41.9	15

Source: Mbuthia (2018)

Table 4. Distance between Banana Farms and Nearest Banana Market

Distance (km)	Imenti North		Imenti South		Imenti Central		Igembe South		Entire sample	
	f	%	f	%	f	%	f	%	f	%
Up to 2	43	44.8	63	65.6	26	27.1	51	53.1	183	47.7
2.1- 4	15	15.6	16	16.7	18	18.8	34	35.4	83	21.6
4.1 – 6	21	21.9	9	9.3	45	46.9	7	7.3	82	21.4
6.1 – 8	13	13.5	4	4.2	5	5.2	3	3.1	25	6.5
More than 8	4	4.2	4	4.2	2	2.1	1	1.0	11	2.9
Total	96	100	96	100	96	100	96	100	384	100
Average distance	3.5		2.5		4.1		2.6		3.3	

Source: Mbuthia (2018)

On one hand, markets occurring close together in time (days), for instance, Tiira and Kanuni were not widely spaced in kilometres (Table 3). The results revealed that Tiira, Kanuni and Maua markets, operated at specific times during the same market days. Although the time was not strictly adhered to, Tiira market day began as early as 7 am to around 10 am. Kanuni's market day commenced at about 9 am to about 12 noon. Maua market started operations after 12 noon. However, the operation times for the markets were not strictly adhered to. The study established that Kanuni and Tiira markets partly supplied bananas to Maua market. All the three markets exclusively served Meru County (i.e., Igembe North, Tigania East, Tigania West, and Igembe Central). On the other hand, markets that had wide temporal spacing such as Ntharene and Kanyakine were not widely separated in location (Table 3). This finding may imply a lack of synchronization of periodic banana markets. Thus, some periodic banana markets in Meru County may face unhealthy competition to serve the same population at relatively the same time. Such competition may lead to a prominence of some markets at the expense of others. This may mean that farmers located at far distances from such markets may have to incur extra costs to access the markets.

For instance, depending on what means of transport the farmers use, they may spend more time as well money in moving bananas to the markets. The *r* analysis yielded a moderate and negative value of -0.530. This indicates that an increase in spatial distance is associated with a decrease in temporal distance. A statistical significance test of the relationship between the spatial distance and the temporal separation of periodic banana markets in Meru County was found to be not significant, p = .076 at .05 level. The nearest neighbour statistic, *Rn* = 0.31, indicated a tendency towards a clustering distribution. A statistical significance test of *Rn* was found to be significant, *p* = .0001 at .05 level. This was interpreted to mean that periodic banana markets in Meru County are not uniformly distributed. This observation may partly be explained with respect to markets bulking activities that these markets perform, enhancing trade for wholesalers who transport their consignments to far located deficit regions. These findings disagree with findings of studies focusing on cereals (e.g., Mwithirwa, 2010; Wambugu, 2005) that such markets were uniformly distributed. This discrepancy in findings may partly be because of the perishability nature of bananas. Therefore, whereas cereals can be stored after

harvesting for relatively long period, bananas spoil within two weeks. Thus, bananas necessitate selling soon after harvesting. Results of this study showed that banana farms were located at relatively short distances to markets. About half of banana farms (47.7 %) were located within a distance of up to 2 kilometres from the nearest banana market, 43 % between 2.1 kilometres to 6 kilometres and only 2.9 % covered more than 8 kilometres (Table 4). On average, the distance covered in the entire study area was 3.3 kilometres. The distance however, varied from one sub-county to the other as follows; 3.5 km in Imenti North, 2.5 km in Imenti South, and 4.1 km in Imenti Central, and 2.6 km in Igembe South. An ANOVA test yielded a significant difference, $F = 12.007$, $p < .000$ at .05 level in distances covered between farms and nearest markets.

Majority of the farmers (47.4 %) sold their bananas at the farm-gate, 18.8 % at the roadside markets, and the rest at both farm-gate and roadside markets. Farmers reported that farm-gate selling relieved them from the burden of harvesting, post harvest handling, transporting of bananas, and enabled them to dictate banana prices. Farmers felt that they were completely in control of non-harvested bananas on their farms. A *t* test yielded a significant difference, $t = 29.135$, $p < .000$, between prices fetched at the farm-gate and markets. On average farmers earned less ($ 1.57) at the farm-gate compared to $ 2.23 at market place per bunch of banana sold. Besides, some farmers selling at the farm-gate sold bananas before they were fully developed and mature. Such transactions transferred banana 'ownership' to the buyer who waited for the banana fruit to mature on the farmer's land. The buyers' 'temporal' ownership of the bananas on the producer's farm denied the farmers the control over the land and benefits that would result from future price rise speculations. The study further revealed that non-all weather feeder roads that became impassable during rainy seasons connected farmers to markets. Moreover, human porterage and motorcycles were the main means of transport used at the farm level. Impassable roads and the means of transport used at the farm level heightened the transport cost in terms of time and effort used as well as crop spoilage resulting from road accidents.

Conclusion

This study concludes that the periodic banana markets in Meru County are not spatially organised to adequately serve farmers. This is because of the significant clustering distribution of markets and the non significant inverse correlation between mean inter-market distances and temporal separation. The markets tend to serve wholesaler traders adequately than they do for farmers. This situation is supported by the finding that banana markets operated along main all weather roads. The study also concludes that spatio-temporal aggregation of markets offered stiff competition to the small markets and created chances for buyers to dictate prices for farmers. It is therefore recommended here that the county government should reduce the banana markets in Meru County to 6 to reflect the 6-market days that the markets function. This would ensure market viability by reducing competition. As markets are reduced in number, their location should be reorganised such that as spatial distance increase, the time distance decreases. This would ensure synchronisation and that farmers are adequately served.

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