

Spatio-temporal Variation in Area of Production, Number of Holders and Productivity of Coffee (*Coffea arabica* L.) and Khat (*Khat edulis* L.) in West and East Hararghe Zone, Eastern Ethiopia

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ABSTRACT

Coffee and Khat are the major cash crop in Ethiopia. To undertake the study secondary data was collected from Central Statistical Agency of Ethiopia for 10 years. Mann-Kendall's was used to test the trend. The result of the study indicated that Khat production has been dramatically expanding in both Hararghe zone regard to both Khat production area and number of small holders. Besides, the result indicated increasing trend for Khat productivity in west Hararghe zone; but decreasing trend in east Hararghe zone. In west Hararghe zone coffee production area and number of holders had showed decreasing trend. However, in east Hararghe zone coffee production area had showed increasing trend by factor of 2200 ha/year; whereas, number of holders had showed significant increasing trend. Comparing year of production 2006/7 with 2019/20 Khat area coverage had increased by 33% in west Hararghe zone. In contrary, coffee area coverage decreased by 72% when year of production 2006/7 compared with 2019/20 in west Hararghe zone. Moreover, the result indicated that decreasing trend of coffee productivity; regardless expansion of coffee production area and increase number of smallholder farmers in east Hararghe zone. Therefore, generally sustainability of coffee production in Hararghe is under question.

Keywords: Coffee; Khat; Area of Production; Number of Holders and Productivity; East and West Hararghe

INTRODUCTION

Khat belonging to family Celastraceous is considered an evergreen plant, cultivated for the production of leaves having sympathomimetic actions, which are used commonly for gradual chewing. Khat production and consumption occupy a major area in eastern Africa, South-west Arabia, and Madagascar. In Ethiopia, this is grown extensively in the middle altitudes between 1500 m.a.s.l. and 2100 m.a.s.l., and performs better on well-drained soil under diverse climatic conditions [1].

The distribution of Khat in tropical Africa extends from north Arabia to South Africa. In Africa it is well established in Ethiopia, Eritrea, Somalia, Kenya, Tanzania, Uganda, Burundi, Rwanda, Democratic Republic of Congo, Zambia, Zimbabwe and South Africa, despite efforts of the respective governments to discourage its cultivation. In East Africa, it grows in the range of 1500-2500 meters above sea level (m.a.s.l.). Outside Africa, it is planted in the Arabian Peninsula, Yemen, Afghanistan, India and Sri Lanka for consumption and in the USA, UK and France for experimental purposes [2].

Ethiopia is the world's largest producer of Khat, which has become the fastest growing export commodity. The history of domestication and introduction of this crop in Ethiopia is not known. According to the folklore, it was first introduced in Harar from where it spread to rest of the country. The major production area of Khat in Ethiopia is the Hararghe highlands located in eastern Ethiopia. It has however been observed Khat production has also been expanding in other regions of the country. Despite silent support and objection against the crop by development institutions, Khat is cultivated and expanding in different parts of Ethiopia. At present Khat is being grown for sale not only in its traditional areas in Hararghe but in Jimma, Shashemene, Sidama, Kembata, Gurage, and even as far as Debre Libanos, Gojam, Wollo and Tigray [3].

Oromia, mainly East and West Hararghe zones, is the most important center of Khat production. The two zones alone contribute half of the total product in Ethiopia. Hararghe is also considered as the most important producer of quality Khat in the world [3]. Despite the government has a policy of non-engagement policy of government with questions of Khat production, marketing and consumption [4]; more dramatic expansion of Khat

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production into new areas along the shifting Khat frontier [5]. The Hararghe highlands' location and its superior transport network have played an important role in the expansion of Khat since the product has to reach its final destination fresh and therefore fast transport is needed. In the domestic market, it is quite evident that Khat chewing has become a recreation activity and now also forms part of the culture of the urban youth [6].

Farmers in a number of areas in Ethiopia grow Khat, which is used as a stimulant, and which provides considerably greater incomes than can't be achieved with the cultivation of other cash crops, including coffee. Less labour and fewer other inputs are required for the cultivation of Khat than for other cash crops [3]. The export price is also rising. While Khat enjoys a relatively stable price at the world market, coffee suffers from both fluctuating export volumes and prices. Producing Khat has thus become a viable and important alternative to ensure continued cash income. Khat has additional advantage because it can be harvested at least twice a year under rain fed agriculture while up to five harvests per year is possible under irrigation. This ensures that households have a well-distributed flow of income [3].

Another economic factor for the growing interest in Khat production is related to its cost of production relative to other competing enterprises. Labour is the most important cost item in the production of Khat. Rapid population growth in the

highlands of Ethiopia has provided enough family labour or highly cheap hired labour for labour-intensive production, making Khat production feasible. In the second place, Khat is hardly affected by any disease except some damage by insects that can easily be controlled by locally developed methods at little or no cost. Khat need for minimum off-farm inputs makes its production compatible with poor farmers' limited access to credit [7].

According to the survey (Tefera) area, cropland area allocated to Khat ranges from 21% in Kuni (Chiro District) to 54% in Haramaya. It was also observed that the majority of irrigated land is allocated to Khat production and in addition, Khat enterprise consumes most of the scarce organic manure in farm households. It can be grown rain fed and/or irrigated, though the later covers less than 20% of the total Khat production area. The crop could be planted both in home garden and in the field.

Ninety five percent of Ethiopia's coffee is produced by smallholder farmers on less than two hectares of land while the remaining five percent is grown on modern commercial farms. Despite Ethiopia's immense potential for increasing coffee production, average per hectare yield remains very low at 0.72 MT per hectare. According to Abu and Teddy study, one of the major factors cause low coffee production is Production of Khat is increasingly competing with coffee for farmlands particularly in the eastern part of the country in the Hararghe region [8]. Khat is a crop with relatively

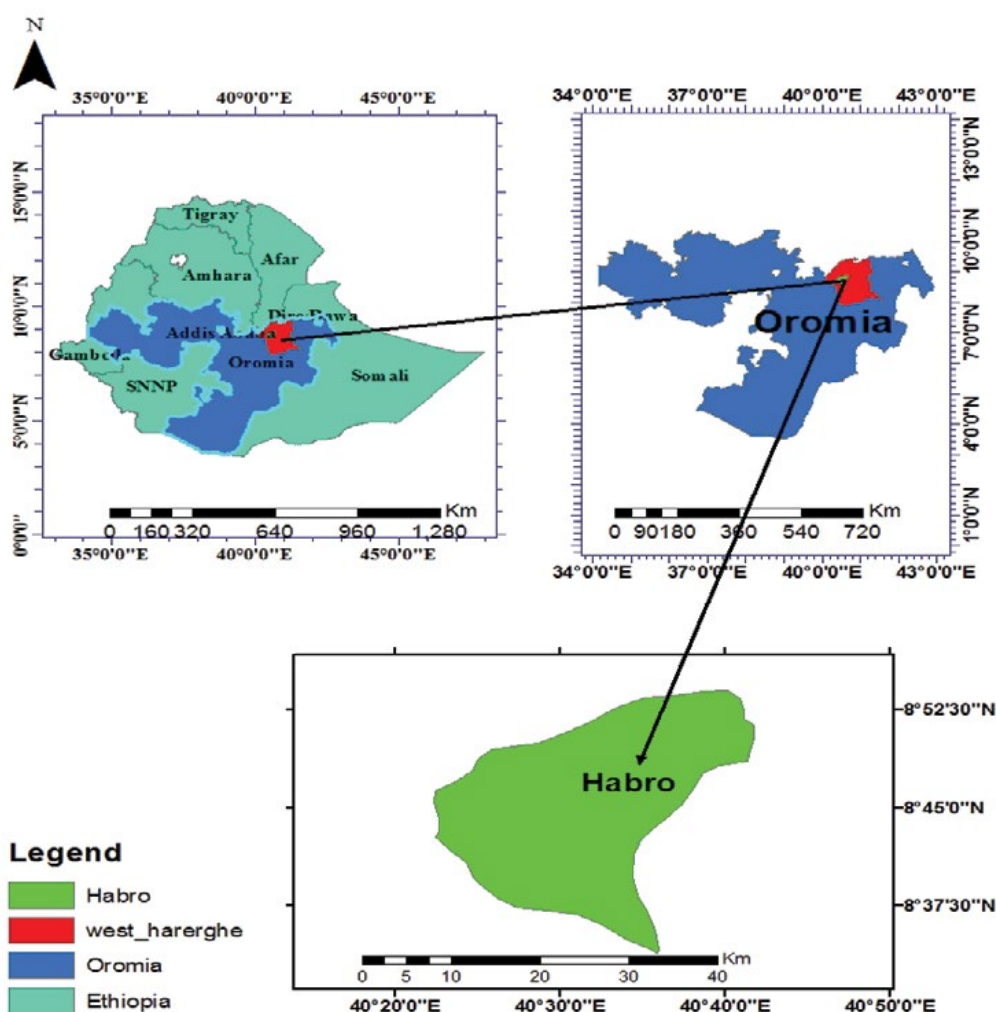


Figure 1: Map of the study area.

high resistance to drought, disease, and pests. It can be harvested three or four times a year and generates better income for farmers than other cash crops including coffee. Several small-scale farmers in the Hararghe region have switched from coffee production to Khat production. The fact that coffee farms are being changed into Khat farms has offset newly planted coffee farms in other regions resulting in a very marginal increase in overall size of area planted to coffee during the study period [8].

Guinand indicated that Khat and coffee are the two major cash crops produced in Hararghe [9]. Whereas, Khat witnessed a tremendous boom these days, coffee is facing a major drawback due to unstable and decreasing prices at the international stock exchanges. Many farmers opted and are opting to cut down their coffee plantations and to replace them with Khat bushes. However, Khat is not only taking coffee's place, it is also planted in favour of staple crops. Many parts of the Hararghe highlands, East and West Hararghe alike, are beginning to turn into a monoculture landscape with Khat being the dominant crop planted and seen everywhere.

According to Feyisa and Aune study results in Habro District, West Hararghe as quote Khat production in this district is rapidly replacing cereal and coffee production [4]. About 70% of farmers' income in the study area was obtained from Khat. One important reason for the expansion of Khat production is that the Khat-maize intercropping system is 2.7 times more profitable per hectare than maize mono cropping. Khat is also less risky to grow than cereals and coffee because it is less vulnerable to drought. In general, the study was designed to identify time serious trends of Spatial and Temporal Variation of Coffee and Khat; Area of Production, Number of Holders and Productivity in West and East Hararghe Zone.

METHODOLOGY

Data of; annual yield, area of production and numbers of holders of coffee and Khat in west and east Hararghe zone for the period 2006/2007-2019/2020 were collected from Central statistical Agency (CSA) [10-14]. Trend test were carried out using the non-parametric Mann-Kendall's trend test which is less sensitive to outliers and test for a trend in a time series without specifying whether the trend is linear or non-linear. The Mann Kendall's test statistic is given as:

$$S = \sum_{i=1}^{N-1} \times \sum_{j=i+1}^N \text{sgn}(x_j - x_i) \quad (\text{Equation 1})$$

Where S is the Mann-Kendal's test statistics; x_i and x_j are the sequential data values of the time series in the years i and j ($j > i$) and N is the length of the time series. A positive S value indicates an increasing trend and a negative value indicates a decreasing trend in the data series. The sign function is given as

$$\text{sgn}(x_j - x_i) = \begin{cases} +1 & \text{if } (x_j - x_i) > 0 \\ 0 & \text{if } (x_j - x_i) = 0 \\ -1 & \text{if } (x_j - x_i) < 0 \end{cases} \quad (\text{Equation 2})$$

The variance of S, for the situation where there may be ties (i.e., equal values) in the x values:

$$\text{Var}(S) = \frac{1}{18} [N(N-1)(2n+5) - \sum_{i=1}^m t_i(t_i-1)(2t_i+5)] \quad (\text{Equation 3})$$

Where, m is the number of tied groups in the data set and t_i is the number of data points in the i^{th} tied group. For n larger than 10, Z_{MK} approximates the standard normal distribution and computed as follows

$$Z_{MK} = \begin{cases} \frac{s-1}{\sqrt{\text{var}(s)}} & \text{if } S > 0 \\ 0 & \text{if } S = 0 \\ \frac{s+1}{\sqrt{\text{var}(s)}} & \text{if } S < 0 \end{cases} \quad (\text{Equation 4})$$

The presence of significant trend is evaluated using the Z_{MK} value. In a two-sided test for trend, the null hypothesis H_0 should be accepted if $Z_{MK} < Z_{1-\alpha/2}$ at a given level of significance. $Z_{1-\alpha/2}$ is the critical value of Z_{MK} from the standard normal table.

RESULTS AND DISCUSSIONS

In east Hararghe zone trends of both Khat production area and number of small holders had showed significant ($p=0.01$) increasing trend by factor of 18,673 ha/year and 4,570 smallholder farmers/year respectively. In the west Hararghe zone trend of Khat production area and number of small holders had showed non-significant increasing trend by factors of 8,395 ha/year and 936 smallholder farmers/year respectively. Furthermore, the result indicated non-significant increasing trend for Khat productivity in west Hararghe zone; but non-significant decreasing trend in east Hararghe zone table 1 and figures 1-3. In general, the result indicated that Khat production has been dramatically expanding in both Hararghe zone.

Table 1: Yield, area of production, number of holders and Productivity of coffee in west and east Hararghe zone average over for the period 2006/2007-2019/2020.

Year	West Hararghe			East Hararghe		
	Holders	Area(ha)	Yield (qt/ha)	Holders	Area(ha)	Yield (qt/ha)
2006/7	138513	13966	10.03	106353	4742	7.39
2007/8	139198	15056	5.12	159036	8408	7.17
2010/11	145738	17822	5.23	140474	5736	7.32
2011/12	132552	14881	5.23	122257	5456	7.32
2012/13	120542	13304	11.84	134696	5797	3.04
2013/14	125660	14170	8.19	136421	6390	5.17
2014/15	134458	15154	8.2	132899	6553	6.26
2015/16	109596	13002	7.32	131057	6604	3.56
2016/17	263276	7746	6.12	331651	7584	4.91
2019/20	112756	10024	6.84	141621	6714	5.78

Data presented in the table 1 noticeably showed west Hararghe zone coffee area coverage was four-fold greater than that of east Hararghe zone in 2006/7 production year. Sen's slope value in table 2 and figures 4 and 5 below indicated that in west Hararghe zone coffee production area and number of holders had showed non-significant decreasing trend by factors of -2862 ha/year and -584 small holder farmers/year respectively. However, in east Hararghe zone coffee production area had showed non-significant ($p=0.48$) increasing trend by factor of 2200 ha/year figure 4; whereas, number of



Figure 1: Khat area of production in west and east Hararghe zone 2006/2007-2019/2020.



Figure 2: Khat number of holders in west and east Hararghe zone 2006/2007-2019/2020.



Figure 3: Khat productivity in west and east Hararghe zone 2006/2007-2019/2020.

holders had showed significant ($p=0.03$) increasing trend by the factor of 218 smallholder farmers/year table 1 and figure 5. This means there were small expansion in coffee production area in East Hararghe zone; while, decline in both coffee area coverage and holders) year-to-year in west Hararghe zone (dominant one).

Comparing year of production 2006/7 with 2019/20 Khat area coverage had increased by 33% in west Hararghe zone (Table 1 and Figure 6). In contrary, coffee area coverage decreased by 72%

when year of production 2006/7 compared with 2019/20 in west Hararghe zone (Table 1). Therefore, one can understand that a smallholder farmer in west Hararghe have been shifted coffee production to Khat and other crops. Moreover, the result indicated that decreasing trend of coffee productivity; regardless expansion of coffee production area and increase number of smallholder farmers in east Hararghe zone (Table 1 and Figures 4,5). This indicates that, even though there were small expansion of coffee



Figure 4: Coffee area of production in west and east Hararghe zone 2006/2007-2019/20.

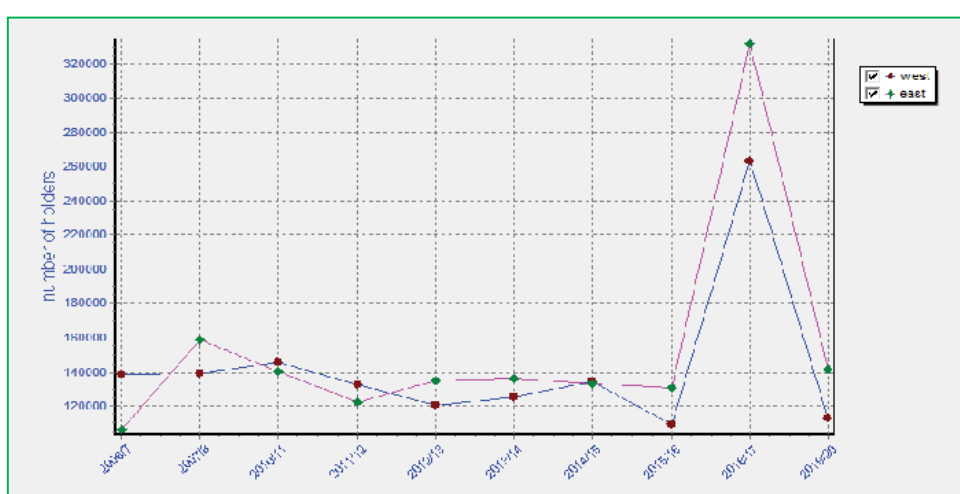


Figure 5: Coffee number of holders in west and east Hararghe zone 2006/2007-2019/2020.

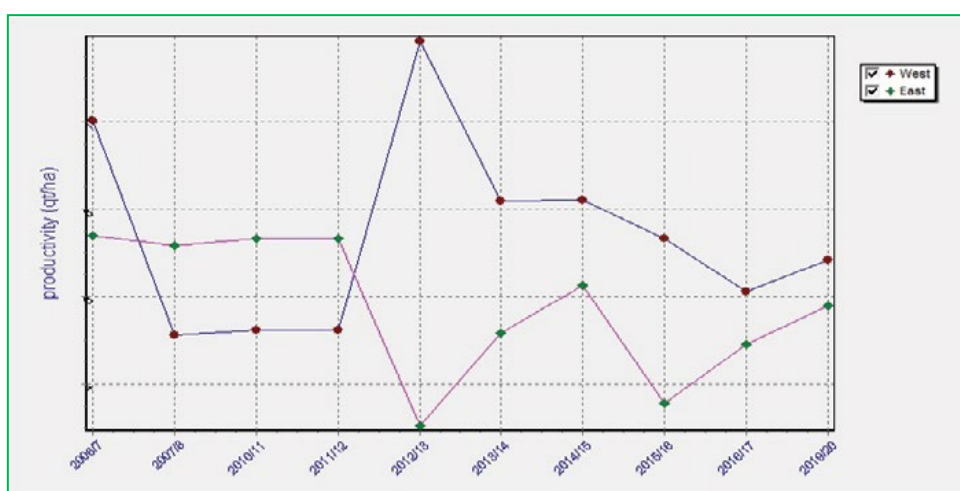


Figure 6: Coffee productivity in west and east Hararghe zone 2006/2007-2019/2020.

production in east Hararghe; however, the negative trends of yield indicate there was either management or land suitability (climate impact) factors is challenging it. Therefore, generally sustainability of coffee production in Hararghe is under question.

The result of this study agrees with others previous study which presented different reasons behind the expansion of Khat and low production trends of coffee in Hararghe. For example, according

to Abu and Teddy study, one of the major factors cause low coffee production is production of Khat is increasingly competing with coffee for farmlands particularly in the eastern part of the country in the Hararghe region [8]. The authors stated the reasons behind this as; a Khat is a crop with relatively high resistance to drought, disease, and pests. It can be harvested three or four times a year and generates better income for farmers than other cash crops

including coffee. Several small-scale farmers in the Hararge region have switched from coffee production to Khat production.

The fact that coffee farms are being changed into Khat farms has offset newly planted coffee farms in other regions resulting in a very marginal increase in overall size of area planted to coffee [8]. Tesfaye stated the reason for expansion of Khat as: the Hararghe highlands' location and its superior transport network have played an important role in the expansion of Khat since the product has to reach its final destination fresh and therefore fast transport is needed [6].

According to Tesfa, less labour and fewer other inputs are required for the cultivation of Khat than for other cash crops [3]. According to Tesfaye, the rising of price is also other factor. While Khat enjoys a relatively stable price at the world market, coffee suffers from both fluctuating export volumes and prices. Producing Khat has thus become a viable and important alternative to ensure continued cash income. Khat has additional advantage because it can be harvested at least twice a year under rain fed agriculture while up to five harvests per year is possible under irrigation. This ensures that households have a well-distributed flow of income.

Feyisa and Aune study results in Habro District, West Hararghe as Quoted Khat production in this district is rapidly replacing cereal and coffee production [4]. About 70% of farmers' income in the study area is currently obtained from Khat. One important reason for the expansion of Khat production is that the Khat-maize intercropping system is 2.7 times more profitable per hectare than maize mono cropping. Khat is also less risky to grow than cereals and coffee because it is less vulnerable to drought. Moreover, Guinand stated that, Khat witnessed a tremendous boom these days; coffee is facing a major drawback due to unstable and decreasing prices at the international stock exchanges [9]. Many farmers opted and are opting to cut down their coffee plantations and to replace them with Khat bushes.

SUMMARY AND CONCLUSION

This study was undertaken to identify Spatial and Temporal Variation of Coffee and Khat area of production, number of holders and productivity in west and east Hararghe zone, for the period 2006/2007-2019/20. Secondary data was collected from Central statistical Agency (CSA) of Ethiopia. Trend test was carried out using the non-parametric Mann-Kendall's trend test using Xlstat software. The result of this study indicated that in east Hararghe zone trends of both Khat production area and number of small holders had showed significant increasing trend by factor of 18,673 ha/year and 4,570 smallholder farmers/year respectively. In the west Hararghe zone trend of Khat production area and number of small holders had showed non-significant increasing trend by factors of 8,395 ha/year and 936 smallholder farmers/year respectively. Furthermore, the result indicated non-significant increasing trend for Khat productivity in west Hararghe zone; but non-significant decreasing trend in east Hararghe zone. In general, the results of this study indicated that Khat production has been dramatically expanding in both Hararghe zone.

In west Hararghe zone coffee area coverage was four-fold greater than that of east Hararghe zone in 2006/7 production year. In west Hararghe zone coffee production area and number of holders had showed non-significant decreasing trend by factors of -2862 ha/year

and -584 small holder farmers/year respectively. However, in east Hararghe zone coffee production area had showed non-significant increasing trend by factor of 2200 ha/year; whereas, number of holders had showed significant increasing trend by the factor of 218 smallholder farmers/year. Comparing year of production 2006/7 with 2019/20 Khat area coverage had increased by 33% in west Hararghe zone. In contrary, coffee area coverage decreased by 72% when year of production 2006/7 compared with 2019/20 in west Hararghe zone. Moreover, the result indicated that decreasing trend of coffee productivity; regardless expansion of coffee production area and increase number of smallholder farmers in east Hararghe zone. This indicates that, even though there were small expansion of coffee production in east Hararghe; however, the negative trends of yield indicate there was either management or land suitability (climate impact) factors is challenging it. Therefore, generally sustainability of coffee production in Hararghe is under question.

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