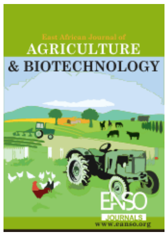


East African Journal of Agriculture and Biotechnology
eajab.eanso.org
Volume 5, Issue 1, 2022
p-ISSN: 2707-4293 | e-ISSN: 2707-4307
Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Farmers' Social capital, Sources of Finances, Information and their implications on Maize Yields in a Rural Highland, Kenya

Joseph Kipkorir Cheruiyot[1] & Festus Kipkorir Nge'tich[2]*

[1] University of Kabianga, P.O. Box 2030-20200, Kericho, Kenya.
[2] Jaramogi Oginga Odinga University of Science and Technology, P.O. Box 210-40601 Bondo, Kenya.
* Author for Correspondence ORCID ID: https://orcid.org/0000-0002-9065-565; Email: cheruiyotjoseph@gmail.com

Article DOI: https://doi.org/10.37284/eajab.5.1.709

Date Published:

15 Jun 2022

Keywords:

Maize, Productivity, Financial Sources, Information Sources, Social Capital

ABSTRACT

Maize (Zea mays L.) is a crop of livelihood, nutritional, economic, and political importance in Kenya. Its productivity growth is estimated at 2% annually, with average yields of 2 tons/ha against a potential 6 tons/ha. Annual production lags behind demand. This study was conducted in a typically rural location of Nandi County in Kenya to investigate smallholder farmers' social capital, sources of finances, information, and their implications on maize yields. Data from 502 farmers, collected ex post facto, was analysed by use of descriptive and inferential statistics. Brown-Forsythe ANOVA showed highly significant differences between groups; based on social capital as measured by their membership to social common-interest groups (F^* (2,499) = 23.826, P = .000), based on main sources of finances for farm operations (F^* (4, 60.649) = 8.519, P = .000) and main sources of technical information (F (3,498) = 38.738, P = .000). A Games-Howell post hoc test showed that the 'no group' category had significantly lower yields compared to members of social groups (P = .000). Farmers who mainly financed farm operations through 'sale of farm produce' had significantly lower yields compared to 'non-farm trade' and 'salaries from off-farm employment' categories (P = .001 and .000). The farmer category that relied mainly on 'mass media' for information had significantly lower yields (P = .000) compared to those who relied on Extension (P = .000) and 'digital sources' (P = .016). The mix of 'extension and digital sources' category showed a significantly higher mean compared to 'Extension only' (P = .000). In conclusion, farmer organizations and the associated social capital, funding of farm operations and information sources that guarantee quality have a positive impact on maize productivity and food security. This study is of value for practitioners and policy-makers on farmer organizations, seasonal credits, and extension information delivery.

APA CITATION

Cheruiyot, J. K., & Nge'tich, F. K. (2022). Farmers' Social capital, Sources of Finances, Information and their implications on Maize Yields in a Rural Highland, Kenya. *East African Journal of Agriculture and Biotechnology*, *5*(1), 138-149. https://doi.org/10.37284/eajab.5.1.709

CHICAGO CITATION

Cheruiyot, Joseph Kipkorir & Festus Kipkorir Nge'tich. 2022. "Farmers' Social capital, Sources of Finances, Information and their implications on Maize Yields in a Rural Highland, Kenya". *East African Journal of Agriculture and Biotechnology* 5 (1), 138-149. https://doi.org/10.37284/eajab.5.1.709.

HARVARD CITATION

Cheruiyot, J. K., & Nge'tich, F. K. (2022) "Farmers' Social capital, Sources of Finances, Information and their implications on Maize Yields in a Rural Highland, Kenya", *East African Journal of Agriculture and Biotechnology*, 5(1), pp. 138-149. doi: 10.37284/eajab.5.1.709.

IEEE CITATION

J. K. Cheruiyot, & F. K. Nge'tich "Farmers' Social capital, Sources of Finances, Information and their implications on Maize Yields in a Rural Highland, Kenya", *EAJAB*, vol. 5, no. 1, pp. 138-149, Jun. 2022.

MLA CITATION

Cheruiyot, Joseph Kipkorir & Festus Kipkorir Nge'tich. "Farmers' Social capital, Sources of Finances, Information and their implications on Maize Yields in a Rural Highland, Kenya". *East African Journal of Agriculture and Biotechnology*, Vol. 5, no. 1, Jun. 2022, pp. 138-149, doi:10.37284/eajab.5.1.709.

INTRODUCTION

Maize (*Zea mays* L.) is a crop of livelihood, economic, and political significance in Kenya. Millions of households rely on it as a staple food, others as a source of cash income. Any maize shortages arising from challenges associated with harsh climatic changes and macro-economic or global shocks often raise political temperatures in the country owing to its central role as a leading staple food. It has an important role to play in human nutrition (Chune, 2022). It is estimated that Kenya's population of about 47.6 million (KNBS Census, 2019) consumes millions of kilograms of maize annually, based on a per capita annual consumption of about 103 kg per person per year. Kenya has the highest demand for maize among all the East African countries. The other East African countries have comparatively lower consumption levels; 73kg per capita per year for Tanzania, 31kg for Uganda and about 14.1kg for Rwanda (Kilimo Trust, 2017).

The productivity growth of maize is estimated at about 2 % per annum, but this growth is not in tandem with the population growth estimated at about 3.5% per annum. Whereas maize yields have remained fairly low at about 2.0 metric tons per ha, authoritative sources suggest that there is a potential to achieve 6 metric tons per hectare (Onono et al., 2013). Kenya's maize production is, however, dominated by smallholder farmers with low levels of access to resources that can improve maize productivity.

Kenya's vision 2030 development blueprint forecasts a future in which Kenya's agriculture will be globally competitive (Government of Kenya, 2007). A globally competitive agricultural sector, however, would be expected to invest, not only in capital or financial resources but also in information and technical resources, in the sector. Information on scientific and technological aspects needed for improving crop productivity ought to be supplied continuously to smallholder producers in ways that are relevant, timely and of the desired quality. Some technologies and scientific information that enhance crop productivity are said to be knowledge-intensive (Mucheru-Muna et al., 2021) and therefore require their presentation in ways that are simplified, relevant, and usable by the smallholder resource-poor farm households. A study report by Onono et al. (2013), for example, singled out the significance of information on quality fertilizers as one strategy for increasing maize productivity in

Article DOI: https://doi.org/10.37284/eajab.5.1.709

Kenya. The same authors cite the provision of agricultural credit or financial resources and extension or information services as significant non-price incentives for increased maize productivity.

The Kenyan smallholder farmers are known to receive financial resources and information resources from diverse sources. Scarce financial resources due to lack of credit facilities have constantly been blamed for low adoption of crop-yield enhancing technologies such as the use of superior inputs. Lack of information or knowledge on the technologies has equally been blamed for low farm-level crop yields (Onono et al., 2013; Sang & Cheruiyot, 2020). Equally important is the contribution of social capital. In Sub-Saharan Africa, community-based social capital has been credited with technological innovations necessary for the development of more productive farming (Heemskerk & Wennink, 2004).

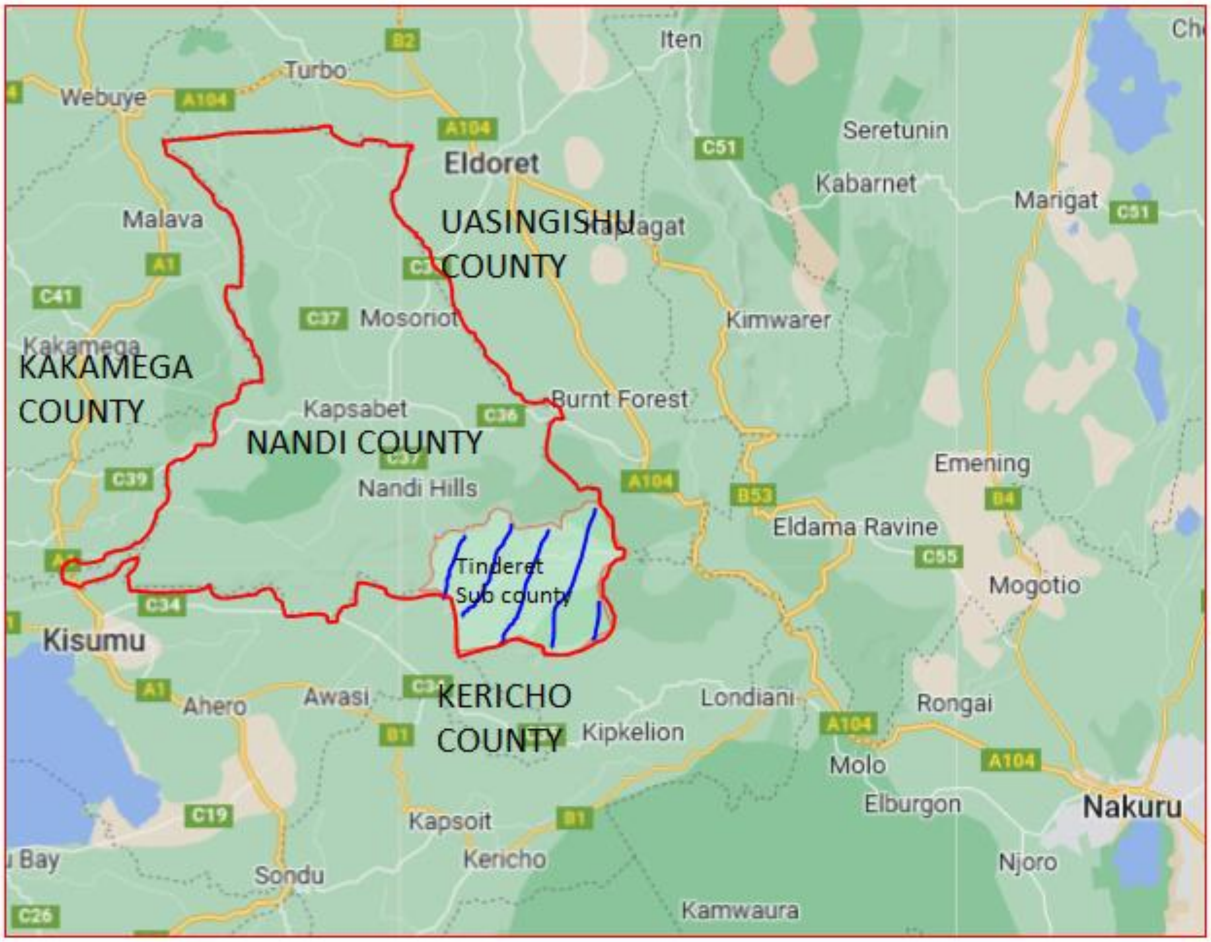
In this study, social capital is understood in the form of local farmer organizations, community-based groups, or farmer groups. These groups are characterized by the three dimensions of social capital within an organization, namely, bonding within a group, bridging between the groups, and linking with service providers (Heemskerk &Wennink, 2004). The three dimensions can arguably be viewed as being potentially beneficial to crop productivity. Ben-Hador (2022) talks about three levels of social capital; personal, intra-organizational, and extra-organizational, apparently similar to the bonding-bridging-linking sequence. It is about connections by an individual (personal), between and within groups (intra), and with factors and institutions outside the group (extra). The connections are based on 'trust, shared goals, information-sharing and reciprocity' (Ben-Hador, 2022). The sharing of information and the connections with the outside factors arguably have implications on how farmers acquire information and technology to ultimately improve their productivity. The purpose of this study was to investigate the smallholder farmers' sources of financial resources, sources of information, membership in social groups or farmer organizations as indicators of social capital and the potential implications of these attributes on maize yields in a rural area that is predominantly occupied by smallholder maize farmers; with fairly low levels of commercialization of the maize sub-sector.

METHODOLOGY

Study Site

This study was carried out in the Tinderet Sub-County of Nandi County in Kenya (*Figure 1*). A rural location in the Tinderet ward was specifically picked for the study due to its physiographic characteristics that provide for diversity of agro-ecological zones and diversity of demographics of the population. The area has diverse agro-ecological zones, with lower highlands and upper midlands suitable for different maize varieties and different crops; tea, coffee, and some sugarcane. The altitude ranges from 1400 to 2100 metres above sea level; consequently, there are temperature variations from one locality to another within the same broad geographical location. Nandi county is located between latitude 0° 34'N and longitude 34° 45'E towards the West and 35° 25'E towards the Eastern side (County Government of Nandi, 2018). The County receives an annual rainfall of between 1200 and 2000mm annually. The high rainfall areas are occupied by tea and the lowlands, low rainfall areas by sugarcane.

Figure 1: Map of Nandi County showing the study area



(Primary source: Google maps: https://www.google.com/maps/)

Data Collection

This study is based on data collected from 502 household heads on a cross-sectional survey from a target population of about 4,900 smallholder maize farmers in the Tinderet ward. Relevant data were collected by the use of pre-designed interview schedules. Demographic data, maize yield data, fertilizer use data, data on information sources, financial sources and membership in farmers or community groups; as indicators of social capital were collected from respondents. The respondents were identified through a random transect walk by enumerators in different directions so as to obtain a representative sample of the population.

Data Analysis

Descriptive statistics, measures of relationships and analysis of variance (ANOVA) were computed by use of Statistical Package for Social Sciences (SPSS) version 20. The descriptive statistics that were generated from the data included means, frequencies, and standard deviations. Tests for differences between group means were tested through analysis of variance (ANOVA) techniques. Post-omnibus tests were performed by using the Games-Howell test, where statistically significant differences were recorded. In social science research where group samples are naturally unequal, Welch ANOVA and Brown-Forsythe ANOVA are often recommended as they are non-sensitive to unequal variance situations that may

Article DOI: https://doi.org/10.37284/eajab.5.1.709

arise from unequal group samples (Delacre et al., 2020). An accompanying post-omnibus test should equally be non-sensitive; the Games-Howell test is used in this study.

RESULTS AND DISCUSSION

Sample Characteristics

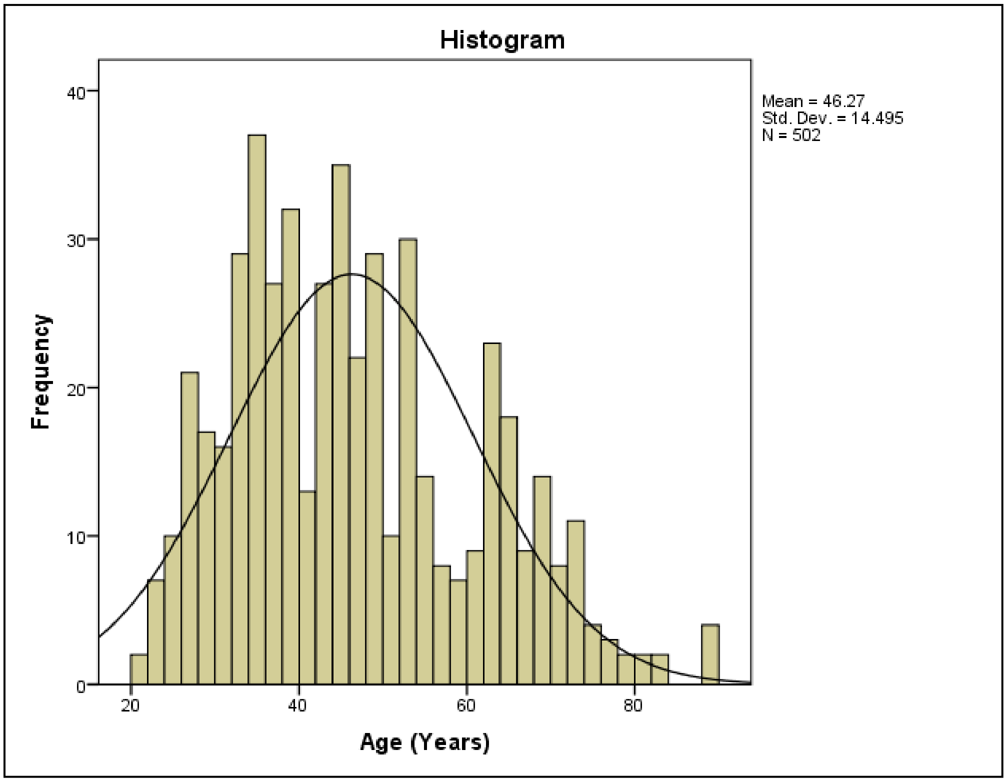
Diverse education levels were observed among the participants, with a majority having completed primary level education (60.8%), others had secondary level (22.3%), certificate (5.8%), diploma (4.4%), and degree level (2.4%). About 4.4% had no formal education. About 63.5% of them were males and 36.5% females. The majority of the households had 4-6 members, constituting 51.8%, as shown in *Table 1*. The sample had a median household size of 6, a mean of 5.90 and a mode of 6. Interestingly the sample population showed a high kurtosis of 10.506, suggesting that there were a very high number of households with household sizes near the mean, making the distribution highly peaked. The mean age for the sample was 46.3 years with the youngest at 21 and the oldest at 89 years; fairly normally distributed with *skewness* of .548 and *kurtosis* of .379, as illustrated in *Figure 2*.

Table 1: Descriptive data on characteristics of the sample

	Description	**Frequency**	**Percent**
Education	No formal Education	22	4.4
	Primary	305	60.8
	Secondary	112	22.3
	Certificate	29	5.8
	Diploma	22	4.4
	Degree	12	2.4
	Total	**502**	**100.0**
Gender	Female	183	36.5
	Male	319	63.5
Age	35 and below	140	27.9
	36-45	131	26.1
	46-55	107	21.3
	Over 55	124	24.7
Household size	1-3	71	14.1
	4-6	260	51.8
	7-9	128	25.5
	10 and above	43	8.6

Article DOI: https://doi.org/10.37284/eajab.5.1.709

Figure 2: Sample characteristics based on chronological age



Social Capital and Maize Yields

A test for homogeneity of variance based on Levene's test showed non-conformity with the equal variance assumption (P < .05); consequently, a standard ANOVA was not used as it tends to increase the chance of error since it is sensitive to unequal variance. Data on group membership was treated as a nominal independent variable. Group means for the variables were analysed for differences based on the Brown-Forsythe ANOVA test. The Brown-Forsythe test (B-F) is an Analysis of Variance based on group medians rather than the mean values (Karagöz & Saraçbasi, 2016). The dependent variable data is transformed before the ANOVA is conducted. This makes the B-F test suitable for data which has unequal variances or has some potential outliers (Karagöz & Saraçbasi, 2016). Since the data was collected *ex post facto*, the group samples are naturally unequal, thus leading to unequal variance between the groups. A test for mean differences by Brown-Forsythe ANOVA showed a significant difference between groups based on their social networks (F (2,499) = 23.826, *P* =.000). A test based on Games-Howell revealed a significant difference between groups who were not part of any social network with the other groups (*Table 2*).

Table 2: Mean differences in maize yields between groups

(A) Group category	(B) Group category	Mean Difference (A-B)	Std. Err	Sig.
None	Producer	-3.168*	.518	.000
	Community-based	-1.847*	.397	.000
Producer	None	3.168*	.518	.000
	Community-based	1.321	.576	.060

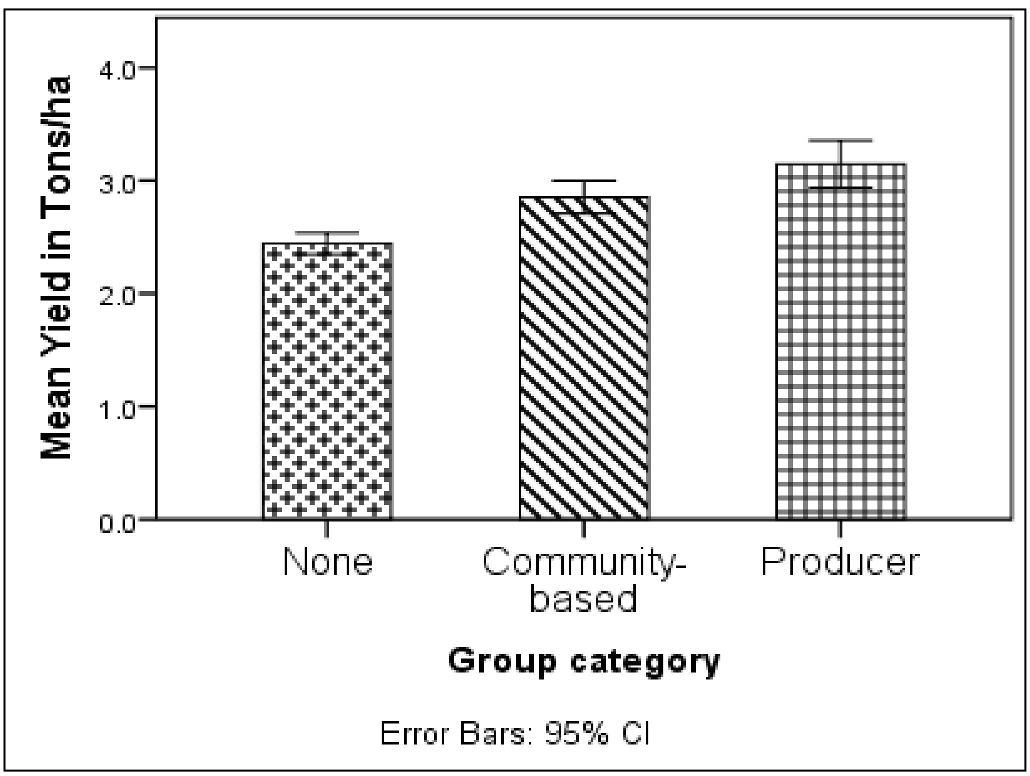
(Means separated by Games-Howell test)

Article DOI: https://doi.org/10.37284/eajab.5.1.709

The 'producer' group appears to post significantly higher yields compared to the 'community-based' social group, but only significant at a 90% confidence interval (*P* = .06), as depicted in Figure 3. This observation makes sense since the 'producer' group has members that have come together to produce; produce what Heemskerk and Wennink (2004) referred to as private goods, as opposed to community-based groups that are more focused on producing public goods or community welfare goods. The authors have given meaning to social capital as the value of connectedness of people and the trust they have within themselves. It includes institutes, relationships, attitudes, and values that govern interactions among people and contribute to socio-economic development. The current study focused on micro-level social capital that focuses on horizontal networks of individuals and households. However, it is plausible that such local networks may also benefit from external linkages, where there are both horizontal and vertical networks, as suggested by Heemskerk and Wennink (2004).

In a study conducted in Nigeria, reports indicate that social capital enhanced farm productivity and food security (Kehinde et al., 2021). The authors have argued that networks improve access to resources and information to improve productivity. They further argued that the participation of farmers in social groups enhanced the farmers' welfare in totality, including farm productivity. Social capital is about a readiness to associate (Balogun et al., 2018). The authors argue that it indirectly affects the supply of labour and information for households. It is also linked to the propensity to adopt new technologies as members of social networks share information and knowledge. Their study showed a positive influence on cassava productivity in a state in Nigeria.

Figure 3: Mean yields based on groups to which respondents belong



Article DOI: https://doi.org/10.37284/eajab.5.1.709

Financial Sources and Maize Yields

Preliminary tests on the equality of variance between groups were violated (Levene statistic (4,497) = 6.975, *P* = .000); for this reason, a standard ANOVA was avoided. A test for the equality of means using Brown-Forsythe ANOVA suggests a significant difference among groups based on their main source of finance for farm operations; *F* (4, 60.649) = 8.519, *P* = .000. Mean separation by Games- Howell test revealed a significant difference between the '*sale of farm produce*' group with the '*non-farm trading'* (*P* = .001). Those who relied on the sale of farm produce had significantly lower productivity by about 0.7 tons/ha (*Table 3*). It was also significantly lower than those who relied on salaried employment to finance their farm operations with a mean difference of 0.51 tons/ha (*P* = .000), as illustrated in *Figure 4*. Other categories had not shown a statistically significant difference (P > .05). This observation suggests that the producer who relies on the sale of farm produce only to finance farm operations is more likely to be less productive, probably due to inadequate capacity to effectively finance the operations. This may be partly attributed to the seasonality of crop sales, and yet farm operations have to be financed throughout the crop calendar. It suggests a need for seasonal credit facilities to finance farm operations for enhanced farm productivity. Some authors have reported a positive influence of access to credit on the productivity of maize (Wangui, 2019). The current findings support a policy of improved access to credit facilities for enhanced maize productivity and food security.

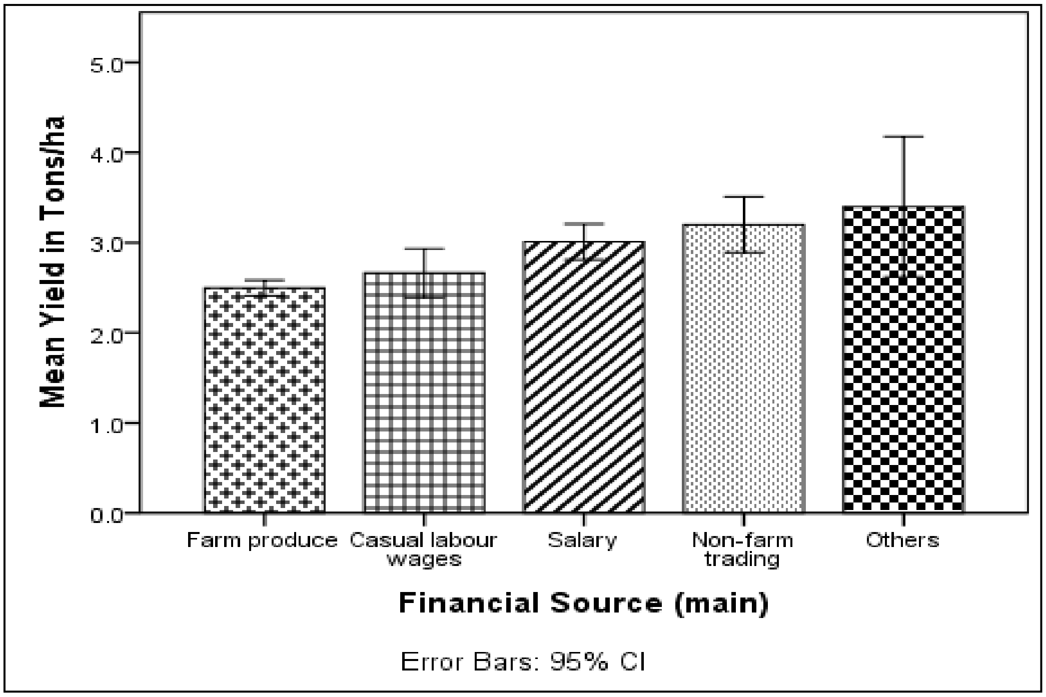
Table 3: Yield differences in tons/ha based on main sources of finance as separated by Games-Howell test

(A) Financial Source (main)	(B) Financial Source (main)	Difference (A-B)	Std. Error	Sig.
Farm produce	Non-farm trading	-.70351*	.15856	.001
	Salary	-.51210*	.10847	.000
	Casual labour wages	-.16665	.13935	.754
	Others	-.90155	.37074	.153
Non-farm trading	Farm produce	.70351*	.15856	.001
	Salary	.19142	.18214	.830
	Casual labour wages	.53687	.20206	.072
	Others	-.19804	.39857	.987
Salary	Farm produce	.51210*	.10847	.000
	Non-farm trading	-.19142	.18214	.830
	Casual labour wages	.34545	.16569	.237
	Others	-.38946	.38142	.843

*(*Significant at .05 level of significance)*

The observation made seems to indicate that those who had other sources of income, apart from the sale of farm produce may have been advantaged by better cash flow for enhanced productivity of their maize farms. It suggests critical operations such as the acquisition of farm inputs, timely weed control, application of fertilizer, and timely harvesting to avoid losses may benefit from steady sources of income as opposed to the seasonal income from crop sales. This observation has implications for the extension agent responsible for delivering information on financial planning at the farm level. It also has implications for policy as regards the provision of credit facilities for smallholder farmers, including farm input subsidy programs that appear should target non-salaried maize producers.

Figure 4: Maize yields based on the main source of finances for farm operations



Information Sources

The distribution of the maize yields per unit of land based on 'main information sources' for the farmers did not show a violation of the homogeneity of variance assumption (Levene's*P*> .05); consequently, a standard ANOVA could be performed. The ANOVA test revealed a significant difference in mean yields between the groups; F (3,498) = 38.738, *P* = .000. A *post hoc* test based on Games-Howell indicated that farmers who relied on mass media (Radio, TV, newspapers) as their main source of technical information on maize production had significantly lower yields than all the other categories (*Table 4*). This suggests that mass media may not be depended upon entirely for accurate, timely, and relevant quality information for the enhancement of maize productivity. A mix that combines the use of extension and digital sources showed significantly higher productivity compared to 'extension only' (*P*= .000) as depicted in *Figure 5*.

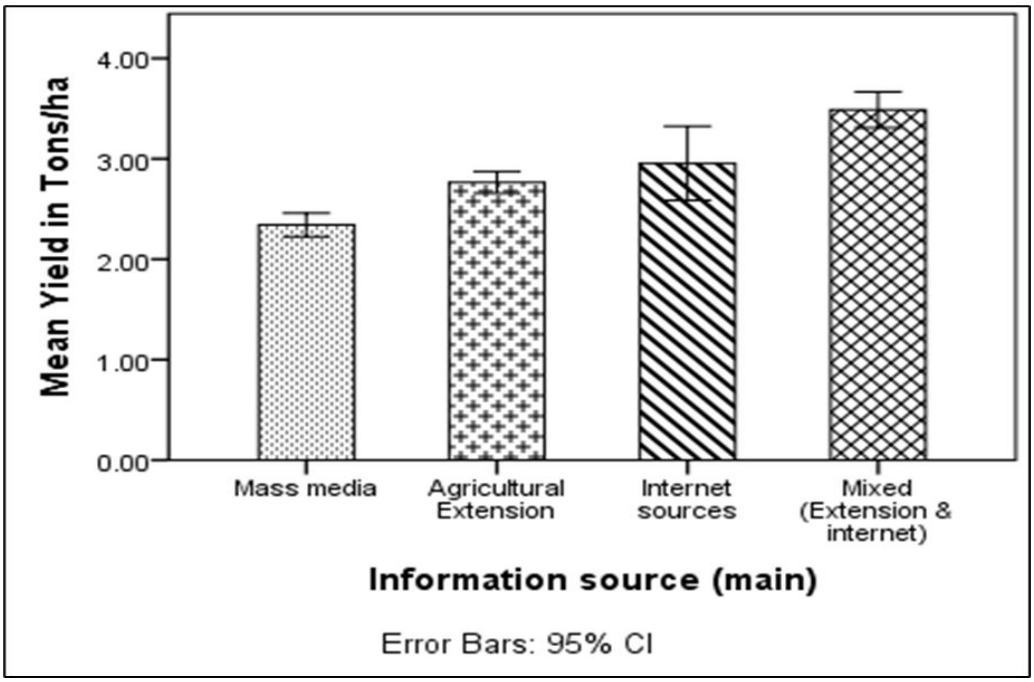
Table 4: Differences in yields based on main information sources

(A) Main Information source	(B) Information source (main)	Mean Difference(A-B)	Std. Error	Sig.
Agricultural Extension	Internet sources	-.19043	.18217	.726
	Mass media	.42248*	.08060	.000
	Mix (Extension & internet)	-.72340*	.10495	.000
Internet sources	Agricultural Extension	.19043	.18217	.726
	Mass media	.61292*	.18351	.016
	Mix (Extension & internet)	-.53297	.19543	.052
Mass media	Agricultural Extension	-.42248*	.08060	.000
	Internet sources	-.61292*	.18351	.016
	Mix (Extension & internet)	-1.14589*	.10724	.000

Article DOI: https://doi.org/10.37284/eajab.5.1.709

Previous studies suggest that formal education levels may have some positive influence on farmers' knowledge and adoption of new technologies (Cheruiyot, 2020) and, therefore could potentially influence farm productivity. To check on this potential compounding effect of education through its contribution to information, ANOVA was carried out for means between groups (based on information) while controlling for the education levels of the respondents. When this potential influence is controlled, mean differences between groups remained significant; $F (3, 494) = 21.491$, $P = .000$). This observation confirms that all other factors held constant, sources of information have a bearing on maize productivity. The highest productivity was recorded among groups who used extension and digital sources for their technical information. This suggests that the two sources offered quality information for productivity enhancement. A study conducted in Zambia concurs with this finding (Mwalupaso et al., 2019). The authors argued that increasing farmers' access to useful information results in reduced cost, increased productivity, and sustained production. They reported, however, that digital sources of information were adversely affected by the education levels of the farmers, access to power, and language barriers.

Figure 5: Maize yields for each group based on the main information source



Further Analysis of Information, Financial Sources and Social Capital

Some authors suggest the need to use non-parametric tests to confirm results from Brown-Forsythe tests (Hill *et al*., 2006 as cited by Statistics How To, 2022). A non-parametric Kruskal-Walli's test was run; the results are as indicated in *Table5*. On information sources, the Kruskal-Walli's test showed a significant difference between mass media use with the others and between extension only and a mix of extension/internet sources suggesting a concurrence with the Brown-Forsythe test. On financial sources, the test showed that a difference existed between the "farm produce" category and the 'non-farm trading' and 'salary' categories; P = .001 and .000, respectively, thus confirming the Brown- Forsythe tests. A similar concurrence was observed regarding social capital; a KW test showed there was a significant difference

Article DOI: https://doi.org/10.37284/eajab.5.1.709

in the order producer > community-based > none, suggesting members of producer groups had relatively higher yields compared to community-based group members and community-based had higher compared to "no group". All the differences were significant (*Table 5*).

Table 5: Mean differences in yield based on Kruskal-Wallis H test (n =502)

Distribution of yields based on:	df	*H* Statistic	*P*-value
Information sources	3	139.290	.000
Financial sources	4	45.405	.000
Social capital	2	49.743	.000

CONCLUSIONS AND RECOMMENDATIONS

Social capital, sources of finances, and information sources have a significant influence on maize productivity. Farmers' participation in social network activities improves their social capital through better sourcing of resources and information that potentially enhances agricultural productivity. A combination of extension services with digital sources of information enhances maize productivity. Technical information on maize production that is relevant, timely and of the right quality is recommended for enhancing productivity and food security. In conclusion, farmer organizations and the associated social capital, funding of farm operations and information sources that guarantee quality have a positive impact on maize productivity and food security. This study is of value for policies on farmer organizations, seasonal credits, and extension information delivery. It is recommended that stakeholders on food security issues endeavour to support farmers' organizations, their access to crop seasonal credits and up-scaling of the delivery of timely, relevant information to smallholder farmers through the extension system and digital sources.

REFERENCES

Balogun, O. L., Ogunsina, I. J., Ayo-Bello, T. A., & Afodu, O. J. (2018). Effect of social capital on the productivity of cassava farmers in Ogun State, Nigeria. *Journal of Agricultural Sciences (Belgrade)*, *63*(1), 99-112.

Ben-Hador, B. (2022). Levels of social capital in organizations [online presentation], May, 13th 2022. https://www.socialcapitalresearch.com/event/webinar-batia-ben-hador/

Cheruiyot, J. K. (2020). Links between Farmers' Socio-demographics and Adoption of Soil Conservation Technologies in Hilly Terrains of Nandi County, Kenya. *Journal of Agriculture and Ecology Research International*, *21*(5), 9–21. https://doi.org/10.9734/jaeri/2020/v21i530143

Chune, M. D. (2022). Determinants of Maize Production Income in Western Uganda. *East African Journal of Agriculture and Biotechnology*, *5*(1), 1– 13. https://doi.org/10.37284/eajab.5.1.532

County Government of Nandi. (2018). *County Integrated Development Plan 2018-2023*.Kenya: County Government of Nandi

Delacre, M., Leys, C., Mora, Y. L., & Lakens, D. (2020). Taking parametric assumptions seriously: Arguments for the use of welch's f-test instead of the classical f-test in one-way ANOVA. *International Review of Social Psychology*, *32*(1), 1– 12. https://doi.org/10.5334/IRSP.198

Government of Kenya. (2007). *The Kenya Vision 2030. Government of the Republic of Kenya,* 2. http://www.vision2030.go.ke/cms/vds/Popular_Version.pdf

Article DOI: https://doi.org/10.37284/eajab.5.1.709

Heemskerk, W., & Wennink, B. (2004). *Building social capital for agricultural innovation: Experiences with farmer groups in Sub-Saharan Africa*. Amsterdam: The Netherlands, Royal Tropical Institute

Karagöz, D., & Saraçbasi, T. (2016). Robust Brown-Forsythe and Robust Modified Brown-Forsythe ANOVA Tests Under Heteroscedasticity for Contaminated Weibull Distribution. *Revista Colombiana de Estadística*, *39*(1), 17– 32. https://doi.org/10.15446/rce.v39n1.55135

Kehinde, A. D., Adeyemo, R., & Ogundeji, A. A. (2021). Does social capital improve farm productivity and food security? Evidence from cocoa-based farming households in Southwestern Nigeria. *Heliyon*, *7*(July 2020), e06592. https://doi.org/10.1016/j.heliyon.2021.e06592

Kilimo Trust. (2017). Characteristics of Maize Markets in East Africa. https://www.kilimotrust.org/reacts/files/Maize_markets_X-tisation.pdf

KNBS Census. (2019). 2019 Kenya Population and Housing Census Volume I: Population By County and Sub-County: Vol. I (Issue November). Republic of Kenya

Mucheru-Muna, M. W., Ada, M. A., Mugwe, J. N., Mairura, F. S., Mugi-Ngenga, E., Zingore, S., & Mutegi, J. K. (2021). Socio-economic predictors, soil fertility knowledge domains and strategies for sustainable maize intensification in Embu County, Kenya. *Heliyon*, *7*(2), e06345. https://doi.org/10.1016/j.heliyon.2021.e06345

Mwalupaso, G. E., Wang, S., Rahman, S., Alavo, E. J. P., & Tian, X. (2019). Agricultural informatization and technical efficiency in maize production in Zambia. *Sustainability (Switzerland)*, *11*(8), 2451. https://doi.org/10.3390/su11082451

Onono, P. A., Wawire, N. W. H., & Ombuki, C. (2013). The response of maize production in Kenya to economic incentives. *International Journal of Development and Sustainability*, *2*(2), 530–543.

Sang, N. C., & Cheruiyot, J. K. (2020). Farmers' Information Literacy and Productivity Performance of Smallholder Horticulture in a Highland Zone, Kenya. *Journal of Scientific Research and Reports*, *26*(6), 89–99. https://doi.org/10.9734/jsrr/2020/v26i630274

Statistics How To. (2022). W or F Statistic. Available: https://www.statisticshowto.com/brown-forsythe-test/

Wangui, M.L. (2019). *An evaluation of the impact of access to credit on maize output amongst smallholder farmers in Kenya* (MA Thesis). Kenya: University of Nairobi.http://erepository.uonbi.ac.ke/bitstream/handle/11295/109630/

