Are the AgriTech Technologies Available, Adaptable and Practical to Young Farmers? Lessons from Tomato farmers in Kirinyaga County, Kenya

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**ABSTRACT**

Information and communication technologies (ICTs) in particular mobile phone applications and internet are transforming how agribusiness is carried out in some parts of developing countries including Kenya. The spread of information and communication technologies (ICTs), especially mobile phones, in developing countries has been both extensive and rapid creating a need to assess its efficiency and the rate of adoption. This study aimed at examining how farmers in the county integrate technological innovations in the production and marketing stage of tomato in the sampled area. The objective of the study was to examine how small scale farmers are integrating social media marketing platforms, digital credit, agricultural value addition and artificial intelligence in their production and marketing stages in the agricultural value chain. The results indicate statistically significant positive effects of AgriTech Technologies on farm income ($\beta = 3.84$). The results notably indicate that using social media marketing platforms has the highest positive contribution to a unit change in farm income ($\beta = 3.84$). Smallholder farmer’s ability to access knowledge, networks, and institutions essential for improving productivity, food security, and employment opportunities is a big challenge especially in rural areas where internet connectivity and poverty levels are alarming.

**Keywords:** Social media platforms; Digital credit; Agricultural value addition; Artificial intelligence

**INTRODUCTION**

In Africa, agricultural practices are more traditionally oriented as most farmers prefer to use processes that depend more on traditional equipment like hoes instead of introducing modern technology [1]. New modern technologies like mobile applications, open-source software and cloud computing are being introduced into farming as they are becoming more affordable and accessible. In Kenya a number of farmers especially the youth have infused ICTs into agribusiness by use of various mobile applications and other information systems available linking all the stakeholders and therefore increasing the outreach of their products to consumers [2]. The use of ICTs enable them make objective decisions on profitable enterprises, their niche markets, modern technology and model success stories [3].

With the increased access to mobile phones, wireless and internet industries, technology has made a great leap from the once costly, bulky, high energy consuming equipment used to analyze agricultural and scientific data. These can now be afforded by smallholder farms for their daily activities across the developing countries [4]. Information and technology has been seen to increase efficiency, productivity and sustainable agricultural sector through improved farm operations by accessing information easily [5].

The future of agribusiness requires great focus on sustainability and digital transformation juxtaposed by an industry that faces various challenges as well as new and exciting opportunities. New ICT technologies that connect the players in the industry bring opportunities for growth and innovation. Kenya has become more gradually visible as an ICT hub in East Africa by being the pacemaker in innovative ICT technology.

A number of ICT oriented youth in Kenya have therefore come up with various software applications and mobile based applications such as Mfarm, Kuza Doctor, icow among others to

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assist farmers to increase their agricultural yields and also their
skills [6]. Mobile phones for short messages (SMS) and voice
messages are also commonly used for accessing timely market
information on prices reaching customers, sharing accurate
information about financial transactions and production.

A number of social media innovations platforms in the country
like Mkulima Young, Young Farmers Market, Digital Farmers
Kenya and Mkulima Hub Kenya have been developed with the
aim of enhancing agricultural productivity [7]. The study notes
that the platforms are aimed at educating and informing farmers
on agricultural related matters through sharing of information
links and news articles as well as making inquiries and obtaining
feedback. In addition to the platforms mentioned above, most
agricultural institutions in Kenya have incorporated social media
as part of their information systems.

Most successful agribusinesses rely on gaining understanding on
how to manage complex value chains within the competitive
global markets. Therefore, most of this agribusiness companies
need more skills and training to ensure that the value of their
products is of the highest standard and also to ensure that the
company will be able to withstand any challenge it may face and
also build the capacity to adapt to change in its environment.

The use of ICTs in agribusiness industry in Kenya has played a
very important role with different types of ICTs having different
advantages and disadvantages when applied. The use of ICTs
improves the performance and profitability of agricultural
activities, provides access to information and services essential
for farmers and their organizations to link to integrated value
chains and it also allows mitigation of inherent risks [8]. Farmers
of different sectors can now employ ICT applications and tools
to manage their farming activities, from crop selection to the
monitoring of production. ICTs help in the efficient use of key
farm inputs therefore help in reducing wastage of resources such
as water, land and other farm inputs thus helping in increasing
farm productivity [9].

RESEARCH METHODOLOGY

The study was carried out in Kirinyaga County in the highlands
of former central province in Kenya. The study area was
purposively selected due to extant literature on massive tomato
farming and its proximity to major market centers in the
country. The scope of the study focused on young farmers
informed by the assumption that the marginal rate of technology
adoption diminishes with age and vice versa. The study sampled
171 youthful farmers who were randomly selected. The required
sample size was determined by proportionate to size sampling
methodology [10].

\[ n = \left( \frac{p(1-p)}{E^2} \right)^{1/2} \]

Where \( n \) = sample size, \( p \) = proportion of the population under
tomato farming, \( q = 1-p \), \( z = \) confidence level \((a = 0.05) \),
\( E = \) acceptable/allowable error. Since the proportion of
the population was not known, \( p = 0.5 \), \( q = 10.5 = 0.5 \), \( z = 1.96 \) and
\( E = 0.075 \). This resulted to a sample population of 171 youthful
farmers in the county who were purposively selected based on age.

A multiple regression analysis to predict the influence of
AgriTech technologies (independent variables) on farmers’
income (dependent variable) was estimated as indicated below.

\[ Y = \beta_0 + \beta_1 SMMP + \beta_2 DC + \beta_3 A VA + \beta_4 AI + \epsilon \]

Where;

- \( Y = \) Farmer’s agricultural income
- \( \beta_0 = \) Constant
- \( \beta_i = \) Coefficient for \( Xi = 1, 2, 3, 4 \)
- \( SMMP = \) Social media marketing platforms
- \( DC = \) Digital credit
- \( A VA = \) Agricultural value addition
- \( AI = \) Artificial intelligence

RESULTS AND DISCUSSION

From Figure 1 below, 11.1% of the sampled farmers indicated an
income of Ksh.200,000-Ksh.300,000, 9.4% Ksh.80,000-Ksh.
150,000, 8.2% Ksh.50,000-Ksh.100,000, 19.9% Ksh.10,000-Ksh.
50,000 and 51.5% indicated an income of less than Ksh.50,000
per hectare of tomato.

![Figure 1: Agricultural income.](image)

A correlation analysis to determine the relationship between
selected AgriTech technologies and agricultural income from a
hectare of tomato produce was performed. The results from
Table 1 below indicate a positive relationship between farm
income and social media platforms, digital credit and
agricultural value addition. The predictors were found to be
significant at 1% confidence level. This concurs with the
findings of Salami who argue that ICTs help in the efficient use
of key farm inputs therefore reducing wastage of resources such
as water, land and other farm inputs thus helping in increasing
farm productivity [11].
Autocorrelation test was performed to establish whether the error terms were serially interdependent using Durbin Watson statistics. Autocorrelation is present if the DW statistics is close to 0 and 4.

Table 1: Technology and farm income.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Income per _HA</th>
<th>Social media Platforms</th>
<th>Digital_ Credit</th>
<th>AVA</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>0.838**</td>
<td>0.632**</td>
<td>0.550**</td>
<td>.b</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
</tr>
<tr>
<td>Income per HA</td>
<td>0.838**</td>
<td>0.740**</td>
<td>0.664**</td>
<td>.b</td>
<td>.b</td>
</tr>
<tr>
<td>Social media Platforms</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
</tr>
<tr>
<td>Digital reddit</td>
<td>0.632**</td>
<td>0.740**</td>
<td>1</td>
<td>0.492**</td>
<td>.b</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
</tr>
<tr>
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<td>0.550**</td>
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<td>0.492**</td>
<td>1</td>
<td>.b</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
</tr>
<tr>
<td>AI</td>
<td>.b</td>
<td>.b</td>
<td>.b</td>
<td>.b</td>
<td>.b</td>
</tr>
<tr>
<td>N</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
<td>171</td>
</tr>
</tbody>
</table>

Note: "Correlation is significant at the 0.01 level (2-tailed). b. Cannot be computed because at least one of the variables is constant.

A value of 0 shows evidence of perfect positive autocorrelation while 4 shows evidence of perfect negative autocorrelation. A Durbin Watson value between 2 and 2.5 indicates absence of autocorrelation. Absence of autocorrelation implies that the data is reliable and suitable for estimation (Table 2). The Durbin Watson value in model 1 was 1.902 which implies weak positive autocorrelation.

Table 2: Durbin Watson test.

<table>
<thead>
<tr>
<th>Model 1 R</th>
<th>R Square Adjusted Square</th>
<th>R Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.838a</td>
<td>0.702</td>
<td>0.697</td>
<td>0.073</td>
<td></td>
</tr>
<tr>
<td>R Change</td>
<td>R Square F Change df1 df2 Sig. F Change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.702</td>
<td>131.438 3 167 0.000 1.902</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: a. Predictors: (Constant), AVA, Digital Credit, Social media Platforms, b. Dependent Variable: Incomeper HA.

The existence of weak positive autocorrelation does not have significant effect on the model estimation and prediction. A regression analysis Y = \beta_0 + \beta_{1SMMM} + \beta_{2DC} + \beta_{3AVA} + \beta_{4AI} + \epsilon was performed using SPSS software to estimate the effects of selected AgriTech technologies on farm income (Y). The results in the Table 3 below indicate that adoption of any
AgriTech technology increases the amount of income that the farmers receive per hectare.

Table 3: Regression analysis.

<table>
<thead>
<tr>
<th>Model 2</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>1.53</td>
<td>0.072</td>
<td>2.824</td>
<td>0</td>
</tr>
<tr>
<td>Social media Platforms</td>
<td>3.839</td>
<td>0.051</td>
<td>1.826</td>
<td>1.299</td>
</tr>
<tr>
<td>Digital Credit</td>
<td>1.08</td>
<td>0.187</td>
<td>0.527</td>
<td>4.429</td>
</tr>
<tr>
<td>AVA</td>
<td>2.056</td>
<td>0.058</td>
<td>0.812</td>
<td>3.216</td>
</tr>
</tbody>
</table>

Note: a. Predictors: (Constant), AVA, Digital Credit, Social media Platforms, b. Dependent Variable: Income per HA.

Model 2

\[ Y = 1.53 + 3.84 \text{SMMP} + 1.08 \text{DC} + 2.06 \text{AVA} + 0.1 \text{AI} \]

The results indicate statistically significant positive effects of AgriTech Technologies on farm income (t-prob 0.000 < 0.05). The results notably indicate that using social media marketing platforms has the highest positive contribution to a unit change in farm income (\( \beta = 3.84 \)). This is in line with the findings of Balkrishna and Deshmukh who conclude that the use of social media in the field of agricultural marketing offers great opportunities for the buying, selling of agricultural commodities. This means that, ceteris paribus, a unit increase in social media platforms usage measured in terms of mobile phone apps used leads to appreciation of farm income by 384%. There was however no indication of application of any artificial intelligence proxy by computerized farming, controlled production and use of drones [12,13].

CONCLUSION AND RECOMMENDATIONS

The formal Kenyan economy has been unable to create enough employment opportunities to absorb the constant supply of labour-seeking youth. Whatever the solution to this problem is, a great deal of coordination and skillful thinking will be required to attract gadget-loving and efficiency-prone young people into the agricultural sector. However, youth participation in the agriculture sector in Kenya is low, largely because the sector is highly unattractive due to risks, costs, inefficiency and its labour intensive nature. As such, motivating the youth to view agriculture as a career opportunity will require a multi-level intervention. The flow of information on agricultural production and marketing to youth has been hampered by under-utilization of information and communication technologies.

However, it is essential to digitize agricultural production and marketing information into web-based resources. This would enable wider outreach and use since the few available extension officers do not effectively reach the majority of the farmers at different locations. The youth could greatly contribute to the agricultural sector through actively participating in generating, posting, management and utilization of this information. Continuous initiatives to support youth in agricultural enterprises and widen the opportunities to showcase their successes in order to attract more young people are paramount. One of these should be the incorporation of information and communication technologies (ICTs) such as the internet, mobile phones, computers and Global Positioning Systems (GPS) associated or not with traditional communication technologies such as radio, television, written press and video. It’s therefore imperative that the county governments and the national government provide up-to-date information centers where young farmers can use the information to plan for a successful agribusiness.

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