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# INVESTMENTS IN TECHNOLOGICAL INNOVATION AND FINANCIAL PERFORMANCE OF SMALL-SCALE TEA INDUSTRY IN KENYA

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## ABSTRACT

The Agricultural sector in Kenya has been facing the challenge of increased costs as a result of outdated technology. In an attempt to reduce its costs tea sector has invested heavily in technology. The purpose of this study was to establish the effect of technological innovation investment on financial performance of small-scale tea industry in Kenya. The study variable was investment on fermentation innovation on the financial performance of small-scale tea firms in Kenya. This study was anchored on; Schumpeterian Theory on Innovations, Efficiency Theory, Technology Acceptance Model and Theory of Innovation Diffusion. The targeted population was 66 small scale tea factories. Secondary data for a period of 5 years was used for analysis using a panel regression model. Person correlation results indicated that investment on investment technological innovations, are positively and significantly associated with financial performance of small-scale tea industry.Innovations affects financial performance of small-scale tea firms. The study recommends the management can consider acquiring more fermentation machinery and modern machinery that can be cost effective.

**Keywords:** *Profits, Investment, Technology, small-scale tea farmers.*

## INTRODUCTION

The financial performance of the tea sectors in the country can be expressed in terms of financial and non-financial metrics. In financial performances, it focuses on the analysis of the economic indicators such as the profits; return on investments (ROI) and return on assets (ROA) as supported by (Agrawal, Mohanty & Totala; (2019). It is evidenced that improvement in the financial performance of firms increases the ability of a particular business to take more on the financial risks, increase firm efficiency and the overall sales revenue. Introduction of the new technology increases economic efficiency which positively affects the performance of tea farmers in the country (Lins, Servaes & Tamayo, 2017).

Innovation is the introduction of modern technology in production and other business activities in a firm (llinson *et al.*, 2013). Innovation is essential to firms in expanding its market share. Technological innovation is a necessary ingredient for improved yields in agricultural sector (Ahmed & Shepherd, 2010). The technological innovation in agribusiness for example,

agrarian biotechnology, apparatus and hereditarily created plants benefits to ranchers by boosting ranch generation.

Countries that have accepted the introduction of the modern technology in the operation of farm activities have improved performance of production and the market share has increased to compete both locally and internationally such as China and Singapore (Zheng & Wang, 2011). Several technological innovations have be introduced in the tea sector and include plucking machines, weighing machines, fermentation units, payment and credit access application systems, communication platforms, digital marketing innovations, storage (Matazarre, 2015; Takano & Kanama, 2019). In the tea subsector, for example, such technologies would perhaps include development of improved high quality clones, cost-effective methods of vegetative propagation of tea cuttings, innovative field management practices such as methods of bringing tea into bearing, plant protection, and effective fertilizer use (Monroy *et al.*, 201eng2). These technological innovations form the basis of this study as study objectives.

Fermentation technological innovation investment is very fundamental and responsible for the final product of tea and will determine its quality (Acharya, 2011). This procedure includes enzymic oxidation/debasement of polyphenols, lipids, carotenoids and tarpene-glycosides, and their ensuing buildup/corruption prompting development of shaded polymers and smell and flavor mixes (Sarkar et al., 2016). The outcome of Continuous Fermentation process is more noteworthy consistency in the nature of made tea and progressively proficient creation (Tanui et al., 2012). Modern machinery which can handle big volumes of inputs can be a good investment and cost effective.

**Technological Innovation investment in the Tea Industry: Global Perspective**

Technological innovation in tea industry has revolved around tea plantation, tea picking, fermentation and tea processing. In China, tea industry stepped into a fast-developing period, with a more prosperous production because of technological innovation in the sector. China continuously invested in the development of tea harvesting mechanization through technological innovation (Zheng & Wang, 2011). In Japan technological innovation of tea industry is highly developed. Japan has technologically sophisticated tea plucking machine, In India, the mechanization of tea leaf collecting was presented which expanded the production rate as well as required less labor. India is the second biggest maker of tea in the World after china and one of the most consumers of tea (Acharya, 2011).

Taiwan is the sole maker of non-matured/non-fermented tea, partly matured/fermented tea and full fermented tea on the planet.Taiwan has successively mechanized of tea production and harvesting.In Sri Lanka, the technology involving the processing of tea was first introduced in the 1870's by pioneer tea planter, James Taylor (Jayasekera, Kaur, Molan, Garg & Moughan, 2014). Introduction of technology in tea harvesting the Sri Lanka improved the speed, efficiency and reliability of machinery, quality of tea and also the tea safety (Ganewatt & Edwards, 2000).

**Technological Innovation investment in the tea Industry in Saharan Africa**

In Africa, the adoption of the improved agricultural technologies has lagged behind compared to other regions (World Development Report, 2012). The production systems have often been associated with market failures, such as inefficiencies in input and output markets, flawed land tenure systems, imperfect labor, credit markets and low technology adoption (Bergek *et al.*, 2008). Therefore, improving tea production in tea producing countries in Africa requires agricultural revolution systems in unique combination mostly with enhanced crop variants mechanization of crop production (Mose *et al.*, 2016).

According to Verter, Bamwesigye and Darkwah (2015) coffee and tea sub-sector has performed dismally poor in Uganda despite the country having a favorable climate for tea production. Malawi is the thirteenth biggest tea maker in the World and sent out 46,000 tons of tea in 2011 and 41,835 tons in 2012 to the market (FAOSTAT, 2014). The financial performance of the tea industries in Malawi is poorly developed in a situation attributed to slow adoption of technological investment (Jomo, 2014). In Rwanda, the tea sector industry is the third largest employer employing about 60,000 people.). In Tanzania, the slow uptake of technological innovation has contributed to low yields in tea production (Tea Exploration Organization of Tanzania, 2013).The introduction of the technological innovation in Tanzania such as the Weighing, pruning and harvesting machines has increased the efficiency and performance of the tea factories in Tanzania (Rutatina & Corley, 2018).

**Tea Sector Technological Innovation investment in Kenya**

Kenya is known for its tea and coffee production however, the tea sector in Kenya have been reporting poor financial performance and increased cost of operations (Kagira, Kimani & Kagwithi, 2012). The tea sector in the country has assumed a critical job in the agriculture sector and Kenya's economy everywhere with tea yield contributing about 11% of the farming segment's commitment to the Gross Domestic Product Kenya earned an approximated income of KES 125.25 billion from tea sends out in 2015, a growth of 23% from KES 101.11 billion recorded in 2014. Kenya Tea Development Agency (KTDA) has been mandated to promote the growth and sustainability of the small-scale tea farmers in Kenya. Currently KTDA has 66 tea factories serving over 500,000 small scale farmers cultivating over 100,000 hectares. Of all tea produced in Kenya, KTDA produces over 60% while the rest is produced by the large-scale producers.

The country has not adequately invested in the modern technology to help farmers improve the performance despite being the fourth largest producer of tea in the World. Low value of tea has negatively affected working conditions and livelihoods of small-scale farmers and plantation workers in tea and therefore, there is need for drastic improvements in the technological innovations Investment (Tea Board of Kenya, 2012)

**Statement of the Problem**

Tea industry continues to suffer due to heavy production costs and the net returns to the farmers are low and unsustainable in Kenya. Other global countries like China and Sri Lanka who are competing Kenya in the tea market have embraced mechanization, which is perceived as a natural process of economic development (Wanjira, Simon & Mathias, 2016). In 2013, the cost of tea production in Kenya was USD 1.33 per kg, while in Vietnam it was USD 0.81 per kg (Keen, 2018; Agriculture and food authority report, 2020). In India, the cost of tea production was USD 0.96 per kg, while in China it was USD 0.72 per kg. Before introduction of technological innovations in the tea sector in Kenya, total tea production was 377,912,178kgs in 2011 and 369,561,924kgs in 2012. However, after introduction of technological innovations in the tea sector in 2014, total production slightly declined to 399,211,367kgs in 2015, before shooting up to 473,011,324kgs in 2016, 439,857,739 kgs in 2017, 492,998,723 kgs in 2018, 458,852,949 kgs in 2019 (Agriculture and food authority report, 2020). However, it is not empirically clear if technological innovations in the tea sector brought more benefits in terms of increased tea production or costs surpassed the benefits.

It is the desire of a tea producing firm to introduce technological innovations with aim of reaping benefits associated with the. Some of perceived benefits to be reaped with the introduction of technological innovations in the tea sector include increase tea production and reduced cost of production. However, technology comes at a heavy cost. There are other

additional costs associated with technological innovations and include cost of acquiring/purchasing the innovation, cost of installing the innovative machines and equipment, cost of operating the technology and cost of maintaining the operations of the innovations. Thus, tea processing firms are faced with the task of undertaking critical cost benefit analysis to determine if the technology or innovation will bring more benefits to the firm or the costs associated with the technology are very high resulting to ultimate loss to the tea processing firm. It is argued that technological innovation in the short run may not be cost effective but in the long run, it is cost effective.

Fluctuation in aggregate tea production, declining return earnings for farmers and rising cost of production has been a cause of concern for tea stakeholders in Kenya (Kagira, Kimani & Kagwithi, 2012). This has resulted into several challenges in the sector such as; uprooting of tea bushes, tea picking boycotts, destruction of factory infrastructure besides threatening the life of factory managers, once the bonuses are announced year after year (Munene, 2016). The farmers were protesting against poor payment and bonuses from the Kenya Tea Development Agency KTDA have argued its harms in to the use of outdated technological innovations (Kimathi & Muriuki, 2013). The government through the Kenya Tea Development Authority has been investing heavily in technological innovations including purchasing modern fermentation machines and picking machines with aim of enhancing productivity and improving. KTDA in conjunction with tea farmers have also been introduced technological supported weighing machines to curb tea weighing cheats often directed against farmers. However, it is not evidently clear how technological innovations in the tea sector are impacting the financial performance of Small-Scale

**Tea Industry in Kenya.**

There has been no consensus on the impact of technological innovation on the performance of tea processing firms. Some authors indicate that technological innovations bring enormous benefits to the tea firms by stimulating productivity by cutting down cost of production (Kiai & Wambui; 2015; Wanjira, Simon & Mathias, 2016; Takano, & Kanama, 2019; Matazarre, 2015). However, other authors say that technological innovations is not cost effective and results declining quality of tea, increasing cost of production (technology acquisition, operation and maintenance costs) (Jayamanne, Wijeratne & Wijayaratna, 2002; Gunarathne & Peiris, 2017). Kiai and Wambui (2015) in a study on the impact of innovation on the financial performance of KTDA managed tea factories in Meru and Kirinyaga counties noted that innovations adopted by KTDA have had a positive impact on the financial performance of the factories by reducing the operational cost. However, Gunarathne, *et al.* (2017) in study assessing the impact of eco-innovations on sustainability of the commercial tea plantation industry in Sri Lanka indicated that innovations aimed at improving economic benefits often result in unintentional environmental degradation, social disturbance and reduced quality. The lack of consensus regarding cost-benefit analysis of technological innovations in the tea sector warrants further research on the effect of technological innovation investment on financial performance of Small-Scale Tea Industry.

**Objective of the Study**

**Specific Objective**

To examine the effect of investments on fermentation innovations on the financial performance of small-scale tea firms in Kenya.

**Research Hypotheses**

The following null hypotheses was tested to determine the influence of independent variable on the dependent variable.

**Ho1:** Investments on fermentation innovations has no significant influence on the financial performance of small- scale tea firms in Kenya.

**Justification of the study:**

The performance of the tea industry has been facing difficulties because of poor innovation investment and slow adoption of modern technology. Factories under the management of KTDA have been facing the challenge of an increase in expense of activities subsequently of the obsolete innovation. Financial performance of the tea farmers has not been improving. For example, in Central Kenya, there was evacuating of tea bushes, tea picking boycotts and destruction of industrial facility framework and also undermining the life of manufacturing plant managers, once the rewards are reported a seemingly endless amount of time after year. The farmers were challenging mediocre installments and prizes from the Kenya Tea Development Agency (KTDA).

## LITERATURE

### Schumpeterian Theory

Schumpeter's (1934) theory of innovative profits emphasized the role of entrepreneurship and the seeking out of opportunities for novel value and generating activities which would expand and transform the circular flow of income through leadership and innovation. Schumpeter, as cited by Swedberg (2000), pointed out economic behavior is somewhat automatic in nature and more likely to be standardized, while entrepreneurship consists of doing new things in a new manner, innovation being an essential value. Schumpeterian Theory regards innovations as the primary cause of economic development. However, this view is far from reality because economic development of a country does not depend on innovations only but also on many economic and social factors.

### Efficiency Theory

The effectiveness hypothesis/theory was detailed by Demsetz (1973) as an option in contrast to the market control hypothesis. The proficiency hypothesis surmises that better administration and scale productivity results to higher fixation hence more prominent and higher money related execution. In like manner, the hypothesis sets that administration effectiveness expands benefits, yet in addition results to bigger piece of the overall industry gains and improved market fixation (Athanasoglou, Brissimis and Shops, 2005**).**

The theory clarifies that achieving higher net revenues emerges from productivity which enables associations to get both great budgetary execution and pieces of the overall industry (Mirzaei, Schaback & Dehghan, 2012). As indicated by Fisseha (2015), the proficiency hypothesis surmises that benefit and high fixation results from effective Investment decrease practices and better administration methodologies over the association.

### Conceptual Framework

Conceptual framework is a diagrammatical representation that shows the relationship between dependent and independent variables. The framework helps the reader to see at a glance the proposed relationships between the variables in the study graphically or diagrammatically. Figure 1 presents the conceptual framework.

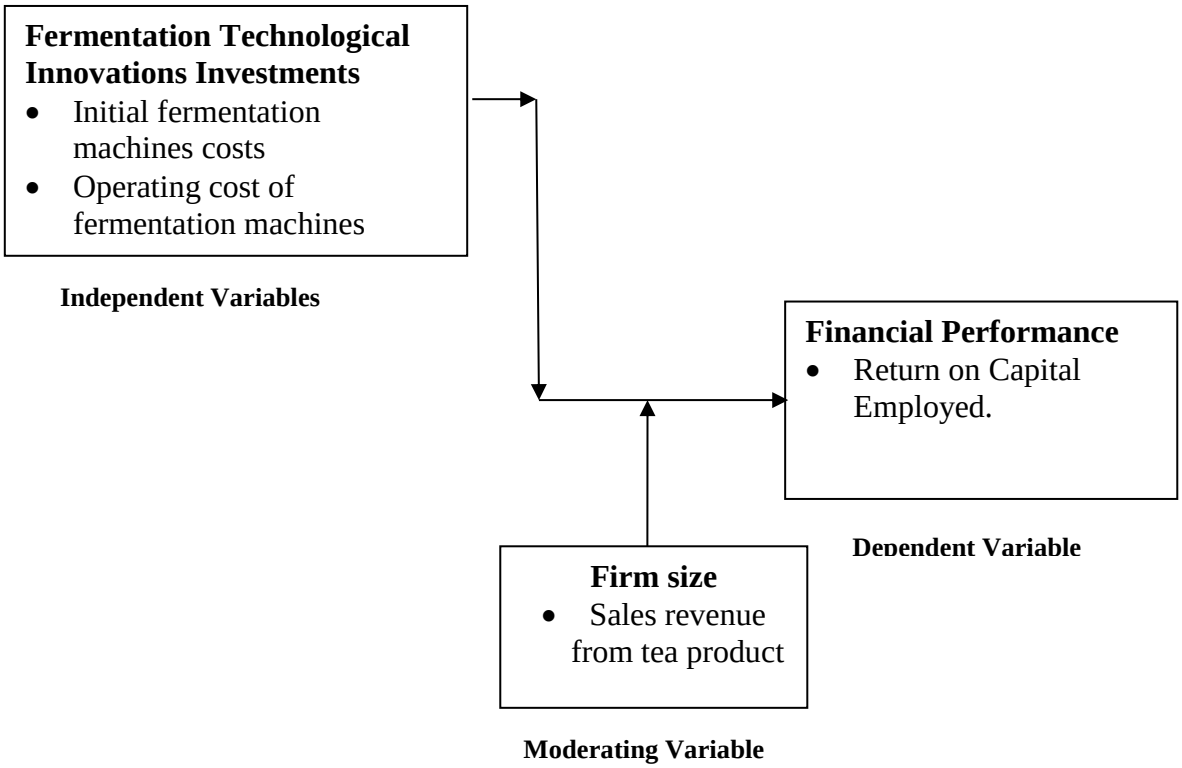


**Figure 1: Conceptual Framework**

There are many costs involved in the acquisition, operational and maintenance of tea sector equipment and include initial costs, investment costs, maintenance costs and operating costs which can either be direct or indirect costs. Initial costs are the average expense of acquiring an item or product. Investment costs are the average expenditures on an item with an aim of using it to generate additional income or revenue for an organization. Operating costs in the context of this study refer to any expense incurred by the tea firm to keep their assets in good working condition including maintenance. Operating costs also refer to the expenses related to the operation of the tea firm including operating the machines, devices, component, and piece of equipment or facility just to keep them functional. The identified costs above are one or several instances linked to the operational of fermentation, punning, weighing and information systems technological equipment and need to be accounted in ascertaining their impact the financial performance of small-scale tea firms. Firm size was measured using total sales revenue from the tea produce. Financial performance of small-scale tea firms in was measured using return on capital employed. Return on capital employed is measured as the ratio of earnings before interest and tax to capital employed. Return on capital employed can be used in assessing a firm's profitability and capital efficiency. It can help to understand how well a firm is generating profits from its capital.

## Empirical Review

### Fermentation Technological Innovations Investments

Tea maturation also known as tea fermentation of tea is the hugest advance in tea production process as it determines the quality of tea produced. This procedure includes enzymic oxidation/debasement of polyphenols, lipids, carotenoids and tarpene-glycosides, and their ensuing buildup/corruption prompting development of shaded polymers and smell and flavor mixes (Sarkar *et al.,* 2016). Maturation on bond floor is the most established and most

mainstream strategy. Be that as it may, with propelling innovation and advancement, there are present day methods for tea maturation/fermentation for example Persistent Maturing Machine or Continuous Fermenting Machine. The Continuous Fermenting Machine (CFM) is broadly utilized for maturation in tea businesses (Rajesh *et al.,* 2011). It comprises of single circuit of plate, top keep running of which goes through the maturing chamber. The expenses of these machines are high. There are additionally the expenses of establishment and upkeep. Thus, any investment on fermentation technology innovation may have a positive or negative effect on the financial performance of the tea processing firms.

**Empirical literature**

Muturi (2018) conducted a study on factors influencing the performance of small-scale tea farmers in Embu north sub County, Embu county Kenya. The targeted population was two factories, 794 small scale tea farmers and 119 employees and a sample of 263 was used. The study adopted the descriptive research design. The findings of the study established that the Continuous Fermentation Unit has significantly increased the efficiency and the overall performance of the factories that have adopted the technology.

Kiai and Wambui (2015) conducted a study on the Impact of innovation on the financial performance of KTDA managed tea factories in Meru and Kirinyaga counties. The study variables were Process innovation and organizational innovation. Moreover, the study employed the descriptive survey design and data was collected from 13 factories in Meru and Kirinyaga counties. Responses were received from a sample of 57 employees from the 13 factories. Under process innovation, the study analyzed at the adoption of continuous fermentation unit and adoption of the firewood boilers. The findings of the study concluded that Continuous Fermentation Unit mainly cut out the increasing labor costs, improved the quality of made tea and increased efficiency of processing. Therefore, innovations were positive and KTDA should continue adopting innovations for the benefits of the farmers.

Moreover, Gitau (2013) conducted a study to investigate the influence financial innovations on the financial performance of commercial banks in Kenya. The study was carried between 2006 to 2011 and a total of 30 commercial banks were used as the study population. The study sampled 12 commercial banks. The data was obtained from the secondary data available in the website of the commercial banks. The study employed a linear regression model in the analysis. The conclusions of the study established that financial innovation improved the financial performance of the commercial banks. The banks that have adopted the modern technology such as use of ATMS and mobile banking have improved in the level of performance significantly over years.

Ismail, Omar, Soehod, Senin and Akhtar (2013) investigated the Role of innovation in Small and Medium Enterprises (SMEs) performance in Malaysian. As ample consisted of SMEs belonging to both manufacturing and services sectors. A total of 870 SMEs from across the country participated in the study that spanned over a period of twelve months. The results revealed that the Malaysian Small and Medium Enterprises management is aware of the role innovation plays in the growth of the firms. However, being resource starved these SMEs are not in a position to either to acquire the most advanced technology in their businesses to improve in performance. Also, the findings revealed study innovation is essential if companies want to grow and become more competitive in the local and international market

Additionally, Kalunda (2014) conducted a study on the financial inclusion impact on small-scale tea farmers in Nyeri County, Kenya. The study adopted the descriptive research design. The targeted population comprised of two tea factories in from the region namely Iriaini and Chingawere. The choice of the two regions was due to their ease of access and small farm sizes

of the members. The findings of the study established that farmers needed empowerment in form of loans so that they can invest in the modern technology to increase in the overall production. Moreover, the study established that farmers who have acquired loans from the financiers have introduced the new technology that has led to persistent increase in the level of incomes. From the critique of the studies above, it is hypothesized that fermentation technological innovation investment has no significant benefit on the financial performance of small- scale tea firms in Kenya.

**Research Gaps**

Kiai and Wambui (2015) conducted a study on the Impact of innovation on the financial performance of KTDA managed tea factories in Meru and Kirinyaga counties. The study variables used were process innovation and organizational innovation. This study used fermentation technological innovations investments, pruning technological innovations investments, weighing technological innovations investments, information systems technological innovations investments as the study variables. A conceptual gap existed. Gitau (2013) conducted a study to investigate the influence financial innovations on the financial performance of commercial banks in Kenya. This study used effect of technology innovation investment on financial performance of small-scale tea industry in Kenya. A contextual gap existed. This study majorly involved tea industry and not in the banking industry.

Ongongâ and Ochieng (2013) conducted a study on the Innovation in the tea industry in Kericho, Kenya. The study used new technology of harvesting tea, highly skilled man power, and new production technique as the study variables. A conceptual gap existed since this study used fermentation technological innovations investments, pruning technological innovations investments, weighing technological innovations investments, information systems technological innovations investments as the study variables

The study of Gichungu and Oloko (2015) on the relationship between bank innovations and financial performance of commercial banks in Kenya presented both conceptual and contextual gap with the current study. The study used mobile phone banking investment in mobile banking, ATM banking Investment in ATM banking, online banking investment in online banking, and agency banking investment in agency banking as the study variables and the study was carried within the banking sectors while current study used use fermentation technological innovations investments, pruning technological innovations investments, weighing technological innovations investments, information systems technological innovations investments as the study variables as the study variables and the study was carried in tea industries.

Sewang, Winder and Zhang (2014) on the effect of Innovation on the Financial Performance of Small and Medium Sized Enterprises in China presented a geographical gap. This study was conducted in Kenya. Moreover, China is more developed as compared to Kenya and therefore the people are more civilized and easier to adapt to any form technology introduced to it. Additionally, China has invested highly in technology and this translates to the reason why they are the largest marketer of tea in the World. A study by Jayamanne, Wijeratne and Wijayaratna (2002) on adoptability of new technology in the small-holdings Tea Sector in Sri Lanka revealed that technology dissemination in the Sri Lankan tea small holding sector is at a satisfactory stage. However, the extent to which technology adoption has impacted the performance of the tea sector was not elaborated presenting a conceptual gap.

A study by Takano and Kanama (2019) on the growth of the Japanese black tea market: how technological innovation affects the development of a new market revealed that fermentation was especially an important process because it determined tea quality. Manufacturing

technology for fermentation was established by entrepreneurial farmers and transferred to other Japanese black tea farmers, resulting in the rapid market creation of the Japanese black tea. However, technological innovation in the tea sector in Japan is far more advanced in comparison to the sorts of tea sector technologies being employed in the Kenyan tea sector presenting contextual gap.

## RESEARCH METHODOLOGY

### Research Design

Explanatory research design was adopted. Explanatory study sets out to explain and account for the descriptive information by seek to answer the 'why' and 'how' questions (Subedi, 2016). It builds on exploratory and descriptive research and goes on to identify actual reasons a phenomenon occurs. The objective population of the investigation was 66 small scale tea firms in Kenya. The study conducted a census of the all the 66 registered Small-Scale Tea industries. The justification for the 66 small-scale tea firms is on the basis that there are only a few firms. The years covered was from 2014-2018. The justification for the 5-year period is that the data is very current and thus provided a true picture of the financial performance of the firms. In Kenya, technological innovations in the tea sector were introduced in the year 2014 informing the time scope of the study. The study used secondary data. Secondary data involved data collection from financial records. Other instruments include: books and journals.

### Measures of study variables

The secondary data to be collected include total initial costs and operating costs for fermentation equipment, pruning machines, weighing machines and information systems. Secondary data for firm size using total sales and financial performance of the tea processing firm measured using return on capital employed for each of the tea processing firm were also extracted.

**Table 1: Operationalization of Variables**

| Variable | Measures/indicators | Operationalization |
|---|---|---|
| Fermentation technological innovations investments | Initial costs of purchase/acquisition and operating costs per annum | Initial fermentation machines costs + Operating cost of fermentation machines |

**Researcher, 2020**

Panel data analysis was conducted per variable of the study, followed by panel model that included all the variables of the study and finally test for moderation.

Descriptive statistics in the form means, standard deviations, minimum and maximums; trend line and simple panel model were determined. The simple panel model determined was

$$(FP_{it}) = \beta_0 + \beta_1 IFI_{it} + \mu$$

Where;

$FP_{it}$= Financial Performance of tea firm i at time t

$IFI_{it}$= Investments on Fermentation Innovations of tea firm i at time t measured as total fermentation Investments per annum

$\beta_1$ = Regression coefficient for investments on fermentation innovations

$\beta_0$= they represent the fixed regression coefficient

i= incorporated small-scale tea firm from 2014 to 2018

t= time period (2014-2018)

μ= Error term

**Hypothesis Testing**

The hypothesis was tested using p-value method. The acceptance/rejection criterion was that, if the p value is greater than the significance level of 0.05, we fail to reject the Ho but if it's less than 0.05 level of significance, the Ho is rejected.

**Assumption Tests**

**Panel Unit Root Test**

Unit root test was conducted using the Fisher-type test to establish whether the variables were stationary or non-stationary. Stationarity results are presented in Table 2. The hypotheses to be tested were;

Ho: All panels contain unit roots

Ha: At least one panel is stationary

**Table 2: Fisher-type test of unit root**

| Variable | | **Inverse chi-squared(70) P** | **Inverse normal Z** | **Inverse logit t(179) L*** | **Modified inv. chi-squared Pm** |
|---|---|---|---|---|---|
| Investments on Fermentation Innovations | test statistic | 516.3705 | -9.0019 | -14.6882 | 23.6564 |
| | p-value | 0.000 | 0.000 | 0.000 | 0.000 |
| | p-value | 0.0000 | 0.0001 | 0.0000 | 0.0000 |

The stationarity results test for unit root revealed that, at level investments on fermentation technological innovations, pruning technological innovations investments, investments on weighing technological innovations, investments on information systems technological innovations, firm size investment and financial performance of small-scale tea industry in Kenya measured using return on capital employed were stationary since p-value<0.05 at P, Z, L* and Pm. This means that the results obtained are now not spurious as supported by Gujarati (2003) and so panel regression models could be generated.

**Hausman Test**

The study used the Hausman's specification test (1978) to choose between fixed and random effect models where the hypotheses were;

$H_0$: Random effect is appropriate

$H_1$: Fixed effect is appropriate

Table 3 shows the results of Hausman test.

**Table 3: Hausman Random Test for random and fixed effects**

| Return on capital employed | (b) Fixed | (B) Random | (b-B) Difference | sqrt(diag(V_b-V_B)) S.E. |
|---|---|---|---|---|
| Investments on Fermentation Innovations | 0.046879 | 0.039097 | 0.007783 | 0.004498 |
| chi2(4) | 9.99 | | | |
| Prob>chi2 | 0.0406 | | | |

**Source: Stata 14 computations**

The null hypothesis of the Hausman test is that the random effects model is preferred to the fixed effects model. Hausman test revealed a chi-square of 9.99 with a p-value of 0.0406 indicating that at 5 percent level, the chi-square value obtained is statistically significant. Thus, the researcher rejects the null hypothesis that random effects model is preferred to fixed effect model for the model. The study concludes that fixed effect is appropriate model in analyzing the effect of technological innovation investment on financial performance of Small-Scale Tea Industry in Kenya.

**Normality Test**

The normality assumption (ut ~ N (0, σ2)) was required in order to conduct single or joint hypothesis tests about the model parameters (Brooks, 2008). Bera and Jarque (1981) tests of normality were performed. If the p-value is less than 0.05, the null of normality at the 5% level is rejected. If the data is not normally distributed a nonparametric test was most appropriate. The study tested the null hypothesis that the disturbances are not normally distributed.

$H_0$: The data are not normally distributed

$H_1$: The data are normally distributed

**Table 4: Normality Test**

| Variable | Observation | Skewness | Kurtosis | P-value |
|---|---|---|---|---|
| Investments on Fermentation Innovations | 330 | 1.4740 | 0.4608 | 0.2963 |

Table 4 presents the normality results using for skewness and Kurtosis test. Combining skewness and kurtosis is still a useful test of normality provided that the limiting variance accounts for the serial correlation in the data. The P-values were higher than the critical 0.05 and thus we conclude that the data is normally distributed. Normality and other assumptions should be taken seriously, for when these assumptions do not hold, it is impossible to draw accurate. The assumption of normality needs to be checked for many statistical procedures, because their validity depends on it.

**Autocorrelation**

This study used the Wooldridge test for serial correlation to test for the presence of autocorrelation in the linear panel data. The null hypothesis of this testing is that data has no

serial correlation. If the calculated p-value>0.05, there is no serial correlation in the data; otherwise serial correlation is present (Anderson *et al.,* 2007). The results are presented in Table 5.

**Table 5: Wooldridge test for autocorrelation**

| **Wooldridge test for autocorrelation in panel data** |
|---|
| $H_0$: no first-order autocorrelation |
| F( 1, 65) = 1.860 |
| Prob > F = 0.4310 |

Source: Research Data, 2020

The null hypothesis of this test was that there is no first order serial/autocorrelation existed in the data. When Serial Correlation was conducted, the test statistic reported is F-test of 0.1.860 and a p value of 0.4310>0.05. The null hypothesis that no first order serial /auto correlation exists is not rejected. From the serial correlation results, the study concludes that serial correlation does not exist. If the serial correlation is detected in the panel data, then the Feasible Generalized Least Squares estimation is adopted. Serial correlation is a typical issue experienced in panel data and must be represented so as to be accomplished in right model in particular. As indicated by Wooldridge (2002), inability to check for presence of serial correlation will render the parameter estimates incorrect.

**Heteroscedasticity**

Breusch-Pagan/Godfrey test used to test for heteroskedasticity. The null hypothesis in the test is that error terms have a constant variance ie homoskedastic, it has steady fluctuation. The heteroskedasticity results are presented in Table 3.6.

**Table 6: Breusch-Pagan test for Heteroskedasticity**

| |
|---|
| Breusch-Pagan / Cook-Weisberg test for heteroskedasticity |
| Ho: Constant variance |
| Variables: fitted values of return on capital employed |
| chi2(1) = 0.33 |
| Prob> chi2 = 0.5668 |

The results in the Table 6 indicate that the error terms are heteroskedastic, given that the p-value (0.5668 >0.05) confirmed that the null hypothesis of constant variance was accepted justifying the absence of heteroskedasticity in the data as supported by Poi and Wiggins (2001). Heteroskedasticity refers to the state of systematic changes in the spread of residuals or the error term of the model. The presence of residual variance in a model reveals that the scattering of the model is dependent on at least one independent variable. In the event that the error variance is not consistent, at that point there is the heteroscedasticity in information. Conducting regression without representing heteroscedasticity would thus prompt impartial parameter gauges. This would result in an inefficient and unstable regression model that could yield bizarre predictions in the model estimate.

**Multicollinearity Test**

Multicollinearity was assessed in this study using the variance inflation factors (VIF). The results in Table 7 indicated absence of multicollinearity since the VIF of all the variables were less than 10.

**Table 7: Multicollinearity Test**

| Variable | VIF | 1/VIF |
|---|---|---|
| Investments on Fermentation Innovations | 2.49 | 0.401437 |
| Mean VIF | 1.94 | 0.528797 |

The results in Table 7 indicate absence of multicollinearity since the VIF of all the variables were less than 10. When multicollinearity was tested, the VIF values for fermentation technological innovation investment, pruning technological innovation investment, weighing technological innovation investment and information systems technological innovation investment were less than 10 indicating absence of multicollinearity. Multicollinearity makes it hard to interpret your coefficients, and it reduces the power of your model to identify independent variables that are statistically significant. The absence of multicollinearity implies that the data could be used to estimate the panel model on how investments on fermentation innovations, investments on pruning innovations, investments and investments on information system innovations influenced financial performance of small-scale tea firms in Kenya using return on capital employed indicator.

## RESEARCH FINDINGS AND DISCUSIONS

### Introduction

The objective of the study was to examine the effect of investments on fermentation innovations on financial performance of small-scale tea firms in Kenya. Descriptive statistics in the form means, standard deviations, minimum and maximums; a trend line and simple panel model were used to answer this objective.

### Descriptive Statistics

Table 8 presents descriptive results for total initial costs and operating costs investments on fermentation innovations acquired between 2014 and 2018. Investments on fermentation innovations have been increasing since 2014 indicating that investment on fermentation machines by the tea processing firms require a lot of financial resources.

**Table 8: Descriptive Statistics on Investments on Fermentation Innovations**

| Costs | Year | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Initial costs on fermentation innovations in KES '000 | 2014 | 19736.55 | 5769.59 | 10215 | 29667 |
| | 2015 | 21207.79 | 6082.127 | 11292 | 29898 |
| | 2016 | 20690.35 | 6398.909 | 10423 | 29926 |
| | 2017 | 20306.39 | 6068.594 | 10159 | 29668 |
| | 2018 | 20591.08 | 5937.676 | 10089 | 29787 |
| | **Total** | **20506.43** | **6037.396** | **10089** | **29926** |
| Operating costs of fermentation innovations in KES '000 | 2014 | 4171.364 | 1269.392 | 2125 | 6327 |
| | 2015 | 4188.348 | 1327.342 | 2074 | 6373 |
| | 2016 | 4440.667 | 1376.887 | 2006 | 6456 |
| | 2017 | 4309.909 | 1171.448 | 2045 | 6500 |
| | 2018 | 4292.53 | 1417.511 | 2096 | 6416 |
| | **Total** | **4280.564** | **1310.929** | **2006** | **6500** |
| Total costs invested on fermentation innovations in KES '000 | 2014 | 23907.91 | 5912.322 | 13023 | 34867 |
| | 2015 | 25396.14 | 6229.555 | 14223 | 35823 |
| | 2016 | 25131.02 | 6432.173 | 13758 | 35902 |
| | 2017 | 24616.3 | 6225.928 | 13762 | 35035 |
| | 2018 | 24883.61 | 6248.038 | 13231 | 35894 |
| | **Total** | **24786.99** | **6195.076** | **13023** | **35902** |

The findings in Table 8 show that the mean average total costs (initial costs and operating costs) for investments on fermentation innovations across all the small-scale tea firms was KES 24.79 million. The tea processing firm that spends the highest total costs by investing on fermentation innovations (initial costs and operating costs) was KES 35.902 million with smallest tea processing firm spending KES 13.023 million in total costs on fermentation innovations. The standard deviation for total costs spend on fermentation innovations was KES 6.195 million indicating that total observations were clustered around the mean. The results indicate that the tea processing firms have been spending lots of money to acquire, maintain and operate fermentation technological machines.

### 4.2.2 Trend line

This section presents the trend line for investments on fermentation innovations from 2014-2018. The study conducted a trend analysis to establish the movement of the variables overtime. Trend analyses for total initial costs and operating costs for investments on fermentation technological innovations is presented. Investment on fermentation innovations by KTDA started in 2014. The explanations of the data are based on the tea seasons (yearly). The trend line is presented in figure 2.

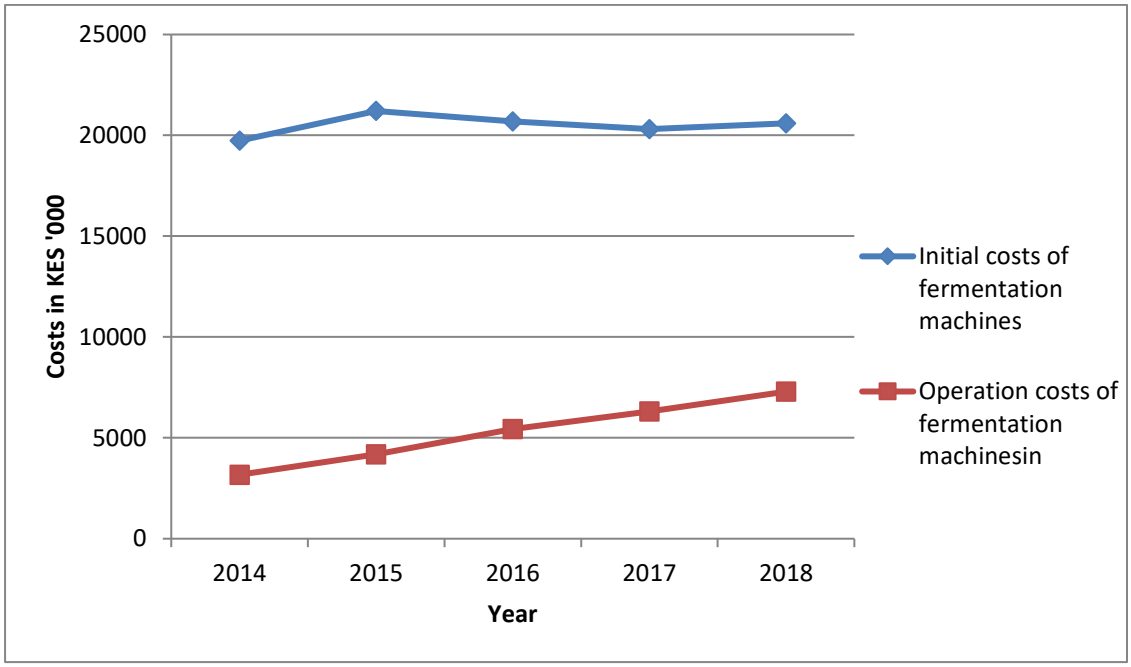


**Figure 2: Investments on fermentation innovations in KES '000**

Initial costs for the investments on fermentation technological innovations were highest at the start in 2014. The rise is attributed to intensive investment to fermentation machines. Fermentation technological innovation investment is very fundamental and responsible for the final product of tea and will determine its quality. However, total costs on fermentation technological innovations declined in the subsequent year of years. However, operation costs were lower during the initial years of operating fermentation machines but rose gradually. The rising costs resulted to fall in earnings before interest and tax to capital employed. Rising operational costs may be due to frequent breakdowns of fermentations machines with continuous usage over time.

**Simple Panel model between investments on fermentation innovations and financial performance of small-scale tea industry**

Fixed effect model was estimated between investments on fermentation innovations and financial performance of small-scale tea industry in Kenya. Simple panel model was conducted to determine whether there was a significant relationship between investments on fermentation innovations and financial performance of small-scale tea industry. Table 4.2 presents the simple panel regression model between investments on fermentation innovations and financial performance of small-scale tea industry.

**Table 9: Investments on fermentation innovation and financial performance of small-scale tea industry**

| Return on capital employed | **Coef.** | **Std. Err.** | **z** | **P>\|z\|** | **[95% Conf.** | **Interval]** |
|---|---|---|---|---|---|---|
| Investments on fermentation innovation | 0.104222 | 0.007032 | 14.82 | 0.000** | 0.090375 | 0.118069 |
| Cons | -0.65675 | 0.055964 | -11.74 | 0.000** | -0.76694 | -0.54655 |
| R-sq: | | | | | | |
| within = 0.4551 | | | | | | |
| between = 0.3255 | | | | | | |
| overall = 0.3833 | | | | | | |
| F(1,263) | 219.64 | | | | | |
| Prob > F | 0.0000 | | | | | |

*Significant at 0.05

**Significant at 0.01

The fitted model from the result is

Financial performance of small-scale tea industry = -0.65675+0.104222Investments on fermentation innovation

As presented in the Table 9, the coefficient of determination R Square is 0.3833. The model indicates that investment on fermentation technological innovation explains 38.33% of the variation in financial performance of small-scale tea industry in Kenya. This implies that 38.33% of the variations in financial performance of small-scale tea industry are attributed to investment on fermentation technological innovation. The findings further confirm that the relationship between investment on fermentation technological innovation and financial performance of small-scale tea industry is positive and significant with a coefficient of ($\beta$ =0.104222, p=0.000). This implies that there exist a positive and significant relationship between investment on fermentation technological innovation and financial performance of small-scale tea industry since the coefficient value was positive and the p-values was 0.000<0.05.

Model results imply that a unitary increase in the investment on fermentation technological innovation leads to an increase in financial performance of small-scale tea industry by 0.104222 units holding investment on other technological innovations constant. Fermentation technological innovation investment is very fundamental and responsible for the final product of tea and will determine its quality. This procedure includes enzymic oxidation/debasement of polyphenols, lipids, carotenoids and tarpene-glycosides, and their ensuing buildup/corruption prompting development of shaded polymers and smell and flavor mixes. The outcome of Continuous Fermentation process is more noteworthy consistency in the nature of made tea and progressively proficient creation. The results agree with Muturi (2018) who conducted a study on factors influencing the performance of small-scale tea farmers in Embu north sub County, Embu county Kenya and established that the Continuous Fermentation Unit has significantly increased the efficiency and the overall performance of the factories that have adopted the technology. Moreover, the results also agree with Kiai and Wambui (2015) who conducted a study on the Impact of innovation on the financial performance of KTDA managed tea factories in Meru and Kirinyaga counties and found that Continuous Fermentation Unit

mainly cut out the increasing labor costs, improved the quality of made tea and increased efficiency of processing. Therefore, innovations were positive and KTDA should continue adopting innovations for the benefits of the farmers.

**Correlation Analysis on Investments in Technological Innovation and Financial Performance**

In order to get an overview of the association between the dependent and independent variables, the study conducted pairwise correlation analysis. The analysis aims at testing for existence of multicollinearity and it is ideal for eliminating variables which are highly correlated. The study conducted correlation analysis between technological innovation investment and financial performance of small-scale tea industry in Kenya. Pearson's product-moment correlation coefficient (r) was used to examine the extent of correlation between the variables of study and to show the strength of the linear association between the variables. r ranges between ±1. Where r= +0.7 and above it indicates a very strong relationship; r=+0.5 to below 0.7 is a strong association; r=0.3-0.49 is a moderate association while r=0.29 and below indicates a weak association. Where r=0 it indicates that there is no association. Table 4.11 presents the correlation matrix for fermentation technological innovation investment, pruning technological innovation investment, weighing technological innovation investment, information systems technological innovation investment and financial performance of small-scale tea industry in Kenya using return on capital employed.

**Table 10: Correlation between Investments on Technological Innovations and financial Performance of Small-Scale Tea Industry**

| | | Fermentation technological innovation investment |
|---|---|---|
| Return on capital employed | 1.000 | |
| Investments on fermentation innovations | 0.6191<br>0.000*** | 1.000 |

**Significant at 0.05, ***Significant at 0.01

The correlation results found that investments on fermentation innovations and return on capital employed of small-scale tea industry in Kenya are positively and significantly associated (r=0.6191, p=0.000<0.05). The results imply that investments on fermentation innovations and return on capital employed move in different direction. Investment on fermentation innovations is very fundamental and responsible for the final product of tea and will determine its quality. Fermentation technological innovation involves automating tea processing by adopting Continuous Fermentation Unit and converting the steam boilers from furnace fuels to firewood fuel with the aim of reducing the operational costs. Implementing Continuous Fermentation Unit is geared towards mitigating the rising cost of labour while improving on quality and efficiency. The results agree with Kiai and Wambui (2015) that the innovations adopted by KTDA including use Continuous Fermentation Unit of have had a positive impact on the financial performance of the factories by reducing the operational cost. The results align with Wanjira, Kubaison and Nzomo (2016) innovation had a positive effect on the performance of KTDA managed factories as CFU technology eliminated human

intervention in the process of fermentation of tea resulting to greater consistency of quality of made tea, more efficient production and lowering labour costs.

**Testing of Hypothesis**

*The study tested a hypothesis which stated that investment in fermentation innovations has no significant relationship to the financial performance of small-scale tea firms in Kenya.*

Results in Table 10 indicates that investment on fermentation technological innovations and financial performance of small-scale tea industry are positively and significantly related with p value=0.000<0.05 hence the null hypothesis was rejected. A conclusion was thus made that investment on fermentation innovations has a significant benefit on the financial performance of small- scale tea firms in Kenya.

Fermentation technological innovation investment is very fundamental and responsible for the final product of tea and will determine its quality. This procedure includes enzymic oxidation/debasement of polyphenols, lipids, carotenoids and tarpene-glycosides, and their ensuing buildup/corruption prompting development of shaded polymers and smell and flavor mixes. The outcome of Continuous Fermentation process is more noteworthy consistency in the nature of made tea and progressively proficient creation. The results agree with Muturi (2018) who conducted a study on factors influencing the performance of small-scale tea farmers in Embu north sub County, Embu county Kenya and established that the Continuous Fermentation Unit has significantly increased the efficiency and the overall performance of the factories that have adopted the technology. Moreover, the results also agree with Kiai and Wambui (2015) who conducted a study on the Impact of innovation on the financial performance of KTDA managed tea factories in Meru and Kirinyaga counties and found that Continuous Fermentation Unit mainly cut out the increasing labor costs, improved the quality of made tea and increased efficiency of processing. Therefore, innovations were positive and KTDA should continue adopting innovations for the benefits of the farmers.

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The objective of the study was to examine the effect of investments in fermentation technological innovation on the financial performance of small-scale tea firms in Kenya. Descriptive results indicated that the average total costs (initial costs and operating costs) for investments on fermentation innovations across all the small-scale tea firms was KES 24.79 million. The tea processing firm that spends the highest total costs by investing on fermentation innovations (initial costs and operating costs) was KES 35.902 million with smallest tea processing firm spending KES 13.023 million in total costs on fermentation innovations.

Correlation analysis revealed that fermentation technological innovation investment and financial performance of small-scale tea industry in Kenya are positively and significantly associated. Investment on fermentation technological innovation was found to be satisfactory in explaining financial performance of small-scale tea industry. Further, results revealed that, fermentation technological innovation investment is a good predictor of financial performance of small-scale tea industry. Panel regression of coefficient results revealed that, there was a positive and significant relationship between investment on fermentation technological innovation and financial performance of small-scale tea industry in Kenya ($\beta$ =0.046879, p=0.000<0.05). This means that, a unitary increase in the investment on fermentation technological innovation leads to a unit increase in financial performance of small-scale tea industry by 0.046879.

## Conclusions

Based on the findings, the study concluded that investment on fermentation technological innovations positively affects financial performance of small-scale tea firms. The average investment fermentation technological innovations have been rising as indicated in the descriptive results. Fermentation techniques have been over the years improved, and improved forms of fermentation machines novel are being explored and implemented to meet the demands of high-quality of tea. Fermentation technological innovation investment is very fundamental and responsible for the final product of tea and will determine its quality. Fermentation technological innovation involves automating tea processing by adopting continuous fermentation unit and converting the steam boilers from furnace fuels to firewood fuel with the aim of reducing the operational costs. The outcome of continuous fermentation process is more noteworthy consistency in the nature of made tea and progressively proficient creation. Implementing continuous fermentation unit is geared towards mitigating the rising cost of labour while improving on quality and efficiency.

## Recommendations

### Recommendations for Management

The study revealed that investment in fermentation technological innovations influences financial performance of small-scale tea firms. The study recommends that management should consider acquiring more continuous fermentation units as to allow efficient fermentation of tea while preserving quality. Implementing Continuous Fermentation Unit is geared towards mitigating the rising cost of labour while improving on quality and efficiency. The introduction of fermentation innovations has to be guided by the cost-benefit analysis to so as to ensure that tea processing firms reap more from benefits in comparison to total costs used to operate the CFUs units.

### Policy Recommendations

The introduction of mechanization in the tea sector increased productivity and efficiency in tea faming and processing. However, technological innovation including introduction of continuous fermentation units resulted to massive job losses to most Kenyans who worked in the tea sector. The policy implication of these scenarios toward Kenya Tea Development Agency, Ministry of Labor and tea workers association is to strike a balance between technological innovations in the tea sector and sustainability without threatening livelihoods of many Kenyans dependent on tea sector.

### Academic Recommendations

The current study has contributed to the knowledge on technological innovation investments and financial performance of small-scale tea industry. It is evident that investment in technological innovations has varying implications both positive and negative to the growth of tea sector. The impacts emanating from investing on tea technologies and innovations were not exhaustive. The study recommends that the academicians and scholars may further investigate the implication of technology in the growth of tea sector.

### Contribution of the Study to Theory

The study established that investments on fermentation technological innovations significantly influenced financial performance of small-scale tea industry in Kenya. Thus, the postulation by Schumpeterian Theory on Innovations, was upheld. According to Schumpeterian Theory regards innovations is the primary cause of economic development. Schumpeter believed that change in the forms of production could occur from the inside, and then go through a form of business cycle to really generate economic change.

**Areas for further research**

It is evident that investment in technological innovations has varying implications both positive and negative to the growth of tea sector. The impacts emanating from investing on tea technologies and innovations were not exhaustive. The study recommends that the academicians and scholars may further investigate the implication of technology in the growth of tea sector.

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