**RUFORUM Working Document Series (ISSN 1607-9345), 2018, No. 17 (1): 867-876.**
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Research Application Summary

# Effects of soybean and sweetpotato vine on growth of weaner rabbits

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## Abstract

Rabbitry as an economic activity is fraught with significant challenges which include; lack of knowledge in rabbit husbandry, the high cost of rabbit feeds and are out of reach for many farmers. The objective of this study was to determine the ideal forage for rabbits which can substitute expensive concentrates that make rabbit farming unsustainable in Elgeyo Marakwet and Kakamega Counties in Kenya. The experiment was carried out on 40 weaned New Zealand rabbits that were randomly selected and put into commercial cages and assigned to five dietary treatment groups with each treatment group having four rabbits. Data on weekly weight gain were recorded and monitored for six weeks. Faecal samples from each experimental unit were collected from the animals and bulked and analyzed for proximate contents. The results showed that all the performance indices of growth performance (weight gain, growth, feed intake and FCR) were statistically significant ($p<0.05$) indicating that different treatment regimes affected the growth performance of New Zealand White rabbits. In particular, the rabbits under the sweet potato and soy bean supplementation achieved desirable growth rate and weight gain while sweet potato vines were the most effective feed supplement in terms of conversion of nutrients into animal protein. The study recommends that small scale farmers can use a mix of sweet potato vines and soybean because the feed is easily available on the farms.

Keywords: Growth performance, Kenya, soybean, sweet potato vines, weaner rabbits

## Résumé

La lapinerie en tant qu'une activité économique est confrontée à des défis importants, notamment: manque de connaissances dans l'élevage de lapins, le coût élevé des aliments pour lapins et sont hors de portée pour de nombreux éleveurs. L'objectif de cette étude était de déterminer le fourrage idéal pour les lapins qui peut remplacer des concentrés coûteux qui rendent l'élevage des lapins non durable dans les comtés d'Elgeyo Marakwet et de Kakamega au Kenya. L'expérience a été réalisée sur 40 lapins néo-zélandais sevrés qui ont été sélectionnés au hasard et placés dans des cages commerciales et assignés à cinq groupes de traitement diététique, avec chaque groupe de traitement ayant quatre lapins. Les données sur le gain de poids hebdomadaire ont été enregistrées et surveillées pendant six semaines. Des échantillons fécaux de chaque unité expérimentale ont été prélevés sur les animaux et groupés et analysés pour le contenu immédiat. Les résultats ont montré que tous

les indices de performance de la croissance (gain de poids, croissance, prise alimentaire et FCR) étaient statistiquement significatifs (p <0,05), indiquant que différents régimes de traitement affectaient la performance de croissance des lapins blancs néo-zélandais. En particulier, les lapins sous la supplémentation en patates douces et fèves de soja ont atteint un taux de croissance et un gain de poids souhaitables tandis que les vignes de patates douces étaient le complément alimentaire le plus efficace en termes de conversion des nutriments en protéines animales. L'étude recommande que les petits agriculteurs puissent utiliser un mélange de vignes de patate douce et de soja, car les aliments sont facilement disponibles sur les fermes.

Mots clés: Performance de croissance, Kenya, soja, vigne de patate douce, lapin sevré

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Background

The rapid population increase in African countries comes with challenges of supplying sufficient animal protein and this has necessitated the increasing focus on the popular livestock species; cattle, sheep, goat, swine and poultry to provide the bulk of animal protein (Sese *et al*., 2014). But, due to the insufficiency in the livestock production systems, the governments of many developing countries have implemented several intervention measures in their agricultural policies in order to mitigate this protein deficiency (Etim *et al*., 2014). Therefore, strategies for improving household food and nutrition security and incomes in developing countries will heavily depend on better utilization of unconventional animal protein sources such as rabbit meat. Due to this, rabbits are seen to have favourable attributes when compared to other livestock in that its productivity can be improved by feed supplementation (Omoikhoje *et al*., 2006).

Rabbits play an important role in poverty alleviation and therefore there is need to rejuvenate rabbit projects for long term sustainability of small holder rabbit production models which include innovative research and upscaling of sound practices in small holder rabbits' units across regions including socio-cultural shifts and providing improved and cost-effective animal feeding practices which emphasizes saving on cost, time and space (Oseni and Lukefahr, 2012; Etim *et al*., 2014).

Other significant challenges to sustainable rabbit production is the low productivity stemning from the inefficient utilization of the feed resources because of deficiencies in nutrients availability (mainly nitrogen, sulphur and minerals) in their diet. Though rabbits can be kept on forage alone, their productivity is significantly higher when fed on concentrates but this is a challenge due to increasing costs of concentrates (Omoikhoje *et al*., 2006). Thus this study aimed at designing altenative feed source for rabbits, especially for small-scale farmers.

**Literature summary**

Rabbits are herbivores with mono-gastric animals with a digestive physiology that is well adapted to cellulose components (Sese *et al*., 2014) with past research showing that that

fibre which form an integral part of a rabbits' diet being derived from several sources such as grass, vegetables and hay (Wanjala, 2015). Feeding rabbits on high energy, low fibre diets leads to poor growth rates and high incidences of enteritis, thus a balance of fibre and energy should be sought. Rabbits have high relative capacity of the caecum where microbial digestion occurs therefore rabbits achieve a high voluntary feed intake which is four times higher that of a 250 kg steer and twice as much as for a 40 kg growing pig on live weight basis (De Blas, 2013).

In rabbit husbandry, nutrition and feeding strategies are key conditional aspects that are considered for the growth performance of rabbits. Rabbits regulates its feed intake according to its energy requirements (Gidenne *et al*., 2010). They not only optimize the production of the meat and fur but also prevent various pathological issues that include utilization of unbalanced diets and the presence of pathogenic agents in feeds or in drinking water. Starch concentration remains low (around 1.5 to 4%), while protein requirements are high not only for body growth but also for intestinal mucus development and renewal (Gidenee *et al*., 2010).

Young rabbits consume less than 2g of feed per day until 20 days of age. This later on increases to 40-50 g/day at the onset of the fourth week while an adult consumes 140-150 g of DM per day, i.e., this is for 4 kg New Zealand White (Gidenne *et al*.,2010). De Blas (2013) asserts that rabbits' diets typically contains 320-360 and 50-90 g/kg of insoluble and soluble fibre, respectively. Rabbits require around 10 g of digestible protein /Mj De in order to reach maximal feed intake daily weight gain, protein retention and protein efficiency and to minimize fattening mortality. When rabbits ingest less than 85% DE concentration of their *ad libitum* intake level, they are likely to have compromised growth and feed efficiency. Rabbits have the desired growth performance when fed on high concentrate diets (Wanjala, 2015).

In rabbits, nutritional disorders can result from both non-infectious and infectious causes such that significant imbalances between protein and fibre increase the risk of enteritis (Marlier *et al*., 2003). Digestive disorders occur when crude fibre is less than 12% in fattening rabbits or 14 – 15% in weaning and post weaning rabbits, while the starch requirements exceeding 15% in weaning rabbits and 25% in fattening rabbits may induce diarrhoea and even death. The dietary protein values for fattening rabbits ranges between 10 to 11gDP/MJDE, however, this is influence not only by digestibility, the satisfactory quantities of essential amino acids but also by the ratio between protein and energy (Xiccato, 2010).

Research has shown that California and New Zealand breeds can reach a desired weight of 2 kg in 10 – 12 weeks. A comparative study of two rabbit breeds (New Zealand White, California White) showed that the consumption range between 23 to 36 g $d^{-1}$ with an FCR ranged from 3.97 to 4.82 under the concentrates - based diet (Wanjala, 2015). A study by Etim *et al*. (2014) on feeding female rabbits indicate that *Ipomea batatas* (sweet potato) vines can be used as a supplement, thus can be said to enhance growth performance of the rabbits when used as a feed main source or as a supplement.

Some of the factors determining the growth performance of rabbits is the feeding arrangement and the nutrient quality of the diets. Though careful management of and balancing of diets is required, rabbits feed on foliage material *ad libitum* can have similar growth performance as those feed on concentrates (Cheeke, 1986). A concentrate: forage ratios of 1:4 have been shown to have the highest live weight and FCR in rabbits (Adeyemo *et al*., 2014). Serem (2014)

reported that commercial concentrates have a low fibre level below the recommended levels of 15 – 16 %. Therefore supplementation can be carried out by inclusion of soybean and/or sweet potato vines in order to balance the crude fibre, crude protein and gross energy needs. Inclusion of forage to the concentrate by certain percentages would lead to a proportionate increase in weight gain indicating a better growth performance of rabbits (Adeyemo *et al*., 2014)

**Research Approach**

The study was carried out in the natural setting of a farm which consisted of small-scale farmers in Kibargo, Elgeyo -Marakwet and Makunga, Kakamega Counties in Kenya. The aim was to design sustainable small-scale integrated sweet potatoes and soybeans use on rabbit production as a tool for soil fertility improvement, food and nutrition security and women and children empowerment. The study obtained commercial rabbit house and cages for the farmers in both counties which were thoroughly cleaned and disinfected before the introduction of the rabbits in cages measuring 0.600m x 0.050m x 0.050m. The study used weaner rabbits which were randomly selected and assigned to five (5) dietary treatment groups with each treatment group having four (4) rabbits. At the onset of the study, the rabbits were dewormed and treated against coccidiosis (Osakwe and Nwose, 2008).

The experimental treatments were arrenged in a randomized complete block design (RCBD), with the blocking factors being other variations such as weight other than the treatments. The dietary combinations were as follows: 30 grams of concentrate to 70 grams of hay added to 30 grams of either soybean or sweet potato vine. The design approach is well suited for agricultural experiments where only one breed is used to control variation in an experiment by accounting for spatial effects. The acronym $T^1$ represents treatment one, $T^2$ represents treatment two while $T^5$ represented treatment five.

The randomized complete block design (RCBD) is given by a linear model as shown in equation 1.

$$Y_{ijk}=\mu + {}_{i} + \beta_j + {}_{ijk} \qquad \text{(Equation 1)}$$

Where:
Yijk= Observation of the ith Treatment in the jth block;
μ = Overall population mean;
i = Effect due to the ith treatment;
$\beta_j$ = Effect due to the $j^{th}$ block;
${}_{ijk}$ = Random error associated with $Y_{ijk}$

The concentrate (commercial pellets), hay, sweet potato vines and soybean were weighed early in the morning and fed in separate feeders daily (30 grams of concentrate to 70 grams of hay; to 30 grams of either soybean or sweet potato vine). Clean water was provided *ad libitum*. In the morning, before any fresh feed was introduced, the feed left-over and wastage were collected and weighed daily. Weekly live weights (in grams) of rabbits were

determined by using a calibrated weight scale. Daily feed intake was determined by weighing the left-over feed from the quantity of feed offered the previous day. Data on weekly weight gain, feed conversion ratio and daily weight gain were recorded and calculated. The weights of the feeds were then used to calculate the daily feed intake and the data generated was used to compute Feed Conversion Efficiency.

**Results**

The sections present the results from the experiment in three important growth performance indicators: the growth performance, the weight gain and FCE. The growth performance is indicated by the weight gains made by the rabbits during the experimental period and signify the growth of the rabbit as measured in kgs. The Feed Conversion Efficiency signify the ratio of the weight gained over the feed intake and is calculated as follows.

$$\mathrm{F.C.E} = \frac{\text{Weighted gained (g)}}{\text{Feed intake (g)}}$$

Figure 1 illustrates the growth performance of the rabbits. All the rabbits exhibited a linear growth performance with little deviations from linearity in growth. Because the experiment was completely random, the rabbits were of different weights at the onset of the experiment but at the end of the experiment, the rabbits in treatment 2 ($T^2$) had the highest and most linear growth than their counter parts. Treatment 5 ($T^5$) ranked second in growth rate with treatment 1 ($T^1$) following. Treatment 3 ($T^3$) had the least weight gain.

The results in Table 1 highlights the differences in weekly weight gains with the different treatments for all the treatments showing progressive increase in weight gains. There were statistically significant differences (p=0.042) in the net weight gains. The hay – concentrate mix had the highest average weight gain of 100.88 g week$^{-1}$, with hay-vines-soybean mix giving the second highest net weight gain at 64.12 g week$^{-1}$, while hay control feed had the least weight gain of 22.79 g week$^{-1}$. These differences in the weight gains is attributable to the treatment regimens administered to the rabbits.

The Tukey's post hoc test show that the treatments could be said to have three effects; the lowest being that of the control feed, the moderate effect being that of the soybean and sweet potato vines supplementation and the highest being that of the concentrate.

The rabbits under concentrate-hay mix recorded highest weight gains of 100.88 g week$^{-1}$ followed by hay-vines –soybean mix at 64.13 g week$^{-1}$, hay –soy mix at 52.21 g week$^{-1}$, hay –vines at 46.30 g week$^{-1}$ while the control had the lowest weight gain of 22.79 g week$^{-1}$.

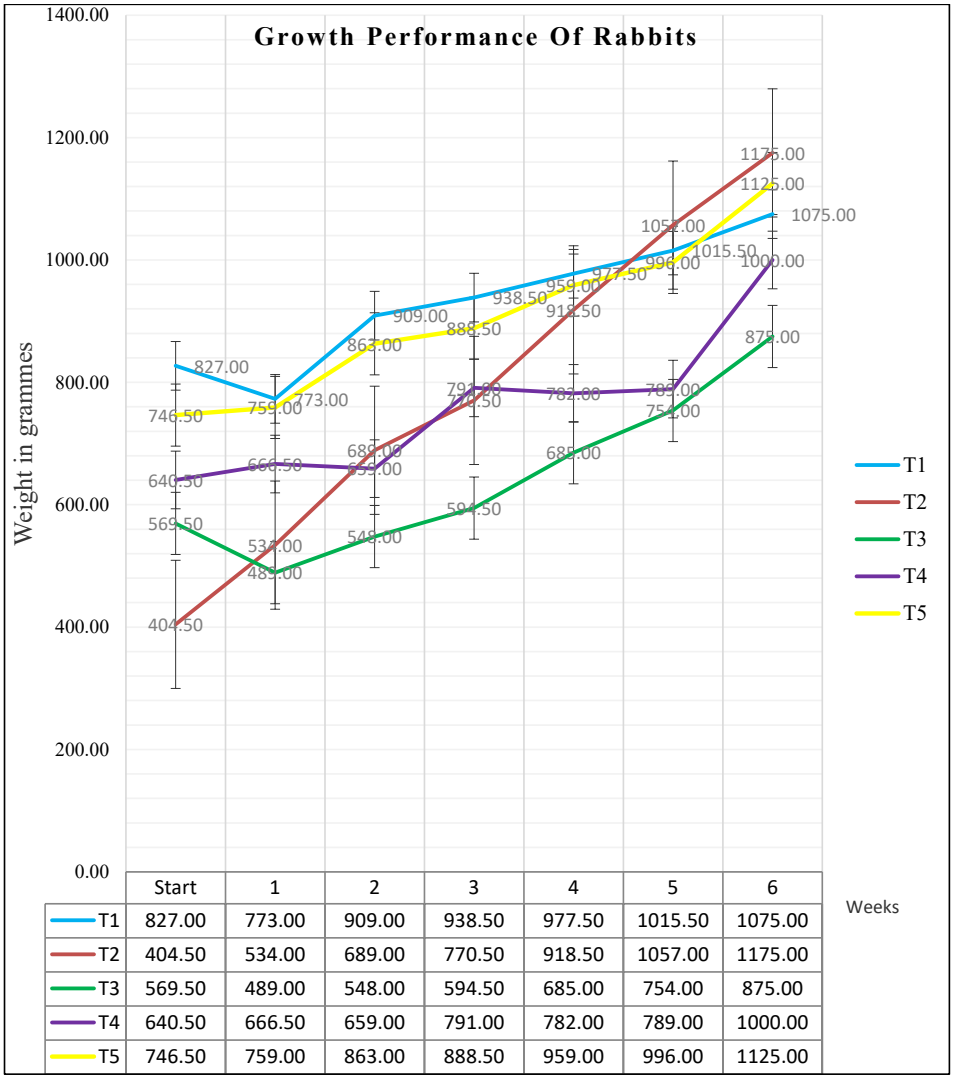


**Figure 1. Growth performance of rabbits during the experiment**

**Table 1. Weight gain during the experiment**

| Time durations in weeks | Treatments | | | | | F-test | p |
|---|---|---|---|---|---|---|---|
| | $T^1$ | $T^2$ | $T^3$ | $T^4$ | $T^5$ | | |
| 1 | -73.75 | 77.50 | -82.50 | -0.50 | -52.75 | Treatment = 2.13, | <0.05 |
| 2 | 41.00 | 161.50 | 92.75 | -8.50 | 63.25 | p = 0.042 | |
| 3 | 34.00 | 61.50 | 72.50 | 141.50 | 41.75 | | |
| 4 | 48.25 | 113.25 | 35.00 | 5.75 | 161.50 | | |
| 5 | -10.50 | 98.00 | 45.50 | 13.00 | 78.50 | | |
| 6 | 97.75 | 93.50 | 114.50 | 162.00 | 92.50 | | |
| Mean | $22.79^{a}$ | $100.88^{c}$ | $46.30^{bc}$ | $52.21^{bc}$ | $64.13^{bc}$ | | |

**Table 2. Performance indices of the rabbits under different feeding regimes**

| Parameters | $T^1$ | $T^2$ | $T^3$ | $T^4$ | $T^5$ | F | p-value |
|---|---|---|---|---|---|---|---|
| Average Initial live weight (g/rabbit) | $827.0^{c}$ | $404.5^{a}$ | $569.5^{ab}$ | $640.5^{b}$ | $746.5^{b}$ | 21.80 | 0.001 |
| Average Final live weight (g/rabbit) | $1200.0^{ab}$ | $1288.0^{b}$ | $1062.0^{a}$ | $1162.0^{ab}$ | $1275.0^{ab}$ | 3.29 | 0.043 |
| Average Weight Gain (g/rabbit) | $22.79^{a}$ | $100.88^{c}$ | $46.29^{ab}$ | $52.21^{ab}$ | $64.12^{ab}$ | 2.13 | 0.082 |
| Average Feed intake (%/rabbit) | 307.8a | $399.6^{b}$ | $292.5^{a}$ | $445.1^{c}$ | $516.5^{d}$ | 136.21 | 0.001 |
| Feed conversion ratio | $7.49^{ab}$ | $10.24^{b}$ | $6.33^{a}$ | $15.31^{bc}$ | $16.50^{c}$ | 1.64 | 0.070 |

F denote the ANOVA statistics, p – values denote the significance levels

[a, b, c, d,] indicates that the values in the same row are not significantly different from each other.

The statistics in Table 2 highlights that performance indices of the rabbits. There were significant differences (F = 21.80, p<0.05) in the average initial weights with rabbits under hay-concentrate mix having the lowest initial weight of 404.5 g while the rabbits in the hay control treatment having the highest initial weight of 827.0g. At the conclusion of the experiment, significant differenes existed (F = 3.29, p<0.05) with the rabbits under the hay-concentrate mix having the average final weight of 1288 g while the rabbits under hay-vine mix had the lowest final weight of 1062 g. There were statistically significant differences (F = 2.13, p<0.05) in average weight gain with rabbits under the hay-concentrate mix having the highest weight gain of 100.88 g $week^{-1}$ while hay control feed had the lowest weight gain of 22.79 g $week^{-1}$. The indicators of average feed intake were also statistically significant (F = 136.21, p<0.05) with rabbits under hay-vine mix having the lowest average feed intake while those under the hay-soybean – vines mix having the highest value. The FCR values were also statistically significant (F = 1.64, p<0.05) with those under hay-vine-soybean mix having the highest feed intake while the control had the lowest value.

## Discussion

The study recorded final live weights of 1,162 grammes in the hay – soybean diet, 1,062 grammes in the hay-vines diet and 1,275 grammes in the hay – soybean – vines mix indicating that the diet composed of hay–vine-soybean is effective in promoting growth rabbits. On the other hand, the diet consisting of hay had a growth rate of 22.80 g $week^{-1}$ which was superseded by hay – sweet potato vine – soybean diet at 64.12 g $week^{-1}$, while hay – concentrate diet had a growth rate of 100.88 g $week^{-1}$ while the hay – sweet potato diet had a growth rate of 46.29 g $week^{-1}$. The experiment recorded weekly mean growth rates of between 22.79 g $week^{-1}$ in hay and 64.12 g $week^{-1}$ in hay–vine-soybean diet in comparison to Wanjala (2015) who reported a daily mean growth rates of 203 g $d^{-1}$ in the hay-concentrate diet. The desired daily growth rate in rabbits is 35 g $d^{-1}$ and this fact could be attributable to the physical environment as well as feed nutrient composition, but poor performance could also be attributed to the lower CP content of the feeds. Thus, feed restriction leads to slower growth rate compared to those animals fed *ad libitum*. The hay – sweet potato diet had a growth rate of 46.29 g $week^{-1}$, a figure that is moderate when compared to the results reported in the study by Franck *et al*. (2016) who indicated that sweet potato vines diet gave on average feed intake of 157g $d^{-1}$ and an average weight of 2081.87g which translates to an average daily gain of 24.38 - 27.29 g $d^{-1}$.

Within the treatment regimes, the differences in the growth indicate that certain feeds had a significant effect on the growth performance of the rabbits. Some notable factors include the birth

weight and the maternal effects. According to Serem (2014) the growth rate of rabbits is dependent on a number of factors such as breed, birth weight and maternal effects such as nutrition and milk production. Since the rabbits were of different weights, these factors might explain the treatment – interactions effects.

Some of the factors determining the growth performance in the study could be the feeding arrangement and the nutrient quality of the diets. Though careful management and balancing of diets is required, rabbits fed on foliage material *ad libitum* can have similar growth performance as those feed on concentrates (Cheeke, 1986). Further analysis show that different diets can have significant growth performance effects, for instance, sweet potato vines are more nutritious than hay, a fact that is confirmed by Wanjala (2015) where sweet potato vines had a higher nutrient content than hay. When the hay diet is supplemented with sweet potato vines and soy bean, the growth rate jumped from 22.76 gweek$^{-1}$ to 64.12 g week$^{-1}$, a two-time increase in the weight gain. This is consistent with the findings by Adeyemo *et al*. (2014) which indicated that a concentrate: forage ratios of 1:4 gave the highest live weight and FCR in rabbits. Thus, the inclusion of forage to the concentrate by certain percentages would lead to a proportionate increase in weight gain indicating a better growth performance of rabbits. Good growth performance can be achieved at 16% crude protein levels, however, CP levels of between 12 and 17% are recommended for different life stages of the rabbits (Wanjala, 2015) depending on the assumption that the CP has adequate quality of essential amino acid requirements (Cheeke, 1986).

The highest increase in growth rate was attained in the hay – soybean diet in that the weight gain significantly rose from 22.76 g week$^{-1}$to 52.21 g week-$^{1}$. However, when hay is mixed with both sweet potato vines and soybean, the growth rate is tripled from 22.76 g week$^{-1}$ to 64.12 g week$^{-1}$. The result indicates that soybean is a better supplement than sweet potato vines, a fact that could be attributed to the higher mineral content of over 56% during the study. Indeed, a study by Etim *et al*. (2014) on the litter traits of breeding female rabbits indicated that sweet potato forage can be used as a supplement, thus can be said to enhance growth performance of the rabbits when used as a main source or as a supplement. Good growth performance can be achieved at 16% crude protein levels, however, CP levels of between 12 and 17% are recommended for different life stages of the rabbits s(Wanjala, 2015) depending the assumption that the CP has adequate quality of essential amino acid requirements (Cheeke, 1986). However, FAO (1997) recommends a fibre content of between 10-14% with fibre levels lower than 10 % promoting incidences of diarrhoea.

## Conclusion

The nutrition of the rabbits and its associated management are important aspects in optimizing small holder rabbit production. Rabbits require adequate nutrition from the very early stages of life for optimum feed intake, growth rate, weight gain and FCR. Rabbits are affected by unbalance diet which is mainly determined by the CP and CF availability to the rabbits and therefore supply of poor quality feed, poor health and environmental conditions influences nutrition and growth. The mitigating factors include good knowledge on feed formulation. Formulation of rabbit feed using field legumes and vines can play an important role towards improving feed intake, growth rate, weight gain and FCR among

smallholder rabbit production. The most effective feed mix was sweet potato vine-soybean mix with Rhodes grass hay basal diet. The effective feed formulation was basal diet (Rhodes hay) 70% and vine supplements (sweet potato vine) 30% in that it had the lowest FCR values with accompanying moderate weight gains. The nutritive value and palatability of the sweet potato vine was fairly good as comparable with other good quality forages. The finding indicated that vines can be used as a protein and mineral supplement for weaner rabbits and can supply adequate nutrients for maintenance and growth in tropical environment. However long-term feeding trials are needed to validate these results.

## Recommendations

The study recommends that rabbit feed formulation be supplemented with sweet potato leaves to provide protein source for small holder rabbit farmers in both Kakamega and Elgeyo-Marakwet counties. The feed formulation should have recommended levels of CP and CF in order to attain recommended growth performance. Further studies are needed to investigate the response to increasing percentages of sweet potato vines in diets of adult rabbits. More research studies are also needed on the length of period after which supplementation of sweet potato vines should be continued to reproductive stage of the rabbits so as to establish additional effects especially on prolonged period of feeding regime.

## Acknowledgements

The authors thank the organizations involved in the study: Department of Animal Science and Production, University of Eldoret and Kenya Agriculture and Livestock Research Organization for help with proximal analysis of the feed content. This paper is a contribution to the 2018 Sixth African Higher Education Week and RUFORUM Biennial Conference.

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