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## EFFECT OF HARVESTING FREQUENCY ON COWPEA GROWTH AND LEAF YIELD IN TRANS NZOIA COUNTY, KENYA

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## ABSTRACT

The frequency of leaf harvesting is a yield determinant factor and leaf defoliation has been shown to stimulate leaf production in cowpeas (*Vigna unguiculata* L. Walp.). However, cowpea farmers continue getting low yields due to harvesting method, among other factors. The purpose of this study was to evaluate the effect of four (4) harvesting frequencies on cowpea growth, and cumulative leaf yield. The four-leaf harvesting frequency experiment was in RCBD with three replications at KALRO-Kitale (UM<sub>4</sub>) in Trans Nzoia County. Data were collected on plant height, shoot number, shoot length, and cowpea yield. The data was subjected to ANOVA on SAS software. Fisher's Least Significant Difference (LSD) at  $p=0.05$  was used to compare the treatments effects. The cowpea plant height increased significantly with increasing harvesting frequency a time-period. The highest average plant height (22cm) was recorded in F<sub>1</sub> (where harvesting was done every seven days) and lower in F<sub>3</sub> with an average of 15cm (where harvesting was done after every 21 days) (F<sub>3</sub>), and lowest for F<sub>0</sub> though not significantly different from F<sub>3</sub>. There were significant differences in the effect of harvesting frequencies on shoot length, which increased significantly as yields increased. The average length of the cowpea plant shoot for uprooted plants at the onset of harvesting frequency (F<sub>0</sub>) was about 48cm. and longer (about 82cm) where harvesting was done at seven days intervals of leaf harvesting (F<sub>1</sub>) and lower (67cm) at 21 days interval of leaf harvesting (F<sub>3</sub>). There was a significant difference in shoot numbers between F<sub>0</sub> (no capping) and the rest of the frequencies (F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub>). There were significant differences in cumulative yield for the four harvesting frequencies. Harvesting at seven days intervals (F<sub>1</sub>) was significantly high and outstanding at 5.40 tons/ha while uprooting at the onset of harvesting (F<sub>0</sub>) was significantly low (1.28 tons/ha). Therefore, the innovation of sequential harvesting promotion will enhance increased yields.

**Key words:** Growth, stages, harvesting, frequency, cowpeas, leaf, yield, Trans Nzoia, Kenya

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## INTRODUCTION

Cowpea (*Vigna niguiculata L. Walp*) (Fabaceae) is a very important food legume in the world. Africa produces about 99% of world cowpea production [1, 2]. Worldwide the crop is highly valued for its leaf and grain for human consumption and for forage. Cowpea is classified as a climate smart crop as it is drought tolerant and is high yielding under low fertility and marginal environments [3]. The crop has the ability to fix nitrogen in soils which contributes to soil fertility improvement [4]. These attributes make the crop to be grown by many smallholder low resource farmers in ASAL and semi-arid regions. Therefore, any intervention to increase productivity will contribute to many households in low and high potential areas of the country.

In Trans Nzoia County and the larger part of western Kenya, the crop is grown for leaf vegetable production for human consumption. Besides being one of the staple food crops which provides protein for resource-poor rural and urban people, cowpea is a source of farm income for communities in the county. The crop is valued for its leaf and grain products for food and feed [5]. Nutritionally, the products have: vitamins/minerals (<1%), fat (0.6–3.7%), proteins (22–32%) minerals (5.80 -7.10%) and carbohydrates (50–60%) [5, 6]. Despite its importance, the yield potential has not been fully achieved due to suboptimal management technologies/practices. Farm level leaf yield is about 0.3 t ha<sup>-1</sup> while the potential yield is about 5 t ha<sup>-1</sup> [7, 8]. The yield gap is for leafy vegetable is about 4.3 t ha<sup>-1</sup> for grains[9]. Yield gap is a function of multiple factors that include; soil fertility levels, climatic factors, plant population, cowpea variety, and leaf harvesting frequency/intensity among others. The study focused on harvesting frequency. Subsequently, one of the solutions to reduce the yield gap is to utilize and manipulate the growing habits during harvesting frequency.

Cowpea growth habits were classified in different ways as determinate, semi-determinate and indeterminate [10-13]. According to Khady *et al.* [11], cowpea growth can be classified into the following three broad stages as; vegetative, flower and pod stages (Figure 1). Ibrahim *et al.* [10], and Ketema *et al.* [14] observed that if someone is interested in cowpea leaves, then output optimization can be done in stage one, but if someone is interested in the seed then cowpea output optimization can be in stage three (Figure 1). Cowpea growth is influenced by the following two broad factors that include: i) external factors (light, temperature, water, nutrients), and ii) internal factors (hormones/regulators and genetics) [15, 16]. Tandzi *et al.* [17] further classified the following as factors the influence cowpea production: i). technological (agricultural and managerial decisions), ii). biological and iii). environmental (climate, soil topography and water). The foregoing three factors interact and account for low cowpea leaf yield in different agro-ecological regions. These can be solved through developing, promoting and adopting the yield



enhancing agronomic technologies/practices like increasing leaf harvesting frequency to optimal levels.

The Apical Dominance in cowpeas, inhibits the growth of the other lateral buds. When the apical growing bud is removed, other lateral buds start growing. The cowpea vegetative components that emerge after removing the apical bud include the stem, shoot system, leaves, and shoots, among others. Therefore, there is a need to apply this technique in sequential harvesting to get more cowpea leaves for food, and as feed production needs may be considered. Natural cowpea hormones or growth regulators influence seed germination and growth, plant longevity, leaf growth, stem growth, shoot growth, and even the death of plants [18-20]. Therefore, hormones are important tools for the management of cowpeas to manipulate, plant growth and increase the yield [21].

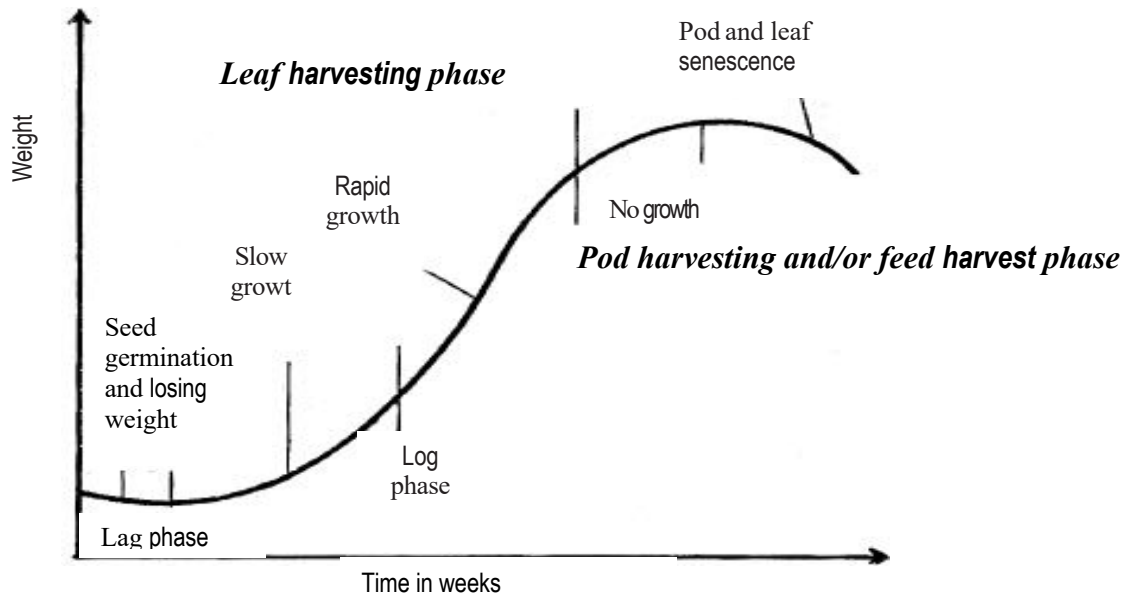
In this study, the harvesting frequencies were used to influence the enhanced growth rate of cowpea leaves using the naturally occurring hormones in plants. Depending on its growth its growth type, the cycle of the cowpea plant is different. There are about three phases of growth, regardless of growth type, which include a) the Lag phase, b) the Log phase, and c) the stationary phase [22, 23].

**Phase one:** This is termed as the lag phase (Figure 1). This is the initial growth stage where the seed germinates and continues to lose weight and the root and shoot systems slowly grow.

**Phase two:** This is the Log phase where there is rapid multiplication and enlargement of cells which results in rapid growth. The plant increases in size. The growth rate is maximum during this phase.

**Phase three:** This is the maturation stage and the most important part of growth. There is the entry of building materials like carbohydrates and dry matter. In this phase, the growth rate starts decreasing and stops.





**Figure 1: Cowpea growth curve (Sigmoid or S-shaped curve)**

Adapted from FAO [9] and Ukalska and Jastrzębowski [23]

### Production trends and limiting factors

According to the Food and Agriculture Organization (FAO) of the United Nations (UN), the world cowpea production in 2021 was estimated to be about nine million metric tons from a harvested area of about 15 million ha [24, 25]. In sub-Saharan Africa, Nigeria is the highest producer of the cowpea, with annual production of 3.63 million tons in 2021 from an estimated acreage of 4.70 million [26]. However, Kenya, Tanzania and Ghana produced about 0.15 million tones [4].

In Kenya, the cowpea is produced mainly by subsistence farmers. The production increased over years due to expansion in the production area, and technological advancement (more varieties developed, released, and promoted, price increase). The contribution to household income has enticed farmers to engage in its production to feed the ever increasing human population [27].

For example, between 2017 and 2022, the largest land area (258,732 ha.) for cowpea production in Kenya, was realized in 2018, while the highest production (264,160 MT) was realized in 2021 [28] and that was attributed to various factors including output price. The average farm gate retail price per 90 kg bag of cowpea, increased from KES 5,269 in 2020 to KES 5,354 in 2021 [28, 29]. The average cowpea wholesale price increased from KES 7,187 in 2020 to KES 8,427 in 2021 per 90 kg bag [28] (Table 1). Despite increase in the crop acreage and production, the yield is still low. The leaf yield ranged between 0.025 to 0.3 tons per ha during the period under review. This could be attributed to suboptimal harvesting

frequencies which is the focus of this study, among other limiting factors. The crop production and productivity can differ by agro-ecological zones and genotype attributes [30].

The cowpea yield gap of 4.3ha<sup>-1</sup> in Kenya could be partially attributed to both biotic and abiotic factors such as climate change, planting methods, poor plant nutrition, disease (fungal, viral and bacterial), pests infestation, poor and inconsistent harvesting methods among other agronomic practices [14]. Other production factors that may have contributed to the yield are poor choice of poor varieties, poor post-harvest losses and marketing. The focus of this study was on harvesting frequencies.

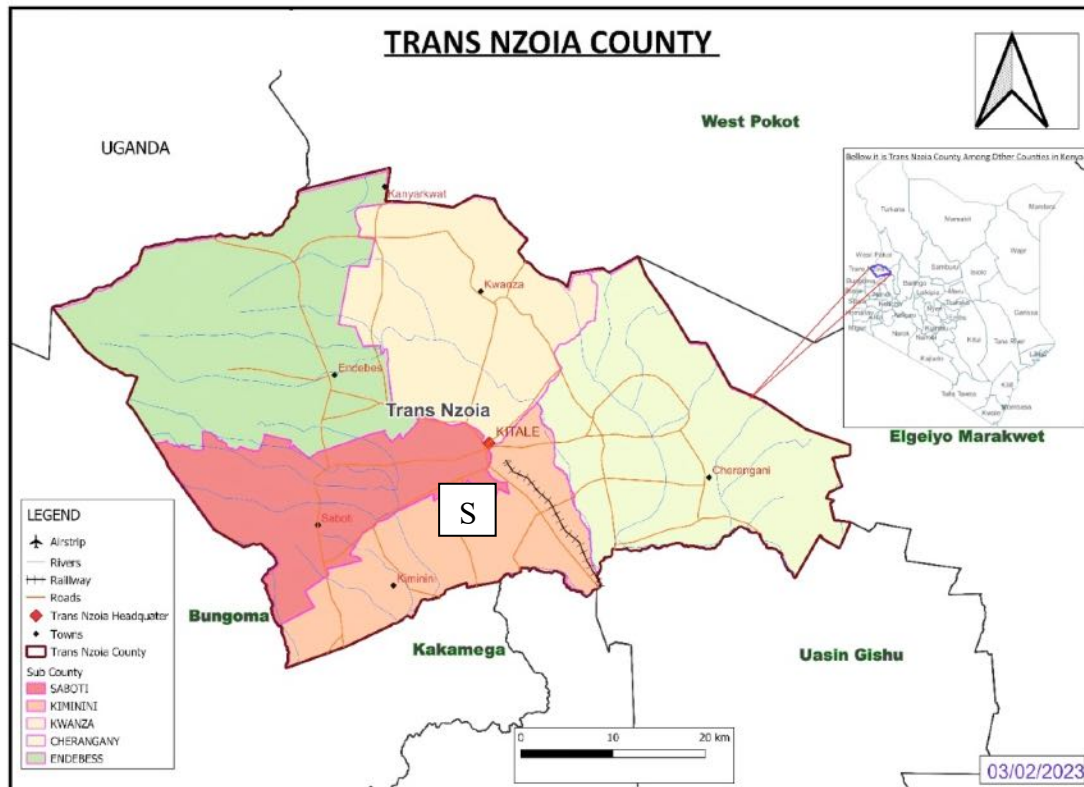
Cowpea harvesting intervals were hypothesized to have a significant effect on cumulative leaf yield [31]. The crop yield is influenced by plant parameters that include; plant height, shoot number and shoot length [10, 32]. The optimal and sustained harvesting frequencies have not been fully established in Trans Nzoia and the North rift region at large. The objective of this study was to evaluate the effect of four (4) different harvesting frequencies on cowpea growth, and on cumulative leaf yield. The key research questions were: i) Does harvesting frequency affect growth factors like plant height, shoot numbers, and shoot length of cowpea? ii) Does harvesting frequency increase the leaf yield of cowpea? iii) Which harvesting frequency gives the highest/optimal leaf yield?

## **MATERIALS AND METHODS**

### **Experimental Site**

The study was conducted in 2014/2015 at KALRO Kitale which is located in the Upper Midland zone 3 (UM<sub>3</sub>), 10° N, 35° 7' E Jaezold and Schmidt [33], Trans Nzoia county (Figure 2). Kitale is an agricultural town with an elevation of 1900m (6200 ft) above sea level. The area receives an average annual rainfall of 1300mm and with an average mean temperature of 24°C. The major soil types in the county are humic nitisol, humic ferrallisols and cambisols. The farmers predominantly practice mixed farming by planting both crops and keeping livestock. Farmers in Trans Nzoia grow cowpeas in major (long) and minor (short) seasons after maize harvest.





**Figure 2: Map of the county showing Trans Nzoia county and the Trial Site**

### Research Design and Treatment

The experimental design was a Randomized Complete Block Design (RCBD), replicated three times. Replication was carefully done to ensure the reliability, and validity of data collected. The blocking was done to make sure that the results were not due to chance but as a result of the harvesting frequency treatments. Each experimental plot measured 1.2m x 4m (four rows of 4m long and 60cm apart within intra-plant row of 20cm). Land preparation was done through bush clearing with herbicide (roundup) one month before ploughing. Ploughing and one harrowing operation were done, three weeks apart to get good seed bed tilth to enhanced soil moisture absorption and retention, get uniform seed germination. Manual hoeing and raking were done before laying out the experiment.

The seed were sourced from KALRO Katumani Seed shop. The seed had been treated with Shield to control pest damage. Three seeds were planted per hole at about 5cm of soil depth. After emergency, plants were thinned to one plant per stand. Two weeding frequencies were done with the first weeding done two weeks after emergence followed by a second weeding three weeks later. To control pests, insecticide was sprayed on weekly basis at recommended rates.

The test treatments were at four levels of harvesting frequencies: harvested after every 7-day interval ( $F_1$ ) (harvested seven times), harvested after every 14-day interval ( $F_2$ ) (harvested four times), harvested after every 21-day interval ( $F_3$ ) (harvested three times), and harvested at once ( $F_0$ ), by uprooting the whole crop at week nine. Leaf harvesting started at week eight and continued until flowering which was at week fourteen. Harvesting and recording of growth parameters commenced with capping and continued weekly is summarized in Table 2.

### Data collected and analytical procedures used

Phenological growth data that were collected, included; days to seedling emergence after planting, plant stand count, number of leaf stages per plant, plant height, and number of shoots per plant, shoot length per plant, and leaf yield at every harvest. In order to measure the plant height, shoot numbers, and shoot length, five plants were randomly selected from each of the two rows (total of 10 plants). Plant height was taken from the plant base to the tip using a ruler, while the branch length was taken from the branch base to the tip using a ruler too. Leaf harvesting was done from the 40 plants from the two inner rows (net plot). Repeated measurements were taken from the five targeted plants in each plot starting from week eight.

Data analysis was done with a one-way analysis of variance (ANOVA) using the PROC MIXED procedure. The Fisher's Least Significant Difference (LSD) at  $p=0.05$  was used to compare the treatments for significance differences. Statistical analysis was done using the SAS statistical package version 9.4MS.

### Computation economic indicators in leaf harvesting frequency

The data for the economic analysis was generated from experimental information using budgetary approach. Using a checklist input (labour, seed, fertilizer, pesticides and fungicides, harvesting bags) and output (leaf yield) quantities and prices were collected. In order to compute benefits over and above the costs Gross margin analysis model [34] was adapted using following formulae was used as given in equations 1 to 3.

$$\text{Gross Margin (GMt)} = \text{Total Revenue (TRt)} - \text{Total Variable Costs (TVct)} \quad \text{Equation 1}$$

$$\text{TRt} = \text{Py} * \text{Yt} \quad \text{Equation 2}$$

$$\text{TVct} = \sum_{x=1}^n (\text{Pxi} * \text{Xi}) \quad \text{Equation 3}$$

Where;

$TR_t$  is the total revenue for treatment t and  $t=1,2,3$  and 4

$GM_t$  is the gross margin for treatment 't'

$TVC_t$  is the total cost of variable costs for treatment 't'



$P_y$  is the per unit price (KES) of cowpea leaf  
 $Y_t$  is the yield (kg) per treatment of treatment 't'  
 $P_{xt}$  is the price (KES) of input  $x$  for treatment 't'  
 $X_{xt}$  is the quantity of input  $x$  for treatment 't'.

## RESULTS AND DISCUSSION

### a. Effect of leaf harvesting frequency ( $F_i$ ) on cumulative leaf yield and other growth parameters

Plant height, shoot numbers, shoot length, and yield were important indicators for assessing the effect of cowpea harvesting frequency on leaf yield. Several authors have used these parameters to measure the effects of harvesting practices on crop vegetative yield. Subsequently, it was hypothesized that there were significant differences in the effect of harvesting frequencies on yield and yield parameters (plant height, shoot numbers, and shoot length) of cowpea. The variability in these growth and yield factors as manifested in this study is a point of discussion.

#### **Plant height**

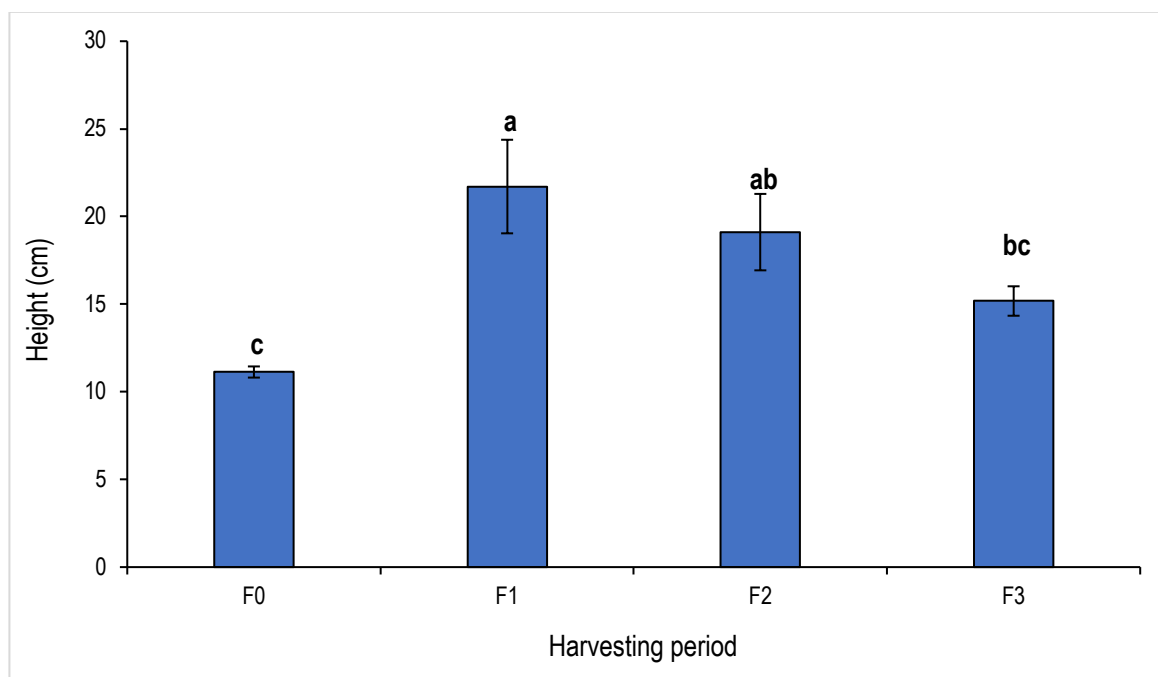
Plant height positively contributes to the yield increase. Therefore, cowpea plant height was one of the measures of productivity. Harvested plant parts included stalks, leaves, and the bud. Nipping off plant parts changes the plant height. Figure 3, gives the results on the effect of harvesting frequency on cowpea plant height. The coefficient of variation (CV) was about 49% which implies that the plant height data moderately clustered around mean plant height.

It was hypothesized that there were significant differences of the effect in harvesting frequencies on plant height. Figure 3 gives the analysis of results on the same. The highest plant height (22cm) was registered where harvesting was done every seven days ( $F_1$ ), which was significantly different from  $F_0$  and  $F_3$  ( $LSD_{0.05}$ ), low where harvesting was done after every 21 days ( $F_3$ ) at an average of 15cm, and lowest for  $F_0$  though not significantly different from  $F_3$  (Figure 3).

This implied that the more the capping/cutting/pinching of the cowpea plants, the more the growth of both the plant height and shoots hence the higher the yield from the extra shoots and leaves. Studies suggest that pitching removes the plant apical dominance by changing the auxin and cytokinin hormones metrics. It is observed that the concentration of cytokinin in the pinched plants increases and this encourage lateral buds to emerge with more shoots growing [35]. The plant then attracts more nutrients and water to the new shoots which leads more leaf yield [36]. Therefore, apical dominance is a survival technique during the growing period of the plant till maturity. Similar results were obtained by Pijlman *et al.* [37] and Ibrahim *et al.* [10] where plant height was significantly affected by harvesting intensity. In this



case, it is recommended that the seven cuttings were the optimal number of cuttings of harvesting frequency.



**Figure 3: Effect of leaf harvesting frequency on cowpea plant height of cow pea**  
 CV=48.9; LSD<sub>0.05</sub>=5.045

**b. Analysis of the effect of leaf harvesting frequency on shoot number**

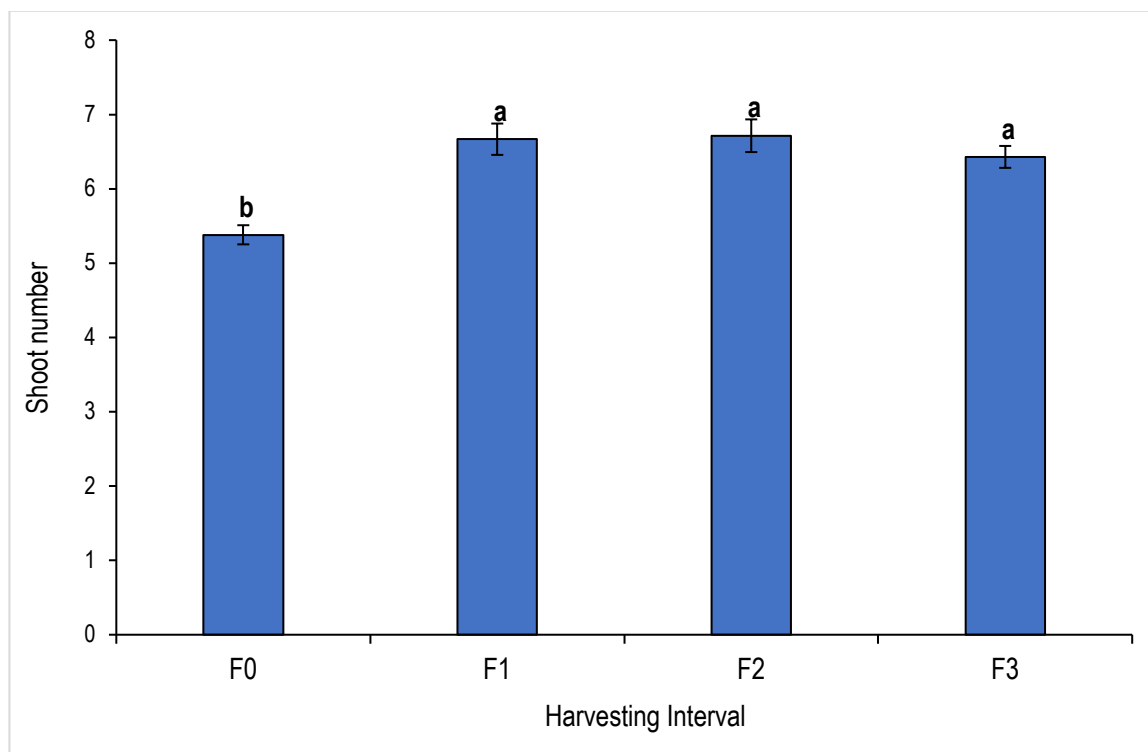
Capping removes apical dominance and encourages lateral branches to grow. Therefore, sequential harvesting was one way of increasing the shoot numbers. It was hypothesized that there were significant differences in the effect of harvesting frequencies on plant shoot numbers. Figure 4 illustrates the analysis of results on the effect of harvesting frequency on cowpea plant shoot numbers. The CV of 13% implying that data for average plant shoot numbers lowly clustered around (close to or low variability) the overall mean of the plant shoot number.

There was a significant difference between F<sub>0</sub> (no capping) and the rest of the frequencies (F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub>). However, there were no significant differences between F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub>. The maximum mean shoot number (6.71cm) at F<sub>2</sub>, which was the treatment with the highest number of capping, and the lowest number was five in F<sub>0</sub> (≈5cm).

The removal of the apical bud (capping) in the cowpea plant allowed more shoots (lateral buds) to grow. The shoot numbers progressively increased from approximately five (F<sub>0</sub>) uprooting the whole plant to seven (F<sub>1</sub> and F<sub>2</sub>) in the seventh

capping (Figure 4). The maximum number was registered at F<sub>2</sub> and F<sub>3</sub> (≈7cm) and declined to six in F<sub>3</sub> (≈6cm).

This implied that the capping encouraged the emergence of more shoots to increase shoot number that subsequently, contribute to the crop yield. Thus, the greater the number of shoots capped the more the number of lateral growths (number of shoots) and the higher the shoot biomass. Similar trends were recorded by other authors in cowpea studies [38, 39, 40, 41, 42].



**Figure 4: Effect of leaf harvesting frequency on shoot number per plant of cow pea**

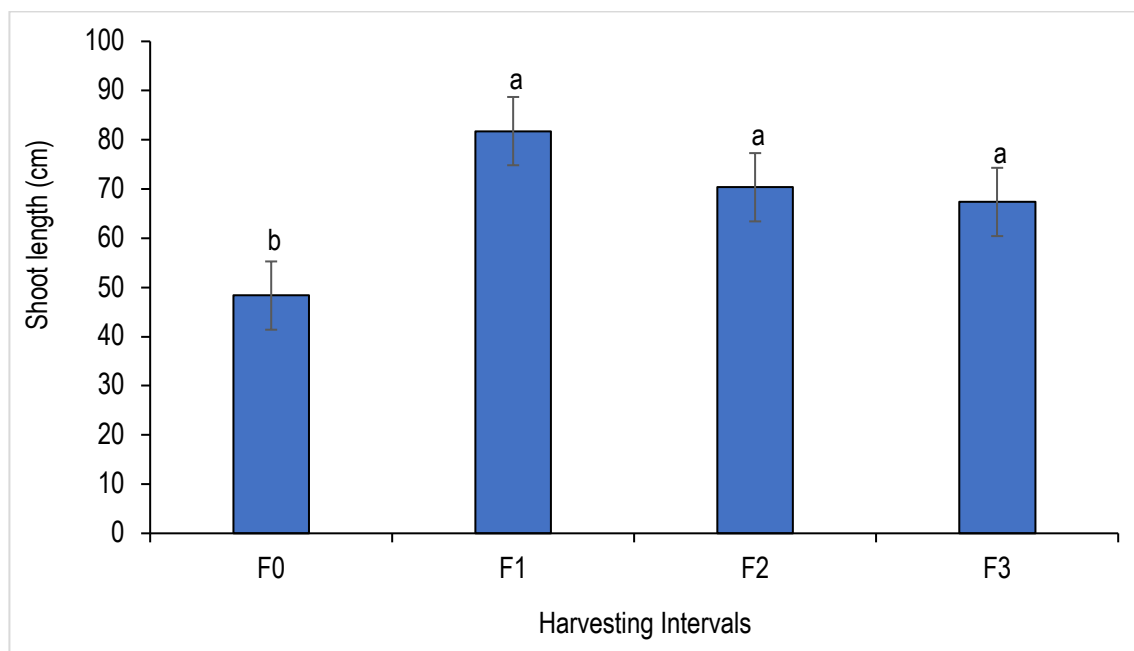
CV=13.3; LSD<sub>0.05</sub>=0.5154

### c. Effect of Leaf Harvesting Frequency on Shoots Length

Harvesting caused wounds to the cowpea plants, which responded by producing growth promoting activities like increase in shoot length. It was hypothesized that there were significant differences in the effect of harvesting frequencies on plant shoot length. Figure 5 shows the effect of harvesting frequency on cowpea plant shoot length. with CV of 39% (Figure 5), which indicated that the plant shoot numbers data also moderately clustered around the mean plant shoot length (moderate variability and close to the mean).

Further analysis showed that the cowpea plant shoot length increased significantly (LSD<sub>0.05</sub>≈5) as the number of harvesting frequencies increased. There were significant differences in shoot length between F<sub>0</sub> and the rest of the treatments (F<sub>1</sub>,

F<sub>2</sub> and F<sub>3</sub>) (Figure 5). The shoot length rose from about 48cm in F<sub>0</sub> to approximately 82cm in F<sub>1</sub> and decreased to 67cm in F<sub>3</sub>. Studies by Kudum [38], Momanyi [41], Onyango [42] and Odhiambo *et al.* [31] indicated that increasing harvesting frequency encouraged shoots to grow. Thus, the optimal length was attained at F<sub>1</sub>. This implied that the longer the length the more the number of leaves.



**Figure 5: Effect of leaf harvesting frequency on shoot length (cm) per plant of cow pea**  
 CV=39; LSD<sub>0.005</sub>=0.50

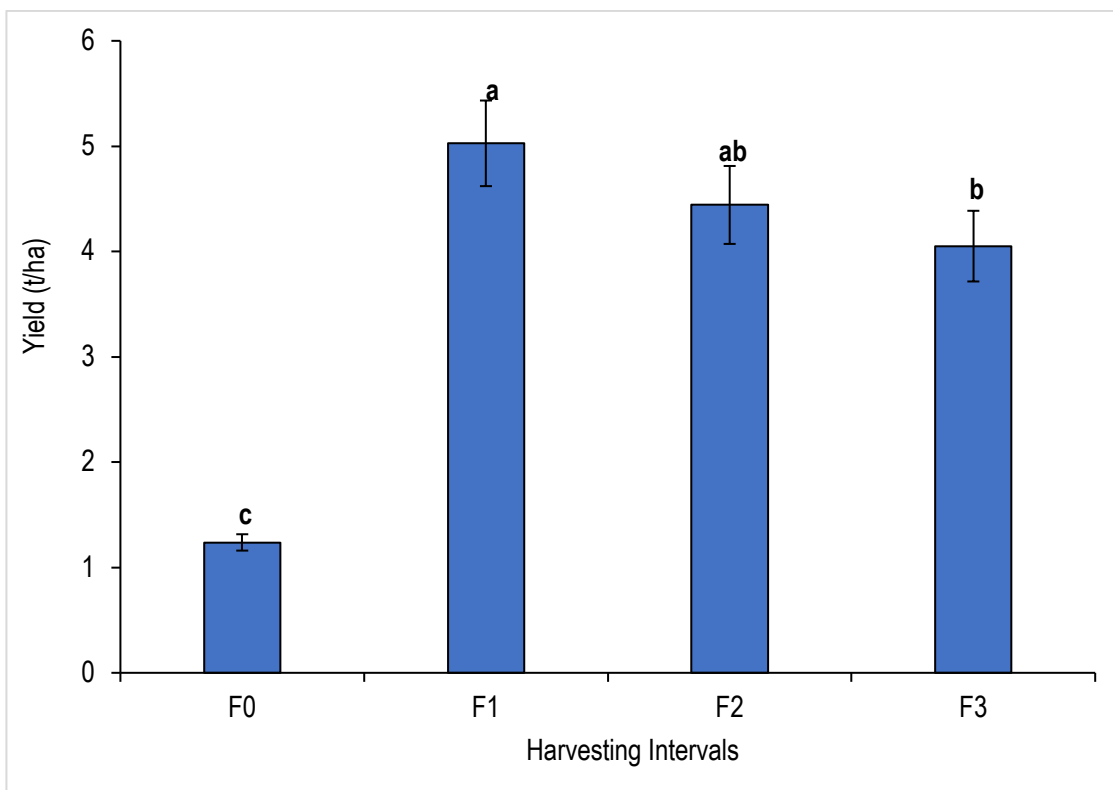
#### **d. Analysis of the effect of leaf harvesting frequency on cumulative cowpea leaf yield**

Figure 6, shows the effect of harvesting frequency on cumulative leaf yield. The leaf yield increased from F<sub>0</sub> when single harvesting was done by uprooting the whole crop to F<sub>1</sub> when frequency was done after seven days interval. A slight drop was observed at F<sub>2</sub> when harvesting was done after fourteen days intervals and the amount of leaf yield picked up again at F<sub>3</sub> (harvesting after twenty-one days interval intervals) (Figure 6).

There were significant differences in the leaf yield between F<sub>0</sub> and the rest of the harvesting frequencies (F<sub>1</sub>, F<sub>2</sub> & F<sub>3</sub>) (Figure 6). However, there was no significant difference in leaf yield between F<sub>1</sub> & F<sub>2</sub>, and between F<sub>2</sub> & F<sub>3</sub>, but there was a significant difference between F<sub>0</sub> and the rest of the harvesting interval (F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub>) (Figure 6). The highest leaf yield was attained at F<sub>1</sub> (5.03 t ha<sup>-1</sup>) and F<sub>2</sub>. (4.44 t ha<sup>-1</sup>). The increase in yield associated with increasing frequency was observed by Okelo *et al.* [43] on *Crotalaria sp.* (*Slender leaf*) and Kudum [38] on cowpea, and

Isutsa and Mallowa [44] on pumpkin (*Cucurbita moschata*, Duchsene (Figure 6). The optimal leaf yield was registered in F<sub>1</sub> where harvesting after seven days interval was done.

Leaf yield is a priority indicator used by farmers to assess the efficiency of cowpea production. Cowpea yield may include the total plant biomass where the whole plant is uprooted and weighed (F<sub>0</sub>), or the shoots are sequentially nipped off along with some leaves (F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub>). The results revealed that across all the harvesting frequencies, the highest cumulative leaf yield was realized for F<sub>1</sub>, where harvesting was done on weekly basis. The implication is that the higher the harvesting frequencies, the higher the yield. Kudum [38] recorded similar trends in cowpea. Additionally, Saidi *et. al.* [45] recorded an increase in leaf yield under cowpea-maize intercrop system. Therefore, farmers are encouraged to increase the harvesting frequency to weekly per plant.



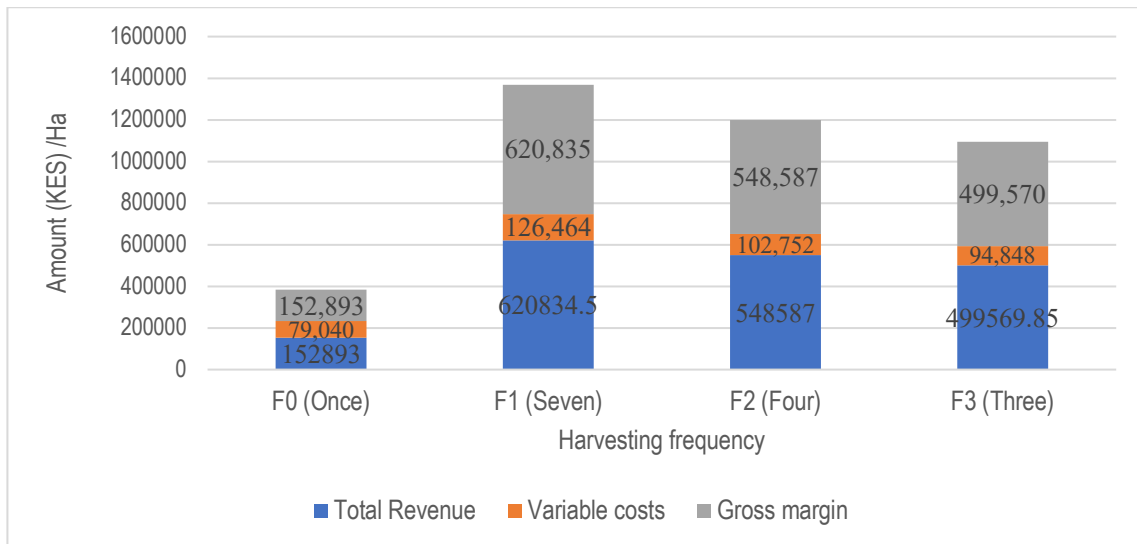
**Figure 6: Analysis of effect of leaf harvesting frequency on cowpea leaf yield per hectare**

CV=38.4; LSD<sub>0.05</sub>=0.87

Means with the same letter are not significantly different at  $P > 0.05$  level of probability following LSD

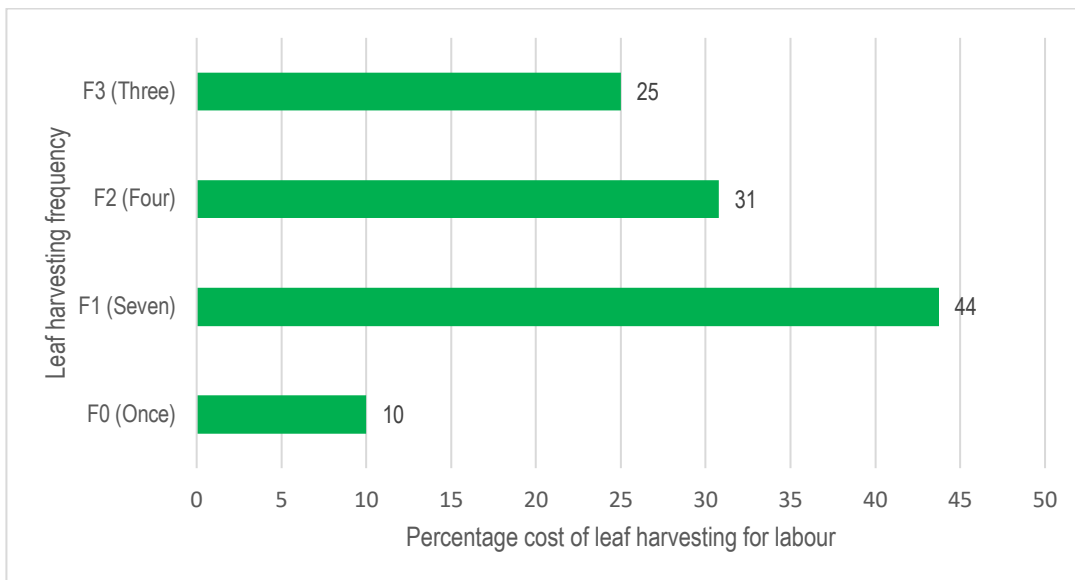
### e. Economics of Harvesting Frequency

Economic performance of an agricultural practice reveals the techno-economic aspects of an agro-entrepreneur. This creates the need to assess the economic performance of different cowpea harvesting entries. Figure 7, gives the gross margin analysis of cowpea leaf harvesting frequency. The highest Gross margin (GM) were realized in F<sub>1</sub> where there the harvesting was done seven times followed by F<sub>2</sub> where harvesting was done four time and the least was in F<sub>0</sub> where the harvesting was done three times. This implies that increasing leaf harvesting frequency increases the total revenue and net benefits to farmers.



**Figure 7: Gross margin analysis of cowpea leaf harvesting frequency**

Figure 8, presents the labour costs in harvesting cow pea leaves. The highest labour cost recorded in F<sub>1</sub>, followed by F<sub>2</sub> and the least was also in F<sub>0</sub>. This implies that additional labour for harvesting does not reduce the benefits.



**Figure 8: Percentage labour of leaf harvesting costs to the total variable costs**

## CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

It is evident from our study that harvesting frequency of cowpea leaf changes plant height, shoot numbers, shoot length and probably more leaves. Subsequently, the changes of these parameters positively influence the cowpea leaf and increases leaf yield. This finding is consistent with other earlier studies, which concluded that cowpea harvesting method is a yield determinant factor and leaf defoliation has been shown to stimulate leaf production in cowpeas. The leaf-harvesting strategy also provides leaves as food throughout the cropping season, and this contributes to household food security. Therefore, the frequency of leaf harvesting in cowpea at seven days intervals and 14 days intervals is an innovation that growers should be encouraged to increase cowpea leaf yields. Harvesting frequencies regulated plant height, shoot numbers, shoot length and cowpea yield, which provides valuable solution for farmers who target optimize crop production.

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## DISCLOSURE STATEMENT

The authors of this paper state that they do not have any conflict of interest.



**Table 1: Cowpea production statistics in Kenya 2022-2017**

Year	area (ha)	production MT	90 kg bag	yield	Farm gate (KES /90 kg)	Wholesale (90 kg bag)	import	total value billions
2022	222,898	131,118	1,456,867	6.5	6,400	7,672	83.9	9.3
2021	235,734	250,060		11.8	5,354	8,427	136	4
2020	239,131	264,160	1,655,788	12.3	5,269	7,187	1.1	15.4
2019	242,275	222,394	2,471,045	10.2	5,430	6,815	0.3	13.4
2018	258,732	179,107	1,990,078	7.7	3,354	6,598	0	6.7
2017	254,669	146,457	1,627,300	6.4	4,295	7,653	238	7

Source: AFA HCD 2022; FAOStat, 2021

**Table 2: Treatment structure (Harvesting frequencies)**

Sequence of harvesting	Period
F <sub>1</sub> , F <sub>2</sub> , F <sub>3</sub> (capping)	week 8
F <sub>1</sub> , F <sub>0</sub>	week 9
F <sub>1</sub> , F <sub>2</sub>	week 10
F <sub>1</sub> , F <sub>3</sub>	week 11
F <sub>1</sub> , F <sub>2</sub>	week 12
F <sub>1</sub>	week 13
F <sub>1</sub> , F <sub>2</sub> , F <sub>3</sub> ,	week 14 – Sampling for leaf for nutritive quality analysis, stand count, plant height, shoot number and shoot length

NB: F<sub>0</sub>=1 harvesting; harvestings; F<sub>2</sub>=4; F<sub>3</sub>=3 harvestings; F<sub>1</sub>=7 harvestings

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