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IMPACT OF PUSH-PULL TECHNOLOGY ON THE NUTRITIONAL STATUS OF FARMERS' CHILDREN IN WESTERN KENYA

Ogot NO[1*], Pittchar JO[1], Midega CAO[1] and ZR Khan[1]

Nicholas Ogot

[*]Corresponding author email: nicholasogot@gmail.com

[1]International Centre of Insect Physiology and Ecology, P.O. Box 30772-00100 Nairobi, Kenya

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ABSTRACT

This study examined the impact of push-pull technology (PPT) on the nutritional status of children aged 1-12 years. Non-push-pull (NPPT) farmers were used as a control group to establish a comparative model for this study. It determined household production, consumption, and surpluses, comparing the PPT adopters to the non-adopters; found out the incomes and food expenditures from farm products; found out the household dietary diversity scores; and finally found the nutritional status of the two household groups. A six faceted household-level metrics was employed. A sample of 216 households that registered 326 children was derived. This study was conducted in western Kenya: Busia, Butere, Siaya, Vihiga, Kisumu, and Migori. In this study 53% were male and 47% female from the households assessed. Households with married couples were 87.5%, 1.9% were single parents, 0.5% were separated and 10.2% were widowed. Averagely, 7.20 members came from PPT households, while 6.99 were from NPPT households. Each household (both PPT and NPPT) had an average number of three children. The study further showed that 88 households of PPT had their income sources from farm products sales as NPPT had 67 households on the same. Income was averagely 126.29US$ for PPT and 91US$ for NPPT. Push-pull households had 1303 Kgs of farm production while NPPT had 578 Kgs per year. The scale of agriculture to nutrition benefits recorded 8.7/10 for PPT and 7.14/10 for NPPT. Finally, PPT registered 12% of ≥+2SD, 84% of between -2 and > +2SD and 4% of ≤ -2SD for children under five years and 3% of ≥+2SD, 89% of between -2 and > +2SD and 8% of ≤ -2SD for children aged between 6 to 12 years. Non Push-pull households controversially registered 3% of ≥+2SD, 61% of between -2 and > +2SD and 36% of ≤ -2SD for children less than five years and 3% of ≥+2SD, 53% of between -2 and > +2SD and 44% of ≤ 2SD for children aged between 6 to 12 years. In conclusion, PPT is proven as an agricultural intervention that has enhanced nutritional improvement.

Key words: Push-pull Technology (PPT), Non Push-pull Technology (NPPT), nutrition, dietary diversity, food security, Body Mass Index (BMI), agriculture

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INTRODUCTION

The push-pull technology (PPT) is a strategy of controlling agricultural pests by using repellant "push" plants and trap "pull" plants [1]. For an instance, the stem borer pests of cereal crops in sub-Saharan Africa comprise the larvae of a number of members of the Lepidoptera, both indigenous species, as exemplified by the maize stalk borer *Busseola fusca* (Noctuidae), and non-indigenous, or introduced, stem borers such as the spotted stem borer, *Chilo partellus* (Crambidae). *B. fusca* is distributed throughout sub-Saharan Africa, whereas *C. partellus* is mainly found in Eastern and southeastern African countries [2]. Cereal crops like maize or sorghum are often infested by these stem borers [1]. Their feeding habits on maize and sorghum result in yield losses of up to 88%, depending on the cultivar planted, the developmental stage of the plant at infestation, infestation rate, and prevailing environmental conditions, among other factors [2]. This has been a major challenge to high quantity and quality harvest of the cereal crops and a direct initiator of food insecurity. These insects use a range of grasses [1, 3] including indigenous crops such as sorghum and the introduced maize.

Field trials were initially established at Mbita Point and at the then Kenyan Agricultural Research Institute's (KARI) field site at Kitale, Trans-Nzoia District, in which 50×50m plots of maize were compared, in terms of stem borer attack, with a similarly sized plot incorporating a surround of two rows of Napier grass. A bare patch of ground was required between the maize and the Sudan or Napier grass so that the trap crops would not take water or soil nutrients from the main crop. Where the maize was grown as a monocrop, there was a statistically significantly higher level of stem borer attack, as measured by cutting the stems and investigating for larval mining (16.8 and 27.5% in the treatment and control plots, respectively, in Suba District, Kenya, and 10 and 20.9% in the treatment and control plots, respectively, in Trans-Nzoia District, district with capital 'D' or small 'd'…choose one and be consistent throughout the text Kenya [4]. Similar comparative trials were established using molasses grass, growing this as a one-to-one intercrop without changing the maize row spacing. Here, the reduction in stem borer damage was even more dramatic (for example, damage reduced from 39.2 to 4.6%) [1].

The push-pull technology was eventually developed at the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya in collaboration with Rothamsted Research, UK, and national partners as an effective and successful program researched and developed at ICIPE. Over 110,000 farmers now use this method of cultivation that was developed initially in 1997 by Professor Zeyaur Khan [5]. It is an excellent example of how we can achieve Sustainable Development Goal (SDG) 2: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" [5]. It has contributed to improved food security and health by increasing the uptake of Push-pull technology for improved cereal and livestock productivity in eastern Africa through innovative and integrated dissemination pathways and partnership platforms, including field days, farmer teachers, field schools, participatory videos, cartoon books, drama and mobile telephones [6].

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By seeking closer collaboration with nutrition, agriculture can gain new insights into the needs of its primary customer, the consumer, whether poor or rich [7]. The four pillars of food security are availability, access, utilization, and stability. The nutritional dimension is integral to the concept of food security [8]. A study on agriculture and food security in Ghana states that, with high levels of farming experience, the productivities and efficiencies of maize farmers in Ghana are expected to be on the higher side since experienced farmers could predict appropriate husbandry practices for efficient maize production [9]. A range of interventions in the agriculture production domain have potential to make it more nutrition-sensitive than in the past [10]. Though most studies focus on income generation and poverty reduction, nutrition improvement is rarely explored. This gap needs to be filled as malnutrition reduction is a long-term goal for major international efforts [11].

This study, therefore, has probed how PPT has enriched nutrition through objectives of determining household production, consumption and surpluses, comparing the PPT adopters to the non-adopters; finding out the incomes and food expenditures from farm products; finding out the household dietary diversity scores; and finding out the nutritional status of the two household groups (PPT and NPPT).

MATERIALS AND METHODS

Research Method

The research utilized both qualitative and quantitative methods. Qualitative method, also known as 'fieldwork, ethnography and grounded theory' entails measuring with non-numerical data [12] while quantitative methods emphasize objective measurements and the statistical, mathematical or numerical analysis of data collected through polls, questionnaires and surveys, or by manipulating pre-existing statistical data using computational techniques [13]. Qualitative methods were used to analyze and describe the diet aspects of the farmers' households while quantitative methods were used to verify a quantified attribution in farm product production, income, food expenditure, energy consumed and the anthropometry measurements between the PPT and NPPT households. It applied household-level metrics that captured six linked facets of food systems and nutrition, which included: intervention food sustainability, accessibility and affordability of food, resilience of food systems, agriculture-nutrition benefit, dietary habit and adequacy, and nutritional status assessment [14].

A hybrid design involving PPT as an agricultural and nutrition design was adopted from Hawkes' conceptual framework to run and evaluate the field tests [15]. This design combined a cluster randomized probability design comparing the PPT to NPPT farmers. Nutritional impact of these two farming systems was defined through the nutritional assessments conducted that included anthropometry and dietary assessments [16].

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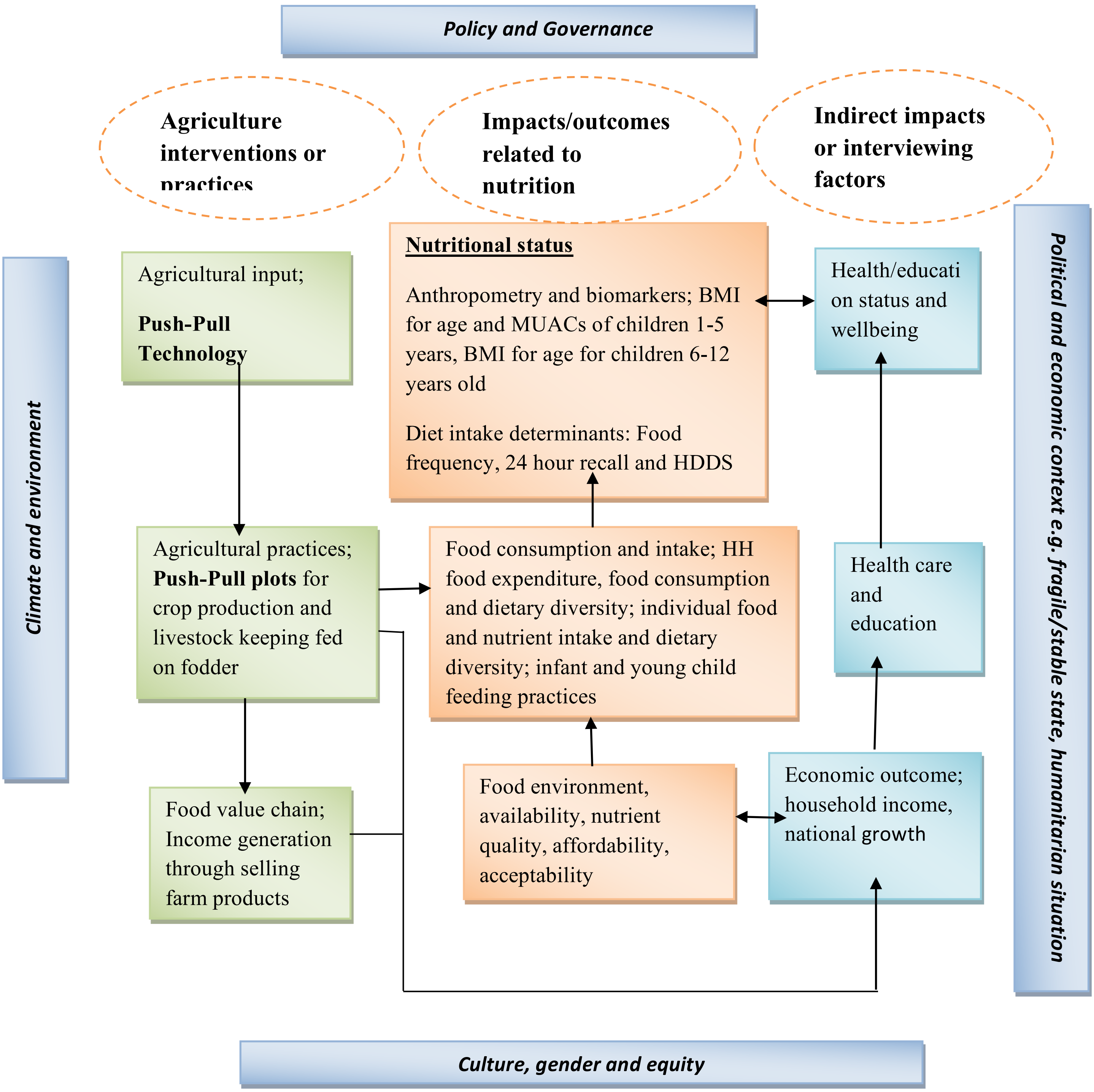

Figure 1: Conceptual framework of push-pull's agriculture-nutrition linkages
Source: Hawke's *et al.* [15]

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Area of study and target population

This study was conducted in selected regions where PPT was first initiated, that is, Western Kenya: Busia (0.4608° N, 34.1115° E), Butere (0.2198° N, 34.4919° E), Siaya (0.0998° S, 34.2747° E), Vihiga (0.0816° N, 34.7229° E), Kisumu (0.0917° S, 34.7680° E) and Migori (-1.0634° S, 34.4731° E). These areas were chosen due to a high number of technology adopters; with the specific target groups required, that is, 1-12-year-old children. Each region had 36 households assessed; 18 PPT and 18 NPPT households. The survey chose to assess a total of 216 households, based on statistical tangibility by FAO [17].

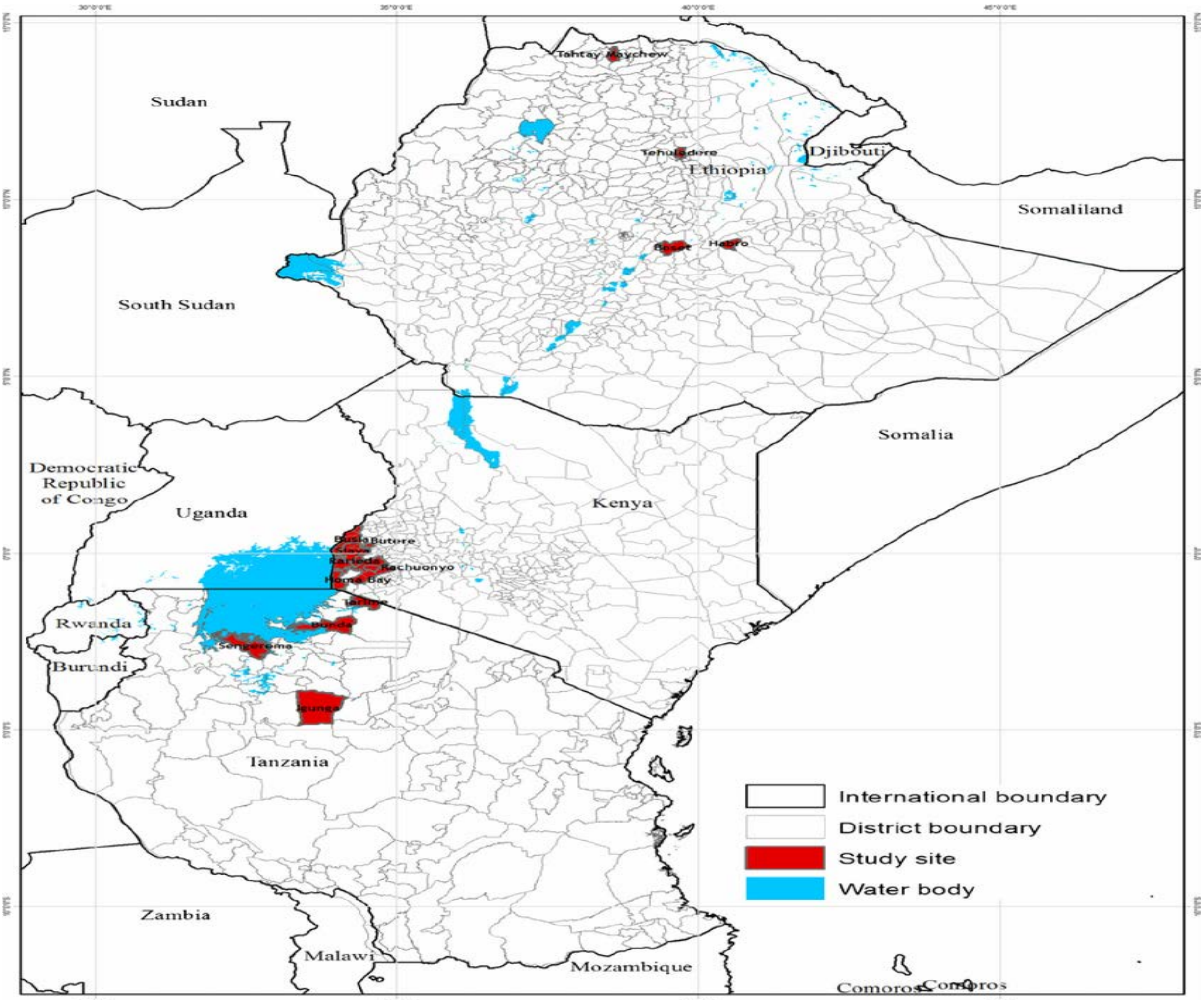

Figure 2: Geographical Regions of Push-Pull Technology
Source: Murage *et al.* [18]

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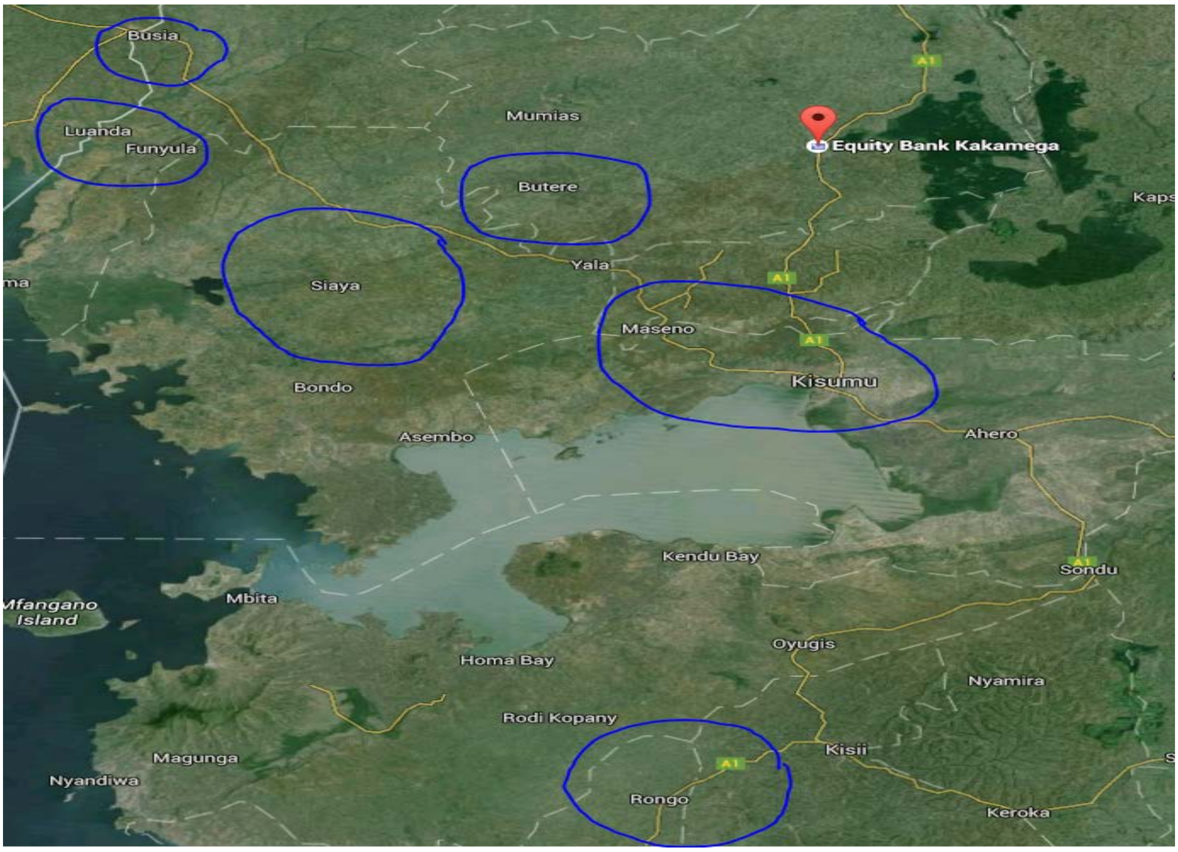

Figure 3: Sites of Western Kenya where the study was done

When it took place

This study was conducted between May and June of 2016. Data cleaning, entry and analysis followed in July and August and ended in September.

Sample size design

A sample size of 216 households was based on the survey monkey calculator. Adopters of PPT were approximately 200,000, giving confidence to the sample formula in the equation below. There was purposeful richer information anticipated from the sample calculated, as regions of survey chosen were the very first in the initiation of this technology. Therefore, 216 farmers' households were to be interviewed; 108 PPT households and 108 NPPT households.

Sample size equation

$$n_0 = \frac{\frac{Z^2 pq}{e^2}}{1 + \frac{Z^2 pq}{e^2 N}}$$

$$no = \frac{\frac{1.96^2 \text{ x } 0.5 \text{ x } 0.5}{0.0667^2}}{1 + \frac{1.96^2 \text{ x } 0.5 \text{ x } 0.5}{0.0667^2 \text{ x } 200000}}$$

$\mathbf{n_o}$ = 216 farmers

Where; Margin of error (e) = 6.67%
Confidence Interval (Z) = ±1.96
Population number (N) = 200,000
Probability distribution (p) = 50% and q = 1-p

Data Collection

The interviews were conducted by the six (6) trained enumerators for the six (6) regions. The enumerators were chosen from the locality of the regions of the survey. Questionnaires were designed for different groups, that is, PPT and NPPT groups but having same variables of the study. Key findings of the survey are below.

Data Analysis

Data entry was made through a Census and Survey Processing Software System (CSpro) and imported to Statistical Packages for Social Sciences software for analysis. Anthropometric calculations were done by WHO Anthroplus software and entered through CSpro software as already refined data from questionnaires. Statistical analyses used were mean, correlation, regression and cross tabs. Tables, graphs and pie charts were used in presenting analyzed data.

RESULTS AND DISCUSSION

Demographic Characteristics

The information on demographic characteristics indicated a 53% of the male household heads and 47% of the female heads. This was in respect to who took the active role in the farming activities. Households consisted of 87.5% married couples, 1.9% single parent, 0.5% separated parents, and 10.2% widowed according to the classification of the study to determine meal consumption process. The average number of household members for the PPT group was 7.2 and 6.99 for the NPPT group. Analysis of the average number of children per household also revealed that NPPT had one child aged between 1 – 5 years and two children aged between 6 – 12 years and the same was for the PPT.

Empowerment of women (at 47%) had improved amongst all the groups of households' farmers compared to a decade ago. Gender equality has remained a major target amongst many regions. Such a transformation can be enhanced with improved information about the range of inequalities and specific constraints facing women. A

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simultaneous and integrated pursuit of such information and transformation is essential for gender equality strategies and food security strategies to complement each other and maximize their synergy.

An assumption of this study regarding the family composition was that a household with both father and mother had a maximum capacity to boost the nutritional status of the children because of full parent-child care that associates mental satisfaction. With the households of married couples indicating 87.5%, the nutritional status anticipated was a majority of nutritionally normal children.

Food accessibility and availability to the members of households, especially children, is majorly determined by the number of the members of a household (children composition). The higher the number of children, the lesser the food accessibility and availability. However, PPT households reflected a higher average number yet sufficiently supplied by food. It related to the other aspects of this study including production and consumption in the households.

The number and sex of competing siblings in a household could affect the nutritional status of children. The presence of more than one child in the household usually results in not only resource constraints but also in competition among the siblings that would result in unequal child nutritional outcomes. For this study, an average of three children per household evinced a slight pressure on food availability and accessibility. According to the "resource dilution" hypothesis, households with more children accrue fewer resources to each of the siblings.

Income sources and their portions in food expenditure

This study also showed that some of the major income sources that contributed abundantly to food expenditure were the sale of farm products (PPT – 88 households and NPPT – 67 households) and dividends/women groups (PPT – 85 households and NPPT – 81 households). Other sources of income such as employment, remittances, pensions, rent, fishing, casual labor and others contributed less to household incomes.

Income sources are the major strength of other food purchases and diet quality of the households. A household with a higher income has the ability to value diverse foods. According to Table 3, PPT households are more pronounced and secured with different sources of income and, therefore, it is with no doubt that food availability and accessibility are associated with fewer challenges as compared to the NPPT households.

Household Incomes

The real income earnings of a household give a reflection of their food and nutrition security situation. An average monthly analysis of the earnings of farmers in PPT households was Kshs. 13,084 (126.29 US$) and for NPPT households was Kshs. 9,428 (91 US$). It reflected an annual income of Kshs. 157,006 (1515.5 US$) for the PPT households and Kshs. 113,139 (1092.08 US$) for the NPPT households.

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Amount of income analysis gives evidence to the sources of income and to the stability of this research in identifying diet quality of the households. With PPT households having a higher income, diet quality is likely to be practiced and nutritional status of the children is likely to be boosted.

Income sources is a considering factor to determine how best the households can access basic needs (specifically food). Increasing individual income and purchasing power is regarded as an important prerequisite for improved nutritional status of the community [19, 20]. Still, PPT proves adequate in the income sources revealing that sales of farm products largely contribute to their income sources as compared to the other sources of income. However, several PPT farmers construed that they made an extra addition for food expenditure from their other sources of income on top of what they got from the sales.

Production, consumption, and surplus

Production, consumption, and surplus here are measured in kilograms of the yields that come from the farm as a result of the specific farm practice (either PPT or NPPT). Apparently, fodder enrolled the highest quantities across all the variables measured in PPT, that is, production – 3,366, consumption by livestock – 3,188 and surplus – 177. Maize, majorly consumed by the households as a staple product recorded production – 1303, consumption – 825 and surplus – 477 in PPT households. This was double the respective quantities in the NPPT households. Sorghum, millet, beans, groundnuts, cassava, and vegetables also revealed significant differences between PPT and NPPT as is in Table 1.

The contribution that PPT has made on the nutrition of farmers is evident from farm production. It is clearly noted that PPT has increased production of farm products compared to the general farming. World Bank reports that agriculture can improve the quantity and quality of diets in households for subsistence farmers, reduce income poverty through production sales and agricultural labor, empowerment of women as income-earners, decision makers and primary childcare providers, decrease food price volatility and increase government revenues that can be used to finance health care, education and nutrition interventions [21]. But this study reveals that NPPT farming produces a little production effect compared to PPT-adoption farming. The latter, PPT, reaps better production and enriches the food value chain to an enhanced nutritional status of household children.

Comparing production in 2015 between PPT and NPPT has indicated that quite a substantial distinction is derived from elevated results of the probable significance of PPT. World Bank establishes that household production for the household's own consumption is the most fundamental and direct pathway by which increased production translates into greater food availability and food security [21]. And as it is in this study, consumption quantity is higher in PPT than in NPPT and hence endorsing World Bank's emphasis that more production of staple foods leads to a greater access to and consumption of energy [21]. Diet quality then improves as food diversity sets in from food availability and accessibility. Most definitely, PPT households have recorded fewer households affected by food inadequacy due to the higher production obtained after technology adoption by farmers.

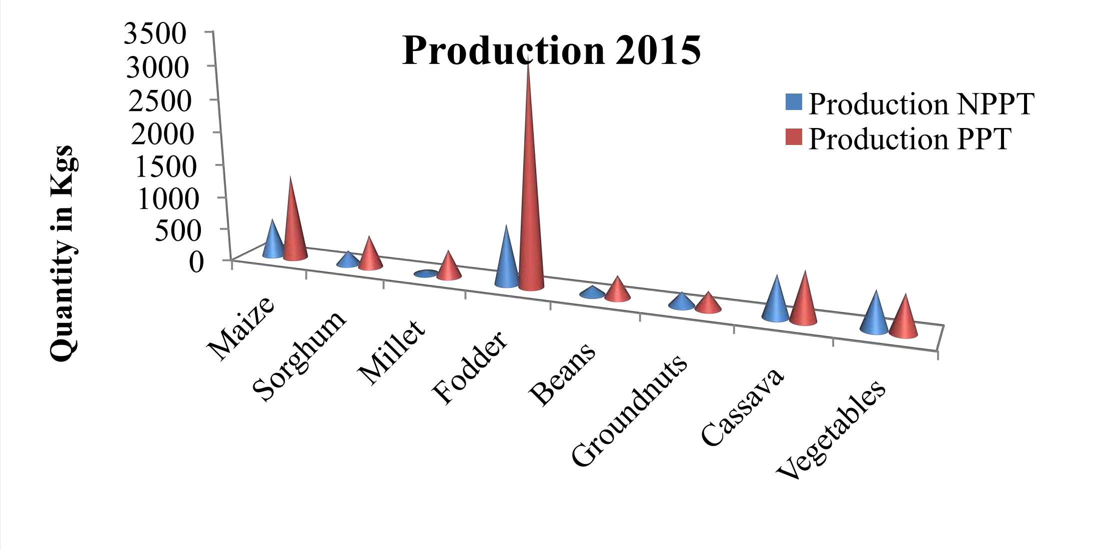

Figure 4: Food production graph

With a higher surplus, farmers sell excess when they do not have enough storage facilities or when there is a need to fund other domestic activities or purchase other food products. Push-pull households with higher surplus benefits largely from income obtained from the sales of farm products and in return, more food expenditure for the household is apparent. Good sales allow for a better expenditure on different food products to ensure diet quality and diversity as observed in the household dietary diversity score (HDDS).

Cost of sales and food expenditure per season

The quantity that remains after consumption of the generally produced yields is surplus. Surpluses in this study were majorly converted to cash (through sales) for domestic purposes and especially additional food expenditure. Analyzing PPT adopters only, the study showed that after adoption, there was a substantial increase in the sale of farm products and corresponding total food expenditure. For instance, before PPT adoption, maize sales earned Kshs. 2,945 (28.43 US$) while after adoption, it had increased to Kshs. 10,827 (104.51 US$). The amount of income used for purchasing food also showed a shift from Kshs. 1,938 (18.71 US$) before adoption to Kshs. 6,439 (62.15 US$) after adoption per season. Other products also showed approximately the same results as in Table 2. This meant a higher income for PPT households and a higher total food expenditure for the 2015 season.

Food inadequacy

Food inadequacy tested the rate at which households had food shortages in the entire year of 2015. Months with little food for the household reflected a confirmed case of food unavailability. In the NPPT group, the numbers of households with food inadequacy across the months of 2015 were higher with a severe case in May, having 88 households affected. And in PPT, fewer households had experienced the severity of

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food inadequacy in fewer months, that is, April, May, and June with 12, 13 and 12 households, respectively. In PPT households, food inadequacy was reduced immensely. Owing to the generally higher production, a food reservoir is formed to last the households longer. This achieves a millennium goal of food security when all households can secure food at all times. The graph below shows the observed food inadequacy situation.

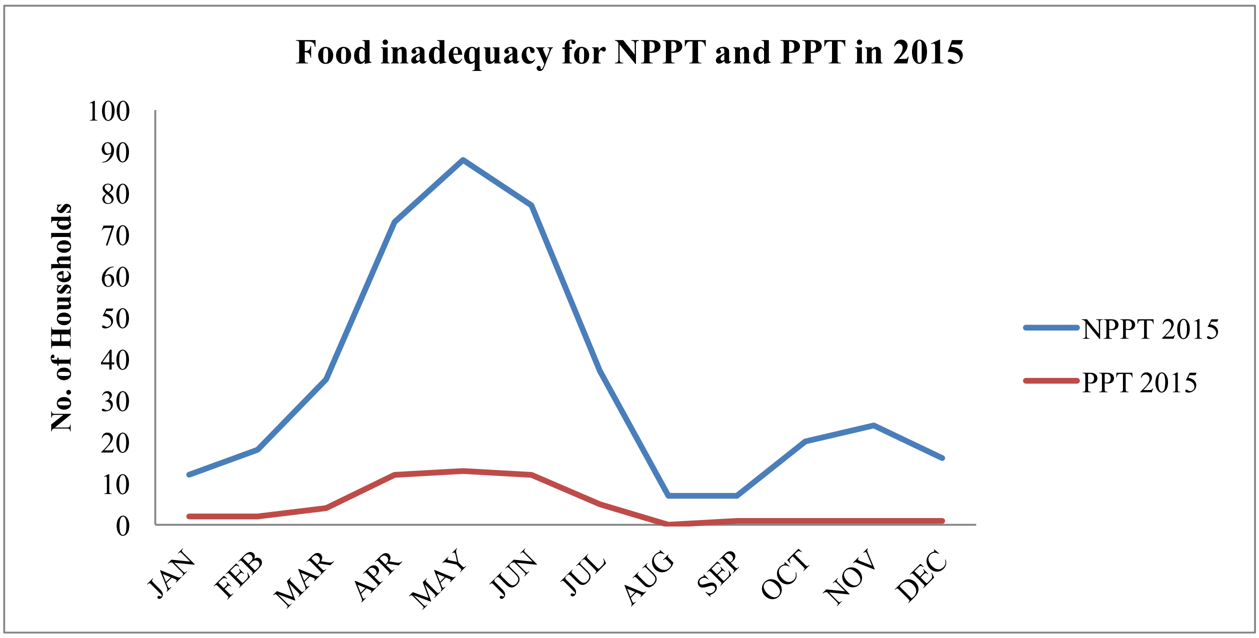

Figure 5: Graph of food inadequacy

Monthly Food Expenditure

The average food expenditure for the entire year of 2015 and the first third of 2016 revealed a slight difference between PPT and NPPT households. Push-pull households recorded Kshs. 5,999 (57.91 US$) as NPPT recorded Kshs. 5,791 (55.9 US$). Food expenditure was looked at in two dimensions. First is when the households' food production is low, there is a likelihood of more food expenditure to avail food for household members and secondly, when there is more surplus which is later sold, more income is availed for food expenditure. The first incidence was probably identified with NPPT households on many occasions since their production was limited. And with the PPT households, food expenditure predominantly depended on the number of sales or additional income. Push-pull households were apparently not highly affected by food availability compared to NPPT households and, therefore, food expenditure does not seem to depend on food shortage.

Scale of agriculture to nutrition benefits

The scale of agriculture to nutrition benefits is a researcher individual test seeking to know the benefits obtained in a comparative set up between PPT and NPPT. The benefits were standardized by a constructed tool investigating what achievement households accrue from certain farming practices (both PPT and NPPT) and the numbers of households that responded positively were noted for both groups. In this scale, PPT reflected 8.7 out of 10 compared to the NPPT's 4.9 as indicated in Table 5.

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The scale of agriculture to nutrition benefits proved a theory that PPT has the capacity to increase the number of animals, increase the live weight of livestock, increase the household's income for purchasing additional food, dietary diversity, promote women empowerment and independence in increased income [19], improve health status, increase the quality of crops and animals, create self-employment, crop diversification and increase quantity of staple grains. These minimally occurred in NPPT households.

Household Dietary Diversity Score

The enlisted analysis on household dietary diversity score revealed a significant difference between the two households. It indicated that a maximum number of households, both PPT and NPPT, consumed food group A (108). That is, all households are maximum dependents of cereals such as maize. This food group is a major energy food that promotes sustenance of household members and critically, their sustenance promotes nutrition through supplementation or complementing with other food groups. However, a founded and critical difference was evidenced in food groups B, C, D, E, F, G, H, I, J, K and L consumption where PPT had more households consuming these categories. Household Dietary Diversity Score finally reflected a general score of **8.5**/10 for the PPT households against **7.14**/10 of the NPPT as in Table 6. This suggests that PPT is richer in providing variety and diversity of essential nutrients through consumption of all ranges of food groups. The graph below shows the HDDS/nutrient diversity intake tendency of the PPT and NPPT.

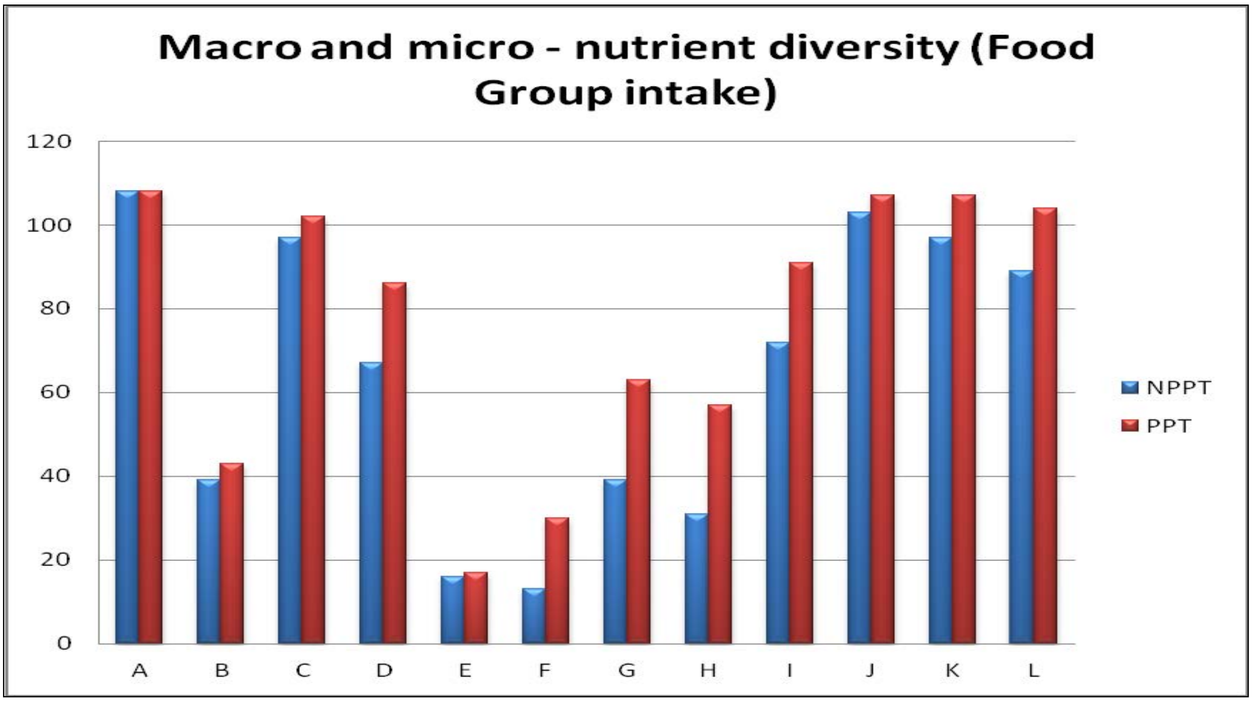

Figure 6: Macro and micro-nutrient intake

BMI presentations comparing PPT and NPPT households' children

Overall, the nutritional status of the two household groups revealed an impressive distinction. Total numbers of underweight children were 11 for PPT households and 65

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for NPPT households. Push-pull households recorded the highest number of normal weight children – 145 compared to the NPPT's – 89. It also recorded a higher number of overweight children (11) compared to NPPT (5). The pie charts below presents the classes of nutritional status for children as revealed in Table 7.

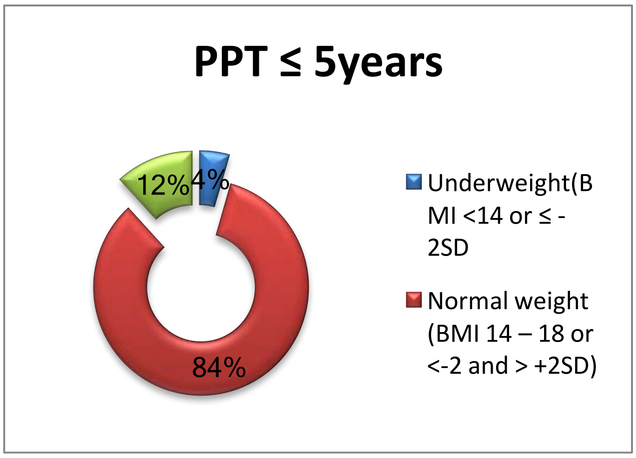

Figure 6A: PPT's BMI ≤5yrs

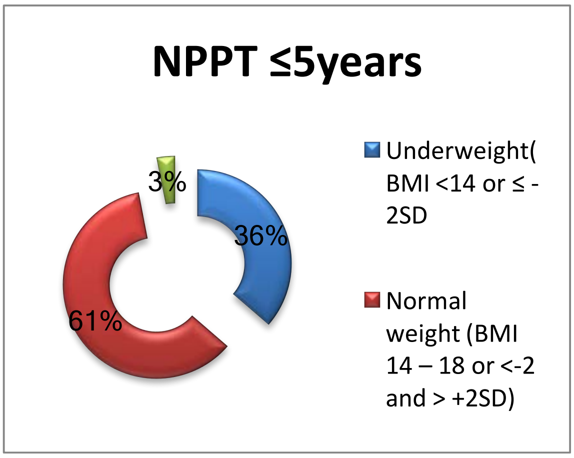

Figure 6B: NPPT's BMI ≤5yrs

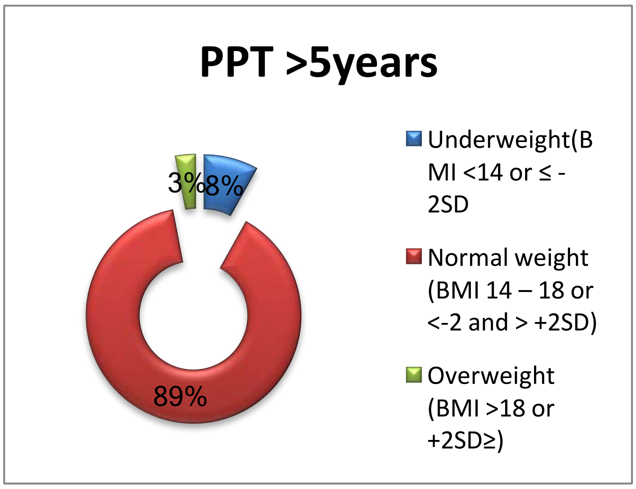

Figure 6C: PPT's BMI >5yrs

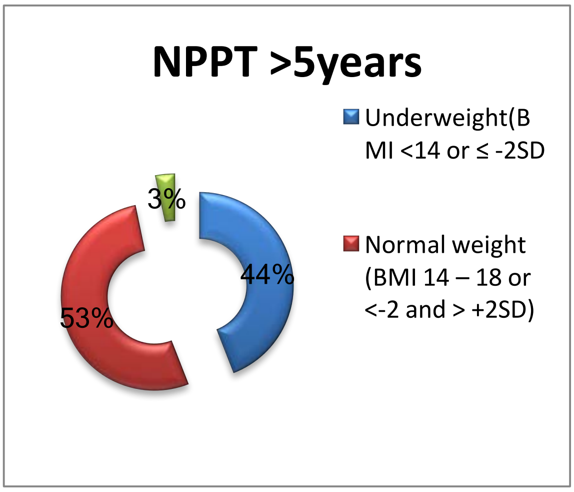

Figure 6D: NPPT's BMI >5yrs

In this presentation, therefore, PPT draws a magnificent result from fewer children found malnourished. The bulk of PPT children are normal and overweight, a positive outcome. Though the underweight children need nutrition intervention, a lesser effort is likely to be put in PPT children compared to the NPPT ones. The WHO Global Database on Child Growth and Malnutrition uses a Z-score cut-off point of <-2 SD to classify low weight-for-age, low height-for-age and low weight-for-height as moderate undernutrition, and <-3 SD to define severe undernutrition. The cut-off point of >+2 SD classifies high weight-for-height as overweight in children [17]. This agricultural technology essentially identifies a sort of reclamation strategy (community nutrition intervention) for a better nutrition-considerate household farming when compared to NPPT where over a quarter of NPPT children are malnourished.

CONCLUSION

The push-pull technology was invented as an agricultural pest and weed control strategy to diminish pest infestation on cereal crops planted by farmers. More studies had, however, showed that it did not only reduce pest infestation but also improved soil health and increased food security through a higher farm production. It is apparent that the production of the cereal crops in PPT households is higher than that of NPPT as evidenced in this study. The objectives were to determine if the technology impacts the nutritional status of the adopters as well as indicate that production is elevated and income boosted in turn and food expenditure is successively raised until a higher and better nutritional status is achieved. Evidently, PPT draws a magnificent result from fewer children found malnourished. Majority of PPT children are normal and overweight, a clearly positive outcome. Thus, less effort is likely to be put into PPT children compared to the NPPT children.

Nutrition improvement by PPT as an agricultural intervention has proven positive with boosted production and food value chain that increases household food consumption, diet quality, and nutritional status improvement. An observable result of reduced food inadequacy amongst the PPT households ranks the technology to a high impact nutrition intervention through the agricultural domain. Nutritional status of children is seen better with the adopters of PPT and this informs the agricultural sector on PPT as a rich and safe intervention that can help reverse the rampant cases of malnutrition in sub-Saharan Africa.

Therefore, this study recommends that further research and evaluations on PPT be done in order to affirm the principles of PPT in enriching nutrition. Although it is a rich technology, a standard agreement and policy are essential to help small-scale farmers reach the optimal goal of nutrition health and development as required by WHO using this technology. It is, therefore, better to bring in an all-inclusive effort in research and appraisal of this technology to promote a better future for farmers and the general population.

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Table 1: Household Production, Consumption and Surpluses in 2015 for PPT and NPPT households

2015						
Farm products	***Production***		***Consumption***		***Surplus***	
	NPPT	**PPT**	**NPPT**	**PPT**	**NPPT**	**PPT**
Maize	587	1303	487	826	100	478
Sorghum	214	493	185	294	29	199
Millet	65	411	56	273	9	138
Fodder	902	3366	662	3189	240	178
Beans	138	328	97	190	41	138
Groundnuts	204	258	120	105	84	153
Cassava	610	714	284	341	326	373
Vegetables	556	553	125	284	431	269

Table 2: Sales and expenditure before and after PPT adoption

Farm products	**Before**		**After (2015)**	
	Cost of quantity sold from farm (Kshs)	*Cost used as food expenditure (Kshs)*	*Cost of quantity sold from farm (Kshs)*	*Cost used as food expenditure (Kshs)*
Maize	2945	1938	10828	6439
Sorghum	1874	700	6290	7629
Millet	1929	1000	8663	8000
Fodder	3382	1880	5561	3774
Beans	2552	1699	8725	5750
Groundnuts	4158	4033	5197	5197
Cassava	4135	338	5152	4704
Vegetables	2950	1015	8162	4086
Mean	**3142**	**1658**	**7453**	**5397**

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Table 3: Household Income Source

Income Source	Number of PPT Households	Number of NPPT Households
Employment	23	21
Remittances	11	11
Pension	5	1
Sale of farm products	88	67
Rent	3	0
Dividends	85	81
Fishing	3	1
Casual labor	44	52
Self-employment	44	50
Others	0	2

Table 4: Food Expenditure

	PPT(Kshs)	NPPT(Kshs)
JAN-2015	5789	5723
FEB-2015	5749	5709
MAR-2015	5858	5784
APR-2015	6182	5936
MAY-2015	5946	5959
JUN-2015	5875	5950
JULY-2015	5768	5778
AUG-2015	5892	5939
SEP-2015	5632	5742
OCT-2015	5701	5756
NOV-2015	5747	5736
DEC-2015	6464	6139
JAN-2016	6306	5649
FEB-2016	6332	5585
MAR-2016	6268	5551
APR-2016	6479	5726
Average	**5999**	**5791**

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Table 5: Scales of agriculture to nutrition benefits by households

Code	Benefit	PPT			NPPT		
		Number benefitting	Total Number of households	% Benefitting	Number benefitting	Total Number of households	% Benefitting
A	Increasing the number of animals due to increased feed	90	108	83%	30	108	28%
B	Increasing the live weight of livestock	95	108	88%	46	108	43%
C	Increasing the household's income for food purchasing	97	108	90%	59	108	55%
D	Promoting women empowerment and independence in increased income	95	108	88%	64	108	59%
E	Improvement in health status	105	108	97%	84	108	78%
F	Increasing the quality of crops and animals e.g. reduced crop or animal diseases	97	108	90%	32	108	30%
G	Creation of self-employment	96	108	89%	64	108	59%
H	Crop diversification through creation/buying of more plots for push-pull	68	108	63%	7	108	6%
I	Increasing the quantity of staple grains for household consumption	102	108	94%	69	108	64%
J	Increasing variety of foods for consumption	96	108	89%	73	108	68%
Average scale (Divide by 108)		**8.7**	**10**	87%	**4.9**	**10**	49%

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Table 6: Household Dietary Diversity Score

Macro and micro-nutrient diversity intake analysis			
Food Groups	*Main Nutrients*	*NPPT No.*	*PPT No.*
A: **Any foods made from maize, sorghum, millet, rice, wheat**	Carbohydrates, protein, fibre, B vitamins, folate, thiamin, riboflavin, niacin, iron, Vitamin E, Zinc, Magnesium, Phosphorous	108	108
B: **Any potatoes, yams, cassava etc**	Carbohydrates, proteins, potassium, zinc, magnesium, copper, iron, manganese, vitamin K, folates, thiamin, pyridoxine (vitamin B-6), riboflavin, and pantothenic acid	39	43
C: **Any vegetables**	Potassium, dietary fiber, folate (folic acid), vitamin A, and vitamin C.	97	102
D: **Any fruits**	Potassium, dietary fiber, vitamin C, and folate (folic acid).	67	86
E: **Any meat or meat products**	Protein, B vitamins (niacin, thiamin, riboflavin, and B6), vitamin E, iron, zinc, and magnesium.	16	17
F: **Any eggs**	Iron, vitamins (A,D,E, B_{12}), folate, protein, selenium, lutein and zeaxanthin and choline	13	30
G: **Any fish**	Protein, Omega-3-fatty acids, vitamin D, riboflavin, Calcium, phosphorous, iron, zinc, iodine, magnesium and potassium	39	63
H: **Any foods made from beans, peas, lentils or nuts**	Protein, alpha linolenic acid, carbohydrates, folate, iron, zinc, calcium, magnesium, fibre, isoflavones, lignans, protease inhibitors and phytoestrogens in soy beans.	31	57
I: **Any milk or milk products**	Protein, carbohydrates, Vitamins (A, B12, B6, D), riboflavin, niacin, thiamine, pantothenic acid, folate, calcium, magnesium, phosphorous, potassium, zinc and Potassium	72	91
J: **Any foods made with oil, fat**	Monounsaturated and polyunsaturated fatty acid, Vitamin K and E	103	107
K: **Any sugar or honey**	Carbohydrates	97	107
L: **Any beverages e.g. coffee, tea or cocoa**	Calcium, vitamin D, Sodium, Potassium and Chloride	89	104
Household Dietary Diversity Score		**7.14**	**8.5**

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Table 7: Z-scores for households' children

Z-score	**Nutritional Status**	**PPT**			**NPPT**		
		≤ 5years	*>5years*	***Total***	*≤5years*	*>5years*	***Total***
≤ -2SD	Underweight (BMI <14)	3	8	**11**	24	41	**65**
-2 and > +2SD	Normal weight (BMI 14 – 18)	57	88	**145**	40	49	**89**
+2SD≥	Overweight (BMI >18)	8	3	**11**	2	3	**5**
Total		**68**	**99**	**167**	**66**	**93**	**159**

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