Agroforestry Extension and Dietary Diversity – An Analysis of the Importance of Fruit and Vegetable Consumption in West Pokot, Kenya

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The motivation

- People in pastoralist societies in dryland areas suffer from problems associated with malnutrition.
- Eastern Africa has the lowest per capita fruit consumption of any region in the developing world.
- Expansion of fruit tree cultivation on farms can have a significant effect on both quantity and quality of nutrition.
- There have been few, if any, comprehensive studies of dietary diversity in emerging livestock-based, agro-pastoralist systems.

The research question

- The paper draws upon an existing household data set from the survey collected and organized by Vi Agroforestry in seven different divisions/locations in West Pokot.
- Adoption of agricultural technologies, such as what crops to grow, is a complex process where education and information are important.
- Under-provision of information plays an important role in developing countries and should be taken into account.
- We present an analysis of the West Pokot survey data with a focus on the effects of extension system by Vi Agroforestry.

The survey

- Since 2001, Vi Agroforestry in Kitale, Kenya, have carried out surveys in the areas where they were active with agroforestry.
- The paper is based on data from the 2007/2008 survey, carried out from May 2007 to July 2008.
- The sample consisted of 296 subsistence farmers, retrieved from lists of farmers from local official administration, from different parts of West Pokot county.
- 164 farmers had received advice from Vi Agroforestry, 127 had not.

Dietary diversity

- The Vi Agroforestry survey covered several topics, but we have chosen to focus on the variables connected with dietary diversity.

- Household dietary diversity is a measure of a household's food access and is a proxy indicator of a household's economic status.

- Throughout the analysis it was assumed that the surveyed households in West Pokot were subsistence farmers, mainly living of their own produce.

Dietary diversity (continued)

- Based on the survey with the household heads, a dietary diversity score was calculated for each household using WHO indicators.

- The seven foods groups used for tabulation of this indicator were:

- Grains, roots and tubers
- Vitamin-A rich fruits and vegetables
- Other fruits and vegetables (excluding legumes and nuts)
- Flesh foods (meat, fish, poultry and liver/organ meats)
- Eggs
- Legumes and nuts
- Dairy products (milk, yogurt, cheese)

Results: *Food intake and dietary diversity*

- Even a cursory look at these data is sufficient to conclude that the studied area in West Pokot is likely to have problems with malnutrition.

- Daily consumption of animal protein and vegetables were reported by 50.5 % and 84.1 % of the household heads, respectively, while less than 10 % reported eating fruit daily.

- In fact, 24.5 % reported that they never ate fruit or did so only a few times per year.

Results: *Food intake and dietary diversity*

Table 1.1: Descriptive statistics by division/location for number of households, size of land (hectares), proportion of households receiving advice from Vi Agroforestry, dietary diversity score and proportion reaching minimum dietary diversity

Division	Households in survey (n)	Size land (ha)[1]	Advice Vi (%)	Dietary diversity score[1] [2]	Minimum dietary diversity[3] (%)
All divisions/ locations	296	5.40 [4.0] (7.14)	56	3.98 [4.0] (1.21)	72
Chepareria	69	5.04 [3.0] (7.37)	78	4.56 [4.0] (0.98)	88
Kacheliba	46	3.59 [3.0] (2.04)	68	3.54 [4.0] (0.65)	59
Kapenguria	55	6.60 [3.0] (9.56)	73	4.38 [5.0] (1.27)	82
Kongelai	50	5.33 [4.0] (6.20)	92	3.54 [4.0] (0.95)	60
Mnagei	20	5.30 [3.5] (4.40)	100	4.20 [4.0] (1.75)	85
Sook	50	6.29 [3.0] (8.64)	0	3.44 [4.0] (1.31)	56
Tapach	6	6.17 [5.0] (2.93)	67	4.83 [5.0] (0.75)	100

[1] Mean [Median] (Standard Deviation)

[2] Dietary diversity score = number of different food groups calculated for each household using the WHO-indicators (WHO, 2010).

[3] Proportion with a dietary diversity score of at least 4.

Results: *Food intake and dietary diversity*

Table 1.2: Descriptive statistics for percent growing crops belonging to food groups[1] A, B, C, D, E, F, and K, as well as having access to food groups G, H, I, and L.

Divisions/Locations	Food groups (%)									
	A	B	C	D	E	F	G & H	I	K	L
All	98	11	24	53	24	37	84	84	97	81
Chepareria	100	14	40	58	58	71	88	43	97	100
Kongelai	100	4	0	30	24	10	80	76	82	98
Sook	100	27	38	82	0	10	70	72	82	94
Kacheliba	96	2	10	24	22	22	80	87	85	100
Kapenguria	90	15	25	70	13	53	94	74	89	91
Tapach	100	6	16	56	67	83	100	100	50	100
Mnagei	100	0	50	50	30	80	90	55	90	85

[1]Food groups: A=grains; B=dark yellow/orange-fleshed roots, tubers and others; C=roots, tubers and plantains; D=dark green leafy vegetables (based on assumption that those reporting growing food groups B and C also eat edible leaves from these products); E=dark yellow/orange fruit; F=other fruit/vegetables; G and H=meat (based on proportion reporting consumption of animal protein at least once per week); I=eggs (based on proportion owning poultry); K=beans, peas, lentil, nuts, seeds; L=milk-based products (based on proportion reporting owning sheep, goats and cattle).

Results – received or didn't receive advice from Vi Agroforestry

Table 2: Descriptive statistics for size of land (hectares), age of household head (years), education level of household head, dietary diversity, and percent growing crops belong to food groups[1] A, B, C, D, E, F, and K, as well as access to food groups G, H, I, and L, all depending on whether the household had received advice from Vi Agroforestry or not.

Variable	Received advice from Vi Agroforestry (n = 164)	Did not receive advice from Vi Agroforestry (n = 127)
Size land (ha)		
Mean (SD)	5.18 (6.09)	5.65 (8.18)
Median [25-75 percentile]	5 [2-25]	3 [2-4]
Age, household head (years)[2]		
Mean (SD)	37.89 (10.46)	39.91 (11.32)
Median [25-75 percentile]	44 [26-44]	44 [26-44]
Education, household head (1 = None, 2 = Primary, 3 = Secondary, 4 = Tertiary)		
Mean (SD)	2.23 (.92)***	1.55 (.78)
Median [25-75 percentile]	2 [2-3]	1 [1-2]
Dietary diversity score		
Mean (SD)	4.25 (1.2) **	3.67 (1.1)
Median [25-75 percentile]	4 [3-6]	4 [3-5]
Minimum dietary diversity (%)[3]	80.5*	61.4
Farmers growing[1]:		
Food group A (%)	97.6	99.2
Food group B (%)	16.6*	4.5
Food group C (%)	32.5**	12.1
Food group D (%)	59.7*	43.1
Food group E (%)	34.9**	9.8
Food group F (%)	53.2***	15.9
Food groups G and H (%)	86.9	81.1
Food group I (%)	77.5**	92.4
Food group K (%)	96.2	100
Food group L (%)	82.2	81.1

Differences between groups tested with Student's t-test: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[1] Food groups: A=grains; B=dark yellow/orange-fleshed roots, tubers and others; C=roots, tubers and plantains; D=dark green leafy vegetables; E=dark yellow/orange fruit; F=other fruit/vegetables; G and H=meat; I=eggs; K=beans, peas, lentil, nuts, seeds; L=milk-based products.

[2] Age groups in questionnaire: under 18, 18-35, 36-55, over 55. The first group was coded 18, the second 26, the third 44, and the last 55.

[3] Minimum dietary diversity indicates the proportion (%) with intake from at least four food groups. This would give a high probability that the household had access to some kind of staple food (grain, root or tuber), at least one protein-rich animal-source food and at least one fruit or vegetable providing important micro-nutrients.

Testing causal effects with regression

- Regression analyses were used to determine the effects of household characteristics, geographical variation and counselling by Vi Agroforestry on number of food groups available and dietary diversity score.

- However, since descriptive statistics suggested that households where the household head had a higher education level, had a higher likelihood of being in the group receiving advice from Vi Agroforestry, an endogenous selection model was needed.

- For this reason the Heckman (1979) two stage estimation procedure was used.

- The probit version of this estimation procedure was used to analyse the effect of Vi Agroforestry, together with other independent variables, on the respective food groups.

Results – effects on consumption of food group and dietary diversity score

Table 3. Heckman two-stage maximum likelihood estimates of the effect of household characteristics, geographical variation and advice from Vi Agroforestry on number of food groups, and the corresponding dietary diversity score (n=283). Chepareria division is used as baseline.

	Coefficient	T-Value	Coefficient	T-Value
Selection (probit) model	**Dependent variable: Received advice from Vi Agroforestry**			
Constant	-.874	-4.11***	-.849	-3.84***
Education level, household head	.521	5.62***	.512	5.31***
Kongelai	1.271	4.38***	1.317	4.46***
Kacheliba	-1.179	-3.17**	-1.254	-3.52***
Second stage model	**Dependent variable: Number of food groups**		**Dependent variable: Dietary diversity score[1]**	
Constant	6.093	9.45***	3.705	7.25***
Age, household head (years)	-.0002	-.02	.0008	.12
Size arable land (hectares)	.017	1.44	.014	1.74
Kongelai	-2.267	-5.53***	-1.337	-4.50***
Sook	-.859	-2.24*	-.716	-2.36*
Kacheliba	-.411	-.74	-.341	-.75
Kapenguria	-.209	-.69	-.214	-.94
Tapach	.442	.56	.346	.59
Mnagei	-.909	-2.73**	-.579	-2.29*
Advice Vi-agroforestry	2.291	3.87***	1.122	2.19*
σ	1.649	15.03***	1.132	15.82***
ρ	-.573	-3.56***	-.409	-1.84
Adjusted R^2	.24		.16	

*= $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$

[1] Dietary diversity score calculated for each household using the WHO-indicators (WHO, 2010).

Table 4.1: Heckman two-stage probit regressions on the effect of household characteristics, geographical variation and the counselling by Vi Agroforestry on the probability of growing food group A (grains), B (dark yellow/orange-fleshed roots, tubers and others), C (roots, tubers and plantains), D (dark green leafy vegetables), E (dark yellow/orange fruits), and F (other fruit/vegetables). T-values are within parenthesis. Chepareria division is used as baseline.

Selection model	**Dependent variable: Received advice from Vi Agroforestry**
Constant	-.833 (-3.63)***
Education level, household head	.505 (4.94)***
Kongelai	1.298 (4.66)***
Kacheliba	-1.341 (-4.11)***

Second stage model	**Dependent variable: Availability of food groups**					
	A	**B**	**C**	**D**	**E**	**F**
Constant	16.692 (0.0)	-2.367 (-3.86)***	-.795 (-1.79)	-.009 (.02)	-.326 (-.73)	-.097 (-.23)
Age, household head (years)	-.060 (-1.41)	.009 (.92)	-.003 (-.39)	-.013 (-1.66)	.008 (.81)	.001 (.14)
Size arable land (ha)	-.0004 (-.01)	-.004 (-.23)	.024 (2.00)*	.016 (1.30)	-.008 (-.51)	.011 (.91)
Kongelai	-6.184 (0.0)	-1.01 (-2.19)*	-1.171 (-3.82)***	-.949 (-3.69)***	-.912 (-3.50)***	-1.888 (-6.22)***
Sook	-5.710 (0.0)	.473 (.92)	-.213 (-.61)	.610 (1.98)*	-7.641 (0.0)	-1.286 (-3.65)***
Kacheliba	-.888 (0.0)	.194 (.39)	-7.008 (0.0)	-.129 (-.42)	-2.003 (-4.07)***	-2.053 (-4.32)***
Kapenguria	.046 (0.0)	.531 (1.88)	-.065 (-.27)	.811 (3.05)**	-1.270 (-4.75)***	-.469 (-1.95)
Tapach	-.547 (0.0)	-6.323 (0.0)	.315 (.58)	-.222 (-.39)	.371 (.66)	.505 (.81)
Mnagei	-7.017 (0.0)	-.275 (-.63)	-.511 (-1.45)	.105 (.30)	-.843 (-2.41)*	.111 (.30)
Advice Vi-Agroforestry	-5.889 (0.0)	1.041 (2.58)**	.672 (2.43)*	.779 (3.18)**	.294 (1.08)	.677 (2.62)**
Pseudo R^2	.42	.15	.18	.15	.28	.34
No. of obs.	283	283	283	283	283	283

*= p ≤ 0.05; ** = p ≤ 0.01; *** = p≤ 0.001

Pseudo R2 is according to McFadden (1974)

Table 4.2: Heckman two-stage probit regressions on the effect of household characteristics, geographical variation and the counselling by Vi Agroforestry on the probability of having own access to food group G (organ meats), H (any meat), I (eggs), K (beans, peas, lentil, nuts, seeds), and L (milk-based products). Chepareria division is used as baseline.

Selection model	**Dependent variable: Received advice from Vi Agroforestry**
Constant	-.833 (-3.63)***
Education level, household head	.505 (4.94)***
Kongelai	1.298 (4.66)***
Kacheliba	-1.341 (-4.11)***

Second stage model	**Dependent variable: Availability of food groups**			
	G & H[1]	**I**	**L[1]**	**K[2]**
Constant	15.449 (0.0)	-.207 (-.40)	7.711 (0.0)	10.722 (0.0)
Age, household head (years)	-.042 (-2.16)*	.004 (.37)	-.004 (-.42)	-.072 (-1.12)
Size arable land (ha)	.173 (1.72)	.006 (.37)	-.0003 (-0.02)	.167 (.96)
Kongelai	-6.614 (0.0)	2.207 (4.91)***	-7.059 (0.0)	
Sook	-12.981 (-0.0)	1.754 (4.00)***	-6.952 (0.0)	
Kacheliba	-.442 (-0.0)	7.708 (0.0)	-6.461 (0.0)	
Kapenguria	-.058 (0.0)	1.722 (5.39)***	-6.957 (0.0)	
Tapach	-1.168 (0.0)	7.834 (0.0)	-.0004 (0.0)	
Mnagei	-6.567 (0.0)	1.191 (3.08)**	-7.646 (0.0)	
Advice Vi-Agroforestry	-6.221 (0.0)	-.167 (-.52)	.146 (.43)	-6.630 (0.0)
Pseudo R^2	.34	.38	.16	.19
No. of obs.	283	283	283	66

*= p ≤ 0.05; ** = p ≤ 0.01; *** = p≤ 0.001

Pseudo R2 is according to McFadden (1974)

[1] Note that the probit regression for G & H (meats), and L (milk-based products) shows signs of multicollinearity problems, i.e. very low t-values and mostly very similar values on the regional coefficients.

[2] Note: The probit model with regional dummies could not be estimated for food group K due to perfect collinearity between some of the independent variables.

Conclusion

- Certain important economic restrictions that hinder this transition towards sedentary agropastoralism become clear.

- One that seems obvious, is financial constraint preventing the purchase of necessary plants and crops.

- Non-governmental organizations can help to overcome this restriction by providing plants and crops freely, or to a very low price, to households involved in the organization's program.

Conculsion

- However, poverty is not the sole explanatory factor behind a lack of dietary diversity – an often overlooked factor is lack of information as a determinant of household behavior in developing countries.

- In fact, the present study found that getting free advice was more important than getting free tree seedlings, as free trees were only distributed for a limited period.

- Developing countries in general are not information-rich environments, a fact that also holds when it comes to nutrition in West Pokot County in western Kenya.

- Careful attention to the information and knowledge available to households is necessary when designing development cooperation interventions.

Conclusion

- We suggest that the positive effects on dietary diversity could be further emphasized through direct dietary information from trained nutritionists or dietitians in the extension service.

- Increased nutritional awareness among other staff and, as a consequence, also among farmers is crucial.

- Through this, extension services can bridge the information gap and provide an even stronger impact.

A little extra: savings and loans in the Vi Agroforestry sample

- A short analysis of the savings and loan behavior of the respondents in the sample.
- Savings are important in many ways and a prerequsite for loans.
- The questionnaire included questions about if and where households save and loan.

Access to finance

- Access to affordable financial services is critical for the empowerment of poor people, especially women.
- Informal schemes like Village Savings and Loan, VSL, organisations is one alternative.
- More formal Savings and Credit Cooperative Organisations, SACCOs, which are institutionalized in the 1997 Co-operative Act.
- A third alternative is to open a bank account.
- Finally, one can save through investing, e.g. in livestock.

Savings

296 respondents

131 (44.2 %)

did not save

Of them 54% had received advice.

165 (55.7 %)

saved

Of them 62% had received advice.

39 % saved in the mattress

13 % saved in informal systems (VSL)

7 % saved in SACCO's, etc.

18 % saved in banks

23 % saved by investing or in other ways

Loans

296 respondents

131 (44.2 %)
did not save

Of them:
4.6 % had loans
89.9 % did not have loans
6.1 % no answer

165 (55.7 %)
saved

Of them:
42.9 % had loans
55.1 % did not have loans
2.4 % no answer

Multinomial logit on savings options

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Characteristics in numerator of Prob[Y = 1]					
Constant	1.72904666	.92508988	1.869	.0616	
AGEHHH	-.00958325	.01560743	-.614	.5392	38.6569343
SEXHHH	-.50707214	.47066336	-1.077	.2813	.89781022
SIZELAND	.00048258	.02500588	.019	.9846	5.39781022
ADVICEVI	.17689317	.33804583	.523	.6008	.56569343
MINIMUMD	-.42152605	.14137764	-2.982	.0029	4.00364964
Characteristics in numerator of Prob[Y = 2]					
Constant	-1.29312140	1.40252086	-.922	.3565	
AGEHHH	-.01772702	.02346490	-.755	.4500	38.6569343
SEXHHH	-.37800815	.71479570	-.529	.5969	.89781022
SIZELAND	-.06509656	.07014880	-.928	.3534	5.39781022
ADVICEVI	1.32335996	.56389280	2.347	.0189	.56569343
MINIMUMD	.03494879	.21630169	.162	.8716	4.00364964
Characteristics in numerator of Prob[Y = 3]					
Constant	-32.2157918	.346089D+07	.000	1.0000	
AGEHHH	-.01294376	.03233333	-.400	.6889	38.6569343
SEXHHH	30.2669386	.346089D+07	.000	1.0000	.89781022
SIZELAND	.04240349	.03151080	1.346	.1784	5.39781022
ADVICEVI	.60379653	.72013488	.838	.4018	.56569343
MINIMUMD	-.11212401	.28166069	-.398	.6906	4.00364964
Characteristics in numerator of Prob[Y = 4]					
Constant	-4.13857483	1.43812911	-2.878	.0040	
AGEHHH	.03873415	.02274164	1.703	.0885	38.6569343
SEXHHH	.03336062	.72700103	.046	.9634	.89781022
SIZELAND	.02977040	.02559627	1.163	.2448	5.39781022
ADVICEVI	2.19865461	.59177063	3.715	.0002	.56569343
MINIMUMD	-.12531435	.18119311	-.692	.4892	4.00364964
Characteristics in numerator of Prob[Y = 5]					
Constant	-30.1911548	.181974D+07	.000	1.0000	
AGEHHH	-.02710262	.01858643	-1.458	.1448	38.6569343
SEXHHH	30.2256358	.181974D+07	.000	1.0000	.89781022
SIZELAND	-.01585610	.03863107	-.410	.6815	5.39781022
ADVICEVI	.58095015	.41334715	1.405	.1599	.56569343
MINIMUMD	-.05811466	.17386427	-.334	.7382	4.00364964

To be continued…