69- Hidden hunger or knowledge hunger? Nutritional knowledge, diet diversity and micronutrient intake in Rwanda: The case of Vitamin A

Julius J. Okello, Kirimi Sindi, Jan Low & Kelvin Shikuku

International Potato Center, ILRI Campus, P.O. Box 25171, Nairobi, Kenya

Paper Prepared for Presentation at the African Association of Agricultural Economists Conference, Tunisia, 22-25 September 2013

Hidden hunger or knowledge hunger? Nutritional knowledge, diet diversity and micronutrient intake in Rwanda: The case of Vitamin A

Abstract

The problem of hidden hunger has emerged as one of the major development issues alongside food security. This problem highlights the likelihood of households having access to inadequate amount of key micronutrients in a diet despite having access to adequate quantities of food. , This paper uses a recent detailed household consumption data to investigate households' nutritional knowledge, the diversity of diets consumed, and the micronutrient uptake, focusing specifically on Vitamin A. The study finds high knowledge of Vitamin A but low understanding of the function of Vitamin A in human bodies. We find a disconnect between the knowledge of Vitamin A and diets consumed by the respondents. Further, the use of diet diversity scores (DDS) reveal a narrow range of foods consumed, with children age 6-23 months most affected. However, the predictions from DDS stand in stark contrast with actual consumption of Vitamin A rich foods. The study concludes that there is high awareness of Vitamin A and Vitamin A-rich foods among rural households although this knowledge does not directly translate into consumption Vitamin A rich foods. The study also concludes that care needs to be taken in using different measures of diet diversity to proxy micronutrient uptake. It discusses policy recommendations of these findings.

Key words: Rural households, Nutritional knowledge, diet diversity, micronutrient intake, Rwanda

1. Introduction

The concept of hidden hunger has become the “buzz word” in the development arena. The phrase is used to describe a situation where individuals/households may have access to food adequate quantity of food but the food is not nutritionally balanced. It implies that individuals may have food but are unable to utilize the food in order to have a functional life. More specifically “hidden hunger” is the lack of the appropriate balance of macro- (calories) and micronutrients (vitamins and minerals such as vitamin A, iron, zinc, and iodine).

As part of the effort to tackle the problem of hidden hunger, members of the Consultative Group on International Agricultural Research (CGIAR) formed a “challenge program” called *HarvestPlus* in 2004. The program was specifically aimed at strengthening and coordinating efforts of the international agricultural research system to enhance micronutrient content in staple food crops. The initiative targeted three main nutritional deficiencies among rural households namely, Vitamin A, iron and zinc consumption. Since its formation, *HarvestPlus* initiatives have focused attention on breeding for enhanced nutrient content in six staple crops: sweetpotato, maize, beans, rice, cassava, wheat and potato.

One of the most successful collaboration efforts by *HarvestPlus* and International Potato Center (CIP) has been the breeding of sweetpotato varieties with high beta carotene[1] content, popularly referred to as the orange-fleshed sweetpotato (OFSP). Recent pilot studies have found evidence that the consumption of OFSP reduces Vitamin A Deficiency (VAD) in children and other members of rural households. Using data from Uganda, Chowdhuri et al (2013) find that consumption of OFSP reduces incidence of VAD. A similar study by Van Jaarsveld et al (2005) in South Africa found that children of age 5-10 feed on daily maeal of OFSP exhibited significantly lower symptoms of VA D. On a broader level, Low et al (2001) found that the substitution of OFSP for the other widely consumed local varieties would significantly reduce VAD.

In tandem with enhanced effort to breed for biofortified sweetpotato and in view of the emerging evidence of the benefits of consumption of OFSP, there is intensified effort to develop and promote the consumption of biofortified foods that deliver essential micronutrients. However,

[1] Beta carotene is a precursor for Vitamin A

emerging evidence suggests that consumers' lack of awareness of the nutritional benefits of biofortified crop products (Okello et al, 2013). In addition, some of the crops being biofortified e.g., sweetpotato and sorghum have traditionally been viewed as inferior goods which excludes them from higher income segments of the consumers as well as city consumers. In this paper we use a very recent dataset collected by International Potato Center from 596 households in Rwanda to examine the nutritional knowledge, diet diversity and consumption of Vitamin A rich foods. Information about nutritional knowledge of the households, diet diversity and micronutrient consumption levels at the household levels is essential in the cost-effective targeting of efforts to promote consumption of biofortified crops and products in various regions and countries where VAD is an acute problem.

The data used in this study was collected through personal interviews from households stratified by region. The regions covered were North (comprising Gakenke, Rulindo and Burera districts) and Southern (comprising Kamonyi and Muhanga districts). The data was collected as a part of the baseline for the project Rwanda Sweetpotato Super Foods project. This project seeks to build an effective public-private sector partnership. The proof of concept project seeks to provide solid evidence that sweetpotato processed products are profitable and acceptable to urban African consumers. Expected impacts also include understanding how to develop efficient and/or gender-equitable organizational model(s) for sweetpotato value chains and enhanced revenues for 500 participant households within 3 years. The districts chosen were where the project had targeted as the intervention areas based on the implementing partners on the ground coverage areas.

2. Methods and Study area

The three districts chosen in the Northern region were based on the proximity to the main processor who is the main private sector partner in the project. The private sector partners provide the main market for the sweetpotato roots produced by the project beneficiaries. The private sector is in Rulindo hence we choose Rulindo district and the neighboring district Gakenke plus a few areas on Burera districts that were very near to the intervention areas to be part of the control. In the Southern region two best sweetpotato producing districts in Rwanda were chosen namely Kamonyi and Muhanga districts.

The project is testing two organizational models for building a viable sweetpotato based value chain. In model one the private sector partner is contracting individual farmers to produce the desired sweetpotato roots that are processed at their factory. In Model two implementing partners Catholic Relief Services and Young Women Christian Association are working with farmer groups. They chose some existing groups and others were formed for the intervention. So after choosing the groups that were to be intervened we got the list of members in each group. We then used a random table to select the individuals to be interviewed from each group. Therefore the sector was predetermined by the location of the group but the cell and the villages were randomly selected depending on the location of each member randomly selected. If for any reason the member of a group selected was not available for the interview a replacement member was chosen using the same criteria. For the contracted farmers, a list of all the farmers contracted or to be contracted was drawn. Since they were few all of them were interviewed. To have some control, villages were chosen from the nearby sectors that were not to be intervened and a village was chosen at random. A list of the members was drawn and then using random sampling, guided by random table, households to be interviewed were selected. In the event the chosen household in the control was not available another one was randomly selected. Using this procedure trained enumerators then administered the survey instrument in 17 sectors, 46 cells and 126 villages. A total of 596 households were surveyed.

3.0 Results

Table 1 provides the summary statistics for the age, education, household size and period spent at home by the respondent for the two study regions. It shows that male and female respondents in the Northern region do not differ much in terms of mean age, household size, highest education attained and period spent in the farm. For instance the mean age of the male and female respondents in the Northern region is 24 years while highest education attained is about standard/grade 5. This implies that most of the study respondents have relatively low levels of education. Similar trends are observed for male and female respondents in the Southern region. Notably, the mean age of male and female respondents is 26years. At the same time, the mean level of education attained is grade/standard 5, the households have on average six members, and the average number of months in the farm is 11 for both female and male respondents in the South. These results suggest that the households in both the North and the South are similar in these key socioeconomic characteristics.

Table 1: Key socioeconomic characteristics of survey households, by gender and region

Region	Sex		age	hhd size	highest education	months at home
North	Female	Mean	24.15	6.08	4.45	11.81
		N	684	684	683	684
		Std. Dev.	15.403	1.968	3.084	1.659
	Male	Mean	23.88	6.21	4.55	11.62
		N	578	578	578	578
		Std. Dev.	15.628	1.881	3.221	1.975
	Total	Mean	24.03	6.14	4.50	11.73
		N	1262	1262	1261	1262
		Std. Dev.	15.501	1.929	3.147	1.812
South	Female	Mean	26.27	6.04	4.95	11.53
		N	790	790	790	790
		Std. Dev.	16.863	2.464	3.218	1.901
	Male	Mean	25.55	6.03	4.62	11.71
		N	635	635	634	635
		Std. Dev.	17.452	2.475	3.322	3.930
	Total	Mean	25.95	6.04	4.80	11.61
		N	1425	1425	1424	1425
		Std. Dev.	17.125	2.468	3.268	2.981

Analysis of the marital status of the household heads indicate that 63% are married, 12% are single, 16% are widowed, while the rest live in other forms of marital relationships. In addition analysis of the gender distribution of the results indicate that only 31% (N=596) of all the respondents are female. In terms of regions, the Southern region had a greater percentage of widowed household heads (18%) than the Northern region (14%). The southern region also leads in the level of unemployment. The data shows that approximately 90% (N=279) of the household heads interviewed did not undertake any paid employment during the study year (2011) compared to 85% (N=317) in the North. At the same time, 71% of the household heads in the South did not participate in causal labor market compared to just 63% in the North. These statistics suggest that the survey households in the South are less endowed with livelihood opportunities compared to their counterparts in the North.

4.1 Knowledge of Vitamin A

Past studies suggest a relationship between nutritional knowledge and food consumption. Tepper et al (1997) indicate that attitude and beliefs towards food affect consumption. Ineke et al (2007) and Pounis et al (2011) find a link between consumers' food perceptions and consumption. The former specifically find that certain segments of the consumers are less likely to eat foods that are traditionally perceived to be inferior (i.e., those labeled as "poverty food"). In Mozambique, Burchi (2010) use econometric techniques to demonstrate a link between mothers' knowledge and children's food consumption and nutritional outcomes. This study therefore examined the study households' knowledge of Vitamin A and food nutrition in general. The results of this analysis are presented in Figure 1 and 2. As shown, large proportions of the women in both regions were aware of Vitamin A with awareness higher in the Northern region.

Figure 1: Ever heard of Vitamin A: women respondents, % by region

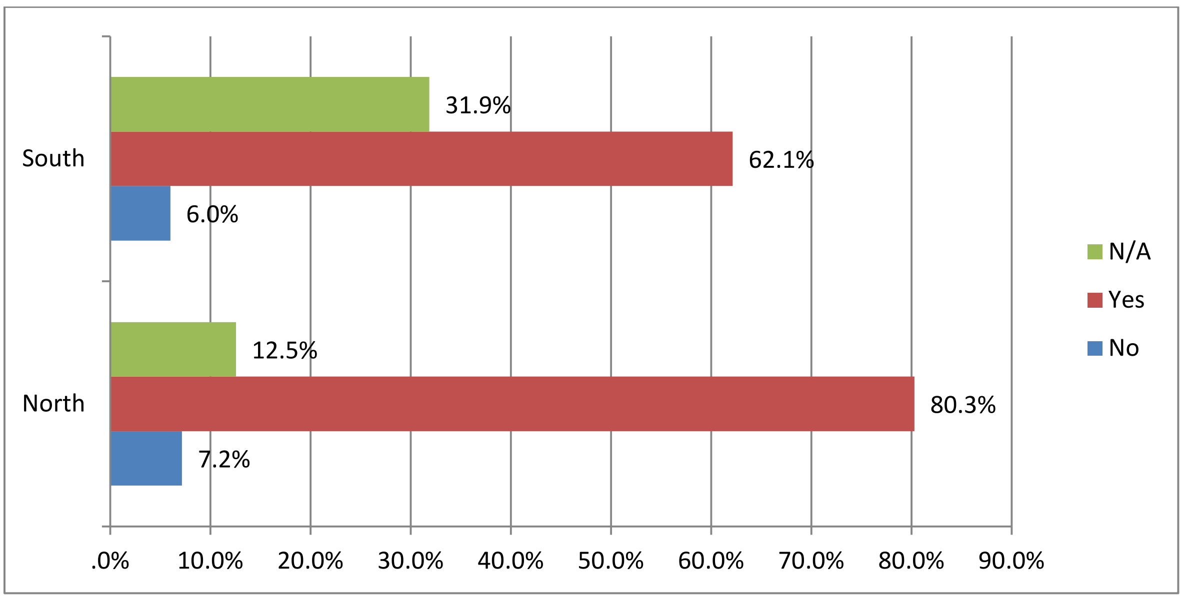
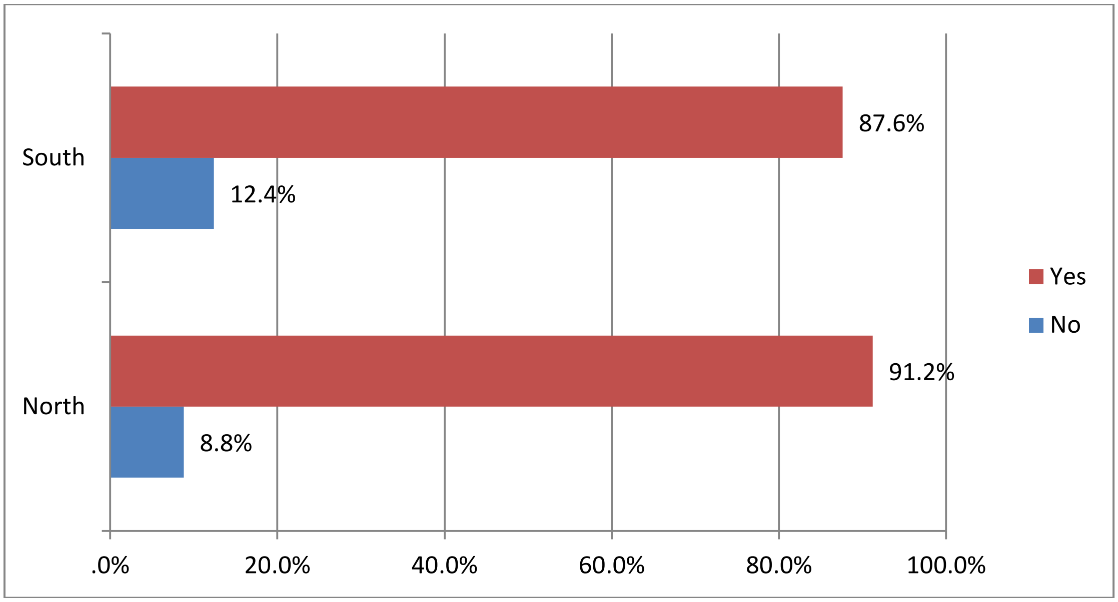


Figure 2: Men's knowledge of Vitamin A (%) by region



Knowledge of Vitamin A is equally high among men in the two study regions. Figure 2 presents the proportion of the 91 and 121 men in the North and South, respectively, that responded to this question who had heard of Vitamin A. As in the case of women, a larger proportion of households in the North were aware of Vitamin A than in the South.

In order to assess the respondents' knowledge of the function of Vitamin A in human body, the study participants were also asked why vitamin A is important. Their responses of the male respondents are presented in Table 2 below. In both the North and South, in almost an equal proportion, the most known function of Vitamin A is body protection. About 45% of the respondents in the two regions cited this reason. The other major function mentioned by the respondents was the improvement of vision (26% and 20% in the North and South, respectively). About 8% and 13% respondents in the North and South, respectively did not know the importance of vitamin A to the body.

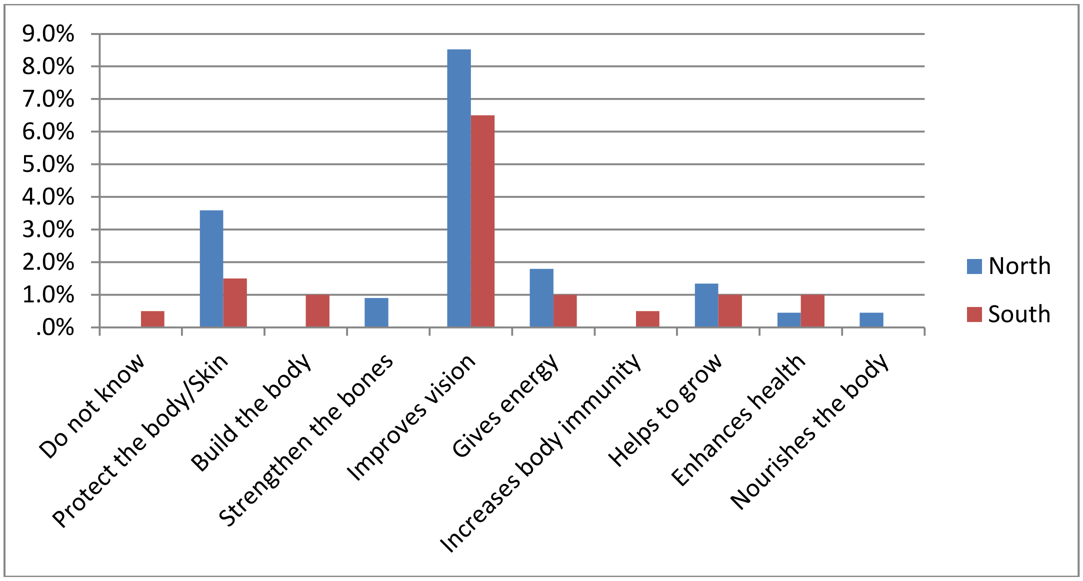
Table 2: Knowledge of functions of Vitamin A among male respondents

Why is Vitamin A important?	Region		
	North (N=220)	South (N=201)	Total
Do not know	8.2%	12.9%	10.5%
Protects the body/Skin	44.5%	45.3%	44.9%
Builds the body	-	1.5%	.7%
Strengthens the bones	1.8%	.5%	1.2%
Improves vision	25.9%	19.9%	23.0%
Gives energy	2.3%	5.0%	3.6%
Increases body immunity	2.3%	5.0%	3.6%
Increases blood	.9%	1.0%	1.0%
Helps to grow	3.2%	.5%	1.9%
Enhances health	5.0%	5.5%	5.2%
Provides nutrients	.5%	-	.2%
Nourishes the body	5.5%	.5%	3.1%
N/A	-	2.5%	1.2%
Total	100.0%	100.0%	100.0%

The finding that a greater percentage of male respondents listed body protection as the major function of Vitamin A suggests that male household heads in the two study regions know in general what Vitamin A can do to the body but not the specific function of Vitamin A, namely that it improves vision.

The analysis of awareness of the functions of Vitamin A by female respondents is presented in Figure 3. Unlike their male counterparts, majority of the female respondents listed vision improvement as the main function of Vitamin A in human bodies. The other major functions of Vitamin A to the body mentioned by the female respondents are body protection and energy source. Thus compared to male counterparts, female respondents were more aware of the specific role of Vitamin A in human bodies.

Figure 3: Awareness of importance of Vitamin A, female by region (%)



The respondents were also asked to list some of the foods that are rich in Vitamin A. The three most frequently mentioned foods by male respondents in the North were amaranth (30%), carrots (16%) and sweetpotato (15%). In the South these foods were mention by 36% (amaranth), 14% (sweetpotato) and 11% (carrot). Hence Sweetpotato as a source of Vitamin A was mentioned by much fewer respondents, suggesting poor knowledge of the high density of Vitamin A in the OFSP among male respondents in both study regions. Among the female respondents, amaranth, sweetpotato and carrot were mentioned by 28%, 21% and 19%, respectively in the North. In the South, amaranth, sweetpotato and carrot as sources of Vitamin A were mentioned by 30%, 20% and 17%, respectively of the female respondents. These findings indicate that more women are aware of the sweetpotato, including the OFSP, as source of Vitamin A than men. There are at least two reasons why this is the case. First, sweetpotato is usually treated in most rural households as "women's crop" and consumed more by women and children than men. Second, it is likely that the launch and promotion of the biofortified sweetpotato targeted women more than men.

In order to test general nutritional knowledge of the respondents, women and men were separately asked whether it's good or bad to give colostrum to a baby and the average age at which water and solid foods can be given to a baby for the first time. Almost all the women

(94% (N=242) and 96% (N=215) in North and South, respectively) said that it is good nutrition practice to give colostrum to the baby. The average age when a baby should be first given water for the first time as reported by the women ranged between 3 to 4 months in both regions. Similarly women reported that the average age at which a baby should be given other foods for the first time was 6 months in both study regions. The reported average age at which a child should be fed on sweetpotato for first time was however longer, i.e., approximately 10 months in the North and 11 months in the South.

Analysis of the sources of nutritional information indicates that most of the women learned about child feeding from the health centers. About 81% (N=244) and 78% (N=216) in the northern and southern regions, respectively learned about feeding children from the health centers. Radio was also cited by a considerable proportion of the women (39% and 32% in the North and South, respectively) as a source of information on nutrition. Other sources included trained volunteer/ promoter (29% in the North and 21% in the south); extension agents (23% and 21% in the North and South, respectively) and mothers (19% in both regions).

As in the case of female respondents, almost all the male household heads (87% (N=91) and 94% (N=124) in the North and South, respectively) noted that it is a good health practice to give colostrum to the baby. As in the case of their women counterparts, male respondents reported that the mean recommended age of starting babies on other foods in the two study regions was 6 months. Male respondents in the both study regions also indicated that average age on when a baby should be fed on sweetpotato for the first time is at least 10 months.

4.2 Food diversity

Food diversity can be targeted through diet diversity. Clausen *et al.* (2005), for instance, found and association between food variety and diversity and the physical and cognitive functioning in older adults in Botswana. However, other studies indicate that household diet diversity is affected by several factors. Hartloy et al (1999) and Nyangweso et al (2007) suggest that diet diversity is affected by both socioeconomic factors such as age, income, ethnicity, and education and also the level of awareness/knowledge about human nutrition. Other studies (Onyango, 2003; Thorne-Lyman *et al*, 2009; Oldewage-Theron and Kruger, 2011) suggest a link between diet diversity and poverty levels. The study households in Rwanda are all likely to affected by these factors. Hence the study investigated whether the relatively high knowledge of Vitamin A and nutrition in general translates into diet diversity. The results of analysis of the different food types consumed by the study households disaggregated to the district level is presented in Table 3 below.

Table 3: Proportion of HH that consumed any of the following foods the day before the interview

	By Districts									
	Gakenke (n=137)		Kamonyi (n=138)		Muhanga (n=180)		Rulindo (n=111)		Burera (n=30)	
	n	%	*N*	%	*n*	%	*N*	%	*n*	%
Legumes/nuts	126	92.0	125	90.6	159	88.3	102	91.9	29	96.7
White tubers and roots	117	85.4	101	73.2	120	66.7	93	83.8	25	83.3
Dark leafy green vegetables	92	67.2	86	62.3	113	62.8	84	75.7	22	73.3
Starchy staples	61	44.5	101	73.2	105	75.0	63	56.8	11	36.7
Source of fat	48	35.0	64	46.4	79	43.9	66	59.5	10	33.3
Any spices, condiments and beverages	25	18.2	43	31.2	31	17.2	42	37.8	8	26.7
Sweet and sweeteners	24	17.5	34	24.6	30	16.7	29	26.1	5	16.7
Other kind of fruits and vegetables	24	17.5	21	15.2	18	10.0	23	20.7	3	10.0
Vegetables that are orange inside	17	12.4	18	13.0	13	7.2	20	18.0	2	6.7
Dairy products	11	8.0	24	17.4	14	7.8	20	18.0	1	3.3
Any other meat	7	5.1	14	10.1	12	6.7	9	8.1	0	0.0
Fruits that are orange inside	7	5.1	8	5.8	1	0.6	10	9.0	1	3.3
Fish and sea food	6	4.4	10	7.2	11	6.1	11	9.9	2	6.7
Eggs	1	0.7	10	7.2	1	0.6	3	2.7	0	0.0
Organ meat	0	0.0	3	2.2	1	0.6	3	2.7	0	0.0
Any starchy staples that are bio-fortified	2	1.5	4	2.9	8	4.4	5	4.5	0	0.0

The most frequently consumed food groups among the households in the two study regions were legumes and nuts. Between 88% and 97% of the households consumed legumes and nuts the day prior to the interview in some of the districts as shown above. Similarly, a greater proportion of households in all the districts, 85% in Gakenke, 73% in Kamonyi, 67% in Muhanga, 84% in Rulindo and 83% in Burera consumed white tubers and roots (e.g., cassava, yams, and sweetpotatoes) the day prior to the survey. A significant proportion of households in all the districts also consumed dark leafy green vegetables, starchy staples and fats. However, the consumption of organ meats and fruits, good sources of iron and vitamins, is quite low across all the study districts.

The above results suggest that most households get proteins from consumption of legumes while the main sources of starch are starchy staples (e.g., maize, rice etc) and white roots and tubers. In addition, the high consumption of dark green leafy vegetables (include amaranth and other traditional vegetables such as cowpeas) suggests the most households obtain Vitamin A mainly from these sources. Notably, although carrots was listed among the most important sources of Vitamin A, only a small proportion of households eat vegetables with orange inside (which included carrots). At the same time, majority of the households mainly consumed white sweetpotato roots indicating that sweetpotato is used as a source of starch (energy) rather than Vitamin A. Further, the results presented in Table 3 indicate that the consumption of fruits in general and fruits that are orange inside is typically low across all the study districts suggesting that these foods do not play a significant role as sources of Vitamin A among the study households.

Children are often the most affected among household members by the inadequate consumption of Vitamin A-rich foods. This study therefore examined the types of foods consumed by the children in the study households in all the five districts. Among the districts covered, the proportion of children age 6-23 months in the households was 29% in Gakenke, 17% in Kamonyi, 13% in Muhanga, 21% in Rulindo and 43% in Burera. Table 4 presents the analysis of the types of foods consumed by children within 24 hours of the interview.

Table 4: Proportion of children consuming different foods within 24 hrs of the survey, by district

	By Districts									
	Gakenke (n=40)		**Kamonyi (n=24)**		**Muhanga (n=23)**		**Rulindo (n=23)**		**Burera (n=13)**	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Legumes/nuts	35	87.5	21	91.3	19	82.6	16	69.6	10	76.9
White tubers and roots	29	72.5	10	43.5	12	52.2	13	56.5	10	76.9
Dark leafy green vegetables	26	65.0	16	69.6	10	43.5	16	69.6	9	69.2
Starchy staples	16	40.0	17	73.9	17	73.9	15	65.2	4	30.8
Source of fat	15	37.5	13	56.5	9	39.1	12	52.5	6	46.2
Sweet and sweeteners	8	20.0	8	34.8	5	21.7	5	21.7	0	0.0
Any other kind of fruits and vegetables	6	15.0	4	17.4	6	26.1	6	26.1	4	30.8
Dairy products	5	12.5	5	21.7	4	17.4	6	26.1	3	23.1
Fruits that are orange inside	5	12.5	6	36.1	2	8.7	6	26.1	1	7.7
Vegetables that are orange inside	2	5.0	3	13.0	3	13.0	2	8.7	0	0.0
Any other meats	2	5.0	4	17.4	2	8.7	3	13.0	0	0.0
Spices, condiments and beverages	2	5.0	3	13.0	1	4.3	7	30.4	2	15.4
Organ meat	0	0.0	1	4.3	0	0.0	0	0.0	0	0.0
Eggs	0	0.0	4	17.4	1	4.3	2	8.7	0	0.0
Fish and sea food	0	0.0	2	8.7	4	17.4	3	13.0	2	15.4
Starchy staples that are bio-fortified	0	0.0	0	0.0	1	4.3	1	4.3	0	0.0
Any vegetables that are orange inside	2	5.0	3	13.0	3	13.0	2	8.7	0	0.0

The Table shows that a large percentage of children in all the study districts mainly consumed food that supply starch/energy. In all the study districts the proportion of children that consumed protein-rich animal-based foods (e.g., dairy products and meats) was quite low. Thus, just as the overall household case, majority of the children obtained proteins from legumes and nuts. Most frequently consumed food groups by the children included legumes/nuts, white tubers and roots, dark green leafy vegetables and starchy staples and fats. The results further indicate that other animal-based sources of protein known to also supply many essential micronutrients i.e., eggs, organ meat, fish and sea-foods were consumed by none or very few of the children in study households. The consumption of Vitamin A-rich foods namely vegetables and fruits that are orange inside, eggs, meats was consumed very few children in all the districts. Specifically, less than one-quarter of the children consumed these foods, with the consumption being lowest in Gakenke and Burera districts. The consumption of dark green vegetables, known to supply Vitamin A, was also lower in some of the districts for the children than in for the households in general. For instance while 63% of the households in Muhanga reported that they consumed dark green vegetables within 24 hours of the survey, only 43% of the children in the same households eat these vegetables. Similar differences in the consumption of dark green vegetables were also observed for Burera and Rulindo where the proportion of households consuming these vegetables was far greater than the proportion of children in the same households that consumed them within 24 hours of the study.

In order to assess further the findings of the last section, this study used proven methods of measuring dietary diversity among households and individual consumers. These methods define dietary diversity as a qualitative measure of food consumption that can be used to evaluate household's access to a variety of foods (households dietary diversity score (HDDS)) and also act as a proxy for nutrient adequacy for individual diet (individual dietary diversity score (IDDS)) (Swidale & Bilinsky, 2006). These measures are based on simple count of foods consumed over a reference period (usually over 24 hour period). They are reported as scores.

Kennedy *et al*. (2011) indicates that the HDDS and IDDS are usually calculated based on different numbers of food groups, because the scores are used for different purposes. The HDDS provides an indication of household economic access to food, thus items that require household resources to obtain, such as condiments, sugar and sugary foods, and beverages, are included in the score. Individual scores (IDDS), on the other hand, reflect the nutritional quality of the diet. The IDDS reflects the probability of micronutrient adequacy of the diet and therefore food groups included in the score are tailored towards this purpose.

In this study, HDDS was calculated based on food groups proposed by Food and Agriculture Organization (FAO) (Kennedy et al., 2011). Specifically, 12 food groups were used to calculate the HDDS. These included grain roots and tubers, dark green leafy vegetables, other plant based vitamin A rich foods, other fruits and vegetables, organ meat, meat and fish, eggs, legumes nuts and seeds, oils and fats, dairy products, sweet and sweeteners and any spices, condiments and beverages. Some of the food groups had to be aggregated in to these 12 food groups.

On the other hand, IDDS was calculated based on seven food groups proposed by World Health Organization (WHO, 2007). These food groups are: Grains roots and tubers, legumes and nuts, dairy products, flesh foods, eggs, vitamin-A rich fruits and vegetables, and other fruits and vegetables. The different groups of foods consumed by children in the current study were aggregated to form the required seven groups. A minimum dietary diversity (MDD) of four is required for children between six to 23 months. Children with IDDS below four (0-3) are considered to have low dietary diversity, while those with IDDS greater than or equal to four are considered to have a high dietary diversity. Consumption of foods from at least four food groups within 24 hours implies that in most populations the child had a high likelihood of consuming at least one animal-source food and at least one fruit or vegetable that day, in addition to a staple food (grain, root or tuber).

The HDDS were ranked into terciles comprising the lowest DDS, middle DDS and highest DDS. Figure 4 shows the proportion of households ranked in to the various terciles for the two study regions. The data shows that, overall 43% of the households in the Southern region had DDS in the lowest tercile, 28% had their DDS in the middle tercile with a similar percentage having DDS in the high terccile. In North, approximately 41%, 21% and 38% of the study households had their DDS in the lowest, middle and higher terciles, respectively. These results indicate that there is considerable lack of diversity in household diets in regions with the South having a higher proportion of households with low diet diversity. Conversely the North had the highest proportion of households whose DDS were ranked highest. Indeed approximately 38% of the households in the North had high diet diversity compared to only 28% in South.

Figure 4: Household Dietary Diversity Scores (HDDS) terciles, by region

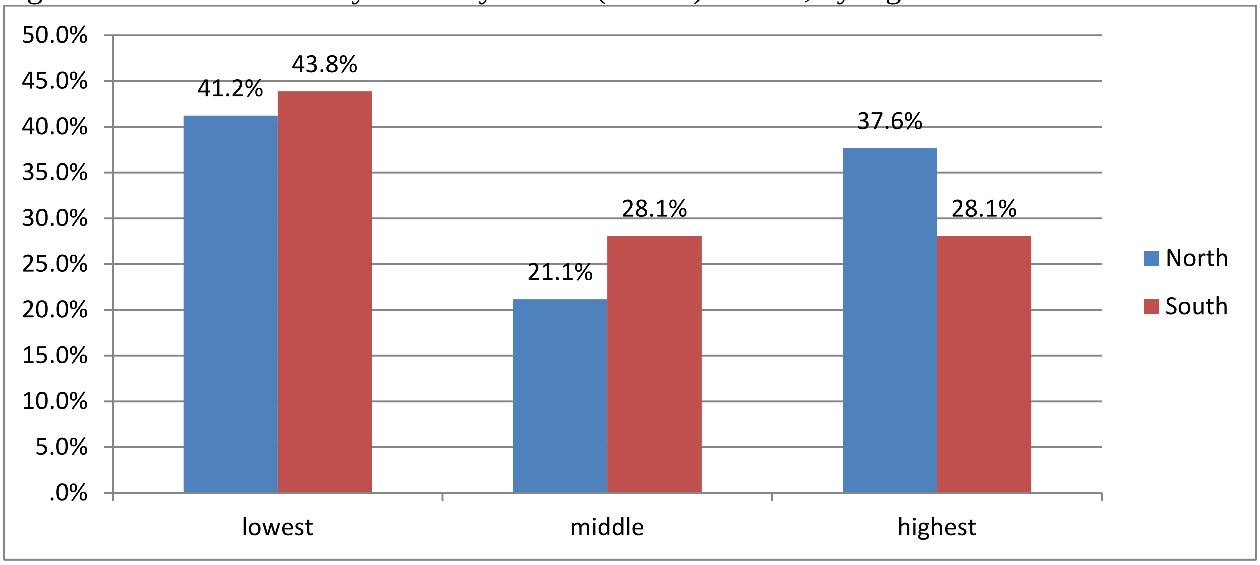
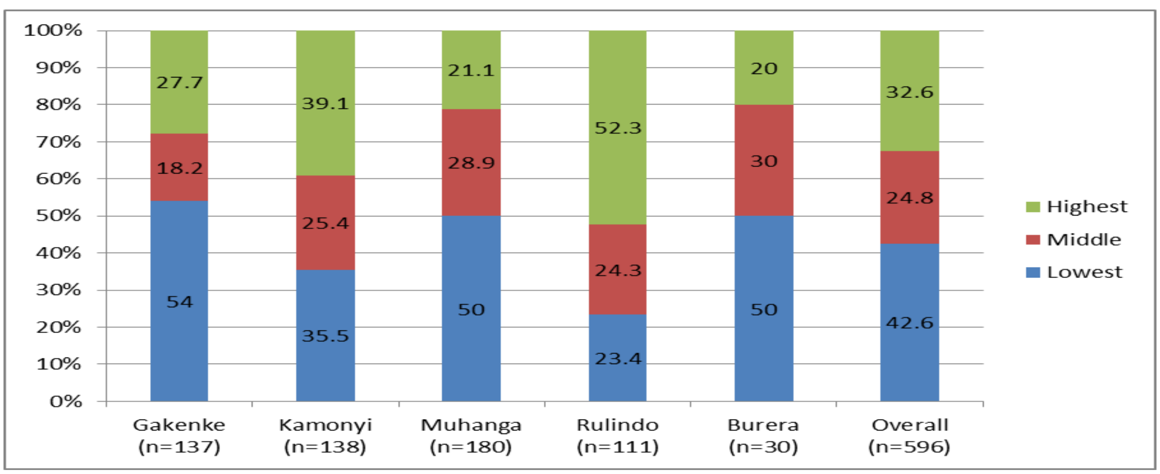


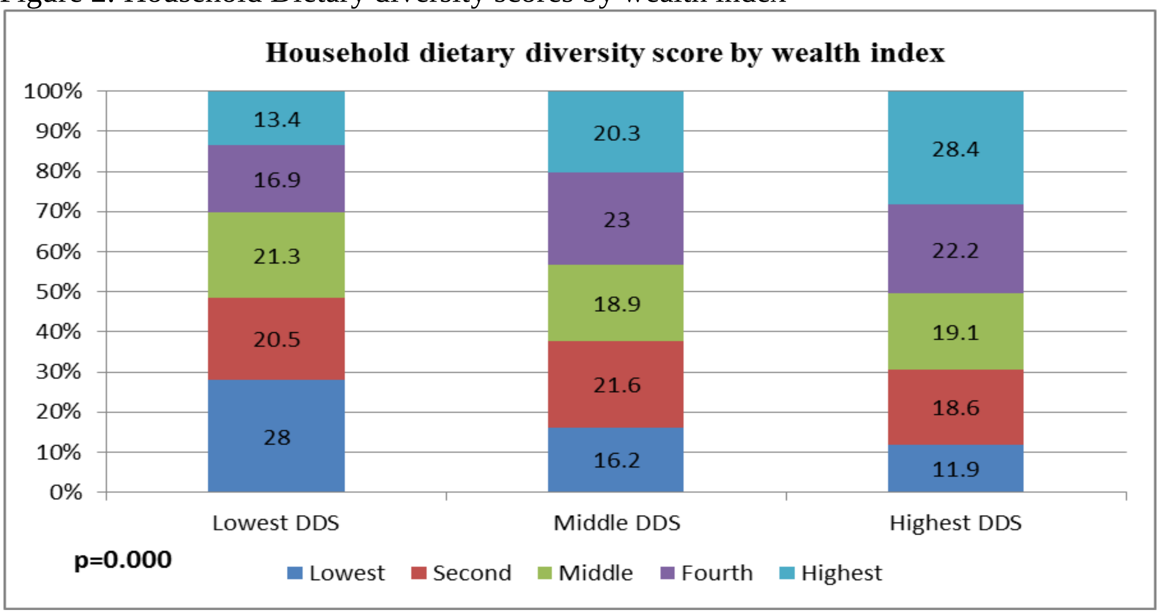
Figure 5 presents the results the diet diversity scores disaggregated by district. Of the five districts, Gakenke had highest number of households whose DDS was ranked lowest (54%) while Rulindo had the lowest of the same (23%). Approximately 50% of the households in Muhanga and Burera also had their DDS ranked lowest. Conversely Rulindo had the highest proportion of households whose DDS were ranked highest (52%) while Burera had the least of the same (20%).

Figure 1: Household DDS terciles by districts



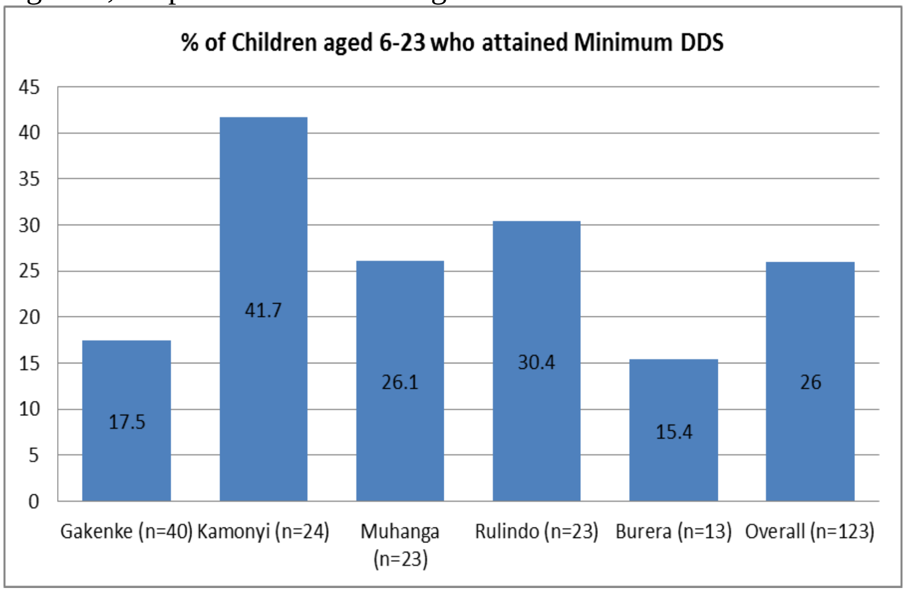
As discussed earlier, diet diversity is likely to be affected by socio-economic factors within the household. Hence this study investigated the effect of wealth the diet diversity within the households in the 5 study districts. The results of this analysis are presented in Figure 6. As expected, the districts whose household DDS were in the highest tercile also had the highest proportion of households who wealth index was in the highest quintile. For instance approximately one-half of the households that had the highest DDS had wealth index ranked 4th highest or highest while for those with the lowest DDS approximately half of them had their wealth index ranked lowest or second. These findings corroborate past studies that indicate that diet diversity is affected by household income and wealth.

Figure 2: Household Dietary diversity scores by wealth index



The previous section indicated that children in all the study districts consumed very few vitamin A rich foods. Fiugre 7 below presents the DDS for children age 6-23 months that attained the minimum WHO recommended DDS.

Figure 3; Proportion of children aged 6-23 months who attained the minimum DDS



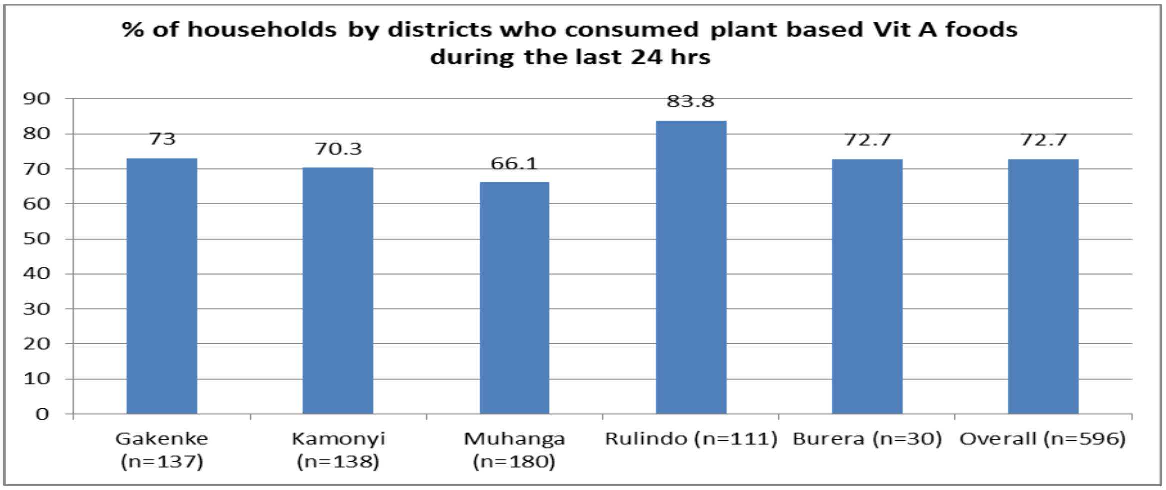
Generally less than one-half of all the children in the study districts attained the minimum recommended DDS. Kamonyi had the highest proportion of children who attained the minimum DDS but with only 42% of the children while, just as with the HDDS, Burera and Gakenke had the least number of children (15% and 18%, respectively) attaining the minimum recommended diet diversity.

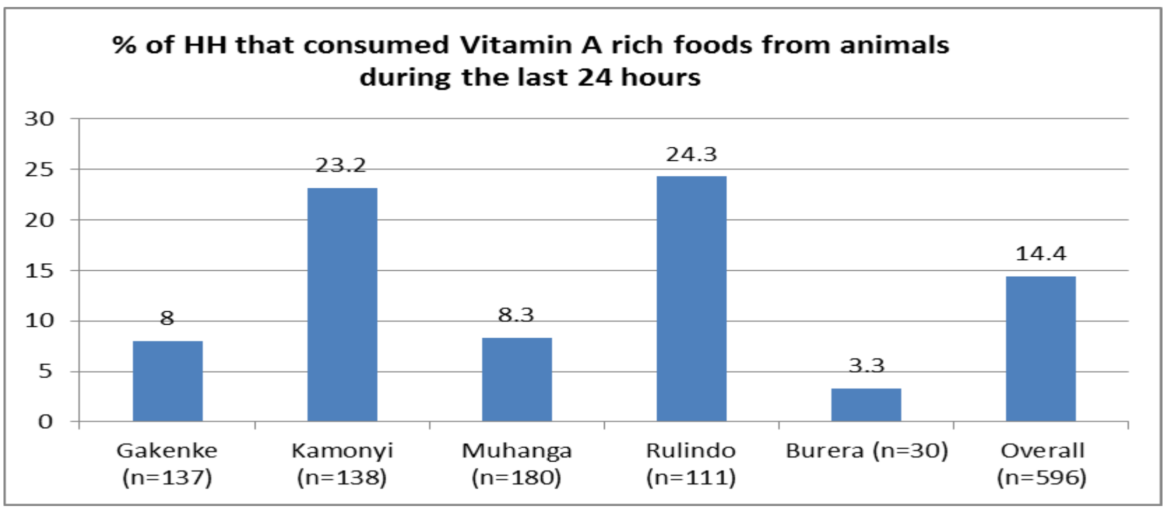
4.3 Vitamin A consumption

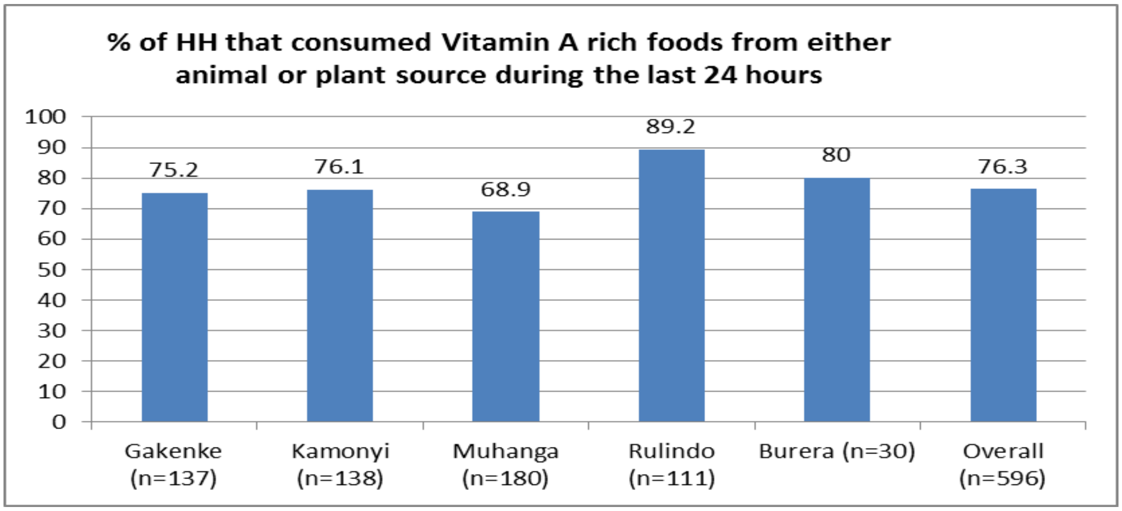
To assess the actual uptake of Vitamin A among the households, the proportion of household who consumed plant based Vitamin A foods and animal based Vitamin A food groups was assessed. We follow Kennedy et al (2011) in the listing of the various foods classified under plant-based Vitamin A source and animal-based Vitamin A source. Plant based Vitamin A sources include d Vitamin A-rich vegetables or tubers, Vitamin A-rich fruits, dark green leafy vegetables and food groups with red palm oil or products made from red palm oil. On the other hand, animal-based Vitamin A source include; organ meat, eggs, milk and milk products.

Figure 8 shows the proportion of households that consumed various Vitamin A rich foods from both animal and plant sources.

Figure 8: Proportion of households consuming Vitamin A rich foods with 24 hours of the survey, by district







Overall, and in line with the earlier findings, a greater proportion of the households consumed plant based Vitamin A foods (73%) compared to those who consumed animal based Vitamin A rich foods (14%). Rulindo districts had the highest proportion of HH that consumed Vitamin A rich foods while Muhanga had the least (89% vs.69%, respectively). The findings of this section, based on consumption of Vitamin A alone, using different food types stand in stark contrast to those based diet diversity score.

5. Summary, Conclusions and Recommendations

The problem of hidden hunger has emerged as one of the major development issues alongside food security. This problem highlights the likelihood of households having access to inadequate amount of key micronutrients in a diet despite having access to adequate quantities of food. Consequently, there have been intensified efforts aimed at tackling the problem of hidden hunger through bio-fortification of crops commonly consumed by less cash-endowed rural households. In this paper, we used a recent detailed household consumption data to investigate households' nutritional knowledge, the diversity of diets consumed, and the micronutrient uptake, focusing specifically on Vitamin A. The study focused on Southern and Northern regions of Rwanda.

We find high levels of awareness of Vitamin A among the respondents in the two regions. Indeed more than 60% and 80% of the households in the Southern and Northern regions respectively had heard of Vitamin A. The study however found relatively low awareness of the function of Vitamin A in human bodies. Further, male respondents only had a general awareness of the function of Vitamin A in the body, namely to protect the body, compared their female counterparts who knew the specific function of Vitamin A which is to improve vision. The differences could be based on the fact that women get training on vitamin A and its function during the pre and post natal clinics during and after pregnancy. It is a common practice that healthcare providers give this education to women. However, since men rarely attend these clinics their main source of information is through the mass media, school and by word of mouth. The study also found that the knowledge of Vitamin A did not directly translate into consumption of food groups listed by the respondents as being rich in Vitamin A. Analysis of diets consumed revealed that majority of the households consume mainly the plant-based foods, especially those rich in starch and proteins. Consumption of animal based products was significantly lower in the two regions, and even absent in some of the study district. Households in Rwanda have very small parcels of land due to the high population density. Hence, unlike other countries where it is common to find small animals they are not common in Rwanda. Hence, the diet is mainly plant based and hence the hidden hunger problem is an issue here. The government has a project to have one cow per household policy but it will take years to have the desired effect and improve the current condition. The computed diet diversity score further confirmed the narrow range of foods consumed by the study households. We found that children of age 6-23 months are more affected than other household members. This is of particular concern since the children are still in the range of the first 1000 days of their lives when proper nutrition is very critical. However, the analysis of consumption of Vitamin A rich-sources of foods consumed by the study households revealed a decent levels of consumption of Vitamin A rich plant based foods. In resource-poor communities like in Rwanda rural areas malnutrition is attributable not solely to insufficient amounts of food but also to the poor nutritional quality of the available food supply. This is because as shown in this study the diet is mainly plant-based diets containing only small amounts of micronutrient-dense animal-source foods. Plant based diets can have low bioavailability of nutrients, arising from the presence of antinutrients such as phytate, polyphenols, and oxalate. Given the heavy reliance of low-income populations on cereals as a food source, the negative effects of low mineral bioavailability on mineral status and subsequent health are potentially quite substantial.

This study concludes that while the awareness of Vitamin A is high among the farm households, there exists a gap between the knowledge and what household members actually consume. This disconnect is likely to be caused by the socio-economic factors that drive consumption patterns. In addition, the study concludes that care needs care needs to be taken when extrapolating the various proxies of diet diversity to draw conclusions relating to micronutrient intake by rural households. Indeed the finding in this study that study households had very low diet diversity (suggesting the possibility of inadequate intake of Vitamin A) and the high consumption of Vitamin A, whether planned or by default, strongly highlights the danger of using these diet diversity proxies. The findings of this study imply the need for careful analysis of consumption data in understanding micronutrient intake. However, more detailed study with blood and anthropometry work could give more insight in the actual health condition in the population.

References

Beydoun, M.A. and Wang, Y. 2008. Do nutrition knowledge and beliefs modify the association of socio-economic factors and diet quality among US adults? *Preventive Medicine*; 46: 145–153

Burchi, F. 2010. Child nutrition in Mozambique in 2003: The role of mother's schooling and nutrition knowledge. *Economics and Human Biology;* 8: 331–345

Chowdhury, S., Meenakshi, J.V., Tomlins, K.I., and Owori, C. 2013. Are consumers in developing countries willing to pay more for micronuntrient dense biofortified foods? Evidence from from a field experiment in Uganda. *American Journal of Agricultural Economics,* 93(1):83-97

Clausen, T., Charlton, K.E., Gobotswang, K.S., and Holmboe-Ottesen, G. 2005. Predictors of food variety and dietary diversity among older persons in Botswana. *Nutrition*; 21: 86–95

Hatleiy, A., Hallund, J., Diarra, M.M. and Oshaug, A. 1999. Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutrition: 3(1), 57-65*

Headey, D.D. 2012. Developmental Drivers of Nutritional Change: A Cross-Country Analysis. *World Development;* Vol. 42, pp. 76–88.

Nyangweso, P.M., Odhiambo, M.O., Odunga, P., Korir, M.K., Kipsat, M.J. and Serem, A.K. 2007. Household Food Security in Vihiga District, Kenya: Determinants of Dietary Diversity. *African Crop Science Conference Proceedings;* vol. 8: pp. 1383-1389.

Onyango, A.W. 2003. Dietary diversity, child nutrition and health in contemporary African communities. *Comparative Biochemistry and Physiology;* Part A 136: 61–69

Rashid, D.A. and Smith, L.C. 2011. Determinants of Dietary Quality: Evidence from Bangladesh. *World Development*; Vol. 39, No. 12, pp. 2221–2231

Tepper, B.J., Choia, Y., and Nayga, R.M. 1997. Understanding food choice in adult men: lnfluence of nutrition knowledge, food beliefs and dietary restraint. *Food Quality and Preference*: Vol. 8, No. 4, pp. 907-317.

Thiele, S. and Weiss, C. 2003. Consumer demand for food diversity: evidence for Germany. *Food Policy;* 28: 99–115

Thorne-Lyman, A.L., Valpiani, N., Sun, K., Semba, R.D., Klotz, C.L., Kraemer, K., Akhter, N., de Pee, S., Moench-Pfanner, R., Sari, M. and Bloem, M.W. 2010. Household Dietary Diversity and Food Expenditures Are Closely Linked in Rural Bangladesh, Increasing the Risk of Malnutrition Due to the Financial Crisis. The Journal of Nutrition Supplement: The Impact of Climate Change, the Economic Crisis, and the Increase in Food Prices on Malnutrition