PAPER

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Nutrition-sensitive agriculture for improved dietary diversity

Learnings from the ENUFF project

ENUFF
Enhancing Nutrition of Upland Farming Families

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ABOUT SNV

SNV is a not-for-profit international development organisation that makes a lasting difference in the lives of people living in poverty by helping them raise incomes and access basic services. We focus on three sectors and have a long-term, local presence in over 25 countries in Asia, Africa and Latin America. Our team of more than 1,300 staff is the backbone of SNV. For more information: www.snv.org

ABOUT THE ENUFF PROJECT

The Enhancing Nutrition of Upland Farming Families (ENUFF) project is a programme of the Swiss Agency for Development and Cooperation (SDC), implemented by SNV in Lao PDR. The goal of the project is to improve family and child nutrition in remote and ethnically diverse upland farming communities through improved feeding, caregiving and dietary practices, reduced incidence of water, sanitation & hygiene related diseases, improved availability and accessibility of diverse nutritious foods, and a conducive institutional framework at the sub-national level. Core pillars of ENUFF are nutrition-sensitive agriculture (NSA) and social and behaviour change communication (SBCC) which are seen as a key way to improve food production and consumption diversity at the household level. The project is being implemented in Xiengkhor and Viengxay districts of Houaphanh province and Nga and Beng districts of Oudomxay province in collaboration with the Provincial Health Departments (PHD), Provincial Agriculture and Forestry Offices (PAFO) and Lao Women's Union (LWU) with their subordinate offices in the target districts. The project targets 34.000 people from 60 villages.

For more information: www.snv.org/project/enhancing-nutrition-upland-farming-families-enuff

COLOPHON

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FOR MORE INFORMATION

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Acronyms

Acronym	Meaning
ASF	Animal-Sourced Foods
CU2/CU5	Children Under 2/5
DDS	Dietary Diversity Score
ENUFF	Enhancing Nutrition for Upland Farming Families
F&V	Fruits and Vegetables
IYCF	Infant and Young Child Feeding
Lao PDR	Lao People's Democratic Republic
LMIC	Low- and Middle-Income Countries
LSIS	Lao Social Indicator Survey
MAHFP	Months of Adequate Household Food Provisioning
MDD (-W)	Minimum Dietary Diversity (for Women)
NNSPA	Lao National Nutrition Strategy and Plan of Action
NSA	Nutrition Sensitive Agriculture
SBCC	Social and Behaviour Change Communication
SEA	South-East Asia
SNV	Netherlands Development Organisation
SUN	Scaling Up Nutrition
UN	United Nations
WFP	World Food Programme
WRA	Women of Reproductive Age (15-49 years old)

Summary

Stunting prevalence of children under 5 in Lao PDR is in the top-3 highest in South East Asia at 33%. Lao PDR is committed to decrease this prevalence and address malnutrition with a multisectoral convergent approach, with the primary goal to reduce chronic malnutrition to 25% by 2025.

Funded by the Swiss Agency for Development and Cooperation, SNV has been implementing the Enhancing Nutrition of Upland Farming Families (ENUFF) project in two phases, with the first phase being from April 2016 to June 2020 and the second phase from July 2020 to June 2024. ENUFF aims to improve family nutrition in remote and ethnically diverse farming communities in Northern Lao PDR through nutrition-sensitive agriculture (NSA) and social and behaviour change communication (SBCC) interventions.

Data from the endline and baseline evaluation in 2020 of ENUFF phase I and II was used to describe the current situation of rural households in two Northern Lao provinces and investigate the predictors for dietary diversity in women of reproductive age (WRA) and children aged 6-23 months.

Dietary diversity score (DDS) for both WRA and children aged 6-23 months was higher in phase I villages, compared to phase II villages in both Oudomxay and Houaphanh. This indicates a possible positive contribution of the ENUFF interventions. From the linear regression it became clear that the number of different food crops produced is positively correlated with DDS in WRA. While this association confirms the importance of agricultural activities in increasing consumption diversity, the increase in dietary diversity score per crop is relatively small, suggesting that agricultural production alone will not resolve the issue of low dietary diversity. The association between crop diversity and dietary diversity score was not observed in children aged 6-23 months. This indicates that infant and young child feeding practices are sub-optimal, as children have poor diets, regardless of the availability in the household.

At national level it is recommended to promote proper infant and young child feeding practices through SBCC. Our analysis has shown that crop and livestock production is not directly associated with child DDS, indicating that mothers do not practice appropriate feeding recommendations. Additionally, emphasis on education for girls is crucial to maximise the effect of nutrition education as well as to address issues of child marriage and early age pregnancy. Lastly, in our analysis we found a negative effect of large family size on dietary diversity. Conducting qualitative research is advised to fine-tune current national family planning initiatives, as uptake of the current strategy is low.

For development organisations, the SNV team emphasises the importance of taking on a multi-sectoral approach when working towards enhancing nutrition in rural communities. It is evident from this analysis that low dietary diversity in women and children cannot be solved with the same approaches. Crop diversification to improve dietary diversity should be encouraged by introducing crops from the entire range of food groups. Tackling this problem calls for a nutrition-sensitive agriculture approach, integrating both agricultural diversification trainings as well as SBCC for improved nutrition practices.

Introduction

Worldwide, around 2 billion people are moderately to severely food insecure. Insufficient physical or economic access to adequate and nutritious food throughout the year increases the risk of malnutrition (FAO et al., 2020). Around 45% of deaths in children under 5 globally are related to malnutrition. Chronic undernutrition, known as stunting, is associated with growth retardation, impaired cognitive functioning, immune dysfunction and increased risk of mortality. Stunting can be caused by a diet of inadequate quality and quantity, and insufficient water, sanitation, hygiene or care practices. These causes are associated with low socio-economic status, poor maternal health and nutrition and improper infant and young child feeding practices (WHO, 2020).

While countries are increasingly recognising the importance of nutrition, stunting remains a global problem. In South-East Asia (SEA), 24.1% of children under 5 years old (CU5) are stunted, while in Lao PDR this prevalence is within the top-3 highest in SEA at 33% (Lao Statistics Bureau, 2018). However, inter-provincial differences are high, with stunting prevalence of CU5 in Vientiane Capital of 13.6% while in rural upland provinces of Oudomxay and Houaphanh this prevalence is 42.7% and 40.7%, respectively.

In 2018, the UN estimated that 79% of the global poor live in rural areas (UNSTATS, 2018) and about half of all poor people live in small-holder farming households. In Lao PDR, 75% of the population lives in rural areas and works primarily in agriculture (WFP, 2017). Poverty prevalence varies from 40% in rural areas without road access, to 10% in urban areas.

As a member of the Scaling Up Nutrition (SUN) movement, Lao PDR is committed to address malnutrition with its National Nutrition Strategy (2015-2025) and Plan of Action (2016-2020) (NNSPA)[1]. This multi-sectoral convergence approach includes nutrition-sensitive agriculture (NSA) and social and behaviour change communication (SBCC) interventions, on the supply- and demand-side respectively. One of the targets within the NNSPA is to reduce stunting from 44% in 2012 to 25% in 2025.

Funded by the Swiss Agency for Development and Cooperation, SNV has implemented the Enhancing Nutrition of Upland Farming Families (ENUFF) project since 2016. The project applies a multi-sectoral approach to improve household nutrition in two Northern provinces in Lao PDR, including NSA and SBCC, in line with the NNSPA. The project worked with 40 villages in Oudomxay and Houaphanh province in phase I. An additional 20 villages were included during phase II of the project which started in 2020. At the end of phase II, the ENUFF project will have reached approximately 34,000 people.

1 The Nutrition Plan of Action for 2021 to 2025 is in development.

Relation between agriculture and dietary diversity

Herforth and Harris have produced a framework to describe the pathways in which agriculture affects nutrition in rural households (Herforth & Harris, 2014). Three main routes are identified: food production, agricultural income and women empowerment (figure 1). The ENUFF project implements activities on all three routes, as can be seen in the figure. The analysis in this brief focuses on activities within the food production route, while all three routes are equally important to realise changes in the agriculture-nutrition pathway.

Research has shown that for small-holder farmers, the diversity of crops produced and livestock owned, influences the diversity of food consumed. Evidence for this association has been found in multiple systematic reviews, although conclusiveness differs between the reviews[2].

A systematic review by Masset et al. (2012) on the effectiveness of agricultural interventions on children's nutritional status, found a positive effect on the composition of the diet (19 out of 23 studies). The systematic review by Girard et al. (2012) found similar effects. On average the agricultural strategy interventions reported significant improvements in dietary patterns for both women and children (Girard et al., 2012). Sibhatu and Qaim conducted another systematic review in 2018, on the association between production diversity, diets and nutrition in smallholder farm households. They included 45 studies and found a positive effect of production diversity on dietary diversity and/or nutrition in 80% of the studies, of which 75% only in certain indicators or subsamples (Sibhatu & Qaim, 2018). Nevertheless, the effect was small. To illustrate: with the effect they found, 16

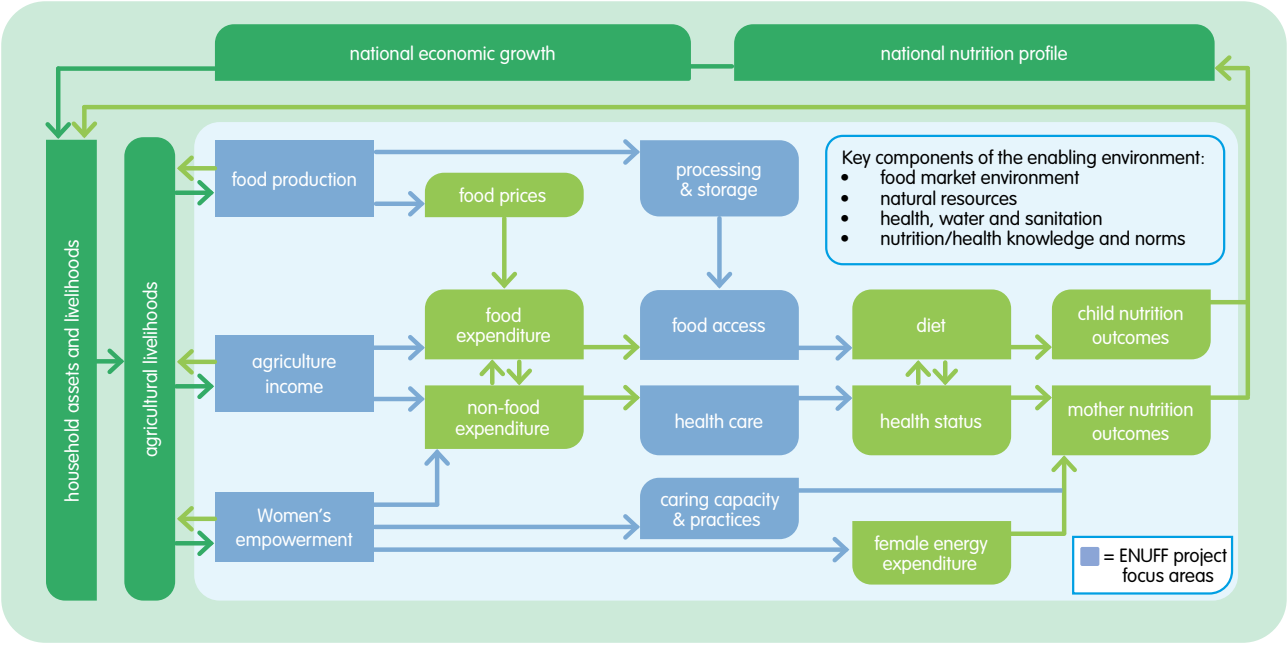

Figure 1 Conceptual Pathways between Agriculture and Nutrition adapted from Herforth and Harris, 2014.

2 Minimal overlap exists between the different reviews, regarding included articles.

additional crops grown by the farmers would increase dietary diversity by one food group.

However, while agricultural diversification is associated with increased household dietary diversity, this increase is not always seen in children (The World Bank, 2016). A study conducted in Lao PDR by the World Bank found a correlation between agricultural diversity and household dietary diversity, but not with child dietary diversity. The main barrier for adequate child dietary diversity seems to be lack of knowledge of feeding practices, instead of lack of access to quality food. For example, the Community Nutrition Project Baseline Survey (2010) found that in households where mothers consumed fruits and vegetables, only 60% of children aged 6-23 months of age consumed these food groups as well. The baseline data from the ENUFF project was used to explore this relationship between production and consumption.

Dietary diversity for women and children

Proper nutrition quality and quantity is crucial for children, especially during the first 1000 days: from conception until the second birthday. This means that pregnant women ought to consume a high-quality diet to be able to provide the essential nutrients to their baby in the womb, and via breastmilk after birth. Therefore, having an adequate diet is imperative for women of reproductive age (WRA), between 15 and 49.

Certain indicators of women's diet diversity, composing a dietary diversity score, have been shown to be strongly and positively correlated with micro-nutrient adequacy of the diet in cross-country analyses using data from several low-income countries (Arimond et al., 2010). Therefore, minimum dietary diversity score for women and children can be used as a validated proxy for minimum nutrient intake (Kennedy, 2009; The World Bank, 2016; WFP, 2017). The dietary diversity score (DDS) assesses the number of food groups WRA or children aged 6-23 months have consumed in the previous 24 hours, out of ten or eight pre-defined food groups (for women and children respectively). Minimum dietary diversity is reached if foods from 5 or more food groups were consumed, for both WRA as well as children. The food groups are listed in table 1.

According to the Lao Social Indicator Survey 2017 (LSIS II), 45.3% of children aged 6-23 months consumed five or more food groups the previous day. Additionally, around 26% of children aged 6-23 months had a minimum acceptable diet which is composed of minimum dietary diversity and minimum meal frequency (Lao Statistics Bureau, 2018).

Table 1 Food groups for dietary diversity scores (DDS) for women of reproductive age (WRA) and children aged 6-23 months

Food groups for DDS WRA	Food groups for DDS children 6-23 months
Starchy staples	Breast milk
Beans and peas	Grains, roots and tubers
Nuts and seeds	Legumes and nuts
All dairy	Dairy products
Flesh foods	Flesh foods
Eggs	Eggs
Vitamin A-rich dark green leafy vegetables	Vitamin-A rich fruits and vegetables
Other vitamin A-rich fruits and vegetables	Other fruits and vegetables
Other fruits	
Other vegetables	

Evidence from ENUFF

Project description and data collection

The ENUFF project uses multi-faceted approach, promoting both agricultural diversity, improved child feeding practices through social and behaviour change communication, improved water, sanitation and hygiene (WASH) and a conducive policy environment. Activities to reach the agricultural outcome of increasing access to nutritious food in the target area include farmer trainings on five different production systems, depicted in figure 2. In this brief, the correlation of dietary diversity of women and children aged 6-23 months with crop diversity and livestock has been analysed.

The ENUFF project is implemented in two phases. 40 villages were included in 2016-2020 (phase I). 20 more villages were included for phase II (2020-2024). The descriptive data used in this report was the endline data for phase I and the baseline data for phase II. Phase II villages had not received any intervention yet, which is why only endline data from phase I is used for the multivariate linear regression. The data used in this analysis was collected in a single point in time, therefore real effect of the intervention is not assessed.

In Oudomxay province, the endline data was collected from 706 and 553 households in Beng and Nga districts, respectively. In Houaphanh province, 511 households in Viengxay and 546 households in Xiengkhor district were included in the survey. Data from 2296 WRA and 522 children aged 6-23 months was included. 37% of the total households of phase I and 38% of phase II were interviewed for the study. A standardised questionnaire consisting of mostly open-ended questions were administered to the household's primary caregiver of the children. A 24-hour recall was conducted to record diets of children aged 6-23 months and WRA in order to calculate the DDS. The 'Months of Adequate

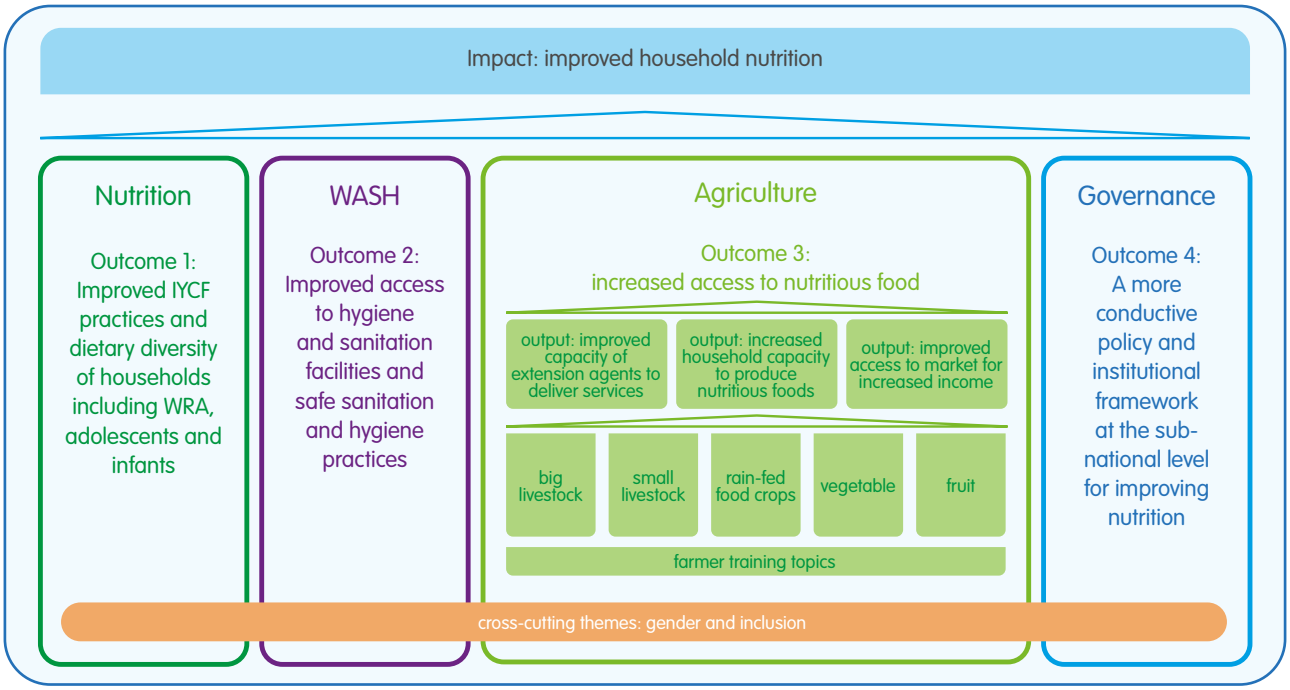

Figure 2 Theory of Change ENUFF with outputs and activities for agriculture outcome

Household Food Provisioning' (MAHFP) was used to assess food security of the households. Additional topics were covered such as household assets, incomes, agricultural production, maternal education and continued breastfeeding.

Current situation ENUFF villages

Diet

As can be seen in figure 3, the mean DDS for WRA lies between the 3.4 and 5.0, with the villages from phase I having higher scores on average. In both provinces this difference is significant, although a larger difference is observed in Houaphanh. For children aged 6-23 months the score ranges from 3.5 to 4.2, with larger scores in phase I villages. Only in Houaphanh is this difference significant.

It is clear that the consumption of pulses, nuts and seeds, dairy and eggs is very low (0-14%) in WRA. The most consumed food groups are grains, roots & tubers, other vegetables (not vitamin A rich) and meat. The consumption from most food groups is higher in phase I villages. Except for the food groups grains, roots & tubers (both phases 100%) and vitamin A rich fruits & vegetables, where the consumption is similar in villages from both phases.

The consumption for children aged 6-23 months, divided into the eight food groups from the DDS is depicted in figure 5. Legumes & nuts consumption is very low with 2-4%. Dairy is only consumed by 10-11% of the children in villages from phase II and I, respectively. The most frequently consumed food groups are grains, roots & tubers, flesh foods and breast milk. Although not visible in this graph, continued breastfeeding decreases over time, with an obvious turning point around 11 months of age. At this age, continued breastfeeding rates decrease by almost half, from 94% to 57%. Interestingly, egg consumption is clearly higher in children than in their mothers. Active promotion of egg consumption in children by ENUFF might have caused the significant difference in consumption between phase I and phase II villages. Next to eggs, only in the food group

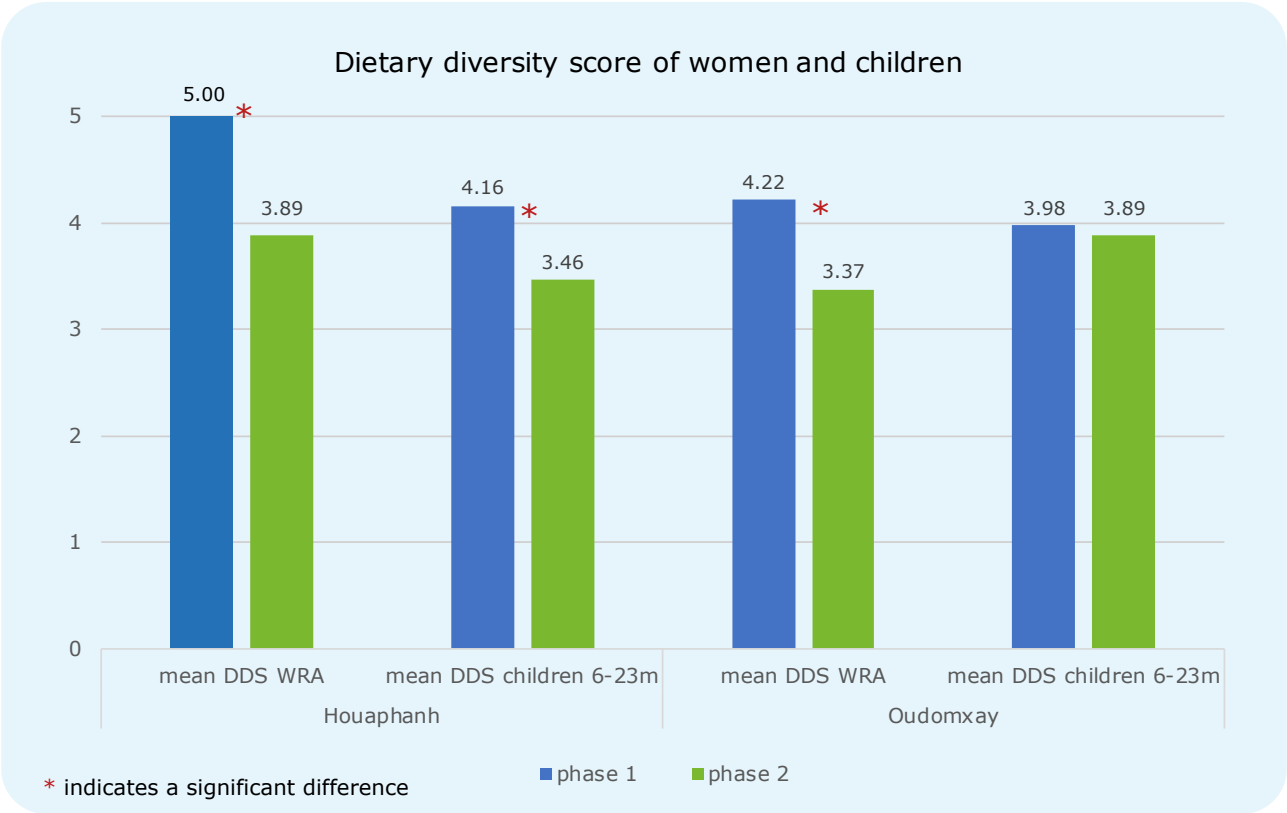

Figure 3 Dietary diversity score for women of reproductive age and children aged 6-23 months by phase and province. Range DDS WRA: 0-10, range DDS 6-23m: 0-8. Asterisk depicts a p-value of <0.05 for the independent sample t-test. WRA N= 2296, children N= 522

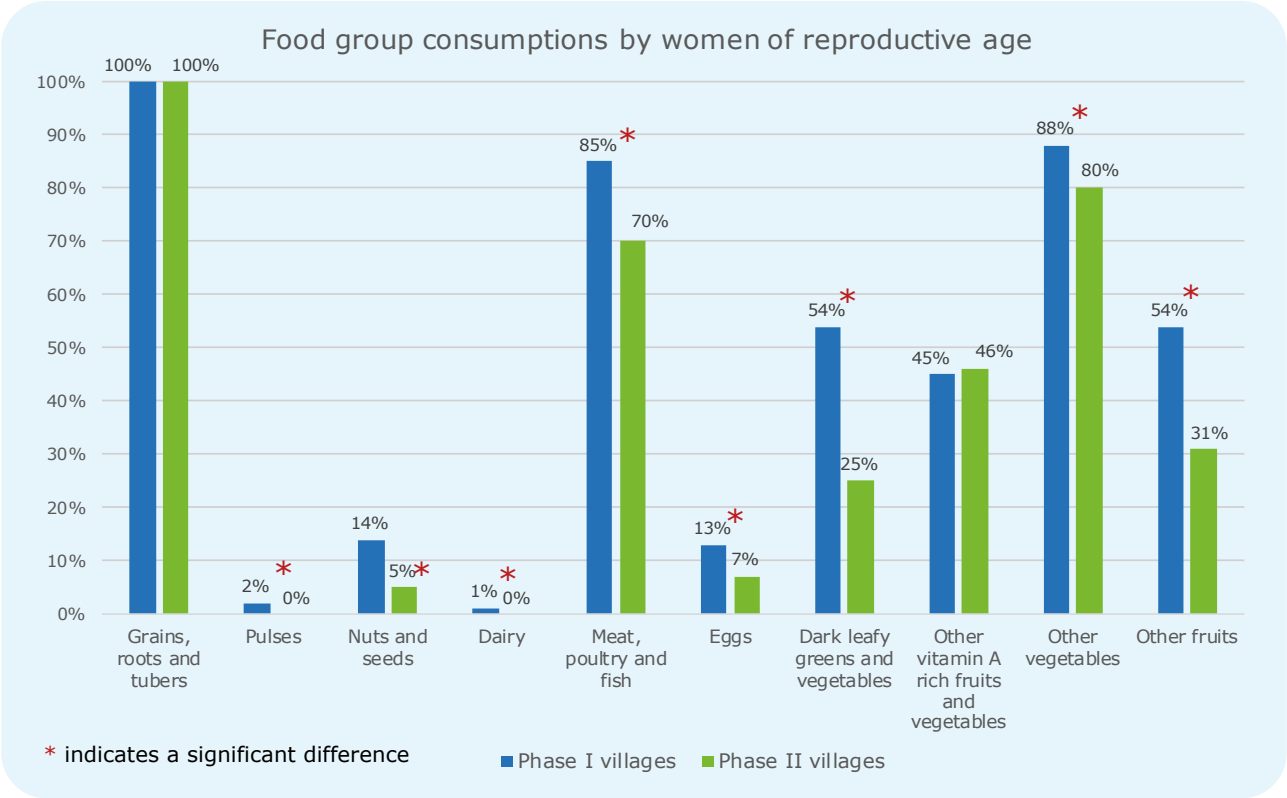

Figure 4 Percentage of women of reproductive age consuming from ten food groups in past 24 hours. Asterisk depicts a p-value of <0.05 for the chi-squared test. N=2296

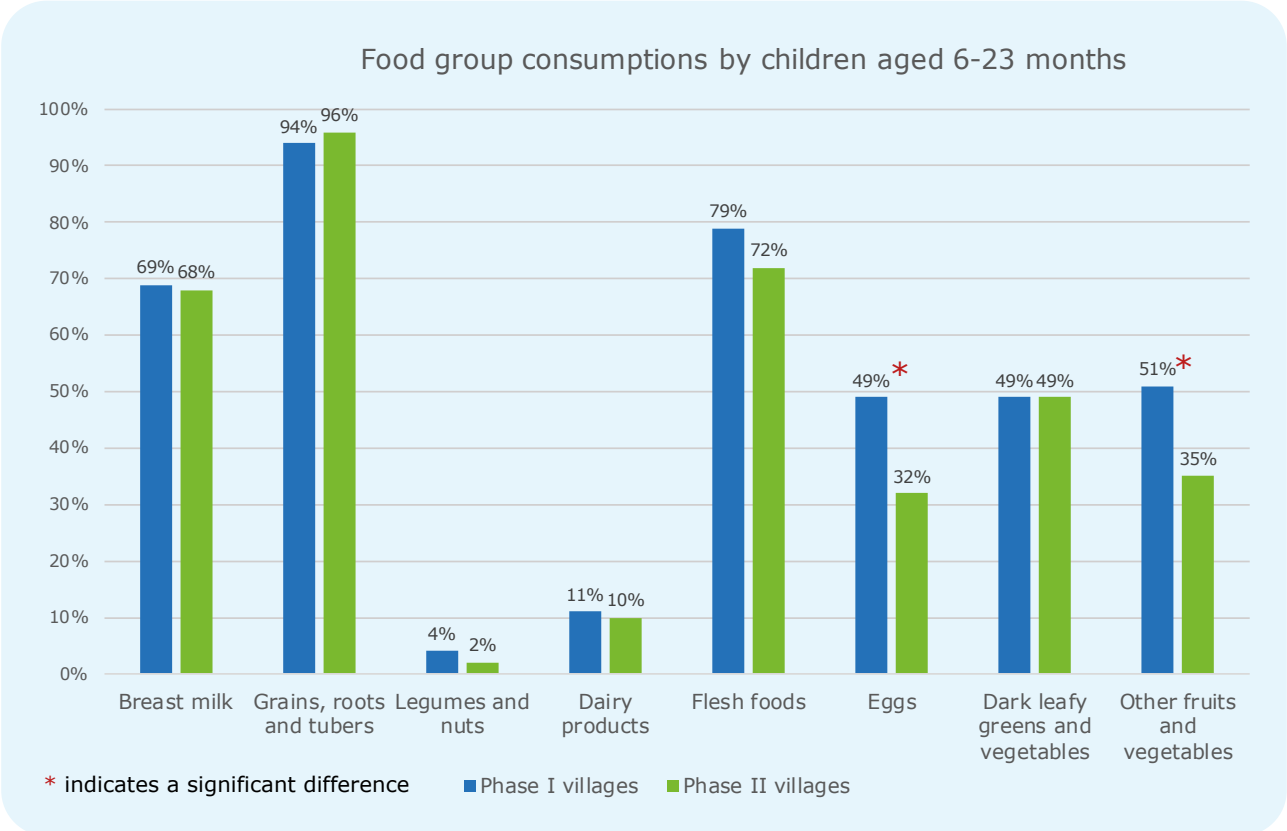

Figure 5 Percentage of children aged 6-23 months consuming from eight food groups in past 24 hours. N=522

'other fruits and vegetables' a significant difference in consumption by children between phase I and phase II villages is seen.

Production

The diversity and amounts of food crops and livestock is higher in phase I villages for each species, see figure 6. The mean number of food crops is highest in Houaphanh villages, with 16.1 and 11.0 in phase I and II villages, while in Oudomxay households are growing on average 9.0 and 7.1 different food crops in phase I and II, respectively. For both provinces the difference between phase I and phase II villages is significant. The number of big livestock, in particular cattle and pigs, is significantly higher in phase I villages compared to phase II villages, in Oudomxay. In Houaphanh the difference is insignificant. The number of goats does not differ between villages in phase I and phase II. While, small livestock production, poultry, is higher in phase I villages in both provinces.

ENUFF promotes the production of legumes and nuts, vitamin A rich fruits and vegetables (F&V) and other F&V because of its high nutritional value and low consumption in WRA and children aged 6-23 months. In figure 7 it is visible that the percentage of households growing crops from these three food groups is higher in phase I villages compared to phase II villages, in both provinces. This difference is significant for each food group, except for legumes and nuts in Oudomxay villages. However, consumption of legumes and nuts is still very low.

Additional descriptives

To give a more comprehensive description of the context in the 60 ENUFF villages, more details are provided in this section. The mean age in months of included children is 14.6 (±5.1) months. In phase I villages the female household head had significantly more years of formal education, compared to women in phase II villages, with the means ranging from 0.6 to 5.3 years. Household size in Oudomxay and Houaphanh lies between 5.7 and 6.1 members. The average distance

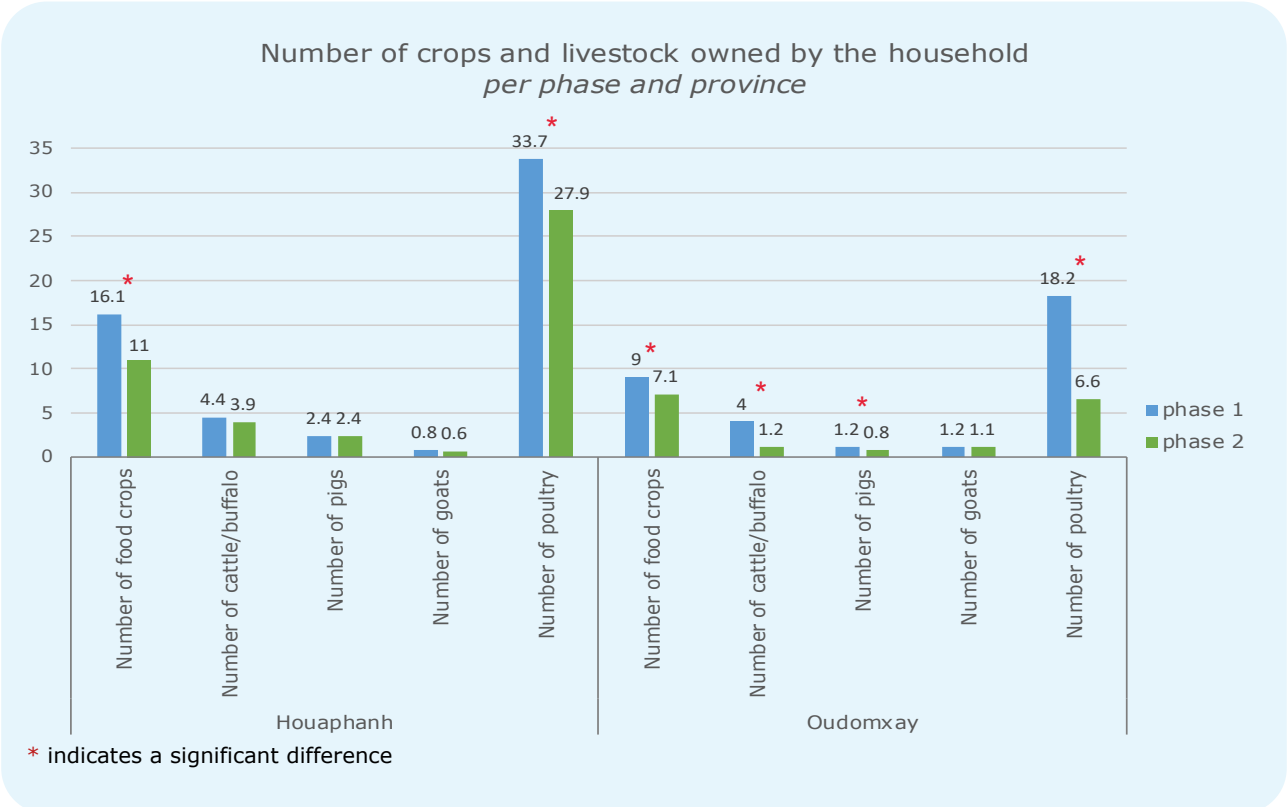

Figure 6 Mean number of food crops and livestock per household, per phase and province. N=2316

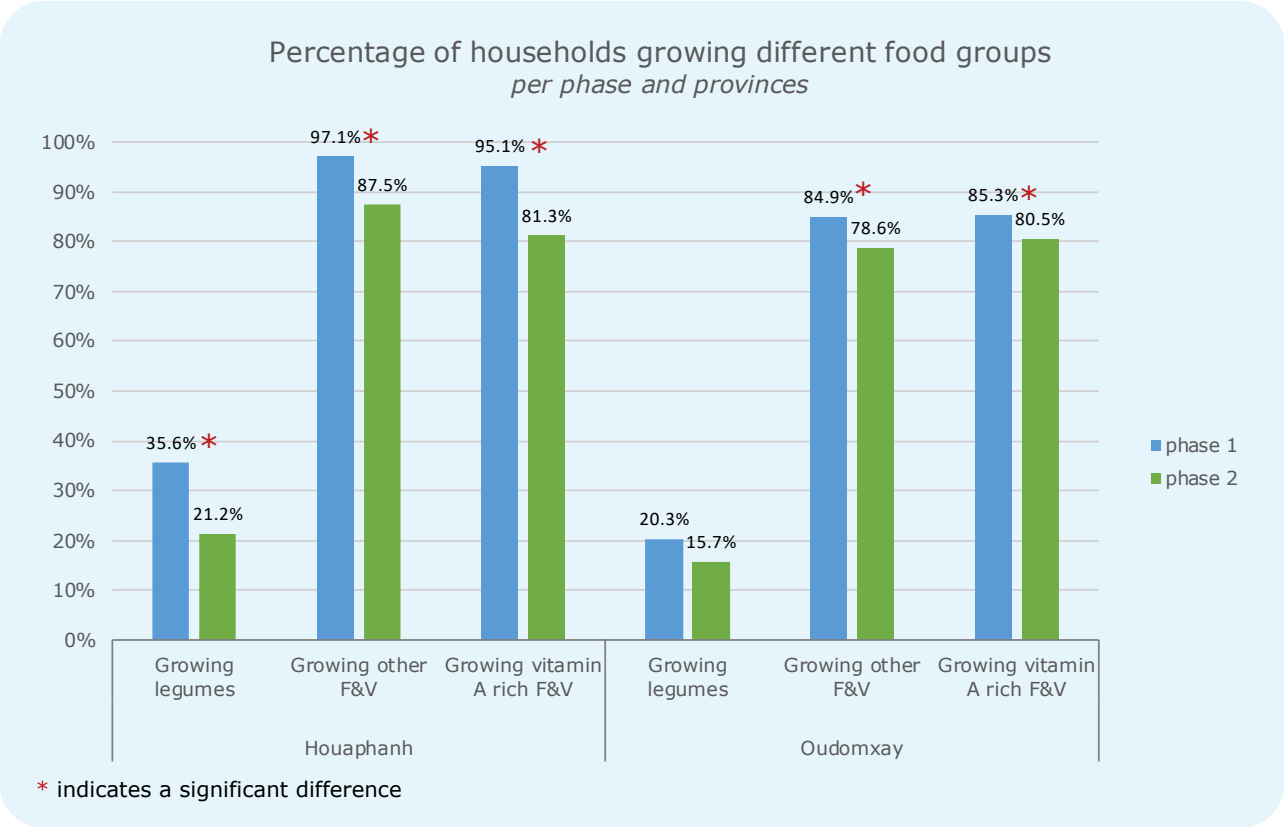

Figure 7 Percentage of households growing food crops from three food groups, per phase and province

of the village to the district market is greater in phase II villages in Oudomxay (38 km) compared to phase I village (25 km). In Houaphanh the villages are slightly closer to the markets namely 24 km. in phase I villages and 20 km. in phase II villages.

A housing type score is composed by combining the type of material used for the walls, roof and floor in the household. More costly materials such as zinc or cement were rated with more points than materials such as wood and bamboo. In Oudomxay, villages from phase I have a higher mean score for housing than villages from phase II, while in Houaphanh this is the other way around. On average, households in Houaphanh receive a higher score than households in Oudomxay. The asset index is based on the possession of assets such as a bicycle, car, tractor, sprayer, mill, TV, phone and so forth. Also for this index, the mean score is higher for households in Houaphanh compared to Oudomxay.

In table 2 the descriptive statistics for the binary variables are seen per phase and per province. The p-value of the statistical test for differences between phase I and II is depicted on the right side of the columns for Oudomxay and Houaphanh. With a p-value of less than 0.05, it can be assumed that these differences are significant, meaning that it is highly unlikely that the difference is due to chance.

Significantly more households have home gardens in phase I villages compared to phase II villages. In phase I villages in Oudomxay and Houaphanh this is 58% and 79%, respectively. While, in phase II villages 36% and 49% of households in Oudomxay and Houaphanh have a home garden. In Oudomxay, food security is significantly higher in phase I village than in phase II villages. In Houaphanh a higher percentage of food secure households is seen in phase II villages.

A meal frequency of four or more for the household is only significantly higher in Houaphanh, with 87% and 64% in

Table 2 ENUFF descriptive statistics by phase and province

Descriptives						
Variables	Oudomxay			Houaphanh		
	phase I N=895	phase II N=364	difference	phase I N=656	phase II N=401	Difference
	%	%	P-value[a]	%	%	P-value[1]
Households with home garden	57.99	35.99	**0.000***	79.42	48.50	**0.000***
Households food secure (MAHFP)	53.85	28.02	**0.000***	78.51	84.79	**0.012***
Meal frequency household ≥4	58.46	58.95	0.872	86.72	63.98	**0.000***
Children ≥4 meals previous day[b]	60.17	60.32	0.983	81.63	67.90	**0.019***
Continuous breastfeeding >6 months[b]	74.89	87.50	**0.036***	55.78	51.85	0.568

a. Difference in proportion, p-value X^2 test
b. Oudomxay phase I: N=231 and phase II: N=63. Houaphanh phase I: N=147 and phase II: N=81.

phase I and phase II villages, respectively. In Oudomxay, meal frequency is virtually equal in phase I and phase II villages.

For children aged 6-23 months, meal frequency above or equal to 4 was significantly higher in phase I villages compared to phase II villages in Houaphanh (82 versus 68%). In Oudomxay this difference between phase I and II villages was not significant (both 60%).

Lastly, continuous breastfeeding was higher in Oudomxay compared to Houaphanh with approximately 81% and 54% of children receiving breastmilk after 6 months. In Oudomxay this percentage was slightly higher in phase II villages.

Predictors for DDS in women of reproductive age

The table below depicts the output of the multiple linear regression model to predict DDS for WRA for phase I (table 3). First of all, it is evident that the number of food crops produced by a household significantly predicts the DDS for WRA. The DDS increases with 0.03 per additional food crop produced, meaning the score increases with 1 when around 37 additional different crops are planted by the household. This linear correlation can also be seen in figure 4.

Food insecurity in households was significantly negatively correlated with DDS. Women with a secondary or university education showed to have a 0.35 or 0.50 higher DDS compared to women with no education, respectively. The DDS for WRA was highest in Xiengkhor and lowest in Nga district. An additional household member was significantly associated with a minor decrease of DDS by 0.03.

Moreover, both the WRA in villages with intensive commercial agriculture as well as the ones with subsistence lowland farming had a significantly higher DDS of 0.50 and 0.68 respectively, compared with WRA from remote extensive upland agriculture villages. An increased distance of the village from the market was associated with a small decrease in DDS of 0.01. The score of asset index and housing type multiplied was positively correlated with DDS. Lastly, having improved water in the household showed a significantly higher DDS of 0.23.

Table 3 Multiple linear regression output of dietary diversity score for women of reproductive age in phase I villages. All regression models were checked for multicollinearity (Variance Inflation Factor < 5) and hetero-skedasticity (p<0.05).

Phase I WRA	**N = 1515**	**Adj. R2= 0.315**		
Predictors for dietary diversity score women of reproductive age		**Beta coef.**	**Std. err.**	**P**
Food crops produced	Number of different food crops produced	0.027	0.005	**0.000***
Food insecurity	Food insecurity in household past 12 months	-0.365	0.074	**0.000***
Education level mother	None	-	-	-
	Primary	0.176	0.087	**0.042***
	Secondary	0.353	0.100	**0.000***
	University	0.499	0.181	**0.006***
	Other education	0.335	0.445	0.452
Districts	Viengxay	-	-	-
	Xiengkhor	0.314	0.124	**0.012***
	Beng	0.247	0.121	**0.041***
	Nga	-0.539	0.122	**0.000***
Household size	Total household members	-0.034	0.015	**0.018***
Village type	Remote village extensive upland ag.	-	-	-
	Accessible village intensive commercial ag.	0.496	0.078	**0.000***
	Subsistence village lowland ag. (paddy)	0.680	0.097	**0.000***
Distance to market	Distance village to market in km	-0.012	0.003	**0.000***
Assets	Asset index * housing type	0.032	0.007	**0.000***
Improved water	Improved water	0.227	0.108	**0.036***

Predictors for dietary diversity score for children 6-23 months

The DDS for children aged 6-23 months consists of 8 food groups, compared to 10 for WRA. In table 4, the output of the linear regression to predict DDS for children aged 6-23 months from phase I villages is shown. Similar as in WRA, a small negative association is seen with household size and DDS. A strong positive correlation was seen between meal frequency ≥ 4 and DDS, with children consuming more than 4 meals the previous day have a DDS of 1.37 points higher than children receiving <4 meals.

The age of the child was positively correlated with DDS, while only when including continued breastfeeding as a variable. Continued breastfeeding was associated with a 1.00 higher DDS. As breastmilk is one of the 8 food groups of which the DDS is composed, a minimum positive association on DDS of 1 for continuously breastfed children is expected.

For children aged 6-23 months from phase I villages, many variables explaining DDS for WRA did not significantly influence children's DDS (see box 1). While, with an adjusted R^2 of 0.303, the proportion of variance for DDS explained by the model is only slightly smaller for children aged 6-23 months compared to WRA in phase I villages. However, none of the production variables for food crops or livestock showed to have a significant effect.

Non-significant predictors of DDS

For women of reproductive age

- Having a home garden
- Production of legumes, vitamin A rich crops or other
- fruits and vegetables
- Number of poultry, cattle, goats or pigs
- Gender of the household head
- Land size
- Meal frequency in the household showed a highly significant positive correlation but also caused for a hetero-skedasticity problem.

For children aged 6-23 months

- Number of poultry, cattle, goats or pigs
- Age of the child only influenced the DDS for children who were continuously breastfed.
- Education level of the mother
- Number of food crops produced
- Assets or land size
- Having a home garden
- Having improved water supply systems
- Gender of the household head

Table 4 Multiple linear regression output of dietary diversity score for children aged 6-23 months in phase I villages

Phase I children 6-23 months N = 373		Adj. R2= 0.303		
Predictors for dietary diversity score 6-23 months		**Beta coef.**	**Std. err.**	**P-value**
Household size	Total household members	-0.087	0.025	**0.001***
Housing	Housing type (score 1-6)	0.133	0.039	**0.001***
Age	Age of the child in months	0.034	0.014	**0.013***
Other IYCF	Meal frequency ≥ 4 for previous day	1.369	0.133	**0.000***
	Continued breastfeeding	1.001	0.149	**0.000***

Conclusion

Dietary diversity score for both WRA and children aged 6-23 months was higher in phase I villages than in phase II villages in both Oudomxay and Houaphanh. Even though these two groups cannot be compared as intervention-control and do not show effect over-time, it does indicate a possible positive contribution of the ENUFF interventions.

When zooming into the different food groups, for WRA a significantly higher consumption is seen in phase I compared to phase II villages in all food groups except for one (as 100% consumed grains, improvement was not possible in this food group). For children aged 6-23 months this difference is only seen in two food groups, namely eggs and non-vitamin A rich fruits & vegetables. This indicates that ENUFF's phase I activities mainly improve dietary diversity in WRA.

Moreover, significantly more households had home gardens in phase I villages, compared to phase II villages. Their agricultural production was also more diversified. More cattle and pigs were owned per household in phase I villages in Oudomxay province, compared to phase II. In both provinces, the number of chickens owned per household was higher in phase I villages. This indicates a high likeliness of a positive effect of ENUFF's agricultural trainings and interventions.

From the linear regression. It became clear that the number of different food crops produced is positively correlated with DDS in WRA. Per increase of 10 different food crops, an increase of 0.3 in DDS was expected. While this association confirms the importance of agricultural activities in increasing consumption diversity, the increase in DDS per crop is relatively small, suggesting that agricultural production alone will not resolve the issue of low dietary diversity. As was seen from the dietary consumption data, pulses, nuts and seeds are rarely consumed food crops. Additionally, production data shows that only 24% of households produce crops from the food group legumes & nuts. This indicates that an increase in crop diversity does not necessarily signify an increase in food group production diversity. Interestingly, having a home garden did not influence dietary diversity score. This could be explained by the fact that households do not necessarily grow their food crops solely in the home garden, but also in the households' upland and lowland farms.

While crop diversity and dietary diversity are correlated in WRA, this association was not observed in children aged 6-23 months. This is in line with the trends found in the study performed by the World Bank in Lao PDR. This indicates that infant and young child feeding practices are sub-optimal, as children are fed a low diversity of food groups, regardless of the availability in the household. For both WRA and children aged 6-23 months, livestock did not influence DDS. Big livestock is usually kept to provide a financial safety net for households in time of emergency, therefore increased consumption of cattle or pigs was not expected. However, poultry is raised for consumption hence the absence of a significant influence of poultry on DDS was unforeseen. On top of that, from the regression results it can be speculated that money earned from selling big livestock is generally not used to diversify the diet.

Education is positively correlated with DDS of WRA. This might be explained by the fact that higher educated women will more easily comprehend the material explained in the nutrition trainings. This phenomenon was also found by Miller et al., in a nutrition education intervention in Nepal. They concluded that maternal education is an important determinant for the efficacy of such intervention, as education enhances

the ability of mothers to put newly obtained knowledge into practice (Miller et al., 2017). Additionally, household size was negatively associated with DDS for both women and children, implying the importance of family planning and having few children.

Lastly, it was found that distance of the village to the district market had a small but significant effect on DDS for WRA. Lao smallholder farmers do not rely entirely on their own production. In Oudomxay and Houaphanh province, around 25% and 15% of food share expenditure respectively is spent on markets (WFP, 2017). This points out the need for strengthened market linkages to increase access to year-round nutritious foods.

Recommendations

Lao PDR is making important progress in reducing malnutrition with the adoption of the NNSPA, Lao's multi-sectoral convergence approach to address malnutrition. SNV's nutrition-sensitive agriculture intervention, combining supply- and demand-side activities, contributes to this national strategy. While strong indicators of a positive contribution to diet by the intervention are found, more investment is needed to alleviate malnutrition in Lao PDR.

Based on the analysis of predictors for dietary diversity in ENUFF villages, the SNV team recommends the following actions on national level and in international development:

Enabling environment

- Increase investments in SBCC for infant and young child feeding practices at the village level. The village health volunteers can play a key role in providing nutrition education to the first 1000 days families. In the ENUFF villages, food availability in the household did not have an influence on dietary diversity in young children. Crop diversity is solely associated with improved dietary diversity for women, while nutrition and infant and young child feeding education is essential to improve dietary diversity for children. Lack of knowledge, skills and time of caretakers for proper IYCF withhold Lao children to grow to their full potential. Young children will benefit tremendously from continued breastfeeding and improved complementary feeding with additional food groups, such as snacks from the fruit food group or the addition of egg and vegetables in the meal.
- Increase investments in education for adolescents and youth, especially young women, and integrate sexual and reproductive health education into the school curriculum. Keeping girls in school prevents early marriage and teenage pregnancies. Furthermore, efficiency of nutrition education is higher in more educated women as they are better equipped to put the interventions into practice.
- Invest in fine-tuning and scaling-up government-led family planning programmes, as a larger family size is associated with less diverse diets of women and young children. Uptake of current family planning strategies is low, therefore we advise to conduct qualitative exploratory research into alternative angles of intervention. Having fewer children increases available financial resources and time per child, which increases the chance at receiving a diverse diet.

Development partners

- Apply a multi-sectoral approach to tackle low dietary diversity in women of reproductive age and young children. Interventions should focus on all three routes within the pathway from agriculture to nutrition: food production, agricultural income and women empowerment. Nutrition-sensitive agriculture engages all three routes, including both agricultural diversification and nutritional behaviour. Additionally, strong market linkages are imperative for food access for households without agricultural land or in times of harvest failure. Promotion of crop diversity alone leads to minor improvements in dietary diversity, indicating that farmers choose to grow additional crops within the same food group. Therefore, multi-sectoral activities should be combined in a multi-faceted nutrition-sensitive agriculture approach to increase knowledge and facilitate behaviour change towards improved dietary diversity.

- Increase investments in SBCC to promote nutritious crops to improve diets. These can include nuts and seeds, legumes or chicken/duck eggs. While various farmers started legume, nuts or poultry production, consumption is still low. SBCC can play a crucial role in self-consumption of own production rather than selling their harvest, or attempting production again the next season even if yields were suboptimal.
- Invest in long-term intervention approaches, as real change takes time. While dietary diversity was higher in most villages which had received four years of intervention, this difference was not observed in each province for meal frequency or number of goats and cattle. Moreover, change in nutrition outcomes requires a more profound change of behaviour which does not happen in a couple of years. It is therefore imperative to invest sufficient time and funds to increase efficiency of the intervention activities to obtain the desired impact.

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