Nutrient Output, Production Diversity and Dietary Needs

Briefing Paper 6

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NUTRIENT OUTPUT, PRODUCTION DIVERSITY AND DIETARY NEEDS

BACKGROUND

Promoting food diversity and nutritionally balanced farm output is critical to securing food and nutrition security and improving resilience of food production. Small farm systems which are reservoirs of agrobiodiversity and associated indigenous knowledge, play a defining role in this endeavour. According to a study based on analysing multiple data sets, family farms produce at least 53% of the world's food and in many countries majority of food supply by volume is supplied by small farms (Graeub, 2014). For example, in Tanzania and Nepal, small farm output constitutes approximately 70% of the national food production (Graeub, 2014). Besides food supply in terms of volume, small farms make a particularly important contribution in providing essential micronutrients. A recent study finds that farms smaller than 2 hectares (ha), produce more than 25% of the nutrients in South Asia, Southeast Asia, sub-Saharan Africa and East Asia Pacific (Herrero et al., 2017).

Over the past few years there has been an increasing recognition of the pathways between agriculture, nutrition and agrobiodiversity. Studies from Rwanda and Nepal demonstrate that there is generally a positive association between production diversity and dietary diversity and the linkage is particularly critical in countries with weak food markets and infrastructure (Shively & Sununtnasuk, 2015; Kumar et al. 2016; Shively & Evans, 2021). However, most contemporary programmes continue to look at agriculture primarily in terms of yields, livelihoods and economic output. It is critical that food production is also understood and evaluated in the context of dietary and ecological quality to inform national and international policy making.

This briefing paper presents some key findings of a study undertaken in Nepal to understand nutrition and ecological sensitivity of small farm agriculture in terms of dietary nutrient output and agrobiodiversity. Data collection consisted of two rounds of surveys to capture the effects of seasonality, December 2018 (corresponding to the agricultural season of July to November), and July 2019 (corresponding to the agricultural dry season of December to June). The study estimates the status of agrobiodiversity and the extent to which farm output fulfils household food requirements for a nutritionally optimum diet.

Nepal is a low-income country with a small-farm based agrarian economy, consisting of highly diverse agro-ecologies. The study is based on two different districts representing distinct agroecological zones, Bardiya district in 'terai' (plains) and Sindhupalchok in 'mid-hills'. 'Terai' (plains) consists of lowland region (<1500 masl) south of the Himalayan foothills. The climate is mostly sub-tropical. 'Mid-hills' is centrally located extending from the southern slopes of the main Himalayan ranges with a varying width of 60 to 110 km running across the length of the country. The altitude range is significant (800–2400 masl) and the climate varies from warm to cool temperate.

RECCOMENDATIONS

1. Targeted investment to support small farmers in terms of inputs, agriculture extension services and procurement support.

2. A national policy on fallow land that should provide for mapping and identification of all fallow lands and strategies to promote appropriate farming activities on such lands.

3. A national representative survey of farm nutrient output and agrobiodiversity to understand regional variations.

4. Multi-sectoral platform to develop robust environment-public health-agriculture linkages and generate evidence to inform policy and programmes.

5. Community level storage facilities for inter-seasonal storage of perishable foods.

6. Policies and investment to promote agrobiodiversity with a focus on micronutrient rich foods and neglected and underutilized species.

DISCUSSION

In examining the amount of nutrients produced by local agriculture in terms of dietary needs, the analysis finds deficient nutrient supply from local production for all nutrients and particularly for micronutrients, based on the target of annual requirements of one notional household. Average vitamin-A output per farm is the lowest in both districts meeting only 14%-22% of annual household (HH) requirement. Bardiya shows high levels of iron deficiency at 36% supply compared to Sindhupalchok at over 100% supply. Energy and protein surplus are also very limited with the upper limit of around 180% for protein in Bardiya.

The deficient supply of nutrients would have a clear impact on local diets. Field interviews suggest that households supplement food production from local market mainly for meat, eggs and processed foods, while for other foods, reliance is primarily on own production. This is also supported by a study analysing national data from Nepal Living Standards Survey 2010/11. It reports that across Nepal, households are most reliant on self-production of milk, staples, vegetables, and pulses to meet dietary needs. In hills AEZ, an average HH consumes 40% from their own production, 57% from purchased food, and 2% in-kind and in Terai AEZ, figures are 43%, 54% and 3% respectively (National Planning Commission 2018). Data on MNR deficiencies and food consumption practices from national surveys such as Nepal Demographic and health survey (2016) and National Micronutrient Survey (2016) also indicates linkages between low farm nutrition output and prevalence of nutrient deficiencies in the population.

The nutrient farm supply output analysis in this study in all probability underestimates the actual deficiencies that occur at many points in a year given the high degree of seasonality in farm nutrient output for most nutrients. This study shows that 60% to 75% of nutrient production is concentrated in the main agricultural season in both study districts. This is a function of highly seasonal rainfed agriculture in most parts of Nepal.

Therefore HH storage and on-farm storage play a particularly important role in food consumption throughout the year. The study shows nutrients such as proteins, calories and zinc represent highest stored values as a percentage of annual HH requirement which is a function of the nature of foods i.e. foods with greater shelf life such as cereals and lentils. Vitamin-A in storage is negligible in both district and iron in storage is also generally quite low. In terms of resilience to production shocks, as a function of reliance on stored foods for consumption, micronutrients buffer is almost non-existent. Strong seasonality and low level of stored nutrients can have serious consequences on diet quality during lean seasons and production shocks.

The loss of agrobiodiversity due to bias towards a few staples and overall reduction in production diversity is a major concern. To test this in the case of Nepal, this paper estimates the level of agrobiodiversity using nutrition sensitive metrics such as MFAD and NSFE. MFAD scores of 0.77-0.81 suggest a reasonably high nutrition functional diversity in comparison with national estimates for other countries (Roseline et al.,2014). NFSE scores are very low and indicate that most of the energy is derived from cereals and tubers, and Simpsons index is also low in the 0.4 to 0.6 range. Overall, these findings show that while nutrition diversity of farms is strong, in terms of volume of production it is heavily biased towards protein and energy.

Qualitative surveys reveal a significant shift in production patterns over recent years with declining production of many varieties and landraces of cereals, legumes and vegetables. In Bardiya and Sindhupalchok, 42 and 16 crops respectively, which were produced and consumed by the previous generation are reported to be not used today. Adoption of new varieties, eight in Sindhuplachok and 19 in Bardiya was also reported. There are many interrelated ecological, economic and behavioural reasons for the low production volumes and disappearance of certain foods, many of which are known to be nutrient rich. The average farm size is very small, ranging from 0.16 to 0.28 ha in the study districts, the actual size of each parcel is even smaller as each farm consists of 2-3 separate land parcels. More critically a consistent finding from all focus group discussions was that overall agriculture has become an increasingly risky and financially unviable occupation.

Farmers in many communities increasingly prefer to leave the land fallow and engage in other livelihood activities due to poor returns in farming. The absence of irrigation facilities, extension services, poor markets and other forms of government support are major reasons for low levels of farming activity which adversely impacts agrobiodiversity. Besides medicinal plants, which have lost utility due to adoption of modern medicine, reasons for abandoning other foods include low productivity, late maturity, high production cost and high labour requirement.

Finally, there is the issue of demand which is guided by a range of issues such as taste, ease of preparation and socio-cultural perception. For example, traditional cereals such as millet have been replaced by rice in most communities as it easier to process and cook. Green vegetables rich in vitamin-A and other nutrients such as stinging nettle and bethe leaves are not consumed as they are considered poor man's food.

This study illustrates that there are many interrelated economic, ecological, political and behavioural components at play that fundamentally determine the nature of agriculture. Policy interventions need to reflect the complex causality between agriculture, nutrition and agrobiodiversity. Multiple discreet interventions targeting specific issues such as diversified demand or increased production of neglected and underutilized species are bound to have limited overall impact, faced with severely limiting structural and ecological constraints. Given the increasingly disincentivized state of agriculture, basic investment and government support to agriculture in terms of extension services, storage, provision of inputs and output support is an indispensable prerequisite to create the enabling environment for a healthy food system. One of the most important contributions of this study is restating the obvious i.e. the urgent need for investment in agriculture ecosystem that supports small farmers.

The findings reflect the irony of a highly biodiverse agrarian country like Nepal suffering from high levels of malnutrition and nutrient deficient agriculture ecology. This is not unique to Nepal, many poor countries in the world share a similar fate. This has serious implications on food security and public health and perhaps calls into question the efficacy of national and international policies and programmes that seek to address food security. The challenges of supporting small farm agriculture in low-income countries with limited government capacity are profound. Funding and research must be directed to enable national and local governments to create mechanisms providing integrated support to agriculture. To improve nutrition and the resilience of food production especially in low-income countries with limited food import capacity, agriculture needs to be recognized in national and international governance priorities as a critical contributor to public health and ecological management.

KEY FINDINGS

This section presents key findings related to nutrient output and agrobiodiversity. Findings on nutrients are examined in terms of farm output, seasonality and storage. Agrobiodiversity is examined though relevant indices as described in latter part of this section.

FARM NUTRIENT OUTPUT

Tables 1 and 2 below summarize the net average supply (taking in account pre-harvest loss and post-harvest loss) of key nutrients per farm, by different farm size categories, as a percentage of annual recommended HH requirement for a typical notional HH (Singh et al.,2020). This is based on the combined sample from both survey rounds.

On average across farm sizes, the supply of all micronutrients in both districts is less than 100 % of a typical HH annual requirement, except for iron. Vit-A annual supply is the lowest at 14% in Bardiya and 22% in Sindhupalchok. Iron supply per farm in Bardiya is 36% of the annual HH requirement whereas in Sindhupalchok it is just over 100%. Energy supply is over 100% in Bardiya and around 90% in Sindhupalcok and protein supply is in surplus by a wide margin in both districts.
There are noticeable differences in nutrient supply by farm size categories; for example, in Bardiya energy supply varies from 56% (0-0.2 ha) to 220% (0.5-1 ha), zinc varies from 44% (0-0.2 ha) to 287% (1+ ha) and iron varies from 23% (0-0.2 ha) to 153% (1+ ha).

TABLE 1- BARDIYA DISTRICT: NUTRIENT SUPPLY FROM OWN PRODUCTION AS A %AGE OF HH REQUIREMENT BY FARM SIZE.

Nutrient	**Nutrient supply as %age of HH requirement**				
	0 - 0.2 ha	**0.2 - 0.5 ha**	**0.5 - 1 Ha**	**1+ ha**	**Avg**
Energy	26.4	63.5	140.9	363.1	123.2
Protein	50.6	114.0	198.5	499.0	182.8
Vitamin A	5.3	11.9	14.9	28.8	13.9
Zinc	23.4	55.6	99.1	249.3	90.4
Iron	15.8	30.9	37.1	73.4	35.8

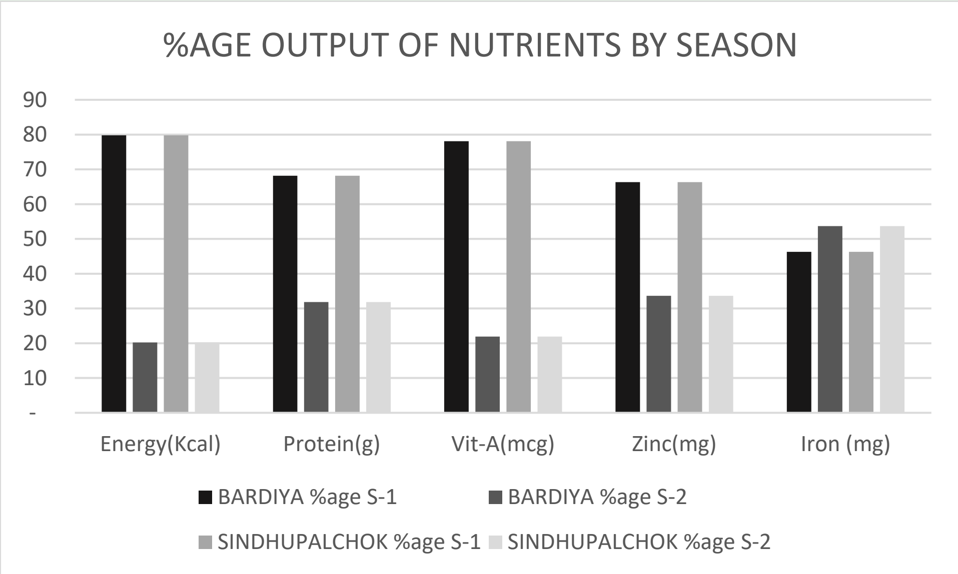
TABLE 2- SINDHUPALCHOK DISTRICT: NUTRIENT SUPPLY FROM OWN PRODUCTION AS A %AGE OF HH REQUIREMENT BY FARM SIZE.

Nutrient	**Nutrient supply as %age of HH requirement**				
	0 - 0.2 ha	**0.2 - 0.5 ha**	**0.5 - 1 ha**	**1+ ha**	**Avg**
Energy	27.8	82.1	151.4	122.5	91.7
Protein	47.0	128.8	251.5	197.5	148.4
Vitamin A	19.4	12.6	41.4	24.5	21.9
Zinc	21.6	66.7	132.6	103.1	76.9
Iron	28.8	71.4	195.6	156.3	100.9

SEASONALITY OF NUTRIENT OUTPUT

The figure below shows the per farm annual nutrient output by agricultural seasons. The output for all nutrients, with the exception of iron in Bardiya is substantially concentrated in season-1 with energy output at over 75%, protein output at over 65%, zinc output at over 65% and Vit-A over 75% in season-1 in both districts. Iron is an exception in Bardiya, season-2 accounts for a greater proportion of annual output, the trend in Sindhupalchok is similar for other nutrients with season-1 accounting for over 85% of iron output.

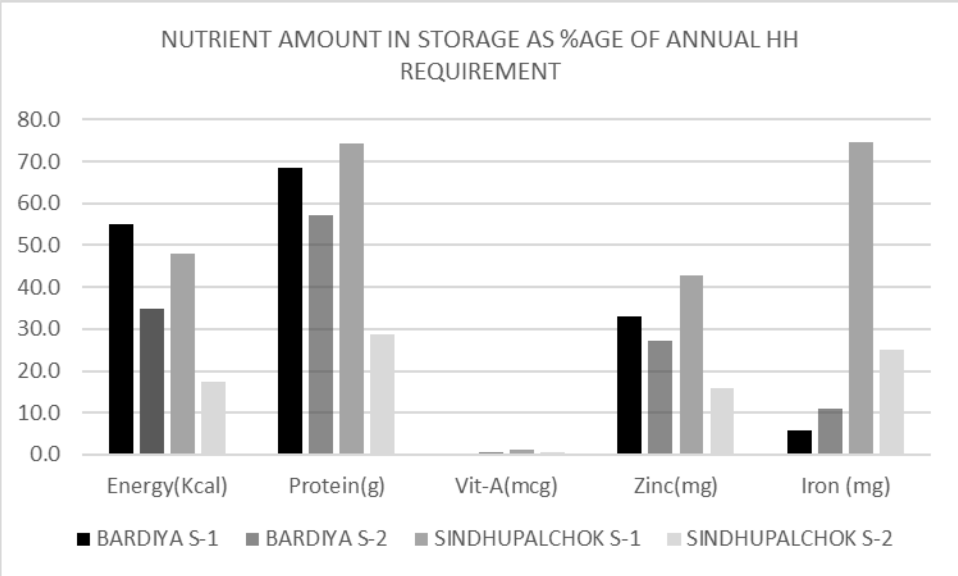
FIGURE-1: SEASONAL OUTPUT OF NUTREINTS



NUTRIENT VALUE OF FOODS IN STORAGE

Figure 2 below summarizes the amount of food in storage per HH in nutrient values and as a percentage of annual HH requirement for harvest and lean season in both districts. Macronutrients such as proteins and calories represent highest stored values. The amount in season-2 (S2) is lower than season-1 (S1), by over 60% for both proteins and calories in Sindhupalchok, decrease is relatively less in Badriya. Amongst micronutrients, vit-A in storage is negligible in both districts, zinc in storage is in the range of 30%-85% depending on the season and district, iron in storage is very different between the two districts, in Bardiya, stored iron in season-1 is equal to 12% of annual HH requirement compared to 149% in Sindhupalchok.

FIGURE 2- NUTRIENT OUTPUT IN STORAGE AS %AGE OF ANNUAL HH REQUIREMENT



PRODUCTION DIVERSITY

To gain an understanding on the diversity of crops grown in terms of nutritional content and production, and how attributes may differ between districts, three diversity indices were calculated. Modified Functional Attribute Diversity (MFAD) score, Simpson's index, and Non-Staple Food Energy (NSFE) score. The MFAD score is a measurement of food diversity by determining the nutritional distance between crops. The Simpson's index is a measure of richness (number of different crops) and evenness (distribution of cultivated area) of farms. The NSFE score is a measurement of the percentage of energy derived from food items that are not staples

MFAD

The nutrients that were used to calculate these MFAD scores are vitamin A, zinc, iron, protein, and energy (measured in calories). The nutritional distance between two crops is calculated as an average dissimilarity among all the assessed nutrients. For each household, this nutritional distance was calculated between every crop grown. The nutrient content of crops was taken from the 2017 Nepal FCT. If crops could not be found the Nepal FCT, the 2017 Indian Food Composition Table was used. Each household was then assigned an MFAD score bounded between 0 and 1, where 0 represents the least nutritionally similar (least diverse) farm and 1 represents the most nutritionally dissimilar (most diverse) farm. The average MFAD score by survey round and by district is represented in Table 3. Overall MFAD scores suggest that on farm nutritional diversity is quite high in both districts and survey rounds.

TABLE 3- MFAD SCORES BY DISTRICT AND SURVEY ROUND

DISTRICT	**MFAD SCORE**	
	Round 1	**Round 2**
Bardiya	0.80	0.77
Sindhupalchowk	0.81	0.78

SIMPSON'S INDEX

The Simpson's index is a measure of richness (number of different crops) and evenness (distribution of cultivated area) of farms. This is calculated using the proportion of land each crop that is grown on the farm takes up and is bounded between 0 and 1, where 0 represents the least rich and least even farm and 1 represents the most rich and most even farm. The average Simpson's index (Table 4) by survey round and district are shown below. Simpson's indices were similar across survey rounds and districts, and they all had very low correlation with farm size except for Bardiya in round 1.

TABLE 4- SIMPSON'S INDEX BY DISTRICT AND SURVEY ROUND

DISTRICT	**SIMPSON'S INDEX**	
District	**Round 1**	**Round 2**
Bardiya	0.36	0.57
Sindhupalchok	0.60	0.52

Non-Staples Food Energy (NFSE)

The NSFE score is a measurement of the percentage of energy derived from food items that are not staples. Staples are defined as cereals or grains/tubers (i.e. any of the following crops: Rice, Maize, Millet, Buck Wheat, Wheat, Pidalu, Sakharkhanda, Potato, and Radish). The average NSFE score by survey round and district is shown in Table 5. NSFE scores are similar across rounds in Sindhupalchok, but vary substantially between rounds for Bardiya with round 1 having a much lower score than round 2.

TABLE 5- NFSE SCORES BY DISTRICT AND SURVEY ROUND

DISTRICT	**NFSE SCORE**	
	Round 1	**Round 2**
Bardiya	5.23	26.74
Sindhupalchowk	10.77	12.08

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