Identifying the household factors, and food items, most important to nutrition in Vanuatu

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Acronyms

ADER	Average Daily Energy Requirement
AME	Adult Male Equivalent
BMI	Body Mass Index
CBN	Cost of Basic Needs
EA	Enumeration Area
EP	Edible Portion
FAO	Food and Agriculture Organisation
FBS	Food Balance Sheet
FPL	Food Poverty Line
HIES	Household Income and Expenditure Survey
MDER	Minimum Daily Energy Requirement
NCD	Non-Communicable Disease
NDS	Nutritional Dietary Surveys
PAL	Physical Activity Level
PIC	Pacific Island Country
RDI	Recommended Daily Intake
RNI	Recommended Nutrient Intake
STEPS	STEPWise approach to surveillance
UL	Upper Limit
WHO	World Health Organisation

Executive Summary

Improving the availability of lower cost, nutritionally superior diet has been identified as critical to improving food security, and health, in the Pacific.[1] Identifying the household and environmental factors contributing most to poor dietary outcomes, and the food items and quantities required for a nutritious diet, will assist policy-makers in this region to design targeted interventions to improve the cost and level of access at which households can access an improved diet.

This paper uses empirical methods to identify households most at risk of poor nutrition outcomes in Vanuatu, using microdata from the Household Income and Expenditure Survey (2010). It first establishes the average daily intake levels of energy and micronutrients among households in Vanuatu, and compares these with recommended intake levels. Subsequently the paper provides descriptive analysis of those households who consume a diet which provides less than 50% or more than 150% of the recommended daily intake levels of calories, total fat, vitamin A, iron, protein and sodium. Using probit regression analysis, it investigates whether insufficient of excessive consumption of these micro and macronutrients is positively or negatively correlated with indicators of income and food poverty identified in the literature on Pacific populations: location (urban or rural); the composition of income (subsistence or waged); the number and ratio of dependents to working age adults in the household; the gender and education level of the household head; and the types of housing construction materials and furnishings used by the household. The paper also compares changes in average household food baskets across urban and rural areas, and populations satisfying and not satisfying the recommended micro and macronutrient intake levels. Finally, this paper identifies the optimum food basket for assisting households meet the recommended energy and nutrient dietary intake levels at the lowest cost.

This paper shows that the optimum basket of goods which meets the minimum food and nutrition needs of households is slightly more expensive than current food poverty line (FPL) in Vanuatu in 2010(168Vt[2]): just 261Vt a day, or US$2.53[3], per person. The analysis identifies that improving access to local vegetable products (such as cooking bananas, island cabbage and peanuts) is the most affordable mechanism for ensuring households meet their minimum nutrition needs, particularly for ensuring access to minimum recommend amount of Vitamin A, Iron and protein.

The paper also identifies the supplementary policies and programs which could increase household intake levels of essential micronutrients, and encourage dietary substitution towards food items important to improving nutrition: targeted food voucher schemes for at risk households; school feeding programmes; applying an excise on food and beverage products

[1] Pacific Islands Forum (2011) Op. Cit.
[2] UNDP (2012) *Poverty and Hardship in Vanuatu*, UNDP Pacific Centre, Suva
[3] Based on exchange rate of 1 US$=103. 050 Vt, provided by xe rates www.xe.com/currecnyconverter 22/5/2015

high in sodium, sugar or fat to disincentivise consumption; and fortifying flour and rice products with micronutrients such as Vitamin A and Iron.

This paper is organized as follows: chapter 1 provides an introduction to the measurement of household food and nutritional security in Vanuatu, and the Pacific; chapter 2 explains the statistical method employed to identify the recommended and actual daily intake levels of Vanuatu households, using the 2010 Household Income and Expenditure Survey; chapter 3 presents descriptive tables providing an overview of the proportion of sub-populations of households failing to meet 50% of the minimum, or exceeding 150% of the maximum, nutrition factors; chapter 4 identifies the correlation between these household factors and the failure to meet the recommended nutrition values, using probit regression analysis; chapter 5 presents the most important food items consumed by households in Vanuatu, comparing both urban and rural households, and households satisfying the recommended dietary intake levels with those whose diet falls short of these thresholds; chapter 6 presents an optimal basket of food items, which is defined as the lowest total cost basket of food items required to reach the recommended threshold of energy and nutrition consumption; and chapter 7 briefly discusses the policy implications of these findings, including possible interventions which could improve nutrition outcomes in Vanuatu. Additional descriptive and methodological information is provided in the Annexes.

1. Introduction

1.1 The impact of the triple burden of malnutrition on household welfare in Vanuatu

Vanuatu has been identified as facing a health epidemic of rising disability, suffering, and early deaths, caused by escalating rates of Non-Communicable Disease (NCDs).[4] NCDs - principally cardiovascular diseases, diabetes, cancer and chronic respiratory diseases – have been identified as the leading causes of death and disability in Vanuatu, and are now responsible for 70% of all deaths.[5]

The overall prevalence of obesity in Vanuatu was estimated 18.8%.[6] However a high level of prevalence of underweight (15.9%) and stunting (20.1%) has also been identified amongst the Vanuatu population.[7]

These results indicate that significant undernourishment and perhaps micronutrient deficiencies co-exist with high rates of excessive macronutrient and sodium intake. As a result, micro and macro nutrient intake levels should be undertaken at a household level to develop accurate profiles for these at risk populations. Identifying which households suffer from micronutrient deficiencies and excessive intake levels is critical to ensuring that future policy interventions are effective at reducing malnutrition and NCDs for Vanuatu population at large.

1.2 The importance of developing evidence-based policy interventions for improving food and nutritional security outcomes in the Pacific context

Household diets and nutrition are of increasing importance to health, agriculture and economic policy-makers worldwide. The triple burden of malnutrition - undernourishment, micro-nutrient deficiencies and overweight/obesity - result in significant social and economic costs in both developing and developed countries. [8] An estimated 12.5% of the world's population is undernourished, whilst 26% of the world's children are stunted and 2 billion people suffer from one or more micronutrient deficiencies[9]. Micronutrient deficiencies - such as physical and cognitive impairment resulting from iron-deficiency anaemia and vitamin A deficiency - impose significant costs on society and act as a significant drag on economic growth in many developing countries.[10]

However, whilst under consumption of dietary energy, protein and micronutrients is still a problem for hundreds of millions of people, rising incomes and increased trade liberalization in the developing world is fuelling a food consumption transition which is contributing to weight gain and

[4] WHO (2013) *Vanuatu NCD Risk Factors: STEPS report,* Manila: WHO
[5] Ibid
[6] Ibid
[7] UNICEF (2007) *Multiple Indicator Cluster Survey Vanuatu*, Suva: UNICEF
[8] FAO (2013) *The State of Food and Agriculture: Food systems for better nutrition*, Rome: FAO
[9] Ibid
[10] Ibid

obesity.[11] More than 500 million people in the developing world are now obese. The impact of this trend has major implications for health and agriculture, and requires considered intervention in order to design policies which effectively incentivize healthier food choices.

While global obesity rates have risen, over the last three decades, the rate of increase among Pacific Island Countries has been startling.[12] Five of the world's ten most overweight nations are now in the Pacific Islands, where obesity rates regularly surpass 60%.[13]

In recent decades, the nations of the Pacific Islands have gone through a nutrition transition associated with the increased availability of cheap, energy dense foodstuffs;[14] migration to urban centres;[15] and diversification of income generation away from primary sector activities.[16] These trends have contributed to an alarming rate of increase in diet and nutrition related disease.[17]

In 2011, the Pacific Island Countries (PICs) were declared to be in an 'NCD Crisis' with the region experiencing growing levels of premature deaths and preventable morbidity and disability from NCDs, principally as a result of rising rates of heart disease and diabetes. Obesity and diet based Non-Communicable Diseases (NCDs), like late onset (type II) diabetes and heart disease, are now at critical levels in many Pacific Island nations - leaving escalating health care costs, morbidity and mortality in their wake.[18] These factors led the Pacific Island Forum leaders to acknowledge that: "*NCDs already undermine social and economic development in the Pacific, and are financially unsustainable. NCDs impose increasingly large, yet often preventable financial costs on national budgets and the economy more broadly."*[19]

At the same time, Pacific Island Countries (PICs)are making progress at reducing the proportion of undernourished. Several countries have already reduced the proportion of undernourished to less than 5 percent: Fiji, French Polynesia, New Caledonia and Samoa. However the percentage of

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[11] Popkin. B, Adair. L, Ng. S, (2012) "Global nutrition transition and the pandemic of obesity in developing countries," Nutrition Review 70:3-21

[12] Finucane M., Stevens G. Cowan M., et al. 2011. "National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants." *The Lancet* 377: 557-67.

[13] Murray, C. Ortblad. K, Guinovart C, et al. (2014) "Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013," The Lancet 384(9947) 1005-70

[14] Popkin. B, Adair. L, Ng. S, (2012) "Global nutrition transition and the pandemic of obesity in developing countries," *Nutrition Review* 70:3-21

[15] UNESCAP (2011) "People," Chapter 1 in *Statistical Yearbook for Asia Pacific*, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand

[16] UNESCAP (2008)"Unequal Benefits of Growth – Agriculture Left Behind," Chapter 3 in *Economic and Social Survey of the Pacific*, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand

[17] Pacific Islands Forum (2013) Towards Health Islands: Pacific Non-Communicable Disease Response, 10th Pacific Health Ministers Meeting, Apia, Samoa

[18] Finucane. M, Stevens. G, Cowan. M, et al. (2011) "National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants," The Lancet 377:557-67

[19] Pacific Island Forum (2014) *Op. Cit.*

underweight children is still at high levels in Papua New Guinea and the Solomon Islands.[20] Micronutrient deficiencies remain pervasive in the region, in particular vitamin A, Iron and iodine deficiency, which are strongly associated with childhood morbidity and mortality.[21] However, lack of data is an issue in several countries. Better data is urgently needed in order to better inform policy-making.[22]

Improving nutrition and reducing these costs must begin interventions to promote improved diet among at risk populations. This has prompted policymakers to explore broad-based approaches to analyzing the key household factors associated with poor nutrition and towards developing the targeted policy tools necessary to improve diets and health outcomes.

1.3 Identifying the causes of hardship and food poverty in the Pacific

Poverty measurement in PICs has been based on the Cost of Basic Needs (CBN) approach. The CBN approach is a commonly used method that attempts to define the minimum resources needed for long-term physical well-being, usually in terms of consumption.[23] Using this approach, a poverty line is defined as the amount of spending required to obtain a basket of food and non-food goods considered to meet the "basic needs" of households in that country.[24] The basic needs of a household are estimated from the cost of a minimally-nutritious, low-cost diet which delivers a minimum of around 2100/2200 calories (Kcal) per average adult per day, rather than the recommended intake levels for both micro and macronutrients.[25] The daily values of food poverty lines using the CBN approach vary substantially across countries in line with national income levels: from below US$1.25 per person a day in the Solomon Islands up to US$2.30 per person per day in Vanuatu.[26]

Previous investigations of household level poverty in the Pacific Islands have identified a number of critical factors, including: location, educational attainment, subsistence and waged income, household head gender, household material and furnishing types, and the number of dependents a household must support.[27]

There has been international evidence for structural differences in the nutritional status of urban and rural households. [28] While most Pacific islanders in rural areas have access to and practice subsistence agriculture or aquaculture, obtaining at least some of their households' food from

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[20] FAO (2014) *State of Food and Agriculture in the Asia-Pacific Region*, Bangkok: FAO Regional Office for Asia-Pacific
[21] Black, R.E., et al., *Maternal and child undernutrition: global and regional exposures and health consequences.* The Lancet, 2008. 371(9608): p. 243-260.
[22] FAO (2014) Op. Cit
[23] Haughton and Khandker (Op. Cit.)
[24] Ibid
[25] UNDP (2010) *Report on the estimation of Basic Needs Poverty Lines, and the incidence and characteristics of hardship and poverty*, Suva: UNDP Pacific Centre
[26] World Bank (2014) (Op. Cit.)
[27] World Bank (2014) Op. Cit.
[28] Anne Hatløy et al., "Food Variety, Socioeconomic Status and Nutritional Status in Urban and Rural Areas in Koutiala (Mali)," *Public Health Nutrition* 3, no. 01 (March 2000): 57–65, doi:10.1017/S1368980000000628.

cultivated gardens, wild vegetation, and the ocean,[29] households located in small villages in remote locations are often exposed to higher transport costs which drives up input prices and reduces income derived from traded goods.[30] Therefore rural location is seen as both a source of income security and a limit upon household income growth. While urban populations are able to access formal and informal employment not always available in rural areas, urbanization has also acted to reduce access to land for subsistence among urban populations, putting a strain on traditional social safety nets.[31] This appears to imply that there is no one-size-fits-all nutrition policy for urban and rural areas, and the effect of urbanization will be analyzed as a part of this study.

Subsistence income provides access to traditional food items not always available for sale in modern market channels.[32] Yet it has also been identified that households who are able to access waged income are subject to lower rates of hardship and poverty, particularly given rising demand for expenditure on new consumption items and services not able to be own produced (like subsistence crops).[33] As households shift from income dependence upon subsistence production to income from cash crops and off-farm employment, households are able to supplement or substitute own produced food items with items purchased from retail outlets. This process leads to a change in diet. However, maintaining access to food gardens and subsistence income may be an important predictor of quality of diet. As a result, the share of household income derived from subsistence and from wages will be analysed in this study.

In general, households headed by individuals who have limited education or who do not work are more likely to live in hardship.[34] Education increases human capital and individual productivity, and in the Pacific is often required for access to formal sector jobs that pay well. A higher level of educational attainment may also increase knowledge of the health benefits of a proper diet. Therefore higher educational levels of the household head might be associated with better household nutrition outcomes. As a result, this study investigates the impact of educational attainment of household nutrient intake levels.

Households headed by men are more likely to live in hardship than those headed by women in most PICs. This may be related to rates of migration and remittances and inter-household transfers.[35] Recent research has found that there are significant gender differences in food choice. Females have been found to be more likely to consume fruit and fiber, while limiting salt and fat intake[36]. What remains unknown is how gender differences impact upon nutrient intake levels among the Pacific Island households.

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[29] WHO (2010) "Pacific Islands Pay Heavy Price for Abandoning Traditional Diet." *Bulletin of the World Health Organization* 88: 484-485

[30] Winters, A. and P. Martins (2004) "When Comparative Advantage is Not Enough: Business Costs in Small Remote Economies." *World Trade Review* 3 (3): 347-383

[31] World Bank (2013) *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience,* Washington, DC: World Bank.

[32] World Bank (2014) (Op. Cit.)

[33] Ibid

[34] Ibid

[35] Ibid

[36] Jane Wardle et al., "Gender Differences in Food Choice: The Contribution of Health Beliefs and Dieting," *Annals of Behavioral Medicine* 27, no. 2 (April 1, 2004): 107–16, doi:10.1207/s15324796abm2702_5; I. Elmadfa, *Diet Diversification and Health Promotion* (Karger Medical and Scientific Publishers, 2005).

The type of cooking fuel used by the household – whether wood/coconut shell or more modern forms of cooking fuel (e.g. gas, electricity, kerosene, charcoal) – provides an insight into the cooking facilities and ease of preparation of meals that the household enjoys, as well as providing a proxy indicator of poverty. This factor is explored in this study.

Finally, households with more children are also more likely to live in hardship, as is observed in most countries around the world.[37] the ratio of household members dependent upon members generating an income has a large impact on nutrient intake levels, as available food resources are divided among a larger number of household members. This factor is explored in this study.

1.4 The advantages of using Household Income and Expenditure Surveys to identify risk factors associated with insufficient nutrition and develop targeted policy response

A more detailed overview the different survey tools and methods used to calculate malnutrition and dietary insufficiency, and the advantages of using HIES for this purpose in the Pacific, is provided in Annex 2. However, among the advantages of using HIES for investigation household nutrition are:

a) Sample unit: given that food insecurity manifests itself at household and individual levels, and the data on food expenditures are collected directly from households themselves, data produced by a HIES are likely to be more reliable than those derived from data collected at more aggregate levels.
b) Sample size: approximately 10 per cent of households participate in a HIES – a far larger dataset than many of the other health and nutrition surveys currently implemented in the Pacific
c) Time period covered by the data: The household food expenditure information collected from households through the HIES covers a 2-week period; whilst the enumeration of households is staggered over a 12-month period. This approach captures a better insight into changes in diet/consumption patterns within the household than a more limited time period like a 24-hour recall method; as well as capturing changes in diet caused by seasonality (food price change and availability)
d) Complimentary data: the HIES collects complimentary demographic and income information which can be used to identify and describe who is food insecure. This information also enables policy makers to examine food security outcomes within-country, at regional and household levels,
e) Regional coverage: Household Income and Expenditure Surveys (HIES) have been adopted by National Statistics Offices throughout the Pacific region over the last two decades, with 16 HIES having been conducted since 2006 and another 6 to be implemented in the next 3 years. 9 PICs have now conducted 2 or more HIES, providing an opportunity for comparisons both between countries and of change over time.

Some criticisms of the use household expenditure information to estimate food consumption have focused on:

[37] Ibid

a) Wastage: food items bought but not consumed by the household (considered to be lower in developing country contexts where food is purchased more frequently, due to lack of cold storage) [38]
b) Stocks: food items purchased in large quantities during the sample period, but not entirely consumed during this period. This is particularly relevant to purchases of grains (rice, wheat, maize) which are less important in the Pacific consumption context given the dependence on root crops for carbohydrates. However this may be more relevant for purchases of condiments such as table salt, cooking oil and soy sauce which are important items in contributing to total household sodium, calorie and fat consumption levels. [39]
c) Intra-household distribution: food expenditure information is collected at a household level not an individual level, and therefore individual results are inferred. In order to more accurately estimate individual consumption outcomes, this paper determines individual shares using a detailed process of calculating proportional shares for different age and sex categories – or Adult Male Equivalents (AMEs) informed by international evidence (see Annex 4).

There are methodological challenges to all empirical work. There are also significant challenges to enumerating accurate datasets in the Pacific Islands. Accepting these challenges and propensity for minor inaccuracies, using Household Income and Expenditure Surveys to estimate individual nutrition outcomes offers the Pacific Islands, and Vanuatu, a unique opportunity to improve the quality of empirical information available to policy-makers seeking to identify the risk factors contributing to one of the great social and economic challenges in the region: obesity and NCDs. Developing interventions for reducing incidence rates for these health issues without exacerbating the health issues associated with insufficient dietary intake, increases the importance of sourcing detailed household level information on these topics. This approach, therefore, provides policy makers with an important tool to better target interventions in the agriculture, education, health and trade sectors critical to improving nutrition in the Pacific Islands.

[38] Calculations using FAO Food Balance Sheets http://faostat.fao.org
[39] Smith, L. (2007) The Use of Household Expenditure Surveys for the Assessment of Food Insecurity, Washington D.C: IFPRI

2. Identifying an adequate diet necessary to engage in a healthy, active lifestyle

2.1 Calculating Average Dietary Energy Requirements

The average dietary energy requirement (ADER) of an individual is the level of energy intake from food that will balance energy expenditure - taking into account their level of physical activity, body size and composition, and long-term good health.[40]

The parameter used for adjusting the energy requirements based on the body weight for that age/sex combination, is the basal metabolic rate. The Schofield Equation is a method of estimating the basal metabolic rate (BMR) of adult men and women.[41] This is the equation used by the WHO and FAO in their technical report series.[42] The Schofield Equation estimates BMR in kcal/day (kilocalories per day) from body mass (kg).

Where the average weight for each corresponding age and sex categories is not available, a BMR is calculated using a weight corresponding to a healthy Body Mass Index (weight/height^2) for that age and sex category.

The parameter used for adjusting the requirements of the BMR due to the level of activity, is the Physical Activity Level (PAL).[43] The PAL expresses a person's physical activity as a number is order to estimate the amount of food energy needed to maintain a particular lifestyle, above the BMR (Table 1).

Table 1: Physical Activity Level (PAL) Scores for different occupations and lifestyles

Activity description	Subject description	PAL Score
1. At rest, exclusively sedentary or lying (chair-bound or bed-bound).	Old, infirm individuals. Unable to move around freely or earn a living	1.2
2. Exclusively sedentary activity/seated work with little or no strenuous leisure activity[a]	Office employees, precision mechanics	1.4–1.5
3. Sedentary activity/seated work with some requirement for occasional walking and standing but little or no strenuous leisure activity[a]	Laboratory assistants, drivers, students, assembly line workers	1.6–1.7
4. Predominantly standing or walking work[a]	Housewives, salespersons, waiters, mechanics, traders	1.8–1.9
5. Heavy occupational work or highly active leisure	Construction workers, farmers, forest workers, miners, high performance athletes	2.0–2.4

[40] Moltedo, *et al*. (2014) Op. Cit p.51
[41] Schofield WN. Predicting basal metabolic rate, new standards and review of previous work. Hum Nutr Clin Nutr. 1985;39 Suppl 1:5-41
[42] World Health Organisation, FAO, and UNU (1985) Energy and protein requirements. Geneva: WHO, Technical Report Series 724
[43] Ibid

Source: Australian and New Zealand National Reference Values for Dietary Energy
http://www.nrv.gov.au/dietary-energy

The adult male ADER can then be used to calculate the ADER for each remaining age and sex category in the sample population by applying an Average Male Equivalent (AME) conversion.[44] Applying an adult male ADER of 2200 kcal per capita per day - assumed in calculating the food poverty and income poverty lines used in household poverty reports in the Pacific (e.g. UNDP, 2012) - we are able to estimate the ADER for each age and sex category. This is provided in Table 2.

Table 2: The Average Daily Energy Requirement by age and sex category

	0 - 6 months	7 - 11 months	1 - 3	4 - 6	7 - 9	Male 10 -18	Female 10- 18	Male 19-65	Male 65+	Female 19-65	Female 65+
Calories (kcal)	418	528	836	1078	1276	1892	1606	2200	1892	1823	1562

2.2 Recommended Dietary Intakes of macro and micronutrients

A balanced diet is a diet that provides energy and all essential nutrients for growth and a healthy and active life. Since no foods contain all the nutrients required to permit the normal growth, maintenance, and functioning of the human body, a variety of food is needed to cover a person's macro- and micronutrient needs. Any combination of foods that provides the correct amount of dietary energy and all essential nutrients in optimal amounts and proportions is a balanced diet.[45]

To minimize the risk of nutrient deficit or excess, a joint FAO/WHO expert group defined the recommended dietary requirement for micro and macronutrients as an intake level that meets specified criteria for adequacy.[46] The Recommended Dietary Intake (RDI) is the daily nutrient intake level, plus two standard deviations, that meets the nutrient requirements of all nearly all (97-98 percent) of the "healthy" individuals in a particular age and sex group.[47] Therefore, to express nutrient requirements and recommended intakes for population groups, the requirements applied separately to each individual belonging to the population of analysis are summed.

There are a large range of micronutrients in food, including vitamins A, B1, B2, B6, C, D, E, K, folate and folic acids, calcium, iodine, iron, magnesium, selenium, sodium and zinc. As earlier identified, iron and Vitamin A deficiency are critical to avoiding health problems associated with poor diet, such as physical and cognitive impairment, and blindness.

Vitamin A is an essential nutrient needed in small amounts by humans for the normal functioning of vision, growth and development, maintenance of epithelial cellular integrity, immune system functioning, and reproduction.[48] High levels of Vitamin A are found in green leafy vegetables (e.g. spinach and young leaves from various sources), yellow vegetables (e.g. pumpkins and carrots), and yellow and orange non-citrus fruits (e.g. mangoes and papayas).

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[44] Moltedo *et al.* (Op. Cit.)
[45] Ibid
[46] Ibid
[47] Ibid
[48] FAO and WHO (2004) *Vitamin and Mineral Requirements in Human Nutrition*, 2nd ed. Rome: FAO

Iron has several vital functions in the body, including the transportation of oxygen to the tissues from the lungs by red blood cell hemoglobin.[49] The primary sources of iron are the hemoglobin and myoglobin from consumption of meat, poultry, and fish; in addition to from other forms (non-heme iron) from cereals, pulses, legumes, and fruits.

Humans gain energy from breaking down five different macronutrients: protein, fat, carbohydrates (including fibre) and alcohol. Each macronutrient contributes to the total dietary energy but in different proportions e.g. 1 gram of protein contributes 4 calories, while fat contributes 9 calories and is, as a result, more energy dense.[50] A joint WHO/FAO expert group established guidelines for a balanced diet, and found that a balanced diet exists when the following conditions are met:

- The proportion of dietary energy provided by protein is in the range of 10–15 percent
- The proportion of dietary energy provided by fats is in the range of 15–30 percent
- The remainder of dietary energy should be contributed by carbohydrates (including fibre) and alcohol[51]

Because both under and overconsumption of sodium and fat is the cause of health problems, sodium and fat have a RDI and an Upper Limit (UL). While a minimum level of sodium intake is required to promote for cell function, excessive sodium intake leads to elevated blood pressure and increased risk of NCDs such as cardiovascular and kidney diseases, and diabetes. The WHO has established that the maximum amount of sodium that adults should consume in a single day – the safe UL - is 2300 mg of sodium, which is equivalent to 5 grams or 1 small teaspoon of salt, per day.[52]

Adequate amounts of dietary fat are essential for health; yet given fat contains more than twice as many calories of energy per gram as carbohydrates and protein, excessive consumption of fat leads more quickly to weight gain, and associated health problems. A diet rich in saturated fats (oil products and fatty cuts of meat, such as corned beef and lamb flaps) raises cholesterol levels and risk for NCDs such as cancer,[53] diabetes,[54] and heart disease.[55] On average, individuals should not consume more than 35 percent of their energy from fat, particularly if it is high in saturated fatty acids which are derived primarily from animal sources.

The key reference values for a healthy diet and RDI of these macro and micronutrients, is provided in Table 3.

[49] Ibid
[50] Ibid
[51] WHO and FAO (2002) Human Vitamin and Mineral Requirements, part of a joint FAO/WHO expert consultation, Bangkok: FAO
[52] WHO (2007) Prevention of cardiovascular disease: guidelines for assessment and management of cardiovascular risk. Geneva, World Health Organization (WHO)
[53] World Cancer Research Fund/American Institute for Cancer Research (1997) *Food, Nutrition, and the Prevention of Cancer A Global Perspective*, World Cancer Research Fund/American Institute for Cancer Research, Washington, D.C., pp. 216–251
[54] Report of a Joint WHO/FAO Expert Consultation (2003) Diet, Nutrition and the Prevention of Chronic Diseases, WHO Technical Report Series 916
[55] Ibid

Table 3: The Recommended Dietary Intake (RDI) and Upper Limit (UL) of key macro and micronutrients

	0 - 6 months	**7 - 11 months**	**1 - 3**	**4 – 6**	**7 - 9**	**Male 10 -18**	**Female 10- 18**	**Male 19-65**	**Male 65+**	**Female 19-65**	**Female 65+**
Vitamin A* (µg/day) RDI	375	400	400	450	500	600	600	600	600	500	600
Iron (mg/day)** RDI	0.2	11	9	9	10	11	14	8	8	18	8
Sodium (mg/day) UL	1500	1500	1500	1900	1900	2200	2200	2300	2300	2300	2300
Protein (g/day)*** RDI	8	11	10	13	16	33	28	55	47	46	39
Total fat(g/day) UL****	28	35	33	36	43	63	54	73	63	61	52

Source: WHO and FAO (2002) Human Vitamin and Mineral Requirements, part of a joint FAO/WHO expert consultation, Bangkok: FAO

* Vitamin A: Vitamin A values are "recommended safe intakes". This level of intake is set to prevent clinical signs of deficiency, allow normal growth, but does not allow for prolonged periods of infections or other stresses.

**Iron: The RDI was set by modeling the components of iron requirements, estimating the requirement for absorbed iron at the 97.5th centile, with use of an upper limit of 14% absorption for 1-3-year-olds and 18% for other ages, and rounding; and an upper limit of 10% absorption, and rounding for babies aged 7-11 months. The RDI for 0-6 months was calculated by multiplying the average intake of breast milk (0.78 L/day) by the average concentration of iron in breast milk (0.26 mg/L), and rounding

*** Protein: The RDI was established based on 10% of dietary energy coming from protein for a daily kcal intake of 2200

****Fat: The UL was established based on 30% of dietary energy coming from fat for an average daily kcal intake of 2200

3. Using the Household Income and Expenditure Survey to identify household risk factors associated with poor nutrition outcomes in Vanuatu

3.1 Vanuatu (2010) Household Income Expenditure Survey data collection methodology

The 2010 Household Income and Expenditure Survey (HIES) was the second comprehensive survey of its type conducted in Vanuatu – the first having been undertaken in 2006. This survey collected demographic, income and expenditure information from 3975 households (out of a total 50,740) across 30 islands. Each participating household kept a diary of the value and volume of all food expenditure (including subsistence, or food produced by the household) for a two week period. This expenditure information is able to be converted into a proxy of household food energy and nutrient intake - following the detailed methodology outlined in Annex 3, and in this section - in order to establish the nutrient and food energy values for each household member, by household type; and to identify the household factors most closely correlated with increased risk of poor nutrition outcomes. Using this information it is also possible to identify those food items which contribute most to positive and poor nutrition outcomes, in order to develop and adopt policy interventions appropriate to improving household nutrition in Vanuatu.

3.2 Vanuatu (2010) Household Income and Expenditure Survey results in brief

This survey identified that 78% of the population was living in rural areas. On average, 4.9 people lived in each household, with a ratio of dependents (those aged <15 or >60) to adults in each household, 0.82:1. Almost 13% of households were headed by a female. Subsistence activities contributed 31% to total household income on average, while wages contributed 39% and agricultural sales contributed a further 26%. Wages and salaries contributed 76% for urban households, whilst contributing 25% for rural households – for whom subsistence provided, on average, 39% of income. Almost 25% of the population had a level of educational attainment higher than primary school. Some 91% of households in rural areas still used wood and coconut shells to cook with, though this dropped to 62% among urban populations.

3.3 Average required daily energy intake levels for households in Vanuatu

Establishing the ADER for Vanuatu requires knowledge of the average height and weight ascribed to household members belonging to each age and sex classification, and the PAL for the population.

Table 4 indicates the main activities of Vanuatu population aged 10 and over, estimated from the 2010 HIES. This table indicates that the average PAL multiplier for Vanuatu is 1.779 - slightly below the international average PAL score of 1.85.

Table 4: Average Physical Activity Level (PAL) using HIES 2010 'main head of household activity' information

Activity category	Mid-range PAL	# individuals in category	# after application of PAL multiplier	National PAL (PAL multiplier individuals/# individuals)
1	1.2	25,640	30,768	
2	1.45	27,090	39,280.5	
3	1.65	40,360	66,594	
4	1.85	23,230	42,975.5	
5	2.2	64,930	142,846	
		181,250	322,464	**1.779**

It is more difficult to predict the energy requirements of individuals in Vanuatu based upon anthropomorphic measurements (height and weight), given that these were not collected in the HIES. The 2013 STEPS Survey found that the average height of a man aged 25-64 was 167.8 cm and the average weight was 72.2kg, for a BMI of 25.5; while the average height of a woman aged 25-64 was 158.7 cm and the average weight was 67.6 kg, for a BMI of 26.7. This provided a BMI for both sexes (in the 25-64 age range) of 26.1 – outside the upper limit of a healthy BMI (24.9). In the absence of available/healthy BMI information, this study emulated the approached used by the FAO (et al 2004), assuming a BMI in the mid-point of the healthy range (22) as an average for each age and sex category. These height and weight values are marginally less than for the Vanuatu adult population indicated by the WHO (2013) Vanuatu STEPS survey. This may lead to a minor underestimation of the actual dietary energy intake levels required by the Vanuatu population.

The ADER for each age and sex category of the Vanuatu population, calculated using this method, is provided in Table 5. It indicates that the ADER for adult males in Vanuatu is 2978 kcal.

Table 5: The Average Daily Energy Requirement for Vanuatu population using healthy BMI* and average PAL

	0 - 6 months	7 - 11 months	1 - 3	4 - 6	7 - 9	Male 10 -18	Female 10- 18	Male 19-65	Male 65+	Female 19-65	Female 65+
Calories (kcal)	554	709	1135	1465	1728	2570	2173	2978	2557	2354	2103

*The body weights used were provided by Kuczmarski et al (2000), who derived them from the 50th percentile of the National Center for Health Statistics (NCHS) data. The weights used are the following: 0-6 mo = 6 kg; 7-12 mo = 8.9 kg; 1-3 yr = 12.1 kg; 4-6 yr = 18.2 kg; 7-9 yr = 25.2 kg; 10-11 yr M = 33.4 kg; 10-11 yr F = 34.8 kg; 12-18 yr M = 55.1 kg; 12-18 yr F = 50.6 kg; 10-18 yr M = 55.1 kg; 10-18 yr F = 50.6 kg; 19-65 yr M = 65 kg; 19-65 yr F = 55 kg.

3.4 Establishing macro and micronutrient RDI and UL for Vanuatu

Recommendations for energy intake differ from those for nutrient intake in that: they are not increased based on body types and activity levels. Therefore the same values provided in Table 2 are combined with the information on ADER to calculate RDI for protein, as well as the Upper Limits (UL) for fat. This information is presented in Table 6. The Upper Limit for total fat is calculated on the basis that no more than 35% of the total calories required for the Vanuatu ADER should come from fat. The RDI for protein is calculated using the total calories required for the Vanuatu ADER, on the basis that at least 10% of energy comes from protein.

Table 6: Recommended Dietary Intake (RDI) and Upper Limit (UL) of key macro and micronutrients

	0 - 6 months	7 - 11 months	1 - 3	4 - 6	7 - 9	Male 10 -18	Female 10- 18	Male 19-65	Male 65+	Female 19-65	Female 65+
Vitamin A* RDI (µg/day)	375	400	400	450	500	600	600	600	600	500	600
Iron RDI (mg/day)**	0.2	11	9	9	10	11	14	8	8	18	8
Sodium UL (mg/day)	1500	1500	1500	1900	1900	2200	2200	2300	2300	2300	2300
Protein RDI (g/day)	11	14	14	18	22	45	38	74	64	62	53
Total fat UL (g/day	38	48	44	49	58	85	72	99	85	82	70
Total ADER (kcal/day)	554	709	1135	1465	1728	2570	2173	2978	2557	2354	2103

3.5 Estimation of nutrition levels per capita

The Vanuatu HIES collected consumption data at an aggregated household level. However, RDI, UL and ADER values are calculated on an individual bases using Adult Male Equivalent (AME) rates. A more detailed explanation of the methodology for calculating AMEs and the AME values used for each micro and macronutrient, for each age and sex category, is provided in Annex 4.

3.6 Establishing edible portions of fresh and unprocessed food items

In order to convert the 'as purchased' (AP) volume of fresh items commonly consumed in Vanuatu, to their edible portion (EP), following the methodology explained in Annex 4.

3.7 Benchmarking

Benchmarks - such as insufficient dietary intake - are often used to interpret continuous variables - such as calorie and nutrient intake – in order to improve the capacity of non-specialists to interpret the outcome of results. Interpreting nutrient intake levels through the use of categorical dependent variables such as an individual having or not having an attribute such as "high fat consumption," therefore introduces a significant degree of simplicity when interpreting household results. As a result, this paper uses macro and micronutrient benchmarks e.g. fat consumption above 150% of UL, in order to identify the proportion of households having "high fat consumption" and investigate the household characteristics factors most closely associated with this outcome. However, this simplicity is gained at some cost to statistical accuracy.[56]

This paper uses the reference values in Table 6 to establishes a common proportional benchmark of the recommended or required intake level, in order to interpret the results of analysis: below 50% or

[56] Though grouping may help data presentation, converting continuous data to two groups (dichotomising): a) reduces the statistical power to detect a relation between the variable and individual outcome; b) may result in an underestimation of the extent of variation in outcome between groups, with individuals close to but on opposite sides of the cutpoint characterised as being very different rather than very similar; and c) may depend upon an arbitrary or convenient cut-off point (i.e. using the median) rather than one that is scientifically determined. These limitations needs to be acknowledged and minimized. From Altman, D. (2006) "The cost of dichotomising continuous variables," British Medical Journal, 332(7549):1080

above 150% of the recommended macro and micronutrient intake levels (ADER, RDI and UL). The percentage of individuals falling above or below these benchmarks is presented in descriptive tables (Chapter 4) for analysis. The negative or positive correlation between household sub-populations (e.g. those with a female household head) and these categorical dependent variables (e.g. fat consumption above 150% of UL) is explored using probit regression analysis (Chapter 5). More information on the statistical methodology used to calculate household nutrition outcomes using these benchmarks, is provided in Annex 4.

3.8 Descriptive tables of household factors and sub-populations

To understand variation in household level nutrient intake, descriptive statistics analysis was conducted on subsamples of the data, and the resulting tables are provided in Chapter 4. This allows the study to compare nutrient intakes across different subpopulations within Vanuatu, or compare different kinds of households. More information on how these variables were constructed is provided in Annex 4.

3.9 Probit Regression analysis

Multivariate regression techniques are used to analyze how household factors are related to nutrition outcomes. With regressions, the study can better identify the effect of a given variable on nutrition outcome by controlling for potentially confounding factors. The outcome of this analysis is provided in Chapter 5. More information on the methodology to undertake this probit regression analysis provided in Annex 4.

3.10 Food Rankings

To identify important food items in the typical consumption baskets of households in Vanuatu, this study produced rankings of foods. This study identifies which foods were most important as a proportion of household expenditure and nutrient intake type, for urban and rural households; and for households satisfying and not satisfying nutrient intake requirements. The outcome of this analysis is provided in Chapter 6. More information on the methodology to select these food baskets is provided in Annex 4.

3.11 Identification of an optimum food basket

One of the objectives of this study is to identify a low-cost bundle of food that meets all the daily recommended nutrient intakes, and the total cost of purchasing that bundle. To identify this optimum basket of food items at the lowest possible cost, we used linear programming. Linear programming is a mathematical optimization technique used to find a maximum or minimum of an objective function (such as cost minimization or profit maximization) that is subject to a set of linear constraints.[57] These constraints are most commonly expressed as inequality constraints that specify a minimum or maximum value for factors.

The optimization problem is then to minimize food expenditures by choosing a consumption bundle of food that meets all the nutrient intake requirements for a healthy diet. The outcome of this analysis is provided in Chapter 7. More information on the methodology to select this optimum food basket is provided in Annex 4.

[57] Robert Dorfman, Paul A. Samuelson, and Robert M. Solow, *Linear Programming and Economic Analysis* (New York: Dover Publications, 1987).

4. Descriptive Tables

4.1 Differences in nutrition between urban and rural households

Figure 1 indicates that households in rural areas consumed more calories than households in urban areas; that they consumed more calories than the required intake level (ADER), while urban households fell some 10% short of this mark; and were less likely than urban households to consume <50% of the required Calorie intake level (ADER). On average, households in Vanuatu consume slightly more calories (3056) the ADER of 2978 calories. Rural households consume significantly more calories (3105), on average, than do urban households (2710 Calories). On average, urban households consume 9.8% less Calories than the ADER. Figure 1 also indicates that rural households are less likely to consumer <50% of required amount of Calories (ADER). This study found that 19% of households in rural areas were reported as consuming <50% of the ADER; while 28% of households in rural areas were in this category.

Figure 1: Per capita (AME) calorie consumption, rural and urban households

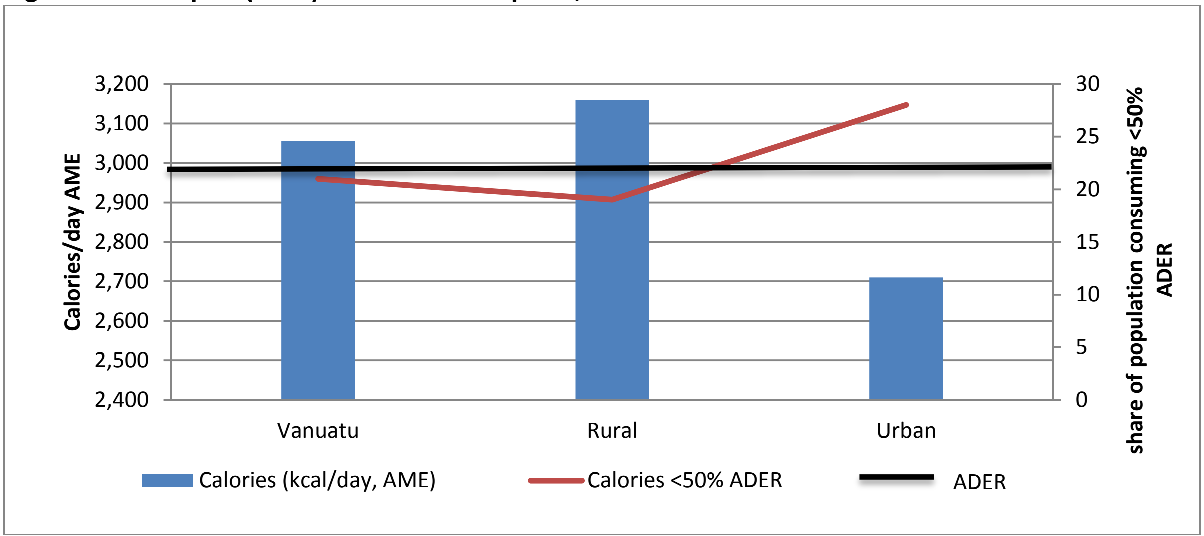


Figure 2 indicates that average per capita consumption levels of sodium in Vanuatu are below the safe recommended level (the UL); and that average sodium consumption is higher among urban household than rural households. Figure 2 also indicates that members of urban households are more likely to consume 150% of the recommended upper limit (UL) for safe sodium intake, than rural households; and that on average, urban households consume more sodium per day than the recommended UL . While the average person (AME) in Vanuatu consumes 2075 mg of sodium a day, this falls to 1921 mg in rural areas and rises to 2580 among urban households. Figure 2 also indicates that some 22% of members of urban households consume >150% of the UL for sodium - well above the 12% figure among rural households.

Figure 2: Per capita (AME) sodium consumption, rural and urban households

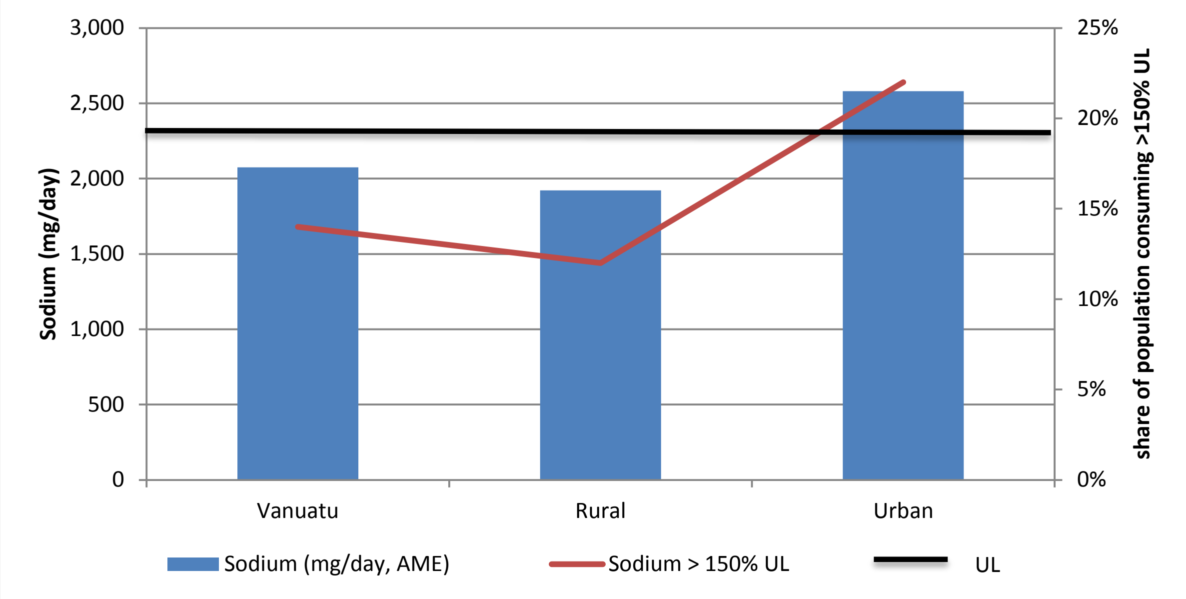


Figure 3 indicates that on average, households in Vanuatu consume more than the recommended daily intake (RDI) of iron (8mg); and that both rural and urban households consume more than the RDI for iron, on average. However, rural households have a higher average intake of iron and a far small proportion (9%) failing to consume <50% the required intake of iron, than urban households (25%).

Figure 3: Per capita (AME) iron consumption, rural and urban households

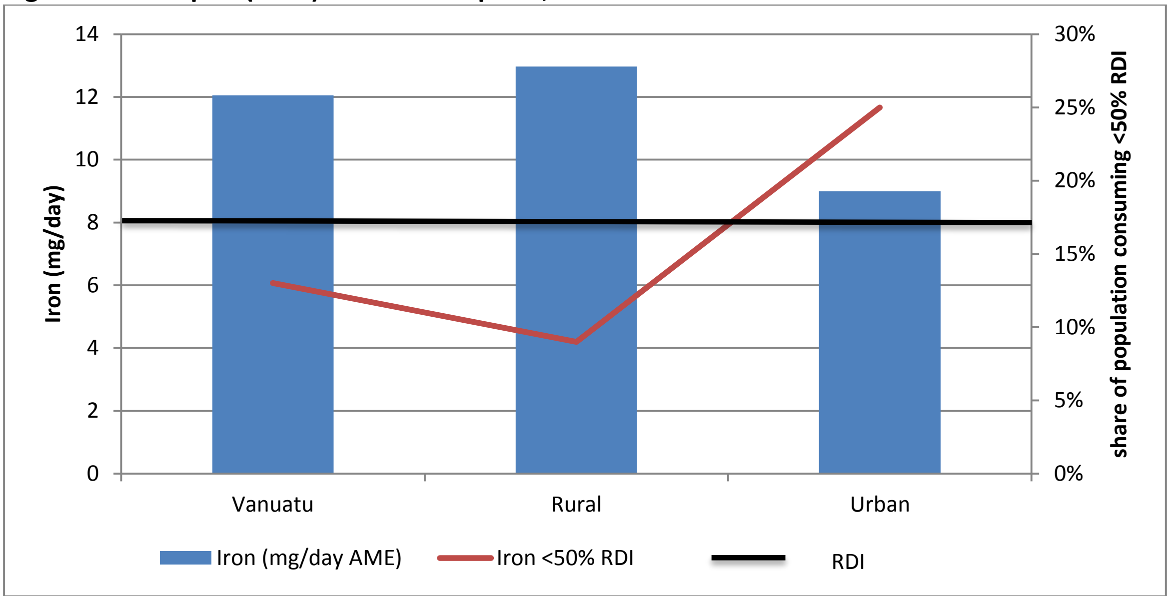
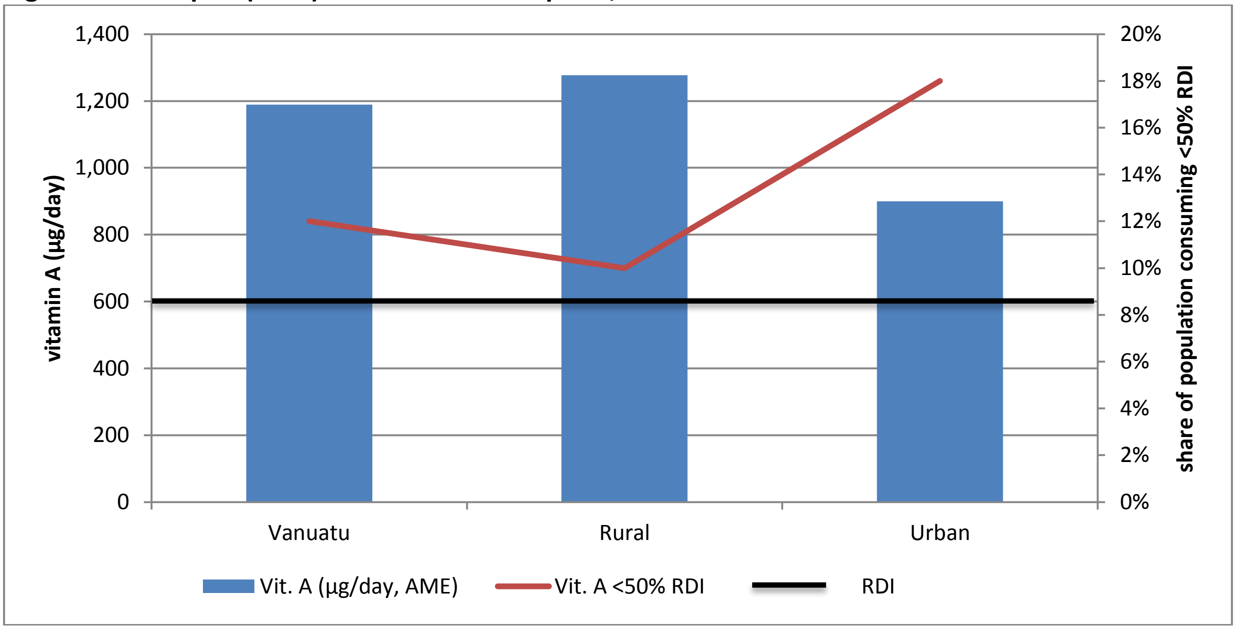


Figure 4 indicates that on average, Vanuatu household members, as well as members of households in both rural and urban areas, consume more than the recommended intake level for vitamin A (RDI): 600 ug/day. It indicates that households in rural areas have a higher level of consumption of vitamin A (1277ug/day) than households in urban areas (900 ug/day). Figure 4 indicates that members of households in urban areas are more likely to fail to consume 50% of the RDI for vitamin A, with some 18% of members of urban areas falling into this category; whilst only 10% of members of rural households do.

Figure 4: Per capita (AME) vitamin A consumption, rural and urban households



In summary, these results indicate that rural households consume more calories, iron and vitamin A than urban households; and that urban households consume on average, more than the safe UL for sodium per day. These results also indicate that a greater proportion of urban households are consuming less than 50% of the recommended levels for energy (ADER), iron and vitamin A (RDI) – as well as more than 150% of the UL for sodium – than rural households, placing them at far greater risk of diet related health issues, such as heart disease, diabetes and stunting. These results indicate, therefore, that rural households enjoy both a more energy dense and nutritionally riche diet, than do their urban counterparts.

Table 7 presents a comparison of the full set of macro and micro nutrient intake results for urban and rural households, as compared to the results for all households in Vanuatu.

Table 7: Household member (AME) nutrition: rural and urban location

VARIABLES	Vanuatu	Rural	Urban
Calories (kcal/day, AME)	3,056	3,160	2,710
Calories > 150% ADER	13%	14%	11%
Calories <50% ADER	21%	19%	28%
Protein Intake (g/day AME)	93	90	103
Protein <50% RDI	9%	10%	9%
Fat (g/day, AME)	75	73	81
Fat > 150% UL	10%	9%	12%
Sodium (mg/day, AME)	2,075	1,921	2,580
Sodium > 150% UL	14%	12%	22%
Iron (mg/day AME)	12	13	9
Iron <50% RDI	13%	9%	25%
Vit. A (μg/day, AME)	1,189	1,277	900
Vit. A <50% RDI	12%	10%	18%
Observations	3,957	3,037	920

4.2 Number of dependents

Figure 5 indicates that household calorie consumption declines as the number of dependents supported by the household increases. It indicates that households supported 3 or more dependents consume, on average, less than the average requirement for Calories (ADER). Figure 5 also indicates that households supporting a large number of dependents are far more likely to offer their household members <50% of the ADER. A third of members of households supporting 4 dependents, fail to consume 50% of the ADER; with this number rising to 42% for households supporting 5 dependents.

Figure 5: Per capita (AME) calorie consumption, by number of household dependents

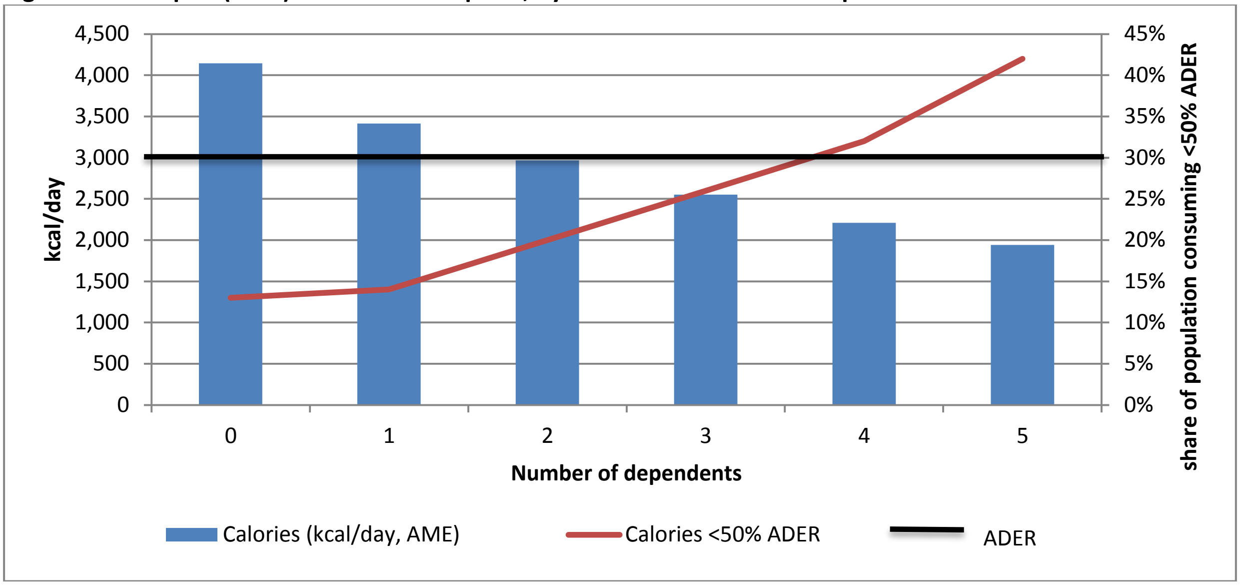


Figure 6 indicates that per capita consumption of iron also decreases steadily as the number of dependents supported by the household, increases. It shows that households supporting 5 dependents consume less than the recommended intake (RDI) for iron, but that households supporting less than 5 dependents provide each member with a sufficient daily intake of iron. Figure 6 indicates that 27% of members of households supporting 5 dependents fail to receive 50% of the RDI for iron, with the proportion of household members failing to reach this threshold falling steadily for households supporting fewer dependents.

Figure 6: Per capita (AME) iron consumption, by number of household dependents

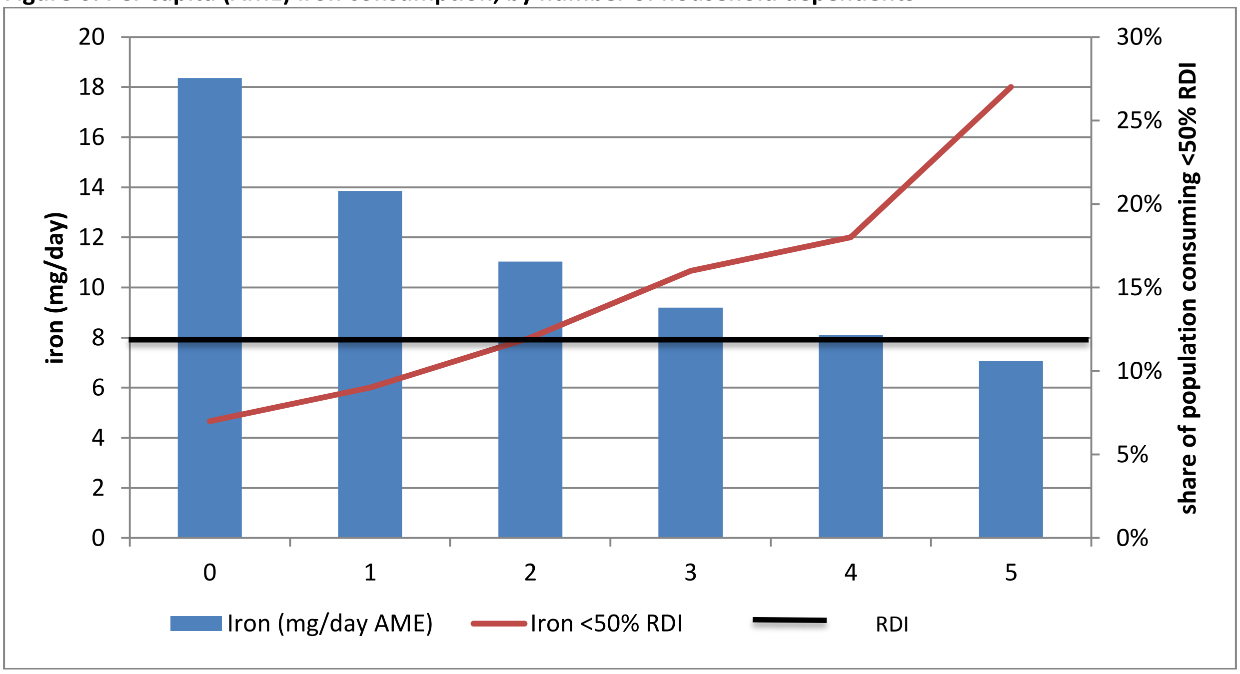
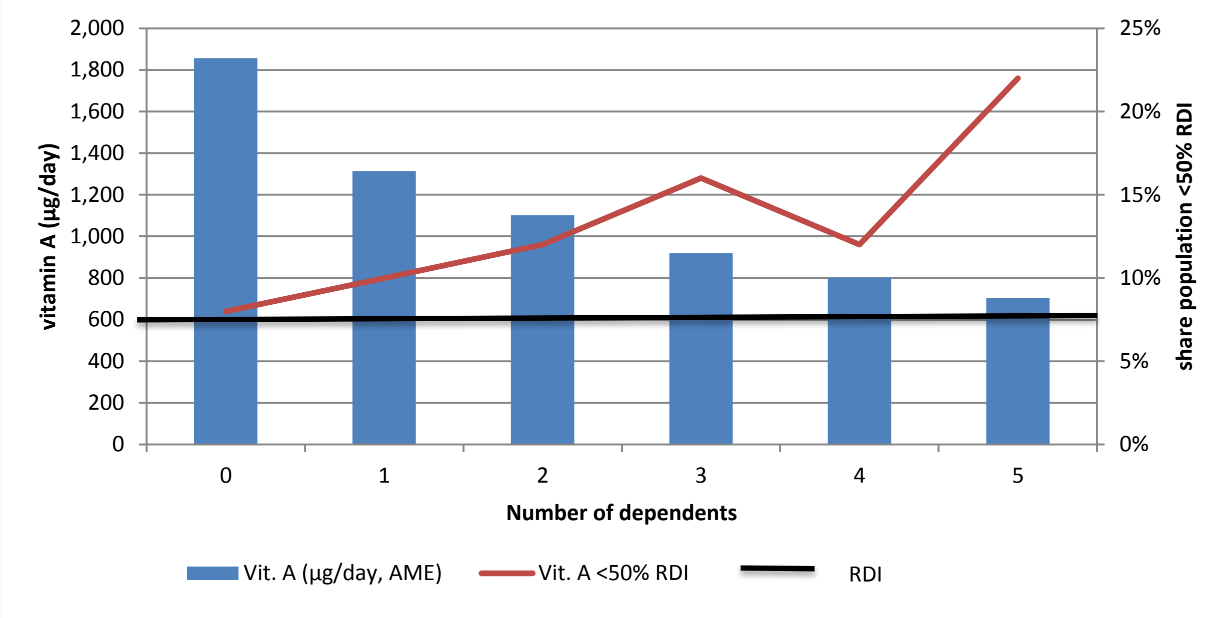


Figure 7 indicates that per capita intake of vitamin A also falls steadily as the number of dependents supported by the household, increases. Figure 7 indicates that members of households supporting between 0 and 5 dependents consume a sufficient intake (RDI) of vitamin A; but that the proportion of household members who fail to consume 50% of the RDI for vitamin A, rises as the number of dependents supported by the household increases. The figure indicates that this proportion rises from 8% for households supporting 0 dependents, to 22% for households supporting 5 dependents; but that it falls from 16% for households supporting 3, to 12% for households supporting 4, before rising again.

Figure 7: Per capita (AME) vitamin A consumption, by number of household dependents



These results indicate that increasing the number of dependents supported by the household does decrease the macro and micronutrients available to each member of the household; and that individuals living in households that support a large number of dependents are more likely to fail to consume 50% of the recommended intake for Calories (ADER) and the micronutrients iron, and vitamin A (RDI). These figures (5-7) indicate that, on average, members of households supporting 0-5 dependents do meet the RDI thresholds for iron and vitamin A, members of households supporting 2 or more dependents fail to receive sufficient Calories to surpass the ADER for Vanuatu.

Table 8 presents the results for average macro and micronutrient intake per number of household dependents, in more detail

Table 8: Household member (AME) nutrition by number of dependents

VARIABLES	Mean	0	1	2	3	4	5
Calories (kcal/day, AME)	3,056	4,145	3,416	2,966	2,552	2,211	1,942
Calories > 150% ADER	13%	28%	16%	12%	6%	3%	3%
Calories <50% ADER	21%	13%	14%	20%	26%	32%	42%
Protein Intake (g/day AME)	93	130	102	91	78	66	58
Protein <50% RDI	9%	5%	6%	8%	12%	13%	21%
Fat (g/day, AME)	75	108	84	72	60	51	44
Fat > 150% UL	10%	20%	12%	9%	6%	4%	3%
Sodium (mg/day, AME)	2,075	3,240	2,281	1,946	1,606	1,387	1,184
Sodium > 150% UL	14%	31%	17%	11%	7%	5%	3%
Iron (mg/day. AME)	12	18	14	11	9	8	7
Iron <50% RDI	13%	7%	9%	12%	16%	18%	27%
Vit. A (μg/day, AME)	1,189	1,856	1,314	1,103	919	802	704
Vit. A <50% RDI	12%	8%	10%	12%	16%	12%	22%
Observations	3,957	639	962	1,023	700	395	238

4.3 Education Level of Head of Household

Figure 8 indicates that members of households headed by individuals with any of none, primary level or post-primary education, all manage to consume a sufficient intake of protein to satisfy the daily intake levels (RDI) recommended for protein. This Figure indicates that a higher level of educational attainment (primary and post-primary) by a household head does provide household members with an increased intake of protein; and a lower proportion of members of households where the head has post-primary education (7%) fail to consume 50% of the RDI for protein.

Figure 8: Per capita (AME) protein consumption, by household head education level

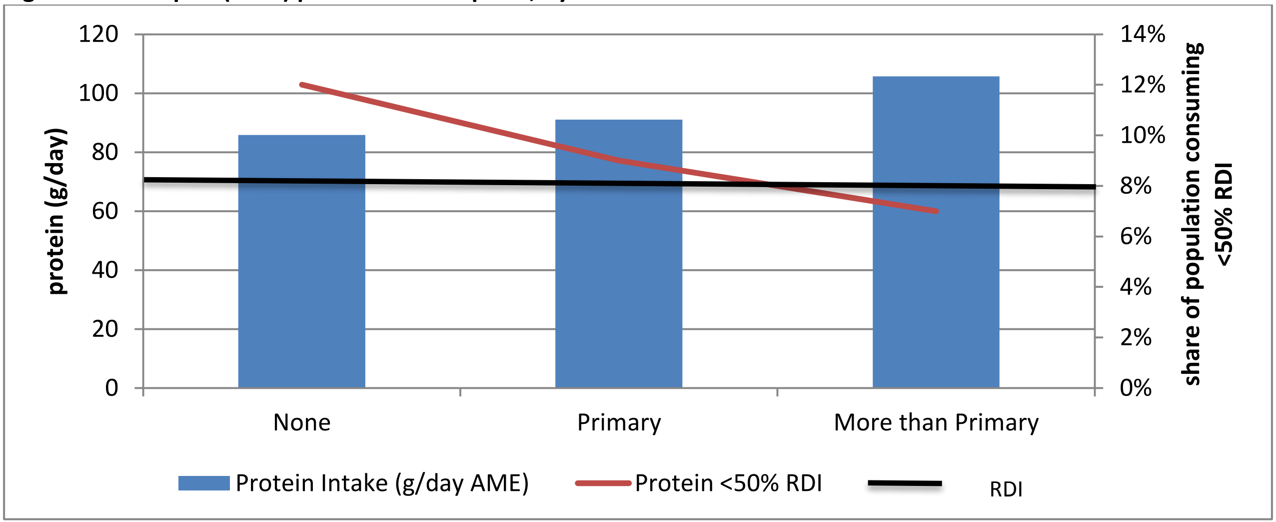


Figure 9 indicates that members of households headed by individuals with any of none, primary level or post-primary education, all consume less than the UL for fat; but that members of households where the head has obtained post-primary education do have an increased intake of fat; and that a slightly higher proportion of them consume 150% of the UL (12%) than members of other houses (9%).

Figure 9: Per capita (AME) fat consumption, by household head education level

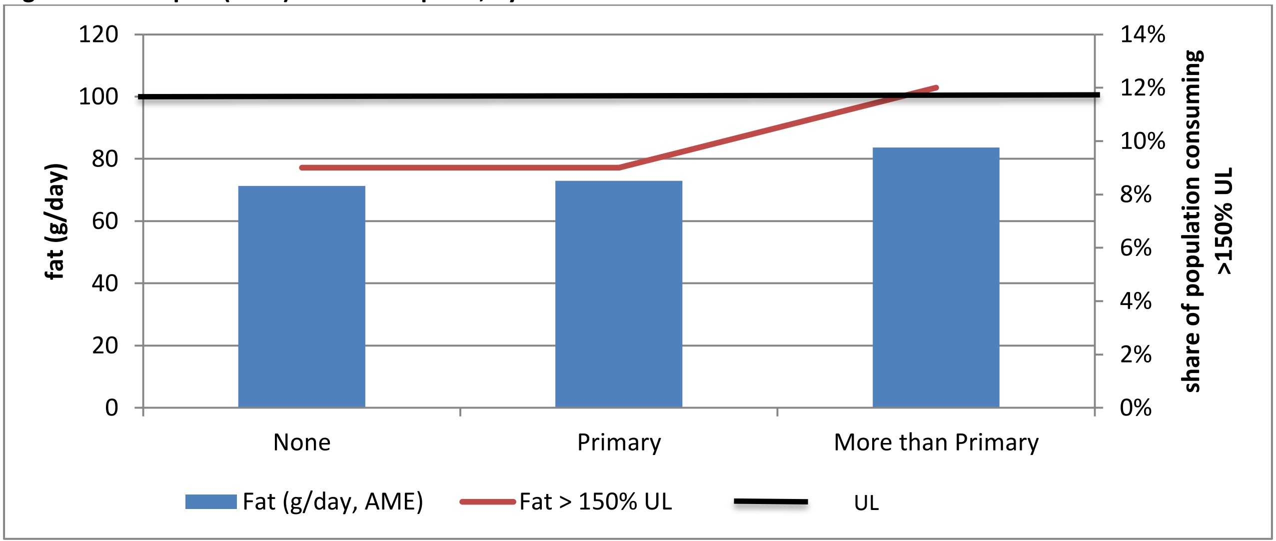
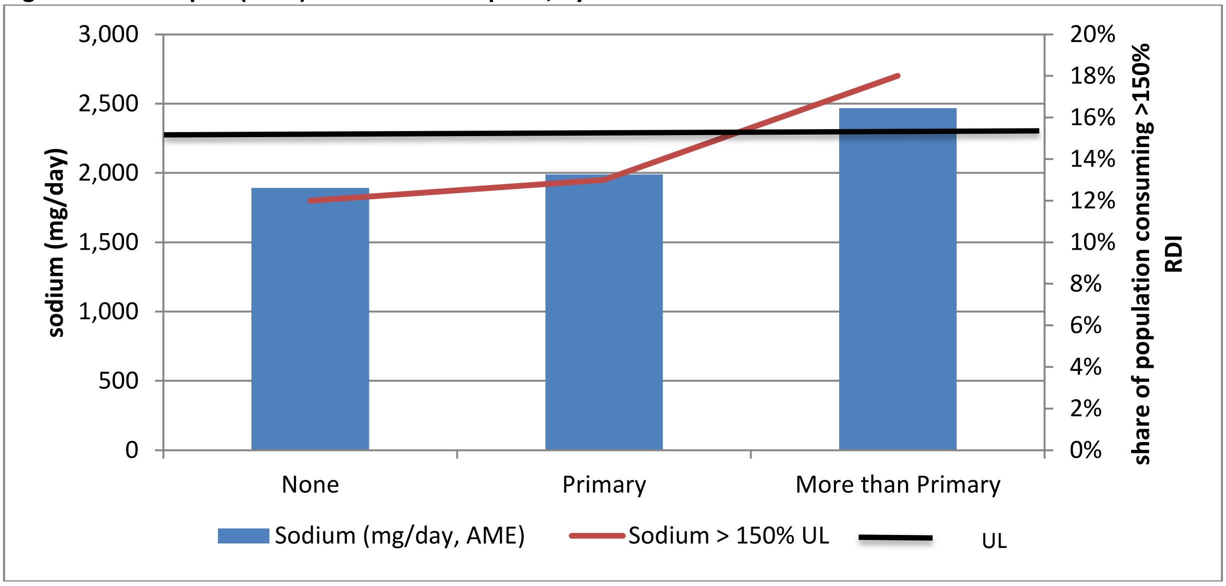


Figure 10 indicates that members of households headed by individuals with no or primary level education consume less, on average, than the UL for sodium; while members of households where the head has obtained post-primary education consume, on average, more than the UL for sodium. Members of these households also consume 150% of the UL in higher proportions (16%) than members of households where the head has obtained no education, or primary education.

Figure 10: Per Capita (AME) sodium consumption, by household head education level



These figures (8-10) indicate that obtainment of a post-primary education by the household head is associated with higher levels of consumption of the macronutrients protein and fat - and with higher consumption of sodium – than households where the head has obtained primary or no education. However the degree of difference across the three categories of education, and across the 3 nutrient types, is less significant than for the other factors examined: urban location and number of dependents supported by the household.

The full range of results for the per capita intake levels of each macro and micronutrient by level of household head educational attainment is provided in Table 9.

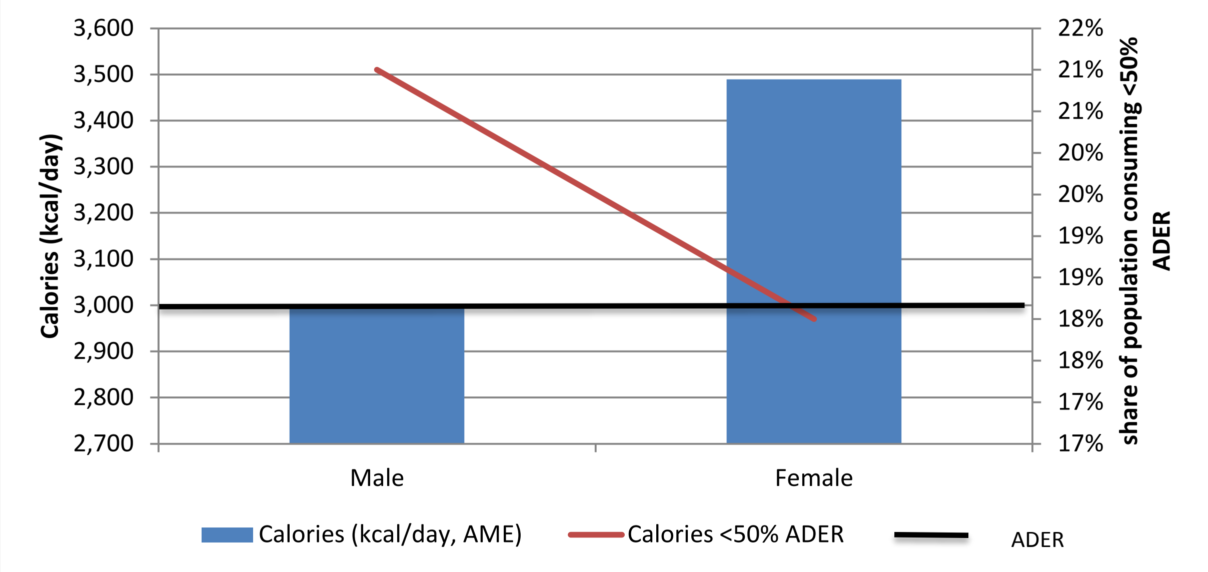
Table 9: Head of household education levels and household nutrition levels

VARIABLES	Mean	None	Primary	More than Primary
Calories (kcal/day, AME)	3,056	3,068	3,036	3,072
Calories > 150% ADER	13%	13%	13%	14%
Calories <50% ADER	21%	20%	20%	23%
Protein Intake (g/day AME)	93	86	91	106
Protein <50% RDI	9%	12%	9%	7%
Fat (g/day, AME)	75	71	73	84
Fat > 150% UL	10%	9%	9%	12%
Sodium (mg/day, AME)	2,075	1,892	1,989	2,467
Sodium > 150% UL	14%	12%	13%	18%
Iron (mg/day AME)	12	13	12	12
Iron <50% RDI	13%	11%	11%	17%
Vit. A (µg/day, AME)	1,189	1,264	1,184	1,095
Vit. A <50% RDI	12%	11%	12%	15%
Observations	3,957	1,342	1,635	980

4.5 Gender of Head of Household

Figure 11 indicates that the gender of the household head does have an impact on the calorie intake levels of household members. This figure shows that households headed by females have a significantly higher average intake of Calories – 3490 kcal/day as compared to 2993 kcal/day for households headed by males. This shows that members of households headed by males consume slightly less Calories than the ADER, and that members of households headed by females consume significantly more (17%) than the ADER, on average. This Figure also shows members of households headed by males are slightly more likely to consume less than 50% of the ADER.

Figure 11: Per Capita (AME) consumption of Calories (kcal), by household head gender



The full results for household member macro and micronutrient by household head gender type, are shown in Table 10.

Table 10: Household member (AME) nutrition by gender of Head of Household

VARIABLES	Mean	Male	Female
Calories (kcal/day, AME)	3,056	2,993	3,490
Calories > 150% ADER	13%	13%	16%
Calories <50% ADER	21%	21%	18%
Protein Intake (g/day AME)	93	92	101
Protein <50% RDI	9%	9%	9%
Fat (g/day, AME)	75.05	73.55	85.41
Fat > 150% UL	10%	10%	12%
Sodium (mg/day, AME)	2,075	2,046	2,273
Sodium > 150% UL	14%	14%	17%
Iron (mg/day AME)	12	12	12
Iron <50% RDI	13%	13%	14%
Vit. A (µg/day, AME)	1,189	1,153	1,439

Vit. A <50% RDI	12%	12%	10%
Observations	3,957	3,456	501

4.6 Source of cooking fuel used by the household

Figure 12 indicates that change in the source of cooking fuel used by the household is associated with the Calorie intake levels consumed by members of that household, with households using 'traditional' cooking fuel types – coconut shell and wood – consuming less calories than households using more modern cooking fuels (gas, electricity, kerosene and charcoal). This Figure indicates that members of households using both categories of fuel consume more than the ADER for Calories; and that a higher proportion (19%) of members of households using 'modern' fuels consume 150% of the ADER, than households using coconut shells or wood (12%).

Figure 12: Per capita (AME) Calorie (kcal) consumption, household cooking fuel type

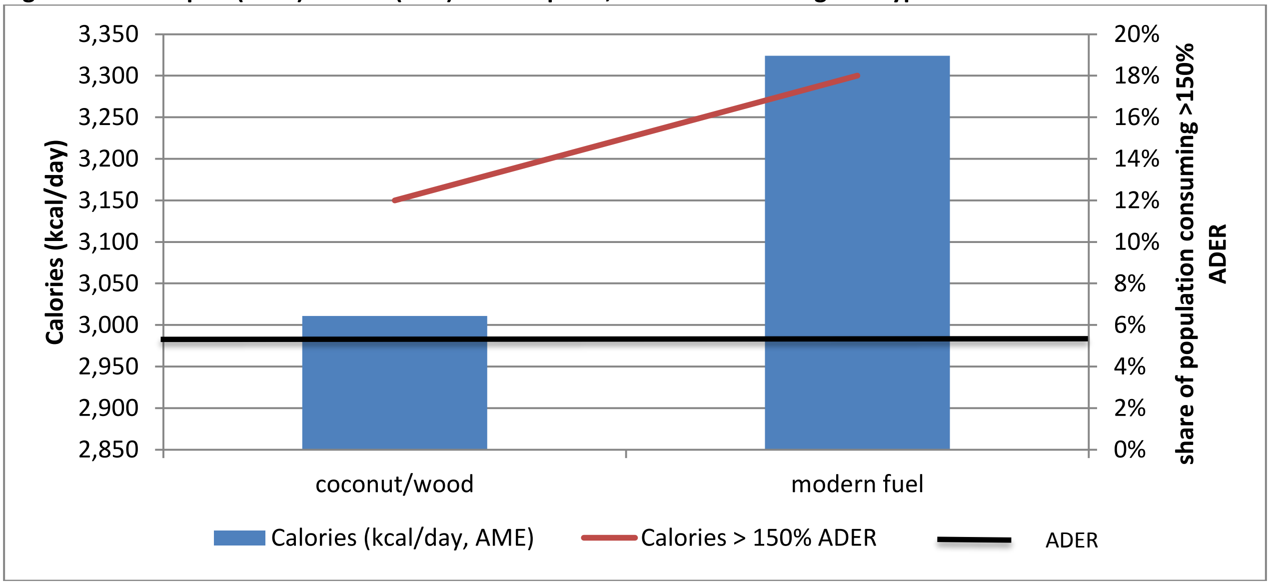


Figure 13 indicates that households using 'modern' cooking fuel types have a considerably higher (50%) per capita intake of sodium than households using coconut shell or wood, consuming 3997 mg/day as compared to 2915 mg/day. The average sodium intake of members of households using modern cooking fuel is far higher than the recommended UL for sodium of 2300 mg/day. The proportion of these households consuming >150% of the UL for sodium is some 25%, compared to 16% for households using traditional cooking fuel.

Figure 13: Per capita (AME) sodium consumption, household cooking fuel type

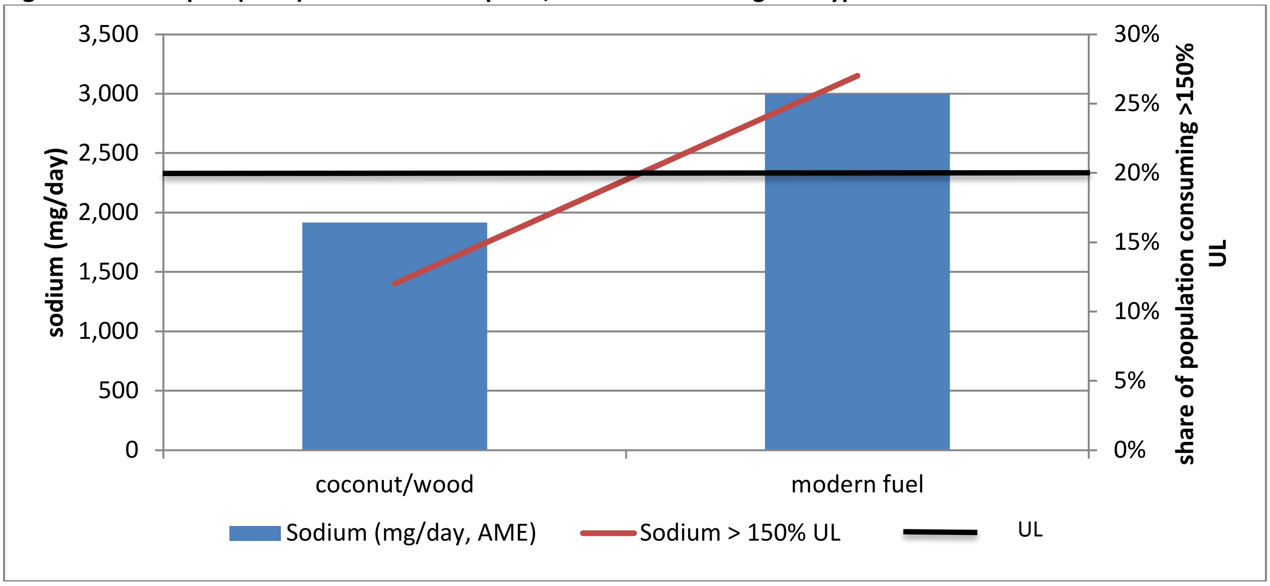
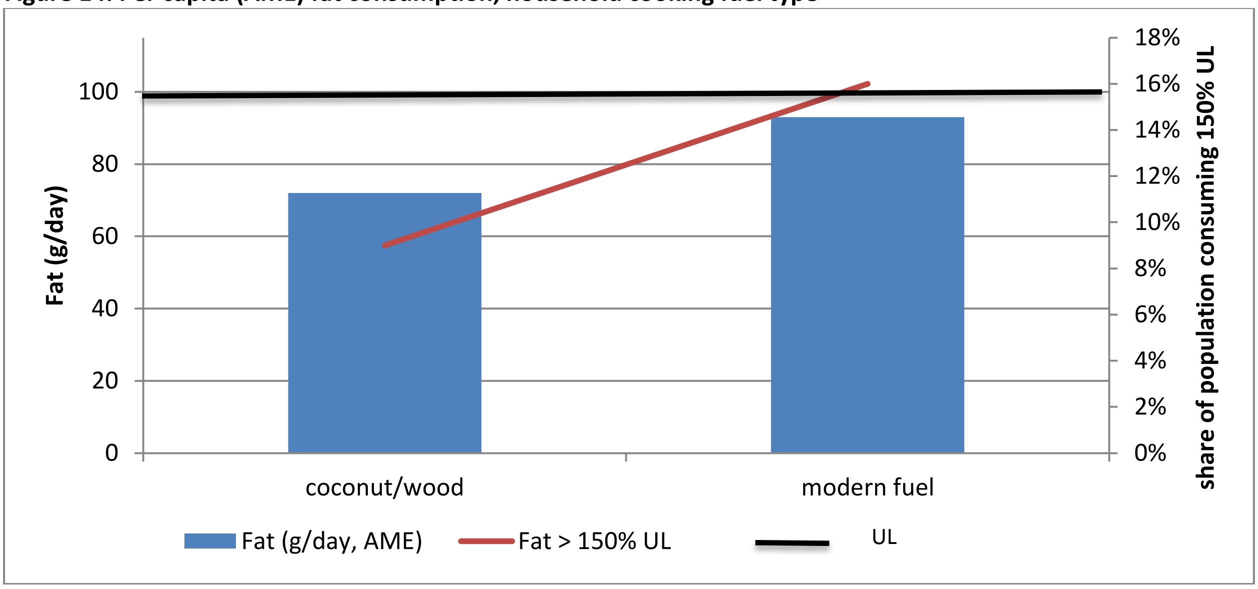


Figure 14 indicates that the per capita fat intake levels for households using modern cooking fuel is higher than among members of households using traditional cooking fuels – though the average fat intake levels for members of both household types, is below the safe UL for fat. A higher proportion of members of households using modern cooking fuels – 14% - have a daily intake of fat >150% of the safe UL for fat, compared to members of households using traditional fuels (11%).

Figure 14: Per capita (AME) fat consumption, household cooking fuel type



These figures (12-14) indicates that the type of cooking fuel used by households, is an indicator of dietary change, with households that use modern cooking fuels having a higher intake rate of calories, fat and sodium. Table 11 illustrates the daily intake levels for households using modern and traditional cooking fuel types, for the full range of micro and macronutrients; and the proportion of the population in each household group who fall above or below the recommended thresholds.

Table 11: Type of household cooking fuel and household member diet

VARIABLES	Average	Wood/ coconut	Modern fuel
Caloric Intake (AME)	3,056	3,011	3324
Calories > 150% RDI	13%	12%	18%
Calories <50% RDI	21%	21%	20%
Protein Intake (AME)	93	89	118
Protein <50% RDI	9%	10%	8%
Fat Intake (AME)	75	72	93
Fat > 150% UL	10%	9%	16%
Sodium Intake (AME)	2,075	1,915	2997
Sodium > 150% UL	14%	12%	27%
Iron Intake (AME)	12	12	13
Iron <50% RDI	13%	12%	18%
Vit. A Intake (AME)	1,189	1,175	1272
Vit. A <50% RDI	12%	12%	14%
Observations	3957	3358	574

4.8 Share of total household income from wages

Figure 15 indicates household calorie consumption decreases as the share of household income derived from wages falls from above zero, to 100%. It indicates that households with no waged income have a lower calorie intake level than household with a share of income from wages of between 0 and 20%. This result indicates that households that manage to supplement subsistence income with a small amount of off-farm income are those that provide their household members with the highest calorie intake level. As household increase their income dependence upon wages, the calorie intake level their members access, falls – with per capita intake of calories falling below the ADER for members of households where more than 20% of income comes from wages. Members of households with a share of total income derived from wages that is higher than 40%, fail to consume 50% of the ADER at steadily higher rates – from 22% for households with an income share from wages of between 40 and 60%, to 42% for households with an income share of wages greater than 80%. Similarly, the proportion of household members consuming >150% of the ADER drops as the share of household income from wages rises.

Figure 15: Per capita (AME) consumption of calories by share of household income from wages

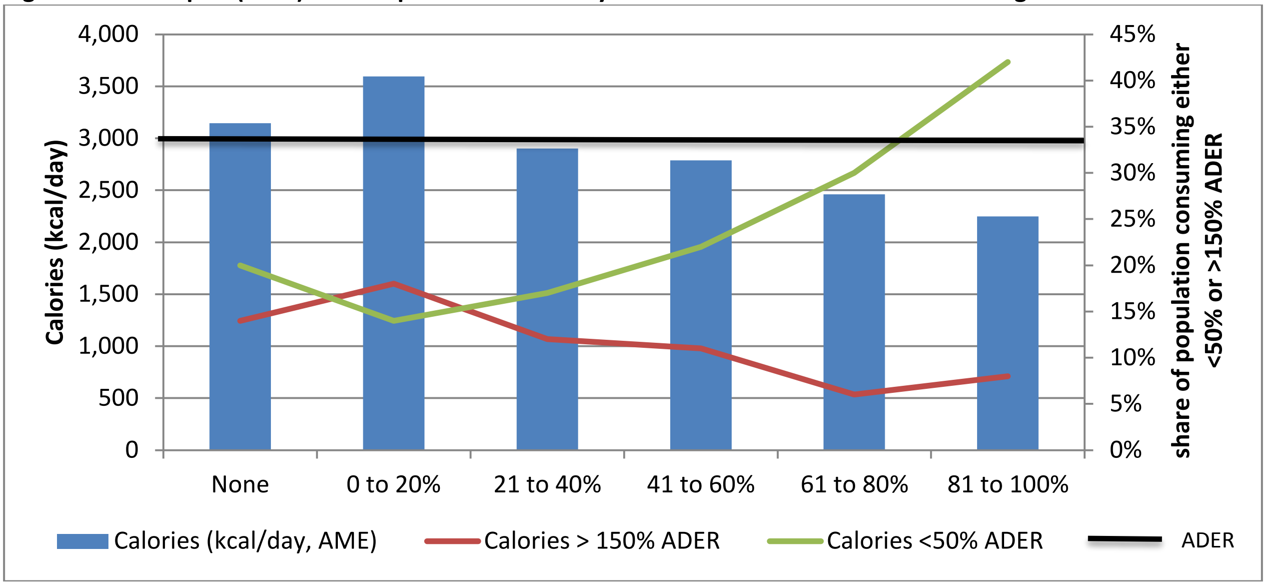


Figure 16 indicates that per capita intake of iron follows a similar pattern: rising slightly as households supplement subsistence income with some (0-20% of the total) income from wages, and then falling sharply as the share of income from wages rises above 20%. Only households who are almost entirely dependent upon income from wages (80-100% of total) fail to provide their members with a per capita intake of iron below the RDI. The proportion of household members failing to consume 50% of the RDI for iron also rises sharply as the share of total income from wages rises, from 20% (40-60%) to 36% (80-100%).

Figure 16: Per capita (AME) consumption of iron by share of household income from wages

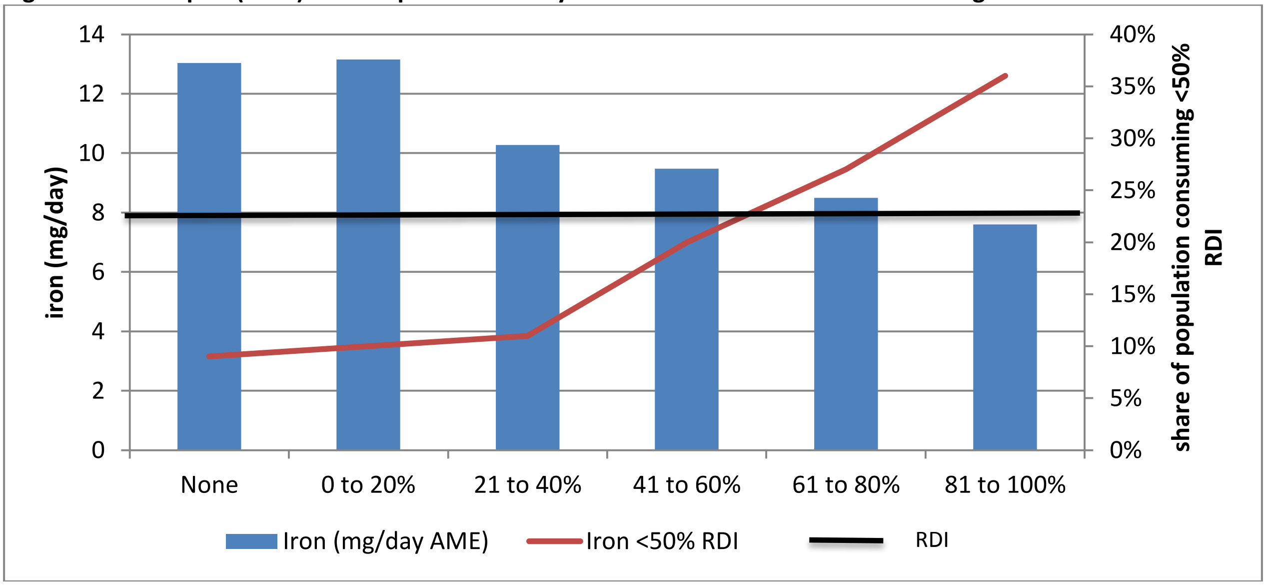
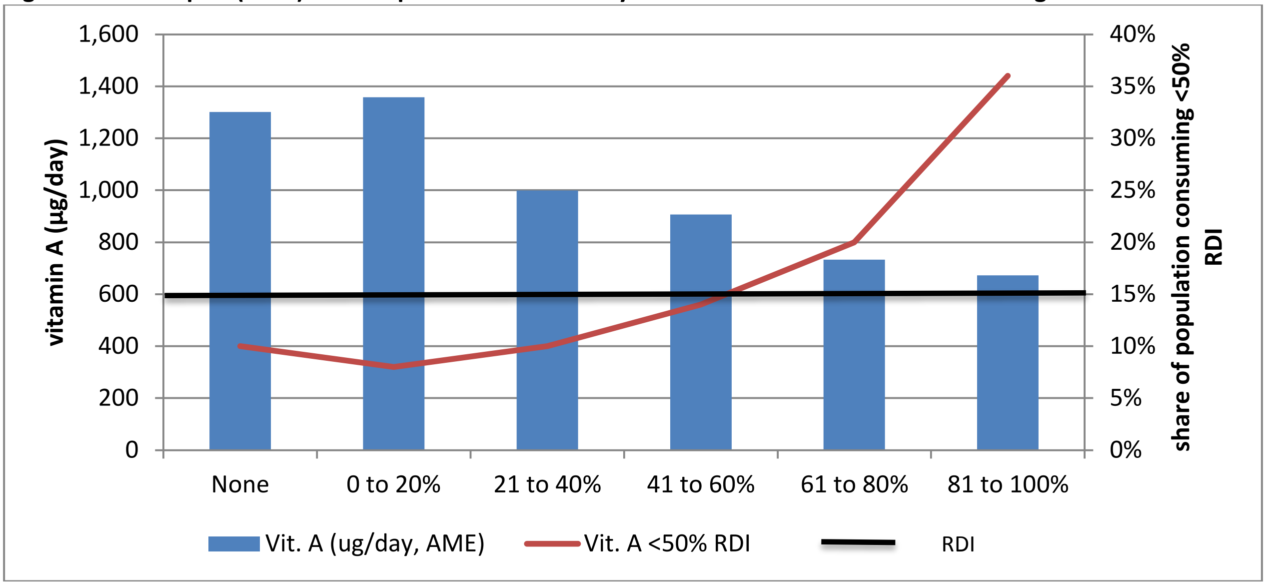


Figure 17 indicates that per capita consumption of vitamin A also follows the same pattern: rising as the household supplements subsistence income with a small share of total income (0-20%) from wages; then falling steadily as the share of total income from wages, rises. The proportion of the population which fails to consume 50% of the RDI for vitamin A rises steadily, from 10% for households getting 21-40% of total income from wages, to 36% for households almost entirely dependent (80-100% of income) on wages. However, per capita intake of vitamin A remains above the recommended level (RDI) for all categories of waged income share.

Figure 17: Per capita (AME) consumption of vitamin A by share of household income from wages



The results of these Figures (15-17) indicate that while income from wages is an important supplement to subsistence income and increases dietary intake levels at low levels of total income share, increased dependence on waged income actually decreases dietary intake levels: for calories, iron and vitamin A.

The full range of micro and macro nutrient intake levels for each category of waged income share in total wages is provided in Table 12.

Table 12: Household member nutrition outcomes by share of household income derived from wages

VARIABLES	Mean	None	0 to 20%	21 to 40%	41 to 60%	61 to 80%	81 to 100%
Calories (kcal/day, AME)	3,056	3,145	3,595	2,903	2,789	2,461	2,247
Calories > 150% ADER	13%	14%	18%	12%	11%	6%	8%
Calories <50% ADER	21%	20%	14%	17%	22%	30%	42%
Protein Intake (g/day AME)	93	88	117	98	99	98	91
Protein <50% RDI	9%	10%	5%	7%	8%	7%	13%
Fat (g/day, AME)	75	71	94	78	80	76	78
Fat > 150% UL	10%	9%	15%	12%	11%	8%	13%
Sodium (mg/day, AME)	2,075	1,867	2,482	2,280	2,507	2,531	2,559
Sodium > 150% UL	14%	12%	18%	16%	19%	19%	22%
Iron (mg/day AME)	12	13	13	10	9	8	8
Iron <50% RDI	13%	9%	10%	11%	20%	27%	36%
Vit. A (µg/day, AME)	1,189	1,301	1,358	999	907	733	672
Vit. A <50% of RDI	12%	10%	8%	10%	14%	20%	36%
Observations	3,957	2611	274	270	280	264	271

4.9 Share of total household income from subsistence

Figure 18 indicates that the trend in the impact of share of total income from subsistence on Calorie intake, is the inverse of the trend for share of income from wages on Calorie intake: per capita intake levels rise as the share of subsistence in total income rises from zero to 80% of the total, and then falls for members of those households who are entirely (or almost) income dependent on subsistence. Average per capita Calorie intake levels for members is above the ADER for those households getting 20 -80% of their total income from subsistence. The proportion of the population in each income category who fail to consume 50% of ADER falls from 30% for those with no waged income, to 12% for those deriving 60-80% of total income from subsistence – and then rises to 20% for those entirely (or near) dependent upon subsistence for income. In contrast, the share of the population in each income category who consume more than 150% of ADER, rises as the share of total income from subsistence rises from 20-80%, and then falls among households entirely (or near) dependent on income from subsistence.

Figure18: Per capita (AME) consumption of Calories (kcal) by share household income from subsistence

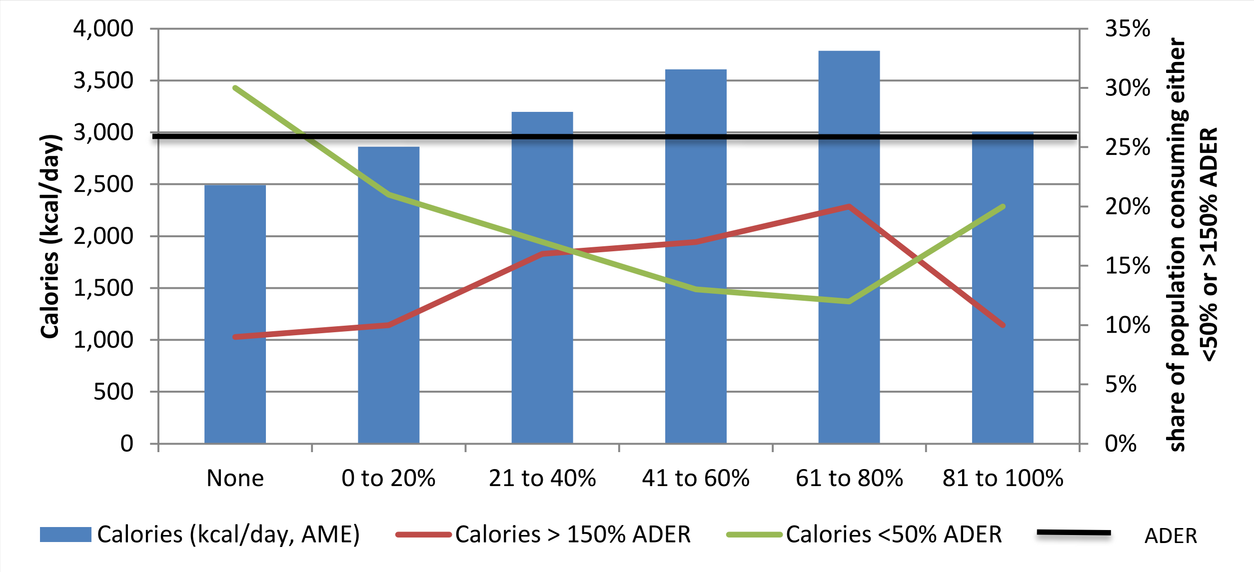


Figure 19 indicates that per capita intake levels for iron follow a similar trend: rising as the share of income from subsistence increases, then falling after income from subsistence represents more than 80% of total income; and the proportion of household members failing to access a daily intake of iron >50% of the RDI falling as subsistence income increases, until that share surpasses 80% of total income. Figure 19 also indicates that household members at every category of income share from subsistence access more than the RDI for iron.

Figure 19: Per capita (AME) consumption of iron by share of household income from subsistence

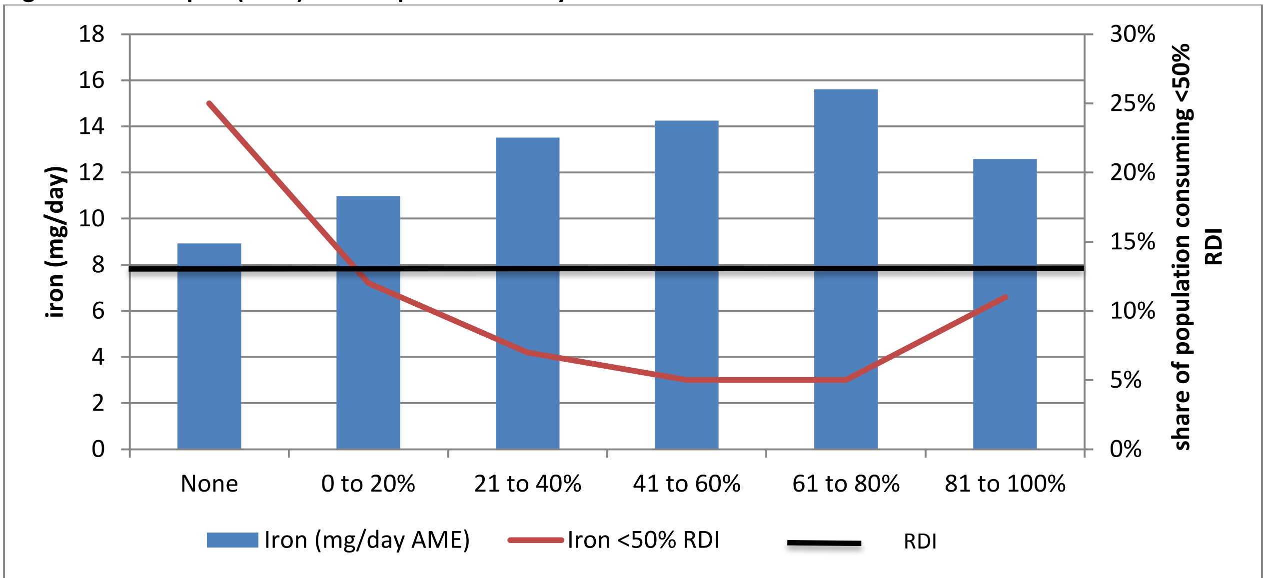
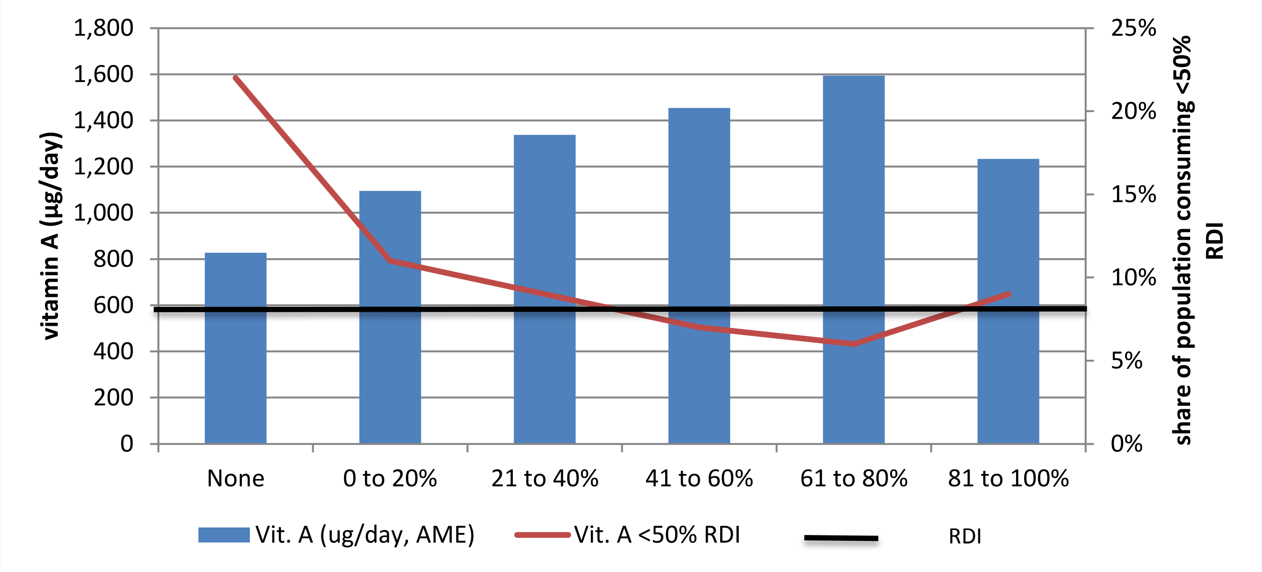


Figure 20 shows the same trend as for iron in Figure 19: vitamin A intake levels rising as the share of income from subsistence increases, then falling after income from subsistence represents more than 80% of total income; and the proportion of household members failing to access vitamin A at >50% of the, RDI falling as subsistence income increases, until that share surpasses 80% of total income.

Figure 19 also indicates that household members at every category of income share from subsistence access more than the RDI for vitamin A.

Figure 20: Per capita (AME) consumption of vitamin A by share of household income from subsistence



The results shown in these Figures 18-20 indicate that income from subsistence is an important source of access to dietary intake, but that overdependence upon subsistence income (80%+) reduces per capita calorie, iron and vitamin A intake levels. Therefore supplementation of subsistence income with income from wages does increase dietary intake levels, and improve food security.

Table 13 provides the full set of information on the average per capita micro and macronutrient intake levels for households at each category share of income from subsistence.

Table 13: Household member nutrition outcomes by share of total Income derived from subsistence

VARIABLES	Mean	None	0 to 20%	21 to 40%	41 to 60%	61 to 80%	81 to 100%
Calories (kcal/day, AME)	3,056	2,492	2,863	3,196	3,607	3,786	3,006
Calories > 150% ADER	13%	9%	10%	16%	17%	20%	10%
Calories <50% ADER	21%	30%	21%	17%	13%	12%	20%
Protein Intake (g/day AME)	93	90	85	93	101	107	82
Protein <50% RDI	9%	11%	9%	10%	8%	7%	10%
Fat (g/day, AME)	75	73	71	72	83	83	69
Fat > 150% UL	10%	9%	9%	10%	11%	13%	8%
Sodium (mg/day, AME)	2,075	2,342	1,949	2,023	2,013	2,028	1,724
Sodium > 150% UL	14%	17%	13%	12%	13%	14%	11%
Iron (mg/day AME)	12	9	11	14	14	16	13
Iron <50% RDI	13%	25%	12%	7%	5%	5%	11%
Vit. A (µg/day, AME)	1,189	827	1,095	1,338	1,453	1,594	1,233
Vit. A <50% of RDI	12%	22%	11%	9%	7%	6%	9%
Observations	3,957	1,072	773	717	573	493	310

5. Correlation between indicators of household poverty and diet

In this chapter, we interpret the results of probit regression analysis to identify whether the household variables described in Chapter 4, are positively or negatively correlated to the satisfaction of the thresholds for Calories, fat, sodium, protein, iron and vitamin A, established in this study (Table 3). These are: the head of household is female; that the head of household has obtained more than primary level education; the ratio of household dependents to adults supporting them; that the household uses modern cooking fuel (gas, electricity, kerosene, charcoal) instead of traditional wood/coconut; that the household is located in an urban area; the share of subsistence income in the households total income; and the share of income from wages in the households total income.

Table 14 displays the results for 8 separate probit regressions. The 8 dependent variables are: (1) that household consumption provides a diet that is above the RDI protein, Vitamin A and iron, below the UL for fat and sodium, and between 50% and 150% of the calories in the ADER; (2) that the household consumes <50% the ADER for calories; (3) that the household consumes more than 150% the ADER for calories; (4) that the household consumes > 150% the UL for sodium; (5) that the household consumes >150% the UL for fat; (6) that the household consumes < 50% the RDI for protein; (7) that the household consumes <50% the RDI for iron; (8) that the household consumes <50% the RDI for Vitamin A.

Table 14 reports marginal effects instead of probit coefficients. This enables the interpretation of these statistics directly as a percentage change (at the mean of X) in the likelihood of households described by the variable satisfying the nutrition thresholds of the dependent variable.

Table 14: Probit regression analysis of impact of household factors associated with food poverty, on dietary outcomes

VARIABLES	(1) Meets all RDI and UL[1]	(2) Calories <50% ADER[2]	(3) Calories >150% ADER[3]	(4) Sodium >150% UL[5]	(5) Fat > 150% UL[7]	(6) Protein <50% RDI[8]	(7) Iron <50% RDI[9]	(8) Vit. A <50% RDI[10]
Household head is female	0.06	-0.18**	0.15+	0.17*	0.13	-0.11	0.10	-0.21**
	(0.073)	(0.071)	(0.088)	(0.085)	(0.091)	(0.072)	(0.071)	(0.074)
Household head has obtained post-primary education	0.00	-0.04**	0.03*	0.04**	0.02	-0.02*	-0.02+	-0.02+
	(0.012)	(0.012)	(0.014)	(0.013)	(0.015)	(0.012)	(0.012)	(0.012)
Share of income from wages	-0.21+	0.12	-0.43**	-0.07	0.04	-0.39**	0.16	0.50**
	(0.115)	(0.108)	(0.140)	(0.127)	(0.143)	(0.107)	(0.105)	(0.106)
Share of income from subsistence	0.65**	-0.86**	0.60**	0.36**	0.46**	-0.79**	-1.01**	-0.81**
	(0.095)	(0.093)	(0.116)	(0.118)	(0.126)	(0.093)	(0.094)	(0.096)
Modern cooking fuel	0.06	-0.18**	0.30**	0.33**	0.20*	-0.20**	-0.35**	-0.31**
	(0.072)	(0.067)	(0.082)	(0.075)	(0.084)	(0.070)	(0.070)	(0.072)
Household in urban location	-0.38**	0.25**	-0.13	0.11	0.03	0.28**	0.53**	0.37**
	(0.083)	(0.079)	(0.097)	(0.090)	(0.101)	(0.082)	(0.079)	(0.081)
Ratio of dependents to adults	-0.21**	0.40**	-0.50**	-0.47**	-0.36**	0.31**	0.42**	0.31**
	(0.032)	(0.032)	(0.047)	(0.045)	(0.048)	(0.030)	(0.030)	(0.030)
Observations	3,814	3,814	3,814	3,814	3,814	3,814	3,814	3,814
chi2	191.2	335.2	204.1	170.9	95.4	205.4	460.0	350.8

** p<0.01, * p<0.05, + p<0.1. Standard errors and shown in parentheses

[1] Households meets all RDI and UL thresholds when AME consumption: kcal/day >50% but <150% ADER (x=>1489 and <4467); fat g/day >66.2 and <115.8; protein g/day >74.5; sodium mg/day >1610 and <2300; iron mg/day >8; vitamin A ug/day >600

[2] Household per capita (AME) consumption of kcal/day <50% of ADER when per capita consumption (AME) <1489 kcal

[3] Household per capita (AME) consumption of kcal/day >150% of ADER when per capita consumption (AME) >4467 kcal

[5] Household per capita (AME) consumption of sodium (mg/day) >150% of UL when per capita consumption (AME) >3450 mg

[7] Household per capita (AME) consumption of fat (g/day) >150% of UL when per capita consumption (AME) >173.7 g

[8] Household per capita (AME) consumption of protein (g/day) <50% of RDI when per capita consumption (AME) <37.25g

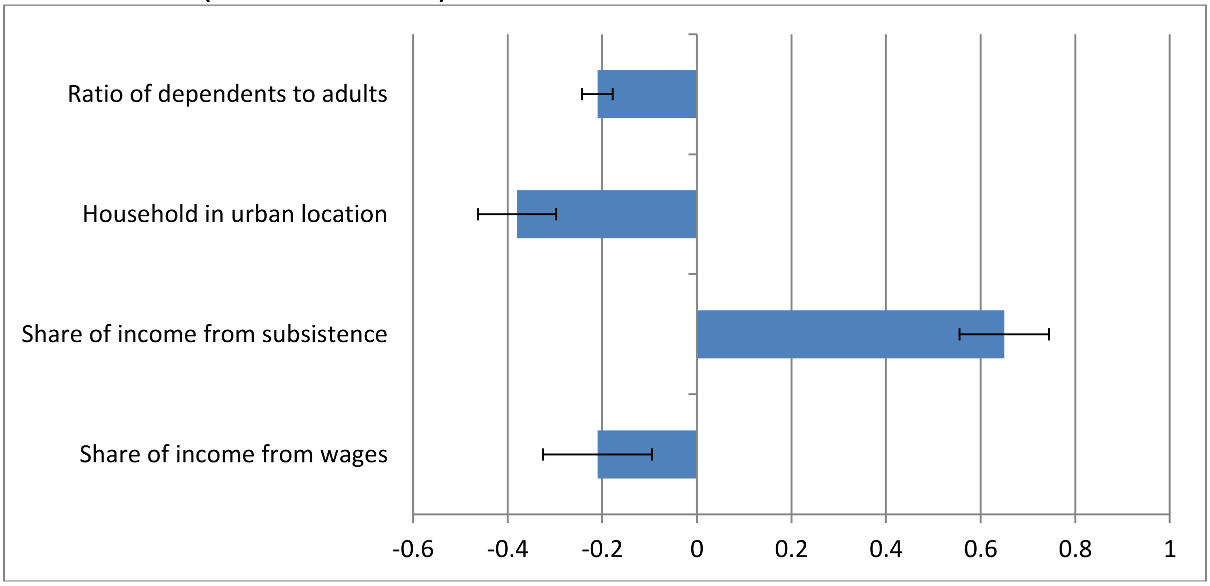
[9] Household per capita (AME) consumption of iron (mg/day) <50% of RDI when per capita consumption (AME) <4mg

[10] Household per capita (AME) consumption of vitamin A (ug/day) <50% of RDI when per capita consumption (AME) <300ug

5.1 Household member satisfaction of all macro and micronutrient intake thresholds

Table 14 indicates that 4 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which satisfies all the macro and micronutrient intake thresholds (ADER, RDI and UL) associated with an adequate diet in Vanuatu. The ratio of dependents to adults, urban location and the share of income from wages all have a significant negative effect on the dependent variable; while the share of income from subsistence income has a significant positive effect (Figure 21). The results show (Table 14 and Figure 21) that a household in an urban location is 38% less likely to satisfy the nutrition thresholds associated with an adequate diet in Vanuatu. They (Table 14 and Figure 21) also show that an increase in the ratio of dependents to adults of 1, would make members of that household 21% less likely to satisfy the nutrition thresholds associated with an adequate diet in Vanuatu. Similarly an increase in the share of income from wages by 1% results in a 0.2% reduction in likelihood of household member satisfying the dependent variable. However an increase in the share of income from subsistence by 1% results in a 0.65% increase in the likelihood of household member satisfying the dependent variable – or a 100% increase in subsistence income leads to a 65% increase in household satisfaction of all the micro and macronutrient thresholds.

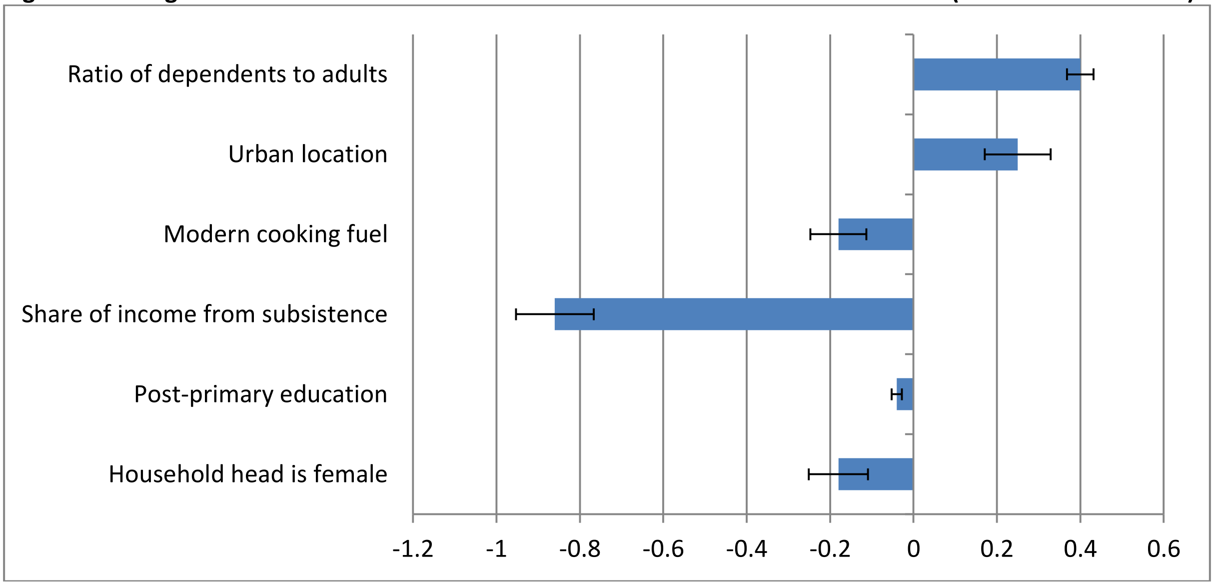
Figure 21: Marginal effect of household factors on member satisfaction of all micro and macronutrient intake thresholds (with standard errors)



5.2 Household member calorie intake is <50% ADER

Table 14 indicates that 6 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides less than 50% of the required Calorie intake (ADER) in Vanuatu. The gender of the household head being female, the education of the household head, the share of income from subsistence and type of cooking fuel used by the household all have a significant positive effect on the dependent variable; while the ratio of dependents to adults and urban location have a significant negative effect (Figure 22). The results show (Table 14 and Figure 22) that members of a household in an urban location is 25% more likely to consume <50% of the Calorie ADER; while an increase in the ratio of dependents to adults of 1, would make members of that household 40% more likely to fail to consume a diet containing 50% of ADER. In contrast an increase in the share of income from subsistence by 1% results in a 0.86% reduction in likelihood of household member failing to consume a diet containing 50% of the ADER. A household headed by a female is 18% less likely to fail to provide its members a diet containing at least 50% of the Calorie ADER; while a household using modern cooking fuel types (gas, electricity, kerosene and charcoal) is 18% less likely to fail to provide its members a diet containing at least 50% of the Calorie ADER. Households headed by an adult who has gained post-primary education qualifications are also (4%) less likely to provide their members a diet containing <50% of the ADER.

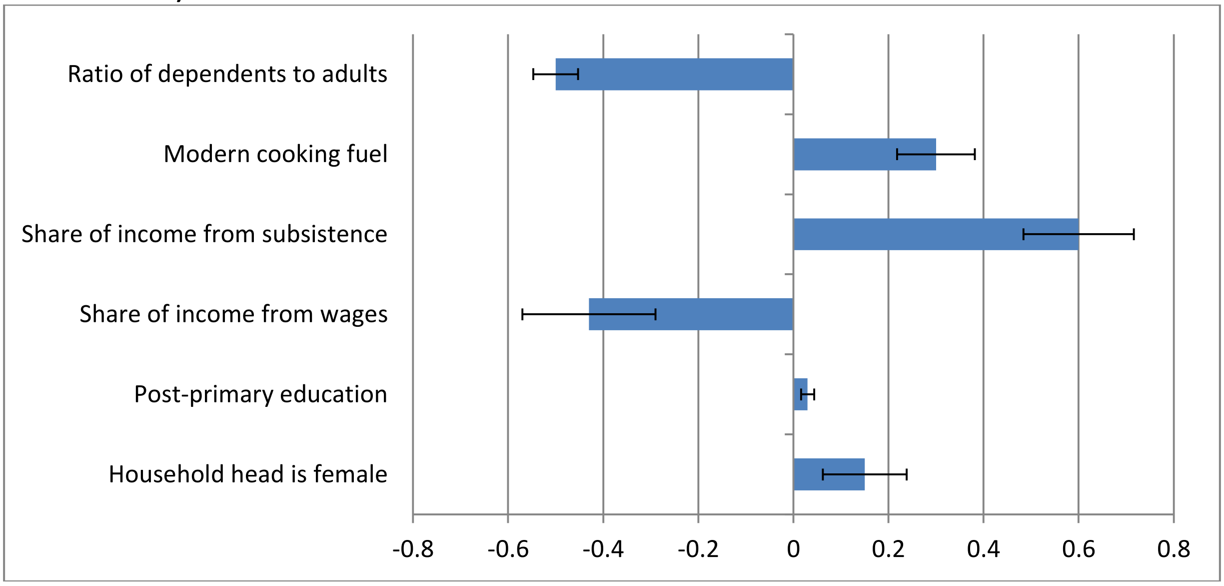
Figure 22: Marginal effect of household factors on member calorie intake <50% ADER (with standard errors)



5.3 Household member calorie intake is >150% ADER

Table 14 indicates that 6 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides more than 150% of the required Calorie intake (ADER) in Vanuatu. The gender of the household head being female, the education of the household head, the share of income from subsistence and type of cooking fuel used by the household all have a significant positive effect on the dependent variable; while the ratio of dependents to adults and share of income from wages have a significant negative effect (Figure 23). The results show (Table 14 and Figure 23) that an increase in the share of total household income from wages by 1%, decreases the likelihood that members of that household consume >150% of the Calorie ADER, 0.43%; while an increase in the ratio of dependents to adults of 1, would make members of that household 50% less likely to consume a diet containing >150% of ADER. In contrast an increase in the share of income from subsistence by 1% results in an 0.43% reduction in likelihood of household member consuming a diet containing >150% of the ADER. A household headed by a female is 15% more likely to provide its members a diet containing more than 150% of the Calorie ADER; while a household using modern cooking fuel types (gas, electricity, kerosene and charcoal) are 30% more likely to provide its members a diet containing more than 150% of the Calorie ADER.

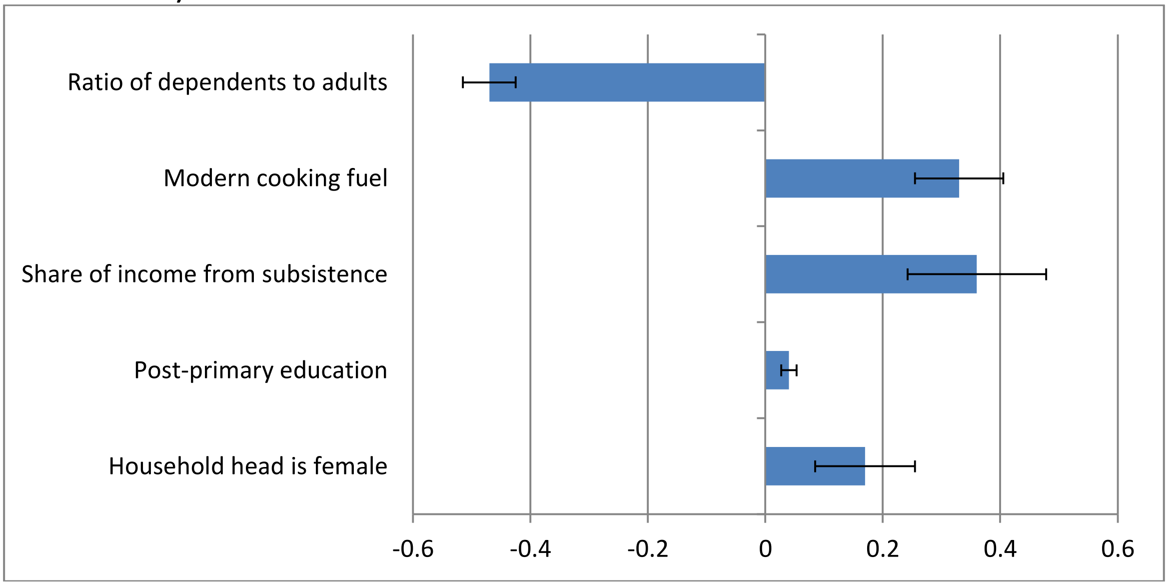
Figure 23: Significant marginal effect of household factors on member calorie intake >150% of ADER (with standard errors)



5.4 Household member sodium intake is >150% of UL

Table 14 indicates that 5 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides more than 150% of the UL for sodium. The gender of the household head being female, the education of the household head, the share of income from subsistence and type of cooking fuel used by the household all have a significant positive effect on the dependent variable; while the ratio of dependents to adults has a significant negative effect (Figure 24). The results show (Table 14 and Figure 24) that an increase in the ratio of dependents to adults of 1 would make members of that household 47% less likely to consume a diet containing 150% of UL for sodium. In contrast an increase in the share of income from subsistence by 1% results in a 0.36% increase in likelihood of household member consumes a diet containing 150% of the UL for sodium. A household headed by a female is 17% more likely to provide its members a diet containing more than 150% of the UL for sodium; while a household using modern cooking fuel types (gas, electricity, kerosene and charcoal) is 33% more likely to provide its members a diet containing more than 150% of the sodium UL. Finally a household where the head has obtained a post-primary level of education or higher is 4% more likely to provide its members with a diet containing more than 150% of the UL for sodium.

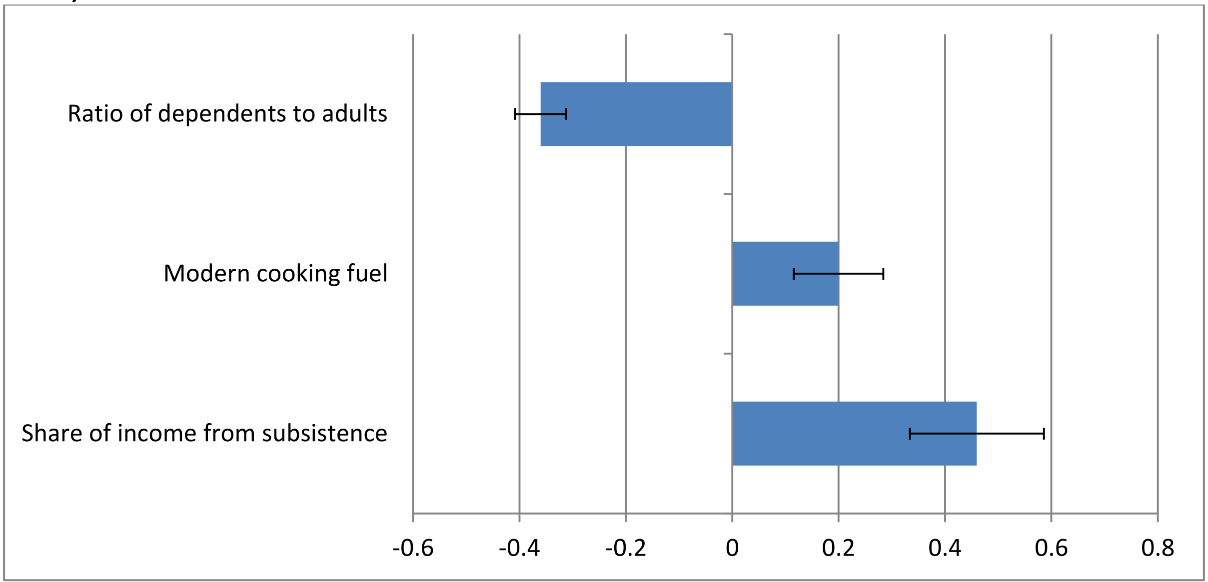
Figure 24: Significant marginal effect of household factors on member sodium intake >150% of UL (with standard errors)



5.5 Household member intake of fat is >150% of UL

Table 14 indicates that 3 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides more than 150% of the UL for fat. The share of income from subsistence, the type of cooking fuel used by the household both have a significant positive effect on the dependent variable; while the ratio of dependents to adults has a significant negative effect (Figure 25). The results show (Table 14 and Figure 25) that an increase in the ratio of dependents to adults of 1 would make members of that household 36% less likely to consume a diet containing 150% of UL for fat. In contrast an increase in the share of income from subsistence by 1% results in a 0.46% increase in likelihood of household member consumes a diet containing 150% of the UL for fat. A household using modern cooking fuel types (gas, electricity, kerosene and charcoal) is 20% more likely to provide its members a diet containing more than 150% of the UL for fat.

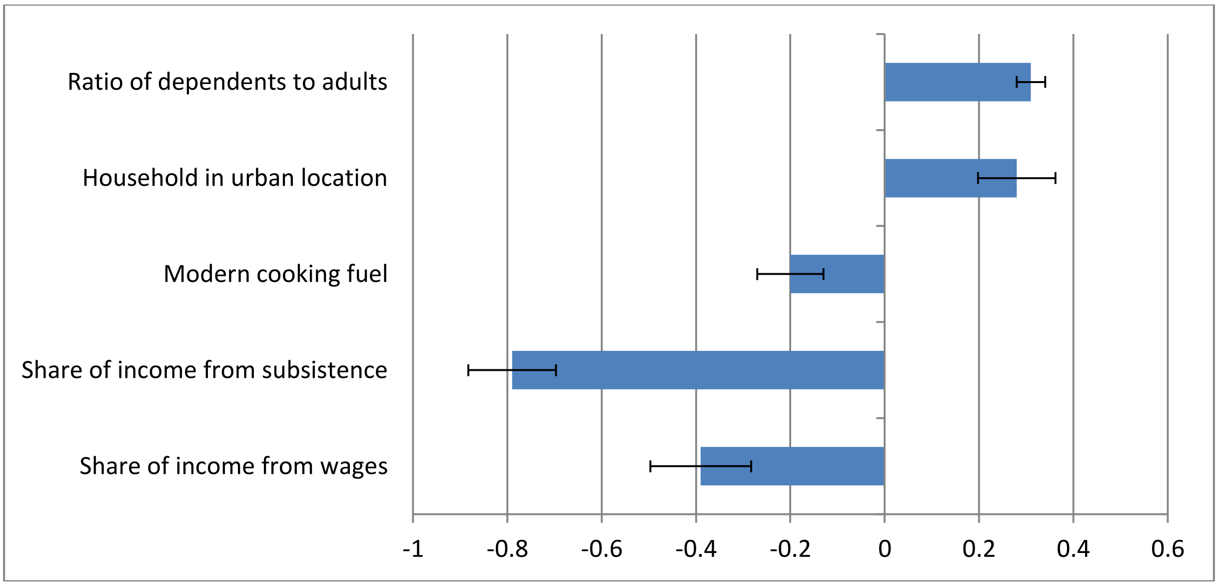
Figure25: Significant marginal effect of household factors on member fat intake >150% of UL (with standard errors)



5.6 Dependent variable is household member intake of protein is less than 50% of RDI

Table 14 indicates that 6 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides less than 50% of the RDI for protein. The education level of the household head, the share of income from wages, the share of income from subsistence, the type of cooking fuel used by the household all have a significant negative effect on the dependent variable; while the ratio of dependents to adults and urban location of the household both have a significant negative effect (Figure 26). The results show (Table 14 and Figure 26) that an increase in the ratio of dependents to adults of 1 would make members of that household 31% more likely to consume a diet insufficient to provide 50% of RDI for protein; while an urban household is 28% more likely to consume a diet insufficient to provide 50% of RDI for protein. In contrast an increase in the share of income from subsistence by 1% results in a 0.79% decrease in likelihood of household member failing to consumes a diet containing 50% of the RDI for protein; whilst an increase in the share of income from wages by 1% also results in a decrease in likelihood of household member failing to consumes a diet containing 50% of the RDI for protein – by 0.39%. A household using modern cooking fuel types (gas, electricity, kerosene and charcoal) is 20% less likely to provide its members a diet containing less than 50% of the RDI for protein. Finally a household where the head has obtained a post-primary level of education or higher is 2% less likely to fail to provide its members with a diet containing 50% of the RDI for protein.

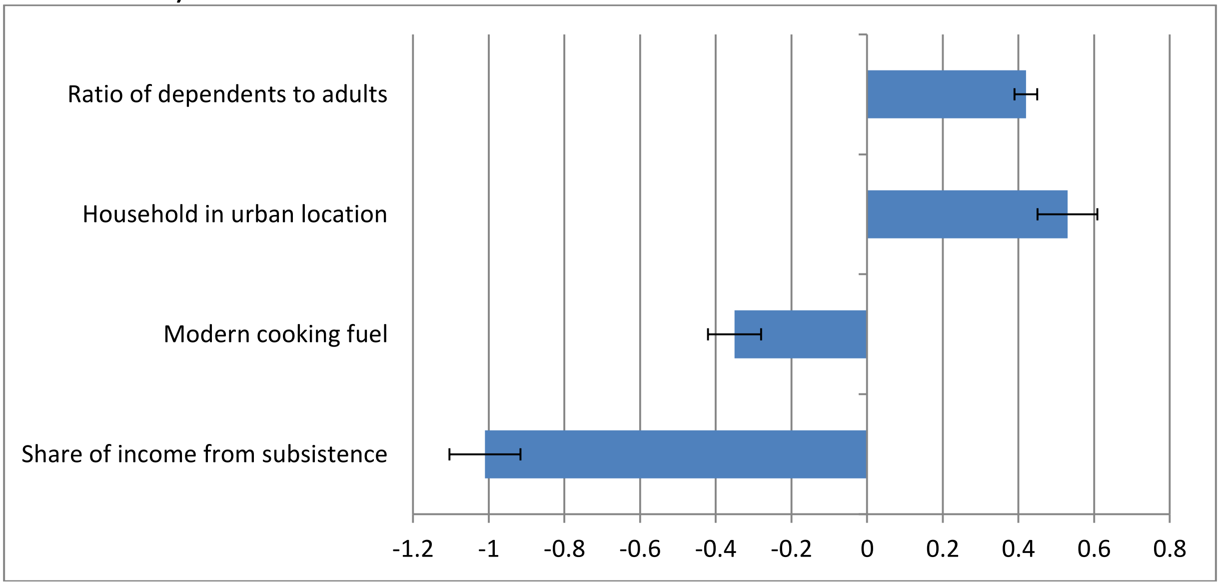
Figure 26: Significant marginal effect of household factors on member protein intake <50% of RDI (with standard errors)



5.7 Household member intake of iron is <50% of RDI

Table 14 indicates that 5 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides less than 50% of the RDI for iron. The education level of the household head and the share of income from subsistence, the type of cooking fuel used by the household all have a significant negative effect on the dependent variable; while the ratio of dependents to adults and urban location of the household both have a significant negative effect (Figure 27). The results show (Table 14 and Figure 27) that an increase in the ratio of dependents to adults of 1 would make members of that household 42% more likely to fail to access a diet providing 50% of RDI for iron; while an urban household is 53% more likely to fail to provide its members a diet containing 50% of RDI for iron. In contrast an increase in the share of income from subsistence by 1, results in a 101% decrease in likelihood of household member failing to consumes a diet containing 50% of the RDI for iron. A household using modern cooking fuel types (gas, electricity, kerosene and charcoal) is 35% less likely to fail to provide its members a diet containing 50% of the RDI for iron. Finally a household where the head has obtained a post-primary level of education or higher is 2% less likely to fail to provide its members with a diet containing 50% of the RDI for iron.

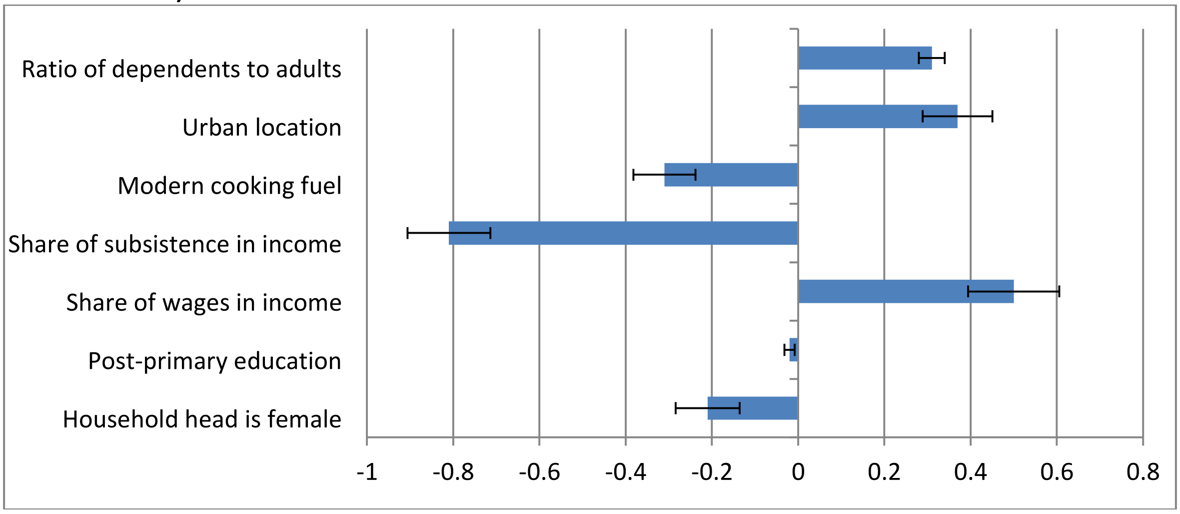
Figure 27: Significant marginal effect of household factors on member iron intake <50% of RDI (with standard errors)



5.8 Household member intake of vitamin A is < 50% of RDI

Table 14 indicates that 7 independent variables have a significant marginal effect on the dependent variable: household members having access to a diet which provides less than 50% of the RDI for vitamin A. The gender of the household head being female, the education level of the household head, the share of income from subsistence, the type of cooking fuel used by the household all have a significant negative effect on the dependent variable; while the share of income from wages, the ratio of dependents to adults and urban location of the household both have a significant negative effect (Figure 28). The results show (Table 14 and Figure 28) that an increase in the ratio of dependents to adults of 1 would make members of that household 31% more likely to consume a diet insufficient to provide 50% of RDI for vitamin A; that an urban household is 38% more likely to consume a diet insufficient to provide 50% of RDI for vitamin A; while an increase in the share of income from wages by 1, will result in a 50% increase in the likelihood that household access a diet insufficient to provide 50% of RDI for vitamin A. In contrast an increase in the share of income from subsistence by 1, results in a 81% decrease in likelihood of household member failing to consumes a diet containing 50% of the RDI for vitamin A. A household using modern cooking fuel types (gas, electricity, kerosene and charcoal) is 31% less likely to fail to provide its members a diet containing 50% or more of the RDI for vitamin A. A household headed by a female is 21% less likely to fail to provide its members a diet containing 50% or more of the RDI for vitamin A. Finally a household where the head has obtained a post-primary level of education or higher is 2% less likely to fail to provide its members with a diet containing 50% of the RDI for vitamin A.

Figure 28: Significant marginal effect of household factors on member vitamin A intake <50% of RDI (with standard errors)



5.9 Discussion of results

An increase in the ratio of dependents to adult is a significant factor in all 8 equations tested in Table 14, having a negative impact on household member access to an adequate diet and to a diet that satisfies each of the minimum (50% of ADER and RDI) macro and micronutrient thresholds; yet also having a negative impact on households having a diet which surpasses 150% of the safe UL for fat and sodium, and for the Calorie ADER.

In contrast, a higher share of income from subsistence has the opposite impact – having a significant effect in each regression, by reducing the likelihood that households will fail to provide a diet surpassing each of the minimums, yet also by increasing the likelihood that households consume more than the 150% of the UL for fat and sodium, and 150% the ADER for calories.

A higher income share from wages decreased the likelihood that members of a household had access to a diet which satisfied all the minimum and maximum nutrient thresholds, and decreased the likelihood of supplying a diet which satisfied 50% or more of the RDI for vitamin A. However it also reduced the likelihood that household members would consume more than 150% of the ADER for calories, or fail to provide 50% of the RDI for protein.

Household urban location has a significant impact on the failure to access an adequate diet, and to access 50% of the ADER and RDI for each of the macro and micronutrients, without having a significant effect on household dietary intake in excess of 150% of UL for fat and sodium, or Calorie intake.

Access to modern cooking fuels did not have a significant effect on increasing or decreasing the likelihood that the household has access to a sufficient diet that satisfies all the nutrition thresholds, but it does reduce the likelihood that households will fail to consume more than 50% of the ADER and RDI thresholds for each nutrient type; as well as contributing to households having an intake of calories, fat and sodium greater than 150% of the UL for these macro and micronutrients.

Household head education levels (attainment of post-primary qualification) did not have a significant marginal effect on a household's likelihood of consuming a diet which satisfied all the minimum and maximum nutrient thresholds. Higher household head educational attainment did reduce the likelihood of its members failing to access at least 50% of the RDI for protein, iron and vitamin A and of the ADER for calories, yet it also increased the likelihood that household members would consume 150% of the UL for sodium and the ADER for Calories.

Finally, having a household head whose gender was female reduced the likelihood the household would fail to access a diet which provided 50% of the RDI for vitamin A, or 50% of the Calorie ADER. However, it also increased the likelihood that the household would access a diet providing more than 150% of the UL for sodium or ADER for Calories.

These findings indicate that policy-makers looking to reduce vitamin A and iron deficiency should target urban households with multiple dependents to every working adult who have a low share of household income (less than 20%) from subsistence. The evidence for targeting interventions aimed at reducing fat and sodium consumption are less clear, with households with a high share of income from subsistence – rather than wages, or based in an urban location, as is often assumed – more closely correlated with these outcomes. This is in large part due, it seems, to their higher overall consumption of food. However, we will compare the average food baskets of households in urban and rural areas, and those satisfying the minimum and maximum nutrition thresholds, in the next section.

6. Average food basket consumed by sample population, and different sub-populations

6.1 Average Vanuatu household food basket by share of household expenditure and nutrient intake

Table 15: Average Vanuatu household food basket (shares of household expenditure and nutrient intake)

Food Item	Expenditure	Calories	Protein	Total Fat	Sodium	Iron	Vit. A
Rice	9.6%	7.7%	4.2%	0.0%	0.6%	0.0%	0.0%
Bananas (Cooking)	8.7%	11.8%	4.4%	0.0%	0.3%	18.5%	2.7%
Island Taro/ Taro Fiji	6.6%	5.8%	3.9%	0.0%	0.4%	8.4%	0.3%
Manioc	5.2%	7.3%	1.7%	1.8%	0.3%	0.0%	0.0%
Island Cabbage	4.7%	0.5%	2.3%	0.6%	0.5%	4.9%	33.4%
Kumala	4.1%	4.2%	1.2%	0.0%	2.2%	5.1%	31.4%
Bread	4.1%	4.3%	5.6%	1.8%	15.4%	2.4%	0.0%
dry Coconut / Copra	3.2%	10.1%	3.6%	34.1%	1.7%	5.0%	0.0%
Yam	3.1%	1.7%	1.7%	0.0%	0.1%	3.6%	0.5%
Tinned Meat	2.5%	1.3%	5.7%	2.4%	3.7%	2.1%	0.7%
Mangoes	2.3%	1.2%	0.6%	0.0%	0.1%	0.0%	5.4%
Water Taro	2.2%	1.6%	0.7%	0.0%	7.5%	2.8%	0.1%
Tinned Tuna	2.1%	0.4%	2.8%	0.3%	7.0%	0.5%	0.1%
Sugar	1.9%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Beef fresh	1.7%	2.4%	12.9%	3.3%	1.3%	5.6%	0.0%
Laplap (Yam, manioc, etc..)	1.6%	1.4%	0.3%	0.3%	2.1%	0.0%	0.0%
Cabin Biscuits	1.6%	3.2%	1.9%	4.5%	7.4%	1.9%	0.2%
Chicken (chicken parts)	1.5%	1.4%	6.5%	3.2%	0.8%	1.0%	0.6%
Chicken/ Local chicken	1.5%	1.3%	3.8%	2.7%	1.0%	1.0%	0.2%
Paw paws	1.3%	0.5%	0.3%	0.0%	0.0%	1.4%	0.3%
Pineapples	1.2%	0.6%	0.4%	0.0%	0.1%	1.6%	1.4%
Cream cracker, biscuits	1.2%	1.5%	0.4%	2.1%	1.5%	1.6%	0.1%
Noodles	1.1%	0.6%	0.6%	0.9%	3.8%	0.9%	0.1%
Plate of food/ Take away	1.0%	0.6%	1.5%	1.8%	0.0%	3.2%	1.9%
Corn	1.0%	0.6%	1.5%	0.2%	2.2%	0.7%	0.3%
Crabs	1.0%	1.0%	2.7%	0.2%	0.7%	1.0%	0.0%
Green Coconut	.9%	0.4%	0.5%	0.1%	1.7%	0.9%	0.0%
Doughnuts, Kato	0.9%	1.3%	0.8%	0.0%	3.5%	0.0%	0.0%
Cooking oil (incl. salad oil)	0.8%	2.8%	0.8%	11.1%	1.8%	0.5%	0.0%
Peanuts	0.5%	0.5%	2.5%	4.7%	0.0%	0.8%	0.0%
TOTAL	**79.1%**	**81.6%**	**75.8%**	**76.1%**	**67.70%**	**75.40%**	**79.70%**

Table 15 shows that rice represents the largest share of an average Vanuatu household's expenditure on food (9.6%). However this Table also shows that cooking bananas provide the most important source of calories in a household's diet (11.8%). While rice provides an important source of both calories and protein, it contributes no value to the diet in terms of other essential micronutrients – specifically iron and Vitamin A. In contrast, cooking bananas provides the most important source of iron (18.5% share), and the fourth most important source of Vitamin A (2.7%). Similarly, local root crops such as taro and manioc (cassava) are also not only very important sources of household food expenditure (3rd and 4th in terms of share of total expenditure) but, are critical sources of calories – manioc providing 7.3% of total household calories, and taro 5.8%. Taro is the second most import source of iron (8.4%). Island cabbage and kumala (sweet potato) are the 5th and 6th most important food items in terms of their share of total expenditure, but critical sources of Vitamin A, providing the first and second most important source of this micronutrient – together accounting for almost 65% of the present intake of this micronutrient. They also provide the 4th and 5th most important source of iron – together accounting for almost 10% of total household iron intake – whilst kumala also contributes an important share of total household calorie consumption.

Table 15 indicates that just 3 of the top 10 food items (in terms of share of expenditure) are imported: rice, bread and tinned meat. Bread is the food item with the 7th largest share of total expenditure (4.1%), providing a 4.3% share of calories and 5.6% share of protein in average household diets. However the most important contribution made by bread to household diets, is to sodium consumption: bread is the single largest source of sodium in household diets, with a 15.4% share. Cabin biscuits, tinned tuna, instant noodles and tinned meat, provide the second, third, fourth and fifth largest share of household sodium consumption (contributing 7.4%, 7.0%, 3.8% and 3.0% respectively).

Dried coconut, or copra, is the third most important source of calories in household diets, with a 10.1% share – despite representing only 3.2% of expenditure. Coconut is also the single most important source of fat in household diets, contributing 34.1% of the total. This result indicates that while imported foods are often considered to be unhealthy, not all poor health outcomes can be attributed to imported foods; and not all local foods are 'healthy,' given that coconut (and particularly, coconut cream) consumption is the major contributor to household fat consumption. Cooking oil provides the second largest share of household fat consumption, contributing an 11.1% of fat intake, despite representing less than 1% of total expenditure. Peanuts provide the third largest source of fat in the diet, contributing just under 5% of total fat despite being only 0.5% of total expenditure.

Fresh beef, whilst representing only a 1.7% share of average household expenditure and 2.4% of calories, provides the most important share of protein in Vanuatu household diets: 12.9% of total protein consumption. In contrast to dried coconut, fresh beef contributes relatively little fat to household diets: 3.3% of total fat consumption. In addition, fresh beef contributes the third most important source of household iron, accounting for 5.6% of total iron intake.

Imported chicken parts – just 1.5% of expenditure and 1.4% of total calorie consumption – is the second most important source of protein, contributing 6.5% of household protein intake. Chicken parts also contribute just 2.7% to household fat consumption.

In contrast tinned meat, representing a 2.5% share of expenditure, provided only 1.3% share of total calorie consumption and a 5.6% of household protein consumption. It also contributed some 7.7% of household sodium consumption – the third largest of any food item – whilst contributing 2.4% of fat (6th largest by share).

These results indicate that seven on the top ten food items, by share of household expenditure, are locally source products – though rice is single item with the largest share of expenditure (9.6%). Local food products provide the most important source of calories (cooking bananas), protein (fresh beef), iron (cooking bananas) and Vitamin A (island cabbage, followed closely by kumala/sweet potato). They also provide the single most important source of fat (34.1%) in household diets: dried coconut, used for making coconut cream. The major sources of sodium in household diets were all imported products, with bread, cabin biscuits, tinned meat and instant noodles together contributing 36.6% of sodium.

6.2 Average rural and urban Vanuatu household food basket by share of household expenditure (Top 10 items)

Figure 29 provides the potential for comparison between the top 10 food items, by share of expenditure, between the food baskets of urban and rural households.

Figure 29: A comparison of the Top 10 food items (by share of expenditure) for urban households with share of expenditure on those items for rural households

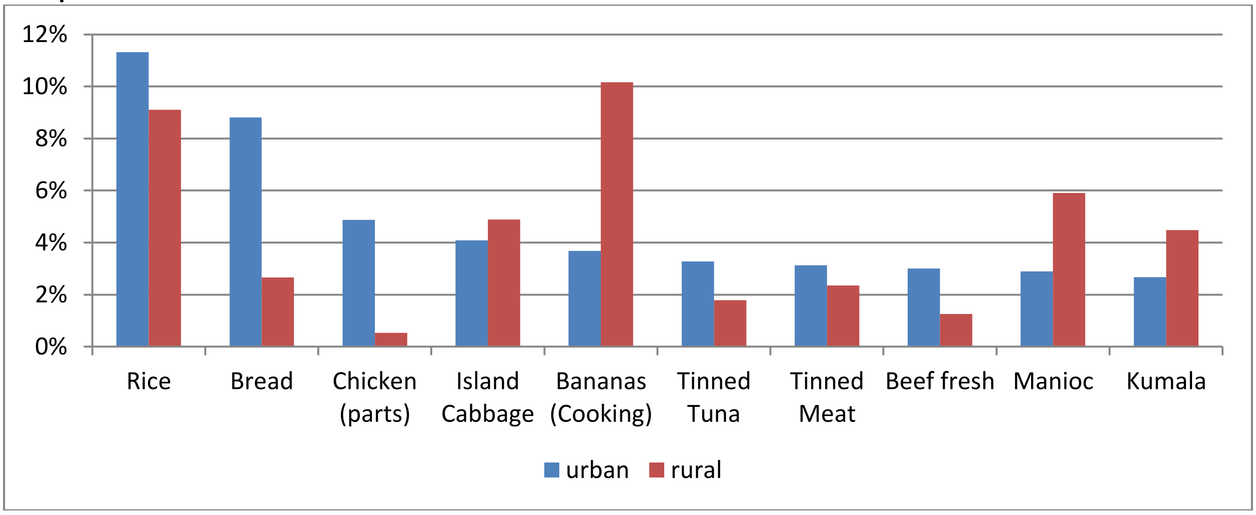


Figure 29 indicates that while rice is the most important expenditure item for urban households, cooking bananas are the most important item (by share of expenditure) for rural household. The second most important item by share of expenditure for urban consumers is bread – though this is far less important in the food basket of rural consumers. Similarly, chicken parts are the third most important expenditure item for urban households, but represent a comparatively small part of rural households' food expenditure. Rural households spend less on other fresh beef and tinned meat products: tinned tuna, and tinned meat. In contrast, rural households spend far more –as a share of total food expenditure – on local root crops manioc and kumala, and on local leafy greens: island cabbage. More information on the total micro and macronutrient contributions of the top 30 food items (by expenditure) for both urban and rural households is provided in the tables in Annex 1.

6.3 Average food basket (top 10 food items by share of expenditure) of households satisfying, and not satisfying, recommended minimum and maximal nutritional thresholds

Figure 30 provides the potential for comparison between the top 10 food items, by share of expenditure, between the food baskets of households who provide their members with a diet that satisfies all the minimum and maximum nutrition thresholds, with one that fails all the minimum and maximum nutrition thresholds.

Figure 30: A comparison of the Top 10 food items (by expenditure) for households satisfying all nutrient intake thresholds, with share of expenditure on these items by households failing all nutrient intake thresholds

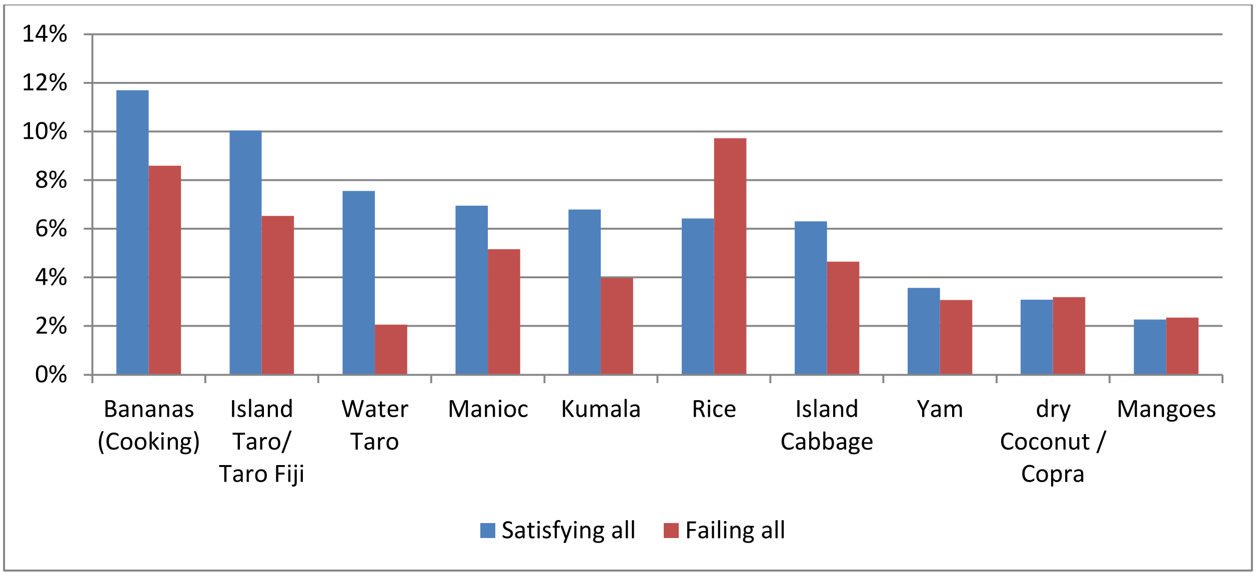


Figure 30 indicates that households which consume a diet that satisfies all the macro and micronutrient minimum and maximum thresholds, is one for whom local starches (cooking bananas, root crops such as 'Fijian' taro, water taro, manioc/cassava and kumala) represent the major expenditure items. For these households, rice is far less important as an expenditure item than for those households failing the nutrient intake thresholds. The top 10 expenditure items for households satisfying all the nutrient thresholds does not include any meat products – tinned or fresh – with much of the protein provided by root crops, cooking bananas and dried coconut; and iron provided by root crops and island cabbage. Kumala and island cabbage provide an immensely important, and relatively cheap, source of vitamin A in this diet. Households failing the nutrient intake thresholds spend far less on nearly all these item.

In the next section, we will explore what mix of food items (food basket) could assist households to reach these recommended energy and nutrient intake thresholds, at the lowest possible cost. This information will help inform the policy and programme interventions required to ensure improved dietary outcomes, without negatively impacting household welfare.

7. Establishing a Nutritious Food Basket for Vanuatu

Identifying the lowest cost basket of food items which also helps households satisfy their minimum nutrition needs, without surpassing the maximal thresholds, would help national authorities monitor individual food items for price changes and availability, and develop programme and policy interventions in order to improve access or reduce cost. Choosing a diet with the right mix of cheap calories, without sacrificing good nutrition across the range of other categories, is therefore something that needs to be established. Table 16 below illustrates the unit value of the top food items consumed in Vanuatu, by kg, kcal, gram of protein and fat, milligram of sodium and iron, and microgram of vitamin A.

Table 16: Food items cost (Vt) per micronutrient

Food Item	Vt/Kg	Vt/kcal	Vt/Protein (g)	Vt/Fat(g)	Vt/Sodium(mg)	Vt/Vit. A(ug)	Vt/iron(mg)
Rice	190.0	2.26	139.0		55.6		
Bananas (Cooking)	166.7	1.33	119.7		59.8	14.1	119.7
Island Taro/ Taro Fiji	146.3	2.10	101.7		7.3	101.7	203.4
Manioc	133.3	1.29	190.3	190.3	7.3		
Island Cabbage	348.0	15.87	123.0	492.0	27.3	0.6	246
Bread	300.0	1.69	43.9	146.3	0.6		439
Kumala	144.6	1.74	204.1		4.5	0.6	204.1
dry Coconut / Copra	661.8	0.56	53.2	5.9	10.0		159.7
Yam	174.4	3.37	109.6		73.1	24.4	219.2
Tinned Meat	430.1	3.46	26.8	68.3	0.9	15.8	303.3
Mangoes	173.1	3.67	249.5		83.2	1.9	
Tinned Tuna	816.3	9.10	45.1	495.9	2.5	66.1	991.7
Water Taro	146.3	2.55	201.4		2.8	67.1	201.4
Sugar	403.5	0.94			370.3		
Beef fresh	202.2	1.28	7.8	32.5	3.1		75.7
Cabin Biscuits	352.9	0.89	51.2	22.8	0.5	37.2	204.8
Laplap (Yam, manioc,..)	463.3	2.14	322.5	322.5	15.4		
Chicken (chicken parts)	414.7	1.90	14.2	36.1	4.1	39.7	397.1
Chicken/ Local chicken	410.9	2.18	23.8	30.6	4.8	35.6	427.7
other fish	250.0	3.33	18.3	121.9	5.0	11.8	365.8
Watermelon	188.7	11.41	273.9		68.5	21.1	
Cream cracker, biscuits	597.8	1.39	79.5	35.3	0.8	57.8	318
Paw paws	147.0	4.20	214.4		35.7	3.6	214.4
Pineapples	125.0	3.43	181.9		91.0	60.6	181.9
Noodles	495.1	3.32	109.6	82.2	0.3		328.8
Plate of food/ Take away	450.0	2.95	41.2	36.6	1.2		82.3
Corn	263.2	3.26	126.0	378.1	22.2	15.1	378.1
Doughnuts, Kato	472.6	1.31	69.6	23.2	1.3	97.4	487

Green Coconut	283.4	14.40			38.4		
Cooking oil	382.6	0.52		4.6			
Peanuts	1097.0	0.57	13.0	6.9	326.2		163.1
Butter/margarine	144.58	1.52	1104.1	13.6	1.5	1.2	

The information in Table 16 helps us to identify that whilst some food items are particularly efficient at providing one form of energy or nutrient type, they may not satisfy other nutrient requirements. For example, Table 24 reveals that cooking oil is the lowest cost method – per unit (volume) cost – of providing calories to a household; however it is also very high in fat, and therefore a high rate of consumption of cooking oil in order to increase calorie consumption, has negative consequences for fat consumption. Dried coconut is the next lowest cost source of calories - though similarly high in fat content (though less than cooking oil) and sodium. Dried coconut has the advantage of being high in protein, as well as of Vitamin A. Thus, while cooking oil is a cheaper source of calories, and therefore a more efficient mechanism for raising total calorie consumption at the cheapest cost, it is less helpful for household fat and sodium consumption, and contributes little to micronutrient consumption. Compared to cooking coil and dried coconut, Table 16 reveals that peanuts are at the same time an efficient source of calories - just 5 Vatu per calorie more expensive than cooking oil, and 1 vatu per calorie more expensive than coconut - as well as the second most efficient source of protein source of protein (13 Vatu per gram) after fresh beef, whilst also a low cost source of Vitamin A. However peanuts are also high in fat, and therefore cannot be eaten in too high quantities. Cabin biscuits, whilst more expensive per calorie than the aforementioned three, are also a cheap source of protein whilst relatively low in fat – yet extremely high in sodium. Bread is a a far more expensive source of calories than the aforementioned – though cheaper than rice. Bread has the advantage of being a good source of protein and low in fat, but also the disadvantage of being high in sodium and providing little in the way of Vitamin A or iron. Cooking bananas - whilst more than twice the price per calorie of cooking oil, coconut or peanuts - provide a lower cost source of iron and vitamin A, as well as being low in fat and sodium.

Table 16 also helps us to identify that beef is a lower cost source of calories, protein and vitamin A - whilst lower in sodium - than tinned meat or imported chicken parts. It helps us identify that local 'leafy green' vegetables such as island cabbage, and local root crops such as kumala, are by far and away, the lowest cost source of vitamin A.

7.1 The optimal food basket

To identify a low-cost bundle of food that meets all the daily recommended nutrient intakes, and the total cost of purchasing that bundle, we took the unit cost information in Table 16 and fed it into the linear programming method described in section 3.11 (and Annex 2). The results of this method are presented in Table 17.

Table 17: Optimal Food Basket

Name	Vt/kg	Consumption (g)	Expenditure (Vt)	Required decrease (Vt/kg)	Required decrease % change	Allowable Increase (Vt/kg)	Allowable Increase % change
Bananas (Cooking)	150	587.97	88.20			5.3	3.5
Island Cabbage	132	315.99	41.71			9.9	7.5
Cabin Biscuits	353	191.47	67.59			71.5	20.3
Peanuts	382	166.33	63.54			18.5	4.8
Water Taro	146	0		6.7	4.6		
Manioc	133	0		9.5	7.1		
Bread fruit	109	0		10.5	9.6		
Kumala	145	0		32.9	22.7		
Other fresh fruits n.e.c	75	0		33.6	44.8		
Ripe Bananas	127	0		36.8	29.0		
Pumpkin	88	0		43.4	49.3		
Island Taro/ Taro Fiji	146	0		52.2	35.8		
Bread (sliced, loaf, rolls)	300	0		62.4	20.8		
Beef fresh	201	0		64.9	32.3		
Sugarcane	128	0		67.6	52.8		
TOTAL		**1261.76**	**261.4**				

Table 17 indicates that households could meet all their food energy (kcal, fat) and nutrient requirements (protein, iron and vitamin A) by consuming 1.261kg per day of just four food items: cooking bananas, island cabbage, cabin biscuits and peanuts. The per capita daily quantities to be consumed of each are given in the table: 587 grams of cooking banana, 315 grams of island cabbage, 191 grams of cabin biscuit and 166 grams of peanuts. The cost of this optimal basket of goods would be just **261.4 Vatu, indicating that the minimum cost of a diet that met all of the food energy and nutrition needs of an adult male in Vanuatu, would cost just over US$2.53[58], a day (in 2010 prices)**.

Whilst these quantities of the four food items selected in Table 17 would satisfy an individual's recommended food energy and nutrition needs, a small change in the price of these items or those of potential substitutes, would have a significant impact on the food items or quantities included in the optimal basket of goods. Column six of Table 17 indicates the 'allowable increase' in the unit price of the four items currently included in the optimal basket, before they would be substituted by another item, all things remaining equal. Thus, column six indicates that a small increase in the price of cooking bananas – an increase of just 5.3 vatu per kilogram - would result in the substitution of cooking bananas by some other source(s) of calories and iron. Similarly, a small increase in the price of island cabbage – 9.9 Vt/kg – would see this important source of locally produced Vitamin A removed from the list. The price of peanuts could increase by up to 18 Vt/kg before this important source of energy and protein (as well as fat) is replaced by other items; whilst the allowable increase

[58] Based on exchange rate of 1 US$=103. 050 Vt, provided by xe rates www.xe.com/currecnyconverter 22/5/2015

for cabin biscuits is considerably higher: 71.5 Vt/kg. In contrast, column five indicates the 'required decrease' in price before food items not currently included in the optimal basket of goods, would be substituted into the optimal food basket. This column indicates that there are a large number of local fruit and vegetable commodities which would contribute to an optimal diet, if a small decrease in price could be achieved. In particular, a small decrease in the unit price of four local starches – water taro, breadfruit, manioc and kumala – would see them included in the 'optimal' basket of food items. Indeed, a reduction in the unit price of water taro, breadfruit and manioc of between 5 and 10% would see these items included in the optimal basket; whilst the price of kumala would have to be reduced by 23% before it would be included.

Whilst the unit prices included in this paper are derived from the average unit prices records in the Consumer Price Index, there is significant variation in the price of fresh products like breadfruit or cooking bananas, depending on location and season. Therefore it is conceivable that households in urban areas far from the major production sites of cooking bananas would face a higher price than the unit cost given here – particularly during winter months. Similarly, fluctuations in international commodity prices and food manufacturing changes impact the price of imported goods – as was seen in 2007 and 2008, when the price of cereals (rice, wheat and maize) skyrocketed, driving up consumer prices.

One striking feature of the optimal basket of food items is the absence of many of the goods that represent such a large share of household food expenditure (particularly among urban households): rice, bread and chicken pieces. This indicates that consumer preferences and convenience in terms of food preparation and storage, are also important considerations influencing food choices and nutrition intake levels, in addition to price.

Another feature of the optimal basket of goods is that the linear programming model used to select food items did not include a preference for variety, but for simplicity: identifying the minimum quantity of the minimum number of food items required to meet the minimum and maximum food energy and nutrition thresholds. Consumers also often value variety when making food selection, once they have sufficient disposable income to allow themselves this liberty. Thus, four food items are unlikely to satisfy this preference for variety.

While the cost of an 'optimum basket of goods' is slightly higher than the 'Cost of Basic Needs' Food Poverty Line (FPL) for Vanuatu (UNDP 2012), which established a minimum requirement of 2100 calories per adult male per day at a cost of 168 Vatu or US$1.63, one could argue that - given this estimate of nutrient intake fails to consider the real activity levels or non-calorie intake requirements of an average Vanuatu household member - an FPL of 2100 calories is not a realistic threshold against which to assess household food and nutritional security levels.

Whilst the selection of an optimal basket of food items (with allowances made for substitution based on price changes) is important to help national authorities prioritise interventions around the food items that will help Vanuatu's population maintain a healthy diet, adopting and monitoring the cost of a Nutritious Food Basket that includes a wider variety of food commodities would be more beneficial than focusing only on these 'optimum' food items.

This policy option will be explored along with other potential policies and programme interventions in the next section.

8. Policy implications and potential interventions

The evidence presented in this paper illustrates that substantial sub-populations fail to meet their minimum food energy and nutrition intake needs. In particular, many urban households and households with large numbers of dependents suffer from low rates of energy, iron or vitamin A intake. This paper also presents evidence that there are a large number of locally produced commodities which are rich in the required micronutrients and in calories, at low unit cost. Subsequently improving access to these commodities amongst at risk groups either by increasing their affordability, or through direct provision, will be critical to improving diet and health outcomes**.** This section explores some policy options and programme interventions for achieving this outcome.

Government can change the price of food consumers pay through the implementation of a range of policy and programme options. FAO promotes three main categories of country level actions in order to improve access to low-cost nutritious foods: 1) trade and market related measures; 2) measures to facilitate access to affordable food by consumers; and 3) measures to increase food production.

Trade and market related measures

The relative price levels of substitutable food items have an important influence on household purchasing decisions. Therefore rapid changes in prices, such as the increase in food prices seen in 2007 and 2008 caused by climbing global commodity prices, can lead to significant changes in purchasing behaviour.

Interventions to reduce the costs associated with price volatility can be divided into two types. First, there are interventions that reduce price volatility, such as improving market information. Information on the current situation and outlook for global agriculture shapes expectations about future prices and allows markets to function more efficiently. Conversely, lack of accurate information on market prices – both at the local and international level - may reduce efficiency and accentuate price movements.[59] Monitoring local food prices, through local market information systems, is another essential component of a food market monitoring system. Linking this information to food Consumer Price Index and regularly analyzing long-term and seasonal price change trends, is important to increasing both consumer awareness, and for increasing the confidence of local agriculture sector stakeholders to identify additional market opportunities.

Facilitating improvements in post-harvest handling and marketing efficiencies in order to reduce the cost of locally produced goods high in iron, vitamin a and protein (cooking bananas, island cabbage and kumala, fresh beef and reef fish) in urban areas, will also be critical to encouraging substitution of these items into their diets.

Investment in reducing the cost of transportation by sea would reduce the substantial cost of marketing agricultural produce from outer islands to urban centres. Inefficiencies in inter-island shipping are widely recognized as a significant impediment to improving supply chain efficiency for agricultural products. Issues include poor frequency of service on some routes, high freight costs, inadequate berthing and loading facilities, as well as poor onboard storage for fresh produce

[59] FAO (2011) *The State of Food Insecurity in the World*, FAO: Rome

(particularly cold storage). These obstacles result in higher priced and poorer quality products arriving on urban domestic markets, and reduce incentives for outer-island farmers to produce beyond local needs. Consequently, government has prioritized actions targeted to address shipping inefficiencies. The Vanuatu Inter-island shipping project address infrastructure needs (wharfs, jetties etc.), and is piloting the subsidization of shipping on uneconomic inter-island routes such as to Tanna, and to Northern Santos and the Banks. This program is unlikely to have a significant impact on freight charges for fresh produce from most locations. The destinations to benefit from the subsidy are also not major producers of agricultural produce for marketing to Port Vila or other markets, and therefore will do little to alleviate the high cost of freight for farmers selling their produce to other islands. To address the high freight charges faced by the major agricultural producing islands to the near north of Efate, a more targeted shipping subsidy program should be considered. An approach might be to use a freight voucher system to target groups or individuals who have the capacity to trade and ship significant quantities of fresh produce to urban markets.[60]

High rates of losses due to poor post-harvest handling practices (from on-farm to transportation to market) and storage also drive up the prices of locally produced goods for consumers. Simple advice on proper harvesting techniques (time of day for harvesting, crop cooling with water etc.) and appropriate packaging for transport (e.g. reusable plastic crates, see photos below), together with some strategically placed cool holding facilities (e.g. solar cooled reefer containers) could significantly enhance product shelf life and quality. One simple technology for reducing fresh produce loss rates and transportation costs is the adoption of plastic field crates for shipping, and charge a flat rate per crate. The crates would hold more volume than a local basket, are much more convenient to carry and can be stacked vertically so as to take up less deck space and volume on board ship. They would also better protect the contents from damage and bruising in transit. The introduction of a pilot crate freighting system should be explored in order to identify the impact on total freight charges levied on the agriculture sector, and on the freight revenue stream of shipping companies.[61] The Government of Vanuatu could, if this pilot scheme results in a positive outcome for both parties, work with private sector shipping companies to introduce this scheme across all the major shipping routes between islands. In addition, the lack of cold storage facilities available to farmers and shipping agents significantly increases post-harvest losses. Recognizing the high cost and unreliability of mains power, purpose adapted reefer containers with solar generated power would seem to be a worthwhile option for provision of cool storage facilities (see photos below). While several commercial companies offer custom made products these could also possibly be fabricated from second-hand reefer containers in-country.[62]

Farmer organizations can also help reduce the final cost of locally produced goods for consumers, by engaging in group marketing strategies which reduce the unit cost of transporting goods.[63] However farmer organisations in remote rural areas traditionally face a large number of organizational issues

[60] FAO (2014) *Linking farmers to markets: improving opportunities for locally produced food on domestic and tourist markets in Vanuatu*, FAO Sub-Regional office for the Pacific: Apia
[61] Ibid
[62] FAO (2015) *Vanuatu fruit and vegetable sector value chain analysis*, FAO Sub-Regional office for the Pacific: Apia
[63] Barrett C. (2008) "Smallholder market participation: concepts and evidence from eastern and southern Africa," *Food Policy* 33(4): 299-317

which require significant investment in capacity building to address.[64] Farmer organisations in the Pacific Islands and Vanuatu face many challenges, and will require ongoing, committed support from technical agencies in order to help small farmers improve their linkages to market, in an effort to reduce the final cost of locally produced goods for consumers.

Changes in trade policies can also have a significant impact on price. The liberalization of tariffs on imported foods has had reduced the price of many energy dense but nutritionally poor convenience foods, relative to local substitute products; and therefore increased the economic incentives to increase the consumption of these imports.[65] The strategic use of tariffs and excises to increase the price of food items identified as contributing to poor health outcomes, such as food products high in sodium, sugar and fat, could help to reduce the economic incentives to consume these items and encourage households to consumer healthier substitute products. Research to date suggests that a tax on sugar-sweetened beverages (SSB) has had strong positive effects on reducing consumption.[66] As of September 2014, there was evidence that SSB taxes have been adopted in ten of fourteen Pacific Island Countries and Territories, with the most commonly taxed beverage being carbonated soft drinks.[67] The use of excise taxes is preferred than the application of import levies, as the WTO's General Agreement on Tariffs and Trade (GATT) prevents imported products from being taxed in excess of like domestic products. Countries are replacing lost revenue with other domestic taxes, such as excise taxes, and/or VAT, sales and goods and services taxes.[68] Health-related taxes are unlikely to be a problem if they are applied equally to domestic and imported products, if import duties are not greater than what has been agreed as the upper limit[69] and there is a health justification.[70] Excise taxes are an established mechanism for taxing alcohol and tobacco in the Pacific Islands, and therefore extending this model to cover food and beverages would involve minimal additional administrative costs. The European Union has developed a number of options for profiling the nutrient content of food and beverages in order to be able to assess them for policy, which could be adapted for Vanuatu.[71] Modeling work done by the OECD has indicated that the application of a health excise tax on less healthy food choices, combined with subsidies of healthier alternative products, could be an effective way to change diets and health outcomes.[72] This is a policy option which demands further exploration, given it would also generate substantial revenue for investing in improving access among at risk households to healthier substitute food products.

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[64] Chirwa. E *et al.* (2005) "Walking tightropes: supporting farmer organisations for market access," *Natural Resource Perspectives* no. 99, Department for International Development

[65] Thow *et al.* (2011) *Op. Cit.*

[66] Brownell et al. (2009) *Op. Cit.*

[67] FAO (2015) *Food Matters: policy options for strengthening food and nutrition security in the Pacific islands*, FAO Sub-Regional Office for the Pacific: Apia

[68] Thow *et al.,* (2011) *Op. Cit.*

[69] C-POND, SPC, UNDP, World Health Organization (WHO). Trade, trade agreements and non-communicable disease in the Pacific Islands. Intersections, Lessons Leaned, Challenges and Ways Forward. In: Workshop on "Trade, Trade Agreements and Non-Communicable Diseases." Nadi, Fiji Islands; 2013

[70] Thow *et. al* (2011) *Op. Cit.*

[71] Drewnowski A, (2007) "What's next for nutrition labeling and health claims: an update of nutrient profiling in the European Union and the U.S." *Nutrition Today* **42**:206–14

[72] Sassi F, Belloni A, Capobianco C (2013) "The Role of Fiscal Policies in Health Promotion", *OECD Health Working Papers*, No. 66, OECD Publishing

Introducing regulations requiring the fortification of bread and rice with iron and other micronutrients could also help to improve nutrition outcome in Vanuatu. While fortified flour and foods manufactured from fortified flour, are available throughout the Pacific, only Fiji operates a systematic fortification policy. An evaluation of Fiji's iron fortification programme indicated that this has successfully reduced anemia amongst at risk populations.[73] Vanuatu should adopt deliberate and mandatory fortification regulations, operating on the basis of a regional fortification standard, in order to ensure flour products sold nationally are fortified with iron. Fiji's Food Safety legislation offers a useful template for how regional fortification standards could be incorporated into domestic law. However, given larger per capita consumption of rice than flour and bread products, making rice more nutritious through fortification would more effectively increase micronutrient intake. Mandatory fortification, in which legislation and regulations require the fortification of all rice to a specific standard, has the greatest potential for public health impact.[74] There is a small increase in price associated with rice fortification, with experience thus far in 15 countries, indicating that the retail price increase for fortified rice ranges from an additional 1% to 10%.[75] Given the potential to reduce Vitamin A deficiencies among at risk populations, such as urban households, further investigation of the cost effectiveness and practicalities of mandatory rice fortification should be explored.

Measures to increase access to affordable and nutritious food by households

This paper has identified that urban households and households with large numbers of dependents need targeted measures to improve access to fresh fruits, vegetable and meat products high in vitamin A and iron. Safety net programs that provide cash transfers or food vouchers to at risk consumers, have been adopted in many countries around the world. However for low-income developing countries, there are often few available resources with which to provide these transfers, and little experience of delivering these effectively to targeted consumers.[76] Some initial trials have already begun in the Pacific Islands (principally in Samoa and Fiji) with the use of mobile-phone based 'mobile money' schemes for transferring to identified households, vouchers redeemable for particular pre-approved goods (such as building supplies) from selected retailers, as part of a post-disaster response. Utilising these schemes might offer a model with few administrative costs and proven capacity to deliver benefits to targeted households, for facilitating transfers to households in food energy and nutrition deficit. However, foreign support will have to be mobilized to enable Vanuatu to cope with the increased demand on their budgets that such a voucher system would entail.

Similarly, policy-makers in the developing world have identified that school-feeding programs can ensure that students facing poor educational and nutritional outcomes receive the minimum nutritional inputs they require to lead healthy and productive lives.[77] International

[73] Clarke, D. et al (2012) *A study on the regulatory requirements for food fortification in the Pacific*, WHO: Suva
[74] Beretta Piccoli N, Grede N, de Pee S et al. (2012) "Rice fortification: its potential for improving micronutrient intake and steps required for implementation at scale," Food Nutrition Bulletin 33(4):360–372
[75] Roks E. (2014) "Review of the cost components of introducing industrially fortified rice," New York Academy Science Annual 1324:82–91
[76] FAO (2011) Op. Cit.
[77] World Food Program (2013) *Home Grown School Feeding: A Framework to Link School Feeding with Local Agricultural Production*, WFP, Rome

experience also indicates that these programmes can improve the supply quality and quantity capacity of small farmers, reducing the cost of healthy eating through bulk procurement arrangements and the use of forward contracts which facilitate scale efficiencies. However experience on school feeding programs from elsewhere in the Pacific, indicates that little attention is currently paid to providing nutritious meals, or securing supply from local farmers. Therefore, it would be important for Vanuatu stakeholders to adopt a programme for school meals that is based on a menu that incorporates local fresh produce (fruits, vegetables and livestock products) to the maximum extent possible. It will be necessary to design a procurement and distribution system to facilitate the purchase of such foods from local farmers and fishers. The school lunch menu should be drafted with the technical advice of nutrition experts and should maximize the use of local food varieties that are rich in vital nutrients. The government agencies that are responsible for the procurement of school lunches should collaborate with local farmers and their associations to encourage the planting and marketing of these essential crop varieties.

The cost of providing free or subsidized meals to school children is a significant potential barrier. There is a compelling case for investment in the establishment of school feeding programs that help to get children into school and help keep them there, however, through enhancing enrolment and reducing absenteeism. Once the children are in school, the programs can contribute to their learning, through avoiding hunger and enhancing cognitive abilities[78] [79]. On this evidence, Vanuatu stakeholders could demonstrate the benefits of a school feeding model through the implementation of pilot schemes targeting a small number of schools containing high populations of students at risk of poor nutrition outcomes. This could help build support for a more widespread program of school feeding.

Establishing a Nutritious Food Basket (NFB) will help to establish a measure of the cost of basic healthy eating that represents current nutrition recommendations and average food purchasing patterns in Vanuatu, to replace the Cost of Basic Needs (CBN) approach to measuring food poverty. This basket would be designed to reflect an example of an eating pattern that meets the minimum and maximum recommended nutrition thresholds (ADER, RDI and UL) established for Vanuatu, and outlined in this report. Systemic monitoring of both the affordability and accessibility of foods on this list could help improve nutrition intake amongst at risk households.

Measures to increase food production

The fall in productivity in the rural sector in PICs has been a key contributor to the increase in the price of domestic foods that are of nutritious value. A review of the patterns of food

[78] Bundy D, Burbano C, Grosh M, Gelli, A, Jukes M, Drake L (2009) Rethinking school feeding: Social safety nets, child development and the education sector. Directions in Development. Human Development, World Bank

[79] Adelman S, Gilligan D, Lehrer K (2008) How effective are food for education programmes? A critical assessment of the evidence from developing countries, Washington, DC, International Food Policy Research Institute

production in the Pacific region, undertaken by the Asian Development Bank,[80] has revealed that the growth in agricultural production has declined over the last four decades, in general; and that it continues to do so across the region. Farming in the region remains mainly at small scale, depends on family labour, and focuses predominantly on meeting household subsistence needs. The small commercial agriculture sector in the region struggles to compete against food imports in domestic markets. The limited capacity of the smallholder agriculture sector to supply and satisfy the needs of the domestic market, at prices that are competitive with imports, is a significant factor that contributes to the increasing dependence on food imports of PICs, and increased incidence of poor household nutrition. Increasing the competitiveness of small farmers in their domestic markets is contingent upon greater investment in the adoption of productivity enhancing technologies and adapted plant varieties.

Adverse weather and pests and diseases result in more variable production, impacting the prices and availability of food commodities. Improving the productivity of the agriculture sector, through additional agricultural research into varieties best able to cope with climate variability and with increased pest and diseases, will be critical to reducing the cost of many of these local products on domestic markets. In addition, additional research and demonstration of off-season production technologies, and varieties, would help to reduce the variability in prices associated with seasonality. In addition, facilitating private sector investment into cost-effective irrigation and coverings to help farmers cope with variability in rainfall, are urgently needed in order to reduce the production risk facing farmers, especially smallholders

Given that the largest share of investment in primary production in the region is undertaken at farm level, facilitating an increase in agriculture production and processing efficiencies to a level that rivals food imports will depend on improving access to finance at interest rates that are competitive with those enjoyed by farmers in neighbouring regions. Accessing the capital to purchase inputs (improved planting materials, fertilizer, improved livestock breeds and feed), combined with the adoption of productivity-enhancing equipment (machinery, greenhouses, hydroponic and irrigation systems to prolong seasons and increase yields), is critical to maintain competitiveness in the agriculture sector. Access to these inputs, however, is constrained by the inability of many agriculture producers to obtain the long-term finance required to acquire such assets.

At present, loans to the agriculture sector in Vanuatu represent less than 1% of total commercial bank lending. Ensuring cheaper access to finance for farmers and other value chain investors (agri-businesses and processing enterprises) will be a critical step towards attracting the investment in modernization necessary to improve the productivity, and competitiveness, of Vanuatu's F&V sector. At the present time the Reserve Bank of Vanuatu (RBV) is working towards developing an accessible credit facility for import substitution and export sectors. This may take the form of very low interest rate (possibly 1%) risk capital to the VADB for on-lending to targeted sector

[80] ADB. 2011. *Food Security and Climate Change in the Pacific: Rethinking the Options*. Pacific Studies Series Manila: Asian Development Bank.

activities.[81] An additional (or alternative) approach may be to provide a partial credit guarantee fund to help secure loans from commercial banks (such as NBV) to the targeted sectors.

Partial loan guarantee schemes can help alleviate collateral deficiencies, which are one of the main reasons small and medium enterprises in the agriculture sector are unable to obtain credit. The schemes decrease the lending risk for financial institutions, through providing a loan repayment guarantee in the case of default and can thus play an important role in expanding access to funds for creditworthy agriculture enterprises. The loans should come at lower interest rates and require less restrictive collateral requirements because of the security of the guarantees. Credit guarantee schemes (CGS) can therefore be a useful policy tool to attract commercial financial intermediaries (e.g. commercial banks) to develop loan products and increase lending to prioritized sectors. National public and international funds are generally the major sources for guarantee funds. CGS are generally considered one of the most market-friendly types of credit intervention and a large number of countries around the world (including Fiji and Samoa) have made CGS a central part of their strategy to alleviate financing constraints.[82] However, ensuring the sustainability of Credit Guarantee Systems will require low loan default rates. In order to achieve this outcome, guarantors and lenders must properly screen and monitor potential clients, and select borrowers motivated to pay back the loans.

Matching grants provided to smallholder farmers to implement a specific development initiative (e.g. purchase farm machinery, invest in irrigation equipment etc.), under the agreement that the applicant will also contribute in money or kind, can also be affective at achieving good agricultural development outcomes. Matching grants are considered particularly suitable for financing capital investments (e.g. equipment) rather than working capital. They provide a less market distortionary approach than artificially lowered interest rates because the subsidy is used to purchase goods and assets whilst any additional loan finance is obtained at market rates. Matching Grant programs (MGPs) supported by development partners (e.g. WB, IFAD, EU, and Australia) are currently being implemented in Solomon Islands, PNG, Samoa and Fiji.

Therefore a private sector demand-led matching grant facility, or partial loan-guarantee system, could be established to supplement the proposed credit facility, in partnership with donors and International Financial Institutions - and learning from the experience in other PICs.

9. Conclusions

Improving the availability of nutritionally superior food products at lower unit costs is critical to improving food security, and health, in Vanuatu.

The migration of households from rural to urban areas, and the diversification of income off-farm, are commonly associated with improved welfare outcomes and access to a wider range of fruit and vegetable products, and meat products, important to nutrition. However the evidence

[81] Personal Communication Simeon Athy (March 2015), Governor RBV
[82] Saadani Y, Arvai Z, Rocha R (2010) A review of credit guarantee schemes in the Middle East and North Africa, World Bank

provided by this paper indicates that these trends actually contribute to reducing household nutrition.

The analysis provided in this paper indicate urban and wage earning households shift their food consumption patterns from local root and tree crops (cooking bananas, taro, manioc and kumala) and leafy greens (island cabbage) towards rice and (particularly tinned) meat products. Associated with this process are reductions in intake of important micronutrients, such as vitamin A and iron, and a reduction in total calorie intake.

This paper indicates the critical importance that island cabbage and kumala play in providing all households with Vitamin A; and that cooking bananas play in improving household iron intake. In addition, peanuts and local beef provide a cheaper alternative source of protein to canned meats, and help to keep down sodium intake levels.

This paper also provides the evidence necessary to develop the targeted policies required to deliver improved health outcomes in Vanuatu.

Improving access to these local food commodities by reducing their price to households identified as ‘at risk’ of poor nutrition through the policy and programme interventions outlined in this paper, will be critical to improving health and nutrition outcomes in Vanuatu. In addition, creating a more enabling environment to facilitate investment in improving the efficiency of local food production and distribution systems will be critical to reducing the cost of nutritious food for the wider Vanuatu population, in the long run.

Annex 1: Household nutrition outcomes by difference in province, island and income factors

Table 18 Differences in daily per capita energy and nutrition values, by Province

VARIABLES	VANUATU	MALAMPA	PENAMA	SANMA	SHEFA	TAFEA	TORBA
Calories (kcal/day)	3,056	2,703	3,279	3,181	3,039	3,093	2,910
Calories > 150% ADER	13%	9%	16%	13%	15%	12%	11%
Calories <50% ADER	21%	23%	17%	17%	27%	21%	20%
Protein Intake (g/day)	93	74	98	104	103	78	80
Protein <50% RDI	9%	12%	7%	5%	10%	14%	12%
Fat (g/day)	75	60	79	79	84	77	58
Fat > 150% UL	10%	4%	13%	10%	13%	11%	7%
Sodium (mg/day)	2,075	1,439	2,167	2,312	2,543	1,659	1,685
Sodium > 150% UL	14%	7%	15%	16%	21%	10%	9%
Iron (mg/day)	12	12	15	12	11	11	11
Iron <50% RDI	13%	9%	6%	11%	23%	11%	10%
Vit. A (µg /day)	1,189	1,040	1,260	1,147	1,167	1,412	1,172
Vit. A <50% RDI	12%	13%	9%	10%	19%	8%	12%
Observations	3,957	562	551	1,019	919	515	391

Table 19: Differences in daily per capita energy and nutrition values, by island

VARIABLES	VANUATU	SANTO	AMBAE	PENTECOST	MALEKULA	EFATE	TANNA
Calories (kcal/day)	3,056	3,140	3,640	3,088	2,972	2,628	3,034
Calories > 150% ADER	13%	14%	20%	14%	9%	8%	16%
Calories <50% ADER	21%	17%	11%	22%	14%	25%	26%
Protein Intake (g/day)	93	104	107	94	77	74	107
Protein <50% RDI	9%	4%	4%	9%	9%	12%	9%
Fat (g/day)	75	78	98	66	77	56	86
Fat > 150% UL	10%	10%	19%	10%	10%	2%	14%
Sodium (mg/day)	2,075	2,423	2,535	2,054	1,599	1,411	2,764
Sodium > 150% UL	14%	17%	22%	12%	8%	6%	24%
Iron (mg/day)	12	12	16	14	11	12	11
Iron <50% RDI	13%	11%	3%	8%	6%	9%	24%
Vit. A (µg /day)	1,189	1,147	1,155	1,420	1,423	940	1,177
Vit. A <50% RDI	12%	9%	7%	9%	4%	15%	18%
Observations	3,957	900	208	278	386	749	448

Table 20: Household nutrition by income quintile

VARIABLES	VANUATU	0-20%	20-40%	40-60%	60-80%	80-100%
Average income (Vt month)	86,021	18,101	38,421	58,526	89,389	225,790
Calories (kcal/day, AME)	3,056	2,280	2,626	2,903	3,502	3,968
Calories > 150% ADER	13%	5%	7%	10%	17%	25%
Calories <50% ADER	21%	35%	24%	19%	14%	12%
Protein Intake (g/day AME)	93	65	78	88	108	126
Protein <50% RDI	9%	18%	11%	8%	4%	5%
Fat (g/day, AME)	75	56	66	69	86	98
Fat > 150% UL	10%	6%	8%	8%	11%	17%
Sodium (mg/day, AME)	2,075	1,544	1,703	1,964	2,369	2,794
Sodium > 150% UL	14%	9%	9%	13%	15%	23%
Iron (mg/day AME)	12	9	10	11	14	16
Iron <50% RDI	13%	21%	13%	11%	9%	10%
Vit. A (µg/day, AME)	1,189	843	1,034	1,086	1,373	1,611
Vit. A <50% RDI	12%	21%	14%	10%	8%	8%
Observations	3,957	792	791	792	791	791

Table 21: Urban Household nutrition by income (quintile)

VARIABLES	VANUATU	0-20%	20-40%	40-60%	60-80%	80-100%
Average income (Vt month)	95,514	15,166	38,000	58,035	89,717	246,234
Calories (kcal/day, AME)	2,710	2,405	2,581	2,632	2,871	2,992
Calories > 150% ADER	11%	8%	9%	9%	13%	16%
Calories <50% ADER	28%	33%	28%	31%	25%	24%
Protein Intake (g/day AME)	103	91	96	100	106	117
Protein <50% RDI	9%	11%	8%	11%	6%	8%
Fat (g/day, AME)	81	69	80	80	85	90
Fat > 150% UL	12%	10%	12%	10%	11%	15%
Sodium (mg/day, AME)	2,580	2,364	2,401	2,580	2,718	2,787
Sodium > 150% UL	22%	20%	18%	22%	19%	28%
Iron (mg/day AME)	9	8	8	9	9	10
Iron <50% RDI	25%	28%	20%	29%	25%	22%
Vit. A (μg/day, AME)	900	816	776	856	962	1,057
Vit. A <50% RDI	18%	19%	19%	19%	20%	15%
Observations	920	170	182	172	186	210

Table 22: Rural Household nutrition by income (quintile)

VARIABLES	VANUATU	0-20%	20-40%	40-60%	60-80%	80-100%
Average income (Vt month)	83,146	18,903	38,547	58,662	89,288	218,401
Calories (kcal/day, AME)	3,160	2,246	2,639	2,979	3,697	4,320
Calories > 150% ADER	14%	5%	6%	11%	19%	29%
Calories <50% ADER	19%	36%	22%	16%	11%	7%
Protein Intake (g/day AME)	90	57	73	84	109	130
Protein <50% RDI	10%	20%	12%	8%	3%	4%
Fat (g/day, AME)	73	53	61	66	86	101
Fat > 150% UL	9%	5%	7%	7%	11%	18%
Sodium (mg/day, AME)	1,921	1,320	1,494	1,793	2,261	2,796
Sodium > 150% UL	12%	6%	7%	10%	14%	22%
Iron (mg/day AME)	13	9	11	12	15	18
Iron <50% RDI	9%	20%	11%	6%	4%	5%
Vit. A (µg/day, AME)	1,277	850	1,112	1,150	1,499	1,811
Vit. A <50% RDI	10%	21%	12%	8%	5%	6%
Observations	3,037	622	609	620	605	581

Table 23: Average Vanuatu household food basket for households satisfying recommended minimum and maximal nutritional values (by share of household expenditure and nutritional intake)

Food Item	Expenditure	Calories	Protein	Total Fat	Sodium	Iron	Vit. A
Bananas (Cooking)	11.7%	17.1%	7.1%	0.0%	0.8%	21.8%	2.6%
Island Taro/ Taro Fiji	10.0%	9.5%	7.3%	0.0%	6.0%	11.3%	0.3%
Water Taro	7.6%	6.0%	2.8%	0.0%	12.0%	8.8%	0.4%
Manioc	6.9%	10.5%	2.6%	3.6%	4.1%	0.0%	0.0%
Kumala	6.8%	7.5%	2.4%	0.0%	6.3%	7.4%	38.0%
Rice	6.4%	5.5%	3.3%	0.0%	0.5%	0.0%	0.0%
Island Cabbage	6.3%	0.9%	4.2%	1.4%	1.1%	6.5%	36.7%
Yam	3.6%	1.9%	2.2%	0.0%	0.2%	3.4%	0.4%
dry Coconut / Copra	3.1%	8.4%	3.3%	40.6%	1.0%	3.4%	0.0%
Mangoes	2.3%	1.2%	0.6%	0.0%	0.1%	0.0%	3.8%
Chicken/ Local chicken	1.9%	1.6%	5.3%	5.6%	1.5%	0.9%	0.2%
Laplap (Yam, manioc, etc.)	1.8%	1.9%	0.5%	0.6%	0.6%	0.0%	0.0%
Crabs	1.8%	0.7%	6.1%	0.3%	5.2%	1.6%	0.0%
Other fish	1.4%	0.8%	5.7%	1.2%	1.2%	0.9%	0.4%
Watermelon	1.3%	0.2%	0.3%	0.0%	0.1%	0.0%	0.2%
Beef fresh	1.3%	2.0%	12.0%	3.9%	1.8%	3.8%	0.0%
Bread	1.3%	1.5%	2.1%	0.9%	8.8%	0.7%	0.0%
Pawpaw	1.3%	0.6%	0.4%	0.0%	0.2%	1.3%	1.1%
Take away food	1.2%	0.8%	2.2%	3.3%	4.3%	3.4%	1.7%
Tinned meat	1.2%	0.6%	3.2%	1.5%	4.8%	0.7%	0.3%
Green coconut	1.1%	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%
Corn	0.9%	0.6%	0.6%	0.3%	0.2%	0.6%	0.2%
Sugar	0.9%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Tinned Tuna	0.9%	0.2%	1.2%	0.2%	1.3%	0.2%	0.0%
Pineapples	0.8%	0.4%	0.3%	0.0%	0.0%	1.0%	0.0%
Beans	0.7%	0.4%	1.0%	0.0%	0.0%	1.5%	0.4%
Chinese Cabbage	0.7%	0.1%	0.4%	0.0%	0.4%	0.5%	1.7%
Ripe Bananas	0.7%	0.8%	0.3%	0.0%	0.5%	0.9%	0.1%
Other fresh fruits n.e.c	0.7%	0.5%	0.5%	0.0%	0.5%	1.5%	0.3%
Reef Fish	0.7%	0.4%	2.7%	0.6%	0.6%	0.4%	0.2%
TOTAL	**87.6%**	**84.8%**	**80.6%**	**63.9%**	**64.5%**	**82.4%**	**88.90%**

Table 24: Average Vanuatu household food basket, for households NOT satisfying recommended minimum and maximal nutritional values (by share of household expenditure and nutrition intake)

Food Item	Expenditure	Calories	Protein	Total Fat	Sodium	Iron	Vit. A
Rice	9.7%	7.8%	4.2%	0.0%	0.4%	0.0%	0.0%
Bananas (Cooking)	8.6%	11.7%	4.3%	0.0%	0.3%	18.4%	2.7%
Island Taro/ Taro Fiji	6.5%	5.6%	3.9%	0.0%	2.1%	8.3%	0.3%
Manioc	5.2%	7.2%	1.6%	1.7%	1.7%	0.0%	0.0%
Island Cabbage	4.6%	0.5%	2.3%	0.6%	0.4%	4.9%	33.3%
Bread (sliced, loaf, rolls)	4.2%	4.4%	5.7%	1.8%	15.5%	2.4%	0.0%
Kumala	4.0%	4.1%	1.2%	0.0%	2.1%	5.0%	31.1%
dry Coconut / Copra	3.2%	10.2%	3.6%	34.0%	0.7%	5.1%	0.0%
Yam	3.1%	1.6%	1.7%	0.0%	0.1%	3.6%	0.6%
Tinned Meat	2.6%	1.3%	5.8%	2.4%	7.0%	2.2%	0.7%
Mangoes	2.3%	1.2%	0.6%	0.0%	0.1%	0.0%	5.4%
Tinned Tuna	2.2%	0.4%	2.9%	0.3%	2.0%	0.6%	0.1%
Water Taro	2.1%	1.5%	0.6%	0.0%	1.7%	2.6%	0.1%
Sugar	1.9%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Beef fresh	1.7%	2.4%	12.9%	3.3%	1.3%	5.7%	0.0%
Cabin Biscuits	1.6%	3.3%	1.9%	4.5%	7.4%	2.0%	0.2%
Laplap (Yam, manioc, etc..)	1.6%	1.4%	0.3%	0.3%	0.2%	0.0%	0.0%
Chicken (chicken parts)	1.6%	1.5%	6.6%	2.7%	0.9%	1.0%	0.2%
Other fish	1.5%	0.8%	5.0%	0.8%	0.7%	1.1%	0.6%
Chicken/ Local chicken	1.5%	1.2%	3.8%	3.1%	0.7%	0.9%	0.2%
Watermelon & Rock melon	1.3%	0.2%	0.3%	0.0%	0.0%	0.0%	0.3%
Paw paws	1.2%	0.5%	0.3%	0.0%	0.1%	1.4%	1.4%
Cracker, biscuits, Buns	1.2%	1.6%	0.9%	2.1%	3.5%	1.0%	0.1%
Pineapples	1.2%	0.6%	0.4%	0.0%	0.0%	1.7%	0.1%
Noodles	1.1%	0.6%	0.6%	0.9%	9.5%	0.9%	0.0%
Corn	1.0%	0.6%	0.5%	0.2%	0.1%	0.7%	0.3%
Plate of food/ Take away	1.0%	0.6%	1.5%	1.8%	2.0%	3.2%	1.9%
Green Coconut	0.9%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%
Crabs	0.9%	0.4%	2.6%	0.1%	1.5%	0.9%	0.0%
Doughnuts	0.9%	1.3%	0.8%	2.5%	1.7%	0.5%	0.0%
TOTAL	**80.4%**	**78.1%**	**76.6%**	**63.1%**	**63.8%**	**74.0%**	**79.5%**

Table 25: Average rural Vanuatu household food basket by share of household expenditure and nutrition intake

Food Item	Expenditure	Calories	Protein	Total Fat	Sodium	Iron	Vit. A
Bananas (Cooking)	10.2%	13.7%	5.4%	0.0%	0.5%	20.6%	3.0%
Rice	9.1%	7.2%	4.2%	0.0%	0.4%	0.0%	0.0%
Island Taro/ Taro Fiji	7.9%	6.8%	5.0%	0.0%	2.9%	9.5%	0.3%
Manioc	5.9%	8.2%	2.0%	2.1%	2.1%	0.0%	0.0%
Island Cabbage	4.9%	0.6%	2.6%	0.7%	0.5%	5.0%	33.9%
Kumala	4.5%	4.6%	1.4%	0.0%	2.6%	5.3%	32.8%
Yam	3.7%	2.0%	2.2%	0.0%	0.1%	4.1%	0.6%
dry Coconut / Copra	3.6%	11.6%	4.4%	41.0%	1.0%	5.6%	0.0%
Water Taro	2.7%	1.9%	0.9%	0.0%	2.6%	3.3%	0.2%
Bread (sliced, loaf, rolls)	2.7%	2.8%	3.9%	1.2%	11.3%	1.5%	0.0%
Mangoes	2.5%	1.2%	0.6%	0.0%	0.1%	0.0%	5.4%
Tinned Meat	2.4%	1.2%	5.6%	2.1%	6.8%	1.7%	0.6%
Laplap (Yam, manioc, etc..)	1.9%	1.6%	0.4%	0.4%	0.3%	0.0%	0.0%
Other fish	1.8%	1.0%	6.2%	1.0%	1.0%	1.2%	0.6%
Tinned Tuna	1.8%	0.3%	2.4%	0.2%	1.7%	0.4%	0.1%
Sugar	1.7%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Chicken/ Local chicken	1.7%	1.4%	4.6%	3.7%	0.9%	1.0%	0.2%
Cabin Biscuits	1.5%	3.1%	1.9%	4.5%	8.1%	1.8%	0.2%
Watermelon & Rock melon	1.4%	0.2%	0.3%	0.0%	0.1%	0.0%	0.3%
Beef fresh	1.3%	2.0%	11.6%	2.9%	1.2%	4.6%	0.0%
Paw paws	1.2%	0.5%	0.4%	0.0%	0.1%	1.3%	1.3%
Corn	1.2%	0.7%	0.6%	0.2%	0.1%	0.8%	0.3%
Pineapples	1.2%	0.6%	0.4%	0.0%	0.0%	1.6%	0.1%
Crabs	1.1%	0.4%	3.4%	0.1%	2.1%	1.1%	0.0%
Plate of food/ Take away	1.1%	0.7%	1.7%	2.0%	2.4%	3.2%	1.9%
Green Coconut	1.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%
Noodles	1.0%	0.6%	0.6%	0.8%	10.0%	0.8%	0.0%
Crackers, biscuits, buns	0.9%	1.2%	0.7%	1.7%	3.0%	0.7%	0.1%
Bread fruit	0.9%	1.1%	0.7%	0.0%	0.0%	1.3%	0.0%
Doughnuts, Kato	0.8%	1.1%	0.7%	2.3%	1.6%	0.4%	0.0%
TOTAL	**83.4%**	**81.2%**	**74.7%**	**66.9%**	**63.6%**	**76.7%**	**82.0%**

Table 26: Average urban Vanuatu household food basket by share of household expenditure and nutrition intake

Food Item	Expenditure	Calories	Protein	Total Fat	Sodium	Iron	Vit. A
Rice	11.3%	9.4%	4.2%	0.0%	0.4%	0.0%	0.0%
Bread (sliced, loaf, rolls)	8.8%	9.8%	10.2%	3.5%	24.4%	6.2%	0.0%
Chicken (chicken parts)	4.9%	4.4%	16.0%	7.1%	1.9%	3.5%	0.6%
Island Cabbage	4.1%	0.4%	1.5%	0.4%	0.2%	4.6%	31.4%
Bananas (Cooking)	3.7%	5.3%	1.6%	0.0%	0.1%	9.6%	1.4%
Tinned Tuna	3.3%	0.8%	4.1%	0.4%	2.5%	1.1%	0.3%
Tinned Meat	3.1%	1.9%	6.0%	3.0%	7.4%	3.8%	0.9%
Beef fresh	3.0%	3.7%	16.2%	4.4%	1.4%	10.2%	0.0%
Manioc	2.9%	4.3%	0.8%	0.9%	0.7%	0.0%	0.0%
Kumala	2.7%	2.9%	0.7%	0.0%	1.0%	4.1%	25.1%
Sugar	2.4%	5.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Island Taro/ Taro Fiji	2.4%	2.1%	1.2%	0.0%	0.6%	3.5%	0.1%
Cracker, biscuits, buns	2.0%	2.8%	1.3%	3.4%	4.5%	2.0%	0.2%
Cabin Biscuits	1.9%	3.6%	1.7%	4.4%	5.8%	2.6%	0.2%
Mangoes	1.9%	1.0%	0.4%	0.0%	0.0%	0.0%	5.2%
dry Coconut / Copra	1.7%	4.7%	1.3%	13.7%	0.2%	2.7%	0.0%
Doughnuts, Kato	1.4%	1.8%	0.9%	3.2%	1.7%	0.8%	0.1%
Noodles	1.4%	0.7%	0.6%	0.9%	8.4%	1.2%	0.0%
Butter/margarine	1.3%	1.6%	0.1%	5.3%	1.4%	0.0%	5.3%
Other beverages	1.3%	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%
Paw paws	1.3%	0.6%	0.3%	0.0%	0.1%	1.8%	1.8%
Cooking oil (incl. salad oil)	1.2%	4.4%	0.0%	15.1%	0.0%	0.0%	0.0%
Pineapples	1.2%	0.6%	0.3%	0.0%	0.0%	2.0%	0.1%
Ice cream	1.2%	0.8%	0.5%	1.4%	0.3%	0.0%	1.7%
Soft drinks (coke, Fanta, etc)	1.0%	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%
Chicken/ Local chicken	0.9%	0.8%	1.9%	1.7%	0.3%	0.6%	0.1%
Plate of food/ Take away	0.9%	0.6%	1.1%	1.4%	1.3%	3.3%	2.0%
Beer (Tusker, etc)	0.9%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Peanuts	0.9%	2.7%	3.2%	6.8%	0.0%	1.5%	0.0%
Yam	0.8%	0.5%	0.4%	0.0%	0.0%	1.2%	0.2%
TOTAL	**75.5%**	**77.9%**	**76.5%**	**77.2%**	**64.9%**	**66.5%**	**76.7.7%**

Annex 2: The Pro’s and Con’s of using Household Income and Expenditure Surveys to estimate household nutrition outcomes

Food consumption data can be captured at the national, household, or individual level. According to nutritionists, the most accurate data on individual food consumption can be obtained through repeat 24-hour recall and observed weighed food record data collected through Nutritional Dietary Surveys (NDS). This information is usually collected in combination with anthropometric measurements (weight, height and waist), haemoglobin (Hb) levels, blood pressure, qualitative data on infant feeding of children less than 2 years of age, exercise, smoking, alcohol and other drug intakes of adults, in addition to food security and socio-economic information. However, because of the operational cost of undertaking blood sampling and measurements, it can be particularly challenging to implement these surveys regularly and reliably in low and middle-income settings, with the most recent survey conducted in the Pacific – Fiji, in 2004 – carried out on a sample of less than 1 per cent of the population.[83]

Demographic and Healthy Surveys have begun to be implemented in the Pacific more frequently, which include food recall (food consumed in the last 24-hours) questions, questions on child feeding practices and examinations of the nutritional status of children; and combines this with demographic, wealth and income information. 8 of these surveys have been conducted among the 14 PIcs since 2007, and 5 more are planned between 2014 and 2017. These surveys do provide a good source of household and dietary information and combine with observation of nutritional impacts. However, the 24-hour recall method of establishing household diet and food intake practices has been subject to growing scrutiny due to the variability of the quality of the data that it can produce.[84] It has been identified that this method is more accurate when administered more than once for each participant, with best practice recommending between 3 and 7 times.[85] This variation can also be reduced by triangulation with other methods.

The WHO has begun to assist a number of PICs to adopt the stepwise approach to NCD surveillance (STEPs); though implementation of STEPs can be challenging.[86] As a result, only two PICs having completed more than 1 STEPS surveys at time of writing.[87] In addition, STEPS collects limited information on both household risk factors, such as diet, food expenditure and income, education

[83] Fiedler, J., Lividini, K., Bermudez, O., Smitz, M-F (2012) “Household Consumption and Expenditures Surveys (HCES): a primer for food and nutrition analysts in low- and middle-income countries.” Food Nutrition Bulletin 33(Suppl 3):242–251

[84] Beaton, G., Milner, J., Corey, P., McGuire, V., Cousins, M., Stewart, E., de Ramos, M., Hewitt, D., Grambsch, P., Kassim, N., Little, J., (1979) “Sources of variance in 24-hour dietary recall data: Implications for nutrition study design and interpretation,” *American Journal of Clinical Nutrition* 32(12):2546-2559

[85] Cupples, J., L. Cobb, E., Miller, D. and D'Agostino, R., (1992) “Comparison of Techniques for Estimating Nutrient Intake: The Framingham Study,” *Epidemiology* 3(2):171-177

[86] Estimé, S. Lutz, B. Sobel, F. (2014) “Trade as a structural driver of dietary risk factors for noncommunicable diseases in the Pacific: an analysis of household income and expenditure survey data,” *Globalization and Health*, 10:48

[87] Ibid

levels, numbers of dependents, rural or urban location, and other factors identified as closely linked to food and income poverty in the Pacific[88]

National-level food data, such as FAO's Food Balance Sheets (FBS) and individual level food consumption data, can be useful sources of information for nutrition policy development. The Food Balance Sheet methodology for estimating national food availability depends upon multiple sources of information, including accurate production, trade, feed and seed, waste and other utilization. It provides information on food availability in quantities (tonnes), by commodity; and by kilograms per capita per year. In addition it provides information on food supply by kilocalories of energy, grams of fat and grams of protein, per capita per day. FBS data is reported regularly, including for the countries in the Pacific Island region. Indeed the FBS dataset for Vanuatu ranges from 1961 to 2011. Using the FBS information the per capita daily energy supply (kcal) has increase 15% between 1961 and 2011 (from 2446 kcal to 2820 kcal), while protein consumption has increased 16 per cent (from 57.8 grams to 67.5 grams) and fat consumption increased 21 per cent (from 83.7 grams to 101 grams) between the same years.[89]

However, there are a few challenges to using FBS data to estimate household consumption and diet, and the implications for health. The major challenge is that the paucity of agricultural production data, and data on the use of production to for feed and seed and waste, as well as other utilization, leads the FAO to depend on aggregate, standardized and 'calculated' data, rather than on official data.[90] Thus, the absence of official input data from countries in the Pacific is a major impediment to the accuracy of the dataset and its ability to track movements in food supply resulting from changed consumer preferences, rising food prices, natural disaster or pest and disease outbreak. Another challenge to using FBS data to examine household nutrition and risk factors is that the Food Balance Sheet dataset provides a single figure of per capita consumption derived from a national aggregate, obscuring distribution and therefore heterogeneity of consumption outcomes among households within countries. Finally, Food Balance Sheets do not report food supply outcomes for micronutrients critical to understanding the triple burden of malnutrition, including Vitamin and Iron; and other factors critical to understanding poor health outcomes, like sodium.

To help address the fundamental information gap, there have been a steadily growing number of studies using household food acquisition and consumption data from a variety of household food expenditure surveys, such as Household Income and Expenditure Surveys, as a proxy measure of household consumption.[91] Household Income and Expenditure Surveys (HIES) have been adopted by National Statistics Offices throughout the Pacific region over the last two decades, with multiple HIES having been conducted in most PICs. 16 HIES have been conducted in the PICs since 2006 with another 6 to be implemented between 2015 and 2018, which will provide 2 HIES datasets in each of Solomon Islands, Vanuatu, Samoa, Fiji, Tuvalu, Tonga, Palau, Kiribati, the Cook Islands, Papua New Guinea and Nauru. As a result, the HIES is the regularly implemented statistical census or survey currently implemented in the PICs.

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[88] World Bank (2014) *Hardship and vulnerability in the Pacific Islands,* A regional companion to the World Development Report 2014, Washington, DC: World Bank
[89] Calculations using FAO Food Balance Sheets http://faostat.fao.org
[90] A review of the FAO Food Balance Sheet for Samoa for the latest available year (2011) indicates that it is derived entirely using aggregate, calculated and standardized datas rather than official data
[91] Fiedler *et al.* (Op. Cit.) 2012

HIES enable policy-makers to gain an insight into household calorie insufficiency, income and the percent of expenditures on food (and other measures of vulnerability to food insecurity) and dietary diversity and quality, whilst also enabling calculation of food security outcomes within-country, at regional and household levels of food insecurity. In addition, because the food data are matched with various demographic characteristics of households they can be used to identify who the food insecure.[92] Finally, given that food insecurity manifests itself at household and individual levels, as the data on expenditures are collected directly from households themselves, they are likely to be more reliable than those derived from data collected at more aggregate levels.

Systematic, scientific sampling, usually approximating 10 per cent of all household, is the norm used in the PICs ensuring a nationally representative sample is surveyed through a HIES. The household sample frame used is provided by national population censuses. The most common method of data collection for HIES in developing countries is the personal interview, where an enumerator asks one or more household members to provide demographic and asset information, and recall income over a reference period, usually one month or twelve months. This is combined with the diary method for collecting household expenditure information. Using the diary method, households are asked to keep a detailed record of every expenditure item purchased or used by the household during the reference period. Through this method, data are collected on food acquired from three sources: (1) food purchases, including food purchased and consumed away from home; (2) food given to a household member as a gift or as payment for work; and (3) food that is home produced.[93]

The main criticism of HIES for the collection of food security and nutrition information is that data is collected at a household level and therefore estimates of individual consumption by converting to Adult Male Equivalents, may ignore differences in intra-household distribution of food resources.[94] Another criticism is that food expenditure data reflects the quantity of food *acquired* by a household rather than that *consumed* by its members, and that therefore some estimate of consumer waste or loss must be included in order to allow for some wastage or depreciation in the stock of food obtained by the household prior to consumption.[95] Based upon FAO Food Balance Sheet formula used to estimate loss in Vanuatu, losses account for 4.32 per cent of food stocks.[96] Another criticism is that the HIES method for collecting food consumption information is affected by reporting biases faced by all household surveys that employ interview methods, including recall errors, reporting errors, interviewer effects and “prestige errors” due to social pressures to inflate actual expenditure.[97] The periodicity of expenditures on different food items and the relative short length of the diary may lead households to either consume a product purchased prior to the diary period, or fail to record a semi-regular purchase which is a typical part of the household diet.[98] Finally, information on food purchased and consumed away from home is either underreported or reported in terms of food expenditures rather than food quantities, which makes conversion to nutrition information difficult. Despite these challenges, estimates of food consumption patterns and

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[92] Smith, L. (2007) Op. Cit
[93] Ibid
[94] Ibid
[95] Ibid
[96] Calculations using FAO Food Balance Sheets http://faostat.fao.org
[97] Deaton, A. and M. Grosh, (2000) “Consumption: Chapter 5,” in Gosh, and P. Glewwe (eds) *Designing household survey questionnaires for developing countries: Lessons from 15 years of the Living Standards Measurement Study Vol.1*,Washington, DC: The World Bank.
[98] Smith (Op. Cit.)

apparent intakes of energy and nutrients obtained from national HIES are feasible and promising, when the challenges facing the alternatives are considered.[99]

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99 Fiedler *et. al.* (Op. Cit.)

Annex 3: Sampling method used for collecting Vanuatu HIES 2010 dataset

The HIES used a two-stage sampling method to select a representative sample of approximately 10 per cent of households to survey. The first stage involved the selection of Enumeration Areas (EAs) using probability proportional to size (PPS) sampling. The size measure was the estimated number of households in the EA based on 2009 population census estimates, which established that there were 249,850 persons in Vanuatu, of which 51% were male and 49% female, living in 50,740 households. On average 4.9 (or five) people usually lived together in one household. There were 6,660 or 13% of households where a female was the head of the household, with the head of the household defined as the main decision maker.

The second stage of sampling adopted systematic sampling from a list of all households contained in the EA. Using this method, 4737 households were selected. Some 7.6 per cent of those households selected were subsequently found to be either vacant or provided an incomplete response. After data entry and improvement was undertaken, data was presented and analysed from a final sample of 3975 private households, from both urban and rural areas across 30 islands.

A household was defined as a group of persons (or a single person) who usually live together and have a common arrangement for food, such as using a common kitchen or a common food budget. The persons may be related to each other or may be non-relatives. Persons living in institutions, such as school dormitories, hospital wards, hostels and prisons were excluded from the survey, as were expatriate temporary residents and permanent residents who were not residing (and intending to reside) in Vanuatu for at least 12 months. Each selected household was asked to complete a household questionnaire, responding to questions regarding household income activities and assets. Household income was considered to consist of all receipts whether monetary or in kind (goods and services) that are received by the household or by individual members of the household at annual or more frequent intervals, but excludes windfall gains and other such irregular and typically onetime receipts. Household income therefore includes: (i) income from employment (both paid and self-employment); (ii) property income; (iii) income from the production of household goods and services for own consumption; and (iv) current transfers received (gifts received).

Each person in the household was asked to provide demographic information including age, sex, highest level of educational attainment and health status. Sample households were also asked to keep a diary of all household expenditure within a two week period. Household expenditure was considered to be the value of consumer goods and services acquired, used or paid for by a household through direct monetary purchases, own-account production, barter or as income in-kind for the satisfaction of the needs and wants of its members. Household expenditure is therefore defined as the sum of household consumption expenditure and the non-consumption expenditures. The latter are those expenditures incurred by a household as transfer payments made to government, non-profit institutions and other households, without acquiring any goods or services in return for the satisfaction of the needs of its members, such as donations to charity.

It is possible to analyse all transactions recorded by the HIES according to the actual item being purchased or received (using the 'item classification') as well as the type of transaction used to acquire the good, service, income or other expenditure for which no good or service was obtained (called non-consumption expenditure). The type of transaction was classified according to cash purchase, own-account (subsistence) production, and gifts of goods received and gifts of goods given.

Annex 4: The methodology for using Household Income and Expenditure Surveys to estimate nutrition outcomes

National household surveys such as the Household Income and Expenditure Survey collect data on food acquisition or consumption from purchases in monetary and quantitative terms, and therefore report data collected at the food commodity by quantity, unit of measurement, and cost (in monetary value).[100] The process of converting this information into nutrition information requires a number of steps to be followed.

Matching Food Diary COICOP codes with food nutrient composition information

To calculate daily calorie and other dietary factors available to a household, the quantities of each food item are first converted to calorie and micro and macro nutrient values using conversion tables. The FAO has produced a series of regional Food Composition Tables providing nutritional information for various quantities of the food products most commonly eaten, including for in the Pacific region. Work undertaken on identifying the correct nutritional reference values for Pacific Island food products dates back to work undertaken in the 1940s and 50s by biochemists employed by the South Pacific Commission, and subsequently, by the Nutrition Department of the Fiji School of Medicine in the 1960's. This foundation work was subsequently improved upon throughout the 1980s and early 90's through subsequent pacific Island food composition programmes, funded by USAID and ACIAR. As a result, a comprehensive source of information of the composition of commonly eaten traditional foods, such root crops, and indigenous nuts, fruits and green leaves, was available when FAO resumed its interest in food composition work and development of regional food composition databases in the mid-90's, and was able to fill gaps in the Pacific Islands food composition tables. This subsequent work resulted in the production and dissemination of the second edition of the (2004) Pacific Island Food Composition Tables. This expressed the calorie, micro and macronutrient quantity contained within each food product available in the Pacific Islands, per 100g serve. Calories are expressed in thousands of calories or kcal, while macro and micro-nutrients values are usually expressed as grams (g), milligrams (mg), or micrograms (µg) of nutrients per 100 grams. The calorie and other nutrition values provided for all the food products purchased are added and then divided by the number of days in the reference period, in order to obtain a daily household figure.

Standardization of the food quantities into grams or milliliters Equivalent

The unit of measurement of quantities used to record food expenditure in HIES household diaries can be either standard metric units - such as gram, kilogram, litre, or milliliter - or a local unit of quantity, such as bag, basket, cup, string or heap. Given all nutrient values are expressed in terms of nutrient content per 100 grams of the food product in the Food Composition Tables, local units need to be converted into metric units for ease of analysis. When the quantities collected are not standard metric weights and metric conversions are not easily known or recorded, metric units can be estimated using market retail prices to divide the value of expenditure by the upper market rate. However where households acquire food items for own consumption for products not commonly sold, they may be unaware of market values. Ensuring enumerators and households are informed of average market values and are trained to more accurately select metric units, will help to improve the accuracy of this method in the future.

[100] Moltedo, A. Troubat, N. Lokshin, M. Zurab, S. (2014) *Analyzing Food Security Using Household data*, Washington D.C.: The World Bank

Adjustment of food quantities for nonedible portions

Nonedible portions (e.g., bones, seeds, peels, etc.) are included in the reported food quantities but their proportion is not known to convert to edible portions (EP). While food quantities acquired include nonedible portions such as peels, bones, seeds, etc., nutrient values in the FCT are usually expressed per 100 grams EP. For this reason, there is the need to transform "as purchased" quantities into edible ones.[101] This transformation is done for each food commodity by applying the appropriate refuse factor. Some food commodities, such as rice, milk, or sugar, are 100 percent edible, but this is not the case for other food items such as bananas or manioc, have a significant refuse factor. The Edible Portion depends on the food product, and when it is expressed as a percentage varies from 1 (all edible) to 0.1.

FAO's *Food Composition Tables for International Use* and *Pacific Island Food Composition Tables* provides guidance on the edible portion of food items commonly consumed in the Pacific[102].

Using this source, we applied the following EP conversion factors to the dataset:

Food item	Edible Portion (% of AP volume)
kumala	83
manioc	75
yam	86
taro	82
chinese cabbage	79
island cabbage	69
carrots	92
pumpkin	68
ripe bananna	71
cooking banana	66
breadfruit	55
mangoes	62
watermelon	53
papaya	66
pineapple	64
coconut cream	15
peanuts	75
corn	38
chestnut	75
almond	75

[101] A resource guide for facilitating conversions, the *Guidelines for Converting Units, Denominators and Expressions* is available at http://www.fao.org/infoods/infoods/standards-guidelines/en/

[102] As purchased (A.P) to edible product (E.P) conversion rates from the above guides can be access at:
http://www.fao.org/docrep/x5557e/x5557e0l.htm#fruits
http://www.fao.org/docrep/x5557e/x5557e0k.htm#freshvegetables
http://www.fao.org/docrep/x5557e/x5557e0h.htm#starchesandstarchy
http://www.fao.org/docrep/x5557e/x5557e07.htm#pulses,nuts,andseeds

Converting household consumption information into per capita information

When carrying out poverty measurement, an important consideration is if and how to account for the fact that the basic needs of young children are generally lower than those of adults.[103] The Adult Male Equivalent (AME) is an expression of household food intake that accounts for the composition of the household and allows the direct comparison of food or energy intakes of households with different numbers of members and different age and sex compositions. Adult males, age 18-60 years, are the benchmark for comparison, with younger and older males and females attributed a smaller or larger proportion of the AME (1). The AME shares attributed to each age and sex category vary for each nutrient factor and are calculated using the nutrient guidelines provided by FAO.[104]

In order to identify if households were consuming the RDI of various nutrients, for example, the study needed to calculate the total household-level RDI for each. This was done by summing the RDI of each individual of the household in the following way:

$RDI_{HH} = \sum_i RDI_i$; where *i* indexes members of a given household

In order to identify if households were consuming above the upper limit (UL) of fat and sodium, the study needed to calculate the total household-level upper limit of fat and sodium. This was done by summing the upper limit of each individual of the household in the following way:

$UpperLimit_{HH} = \sum_i UpperLimit_i$; where *i* indexes members of a given household

Using this information, it is possible to establish all the food items consumed by household members during the survey period, and calculate an average daily consumption figure for household members as a proportion of the Average Male Equivalent (AME). This information could be used to compare households with the required nutrient RDIs, ULs and ADERs for a healthy lifestyle, and to identify the characteristics of sub-populations of at risk households in order to better inform nutrition policy.

Establishing an Adult Male Equivalent (AME) rate

The AME for each individual in the household is the ratio of that individual's recommended caloric intake to the caloric intake of an adult male. The AME is used to calculate the total AMEs in a household, which is a more appropriate measure of household size when analyzing nutrition. The sum of AMEs in a household is a standard unit of household size that gives different weights to individuals based on their recommended daily intake. This means that a household consisting of 4 adult males will be considered to be larger than a household consisting of 4 infants.

The AME for a child, for example, is calculated as the following:

$$AME_{child} = \frac{ADER\ or\ RDI_{child}}{ADER\ or\ RDI_{Adult\ male}}$$

Table 7 below presents the AME for individuals by gender and age category.

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[103] Haughton, H. and S. Khandker (2009) *Handbook on poverty and inequality*, Washington D.C: World Bank
[104] WHO and FAO (2002) Human Vitamin and Mineral Requirements, part of a joint FAO/WHO expert consultation, Bangkok: FAO

Table 27: Calculating macro and micronutrient shares for age and sex categories on the basis of Adult Male Equivalents

	Infant		Young Child		Child	Adolescent		Adult			
						Female	Male	Female		Male	
	0-0.5	0.5-1	1-3	4-6	7-9	10-18	10-18	19-65	65+	19-65	65+
KCalADER (kcal/day)	554	709	1135	1465	1728	2570	2173	2978	2557	2354	2103
Kcal AME	19%	24%	38%	49%	58%	86%	73%	100%	86%	79%	71%
Fat UL (g/day)	36.9	47.3	44.1	57.0	67.2	99.9	84.5	115.8	99.4	91.5	81.8
Fat AME UL	32%	41%	38%	49%	58%	86%	73%	100%	85%	83%	74%
Sodium UL (mg/day)	1500	1500	1500	1900	1900	2200	2200	2300	2300	2300	2300
Sodium AME UL	65%	65%	65%	83%	83%	96%	96%	100%	100 %	100%	100 %
Protein RDI (g/day)	11.1	14.2	14.2	18.3	21.6	45.0	38.0	74.5	63.9	58.9	52.6
Protein RDI AME	15%	19%	19%	25%	29%	60%	51%	100%	86%	79%	71%
Iron RDI (mg/day)	0.2	11	9	9	10	11	14	8	8	18	8
Iron RDI AME	3%	138%	113 %	113 %	125%	138%	175%	100%	100 %	225%	100 %
Vitamin A RDI (µg/day)	375	400	400	450	500	600	600	600	600	500	600
Vitamin A RDI AME	63%	67%	67%	75%	83%	100%	100%	100%	100 %	83%	100 %

The household AME for each nutrient or energy category is the sum of all AMEs of individuals within the household. It is calculated as:

$$AME_{HH} = \sum_i AME_i; \text{ where } i \text{ indexes members of a given household}$$

For example, the total Kcal AME for a household with 1 adult male and 1 child would be:

$$AME_{HH} = AME_{Adult\ male} + AME_{child} = 1 + 0.58 = 1.58$$

Adult male equivalent intakes were calculated to standardize household consumption to intake per adult male equivalent. It does not utilize the richness of the RDI and UL standards, but it allows the study to benchmark using the standard AME. The AME intake for each nutrient is calculated as the total intake of the household divided by the total AMEs in the household.

For calories, it would be calculated in the following way:

$$AME_{Calories} = \frac{Caloric\ Intake_{HH}}{AME_{HH}}$$

Establishing benchmarks for interpreting continuous variables

This study interprets insufficient nutrient intake by the sample population, as a binary variable. It takes the value of 1 if the household intake is less than 50% of the household's RDI, and takes the value of zero otherwise. For each nutrient, insufficient intake was measured in the following way:

$$Insufficient = \begin{cases} 1, & Intake_{HH} < 0.5 * RDI_{HH} \\ 0, & Intake_{HH} \geq 0.5 * RDI_{HH} \end{cases}$$

Overconsumption was measured in the data as a binary variable. It takes the value of 1 if the household intake was more than 150% of the household's ADER or UL, and takes the value of zero otherwise. For fat and sodium, over consumption was measured in the following way:

$$Over = \begin{cases} 1, & Intake_{HH} > 1.5 * UL_{HH} \\ 0, & Intake_{HH} \leq 1.5 * UL_{HH} \end{cases}$$

Constructing independent variables

To conduct this analysis, the means for each of our nutrient intake indicators were calculated for each subsample of the data as it related to the following variables*:

(1) *Rural/Urban location*

Household are identified as urban if they are located in Port Vila or Luganville. All other households are designated as rural. This is used as a binary indicator in the regression analysis, with households in an urban location assigned a value of 1.

(2) Subsistence income as a proportion of total income

This variable is constructed using the total and subsistence income data collected in the HIES survey and compiled by the statistics office. The subsistence income (subsistence value) was calculated as the total value of subsistence production goods valued at the local market price. This is done to standardize the unit of measurement for home produced goods. The market valuation of home produced goods is upward based and represents a ceiling value for these products.

This information is used as a continuous variable in the regression analysis, but is presented in the descriptive tables in quintiles. The quintiles were generated by ranking subsistence value from largest to smallest and divided into 5 equal groups. The groups are: (1) 0-20% lowest; (2) 20-40%; (3) 40-60%; (4) 60-80%; (5) 80-100% highest. Despite this upward bias in our measure, the quintile divisions should remain consistent. This is due to the fact that rank orders are robust to a positive scaling.

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* Additional Tables displaying household nutrition outcomes are provided in the Annexes. These include: Household Nutrition outcome by Province; Household Nutrition outcome by Island; Household nutrition outcome by income quintile; Rural household nutrition outcome by income quintile; Urban household nutrition outcome by income quintile.

(3) Wage income as a proportion of total income

This variable is constructed using the waged income data collected in the HIES survey and compiled by the stats office. Wage income is the total income that households earned from wage labor. It represents the degree to which the household is engaged in activities off-farm. Understanding how the diversification of household labor activities and the level of engagement in economic activities outside of the household impacts upon nutrient intake levels, will be important to understand in light of the growing importance of off-farm employment.

This information is used as a continuous variable in the regression analysis, but is presented in the descriptive tables in quintiles. Similar to the subsistence production quintiles, wage income quintiles were generated by ranking wage income from largest to smallest and dividing the sample into 5 equal groups. The groups are: (1) 0-20% lowest; (2) 20-40%; (3) 40-60%; (4) 60-80%; (5) 80-100% highest.

(4) Ratio of dependents to 'working age' adults in household

This variable is constructed using the household composition data collected as a part of the HIES survey. It measures the total number of dependent children (below age 15) and dependent adult members (above age 65) of the household, as a ratio of working age adults (16-64). This variable allows the study to identify variation in household nutrition intake as it relates to the number of non-productive members of the households. This information is presented in the descriptive tables as the number of dependents in the household, though the ratio of dependents to working age adults is used in the regression analysis.

(5) Household head education

Household head education is a categorical variable that measures the highest educational attainment of the household head in the following way:

a. No schooling
b. Primary Education
c. More than Primary education

The number of household heads who belong to each category of educational attainment is presented in the descriptive tables. In the regression analysis however, a binary variable is used with those household heads who have attained a post-primary level of education assigned a value of 1.

(6) Household head gender

The average nutrition and energy intake levels for both male and female headed households in presented in the descriptive tables. This factor is presented as a binary indicator in the regression analysis, with female headed households assigned a value of 1.

(7) Type of energy used for household cooking

The categories of energy used for household cooking include the following:

a. Electricity
b. Gas
c. Kerosene
d. Charcoal

e. Coconut shells/wood
f. other

Given the overwhelming majority (more than 85%) of households continue to use coconut shells/wood for cooking, the small sample size for each of the remaining categories made it difficult to accurately interpret results. Subsequently the remaining categories were combined into one indicator: modern cooking fuel.

'Modern cooking fuel' is used as a binary indicator in the regression analysis, with households which use a cooking fuel other than coconut shells or wood, assigned a value of 1.

Probit regression analysis

This study uses probit method of multivariate regression analysis.

The dependent variable in the analysis, nutritional outcomes (Y), is a set of dummy variables that indicate if a household is achieving the minimum recommended daily intake for a given nutrient (calories, protein, fat, carbohydrates, sodium, iron, vitamin A).

Formally, the dependent variable is measured in the following way

(1) $y_{i1} = 1[Kcal_i < 2978]$
(2) $y_{i2} = 1[Protein_i < 74.5]$
(3) $y_{i3} = 1[Na_i < 1610]$
(4) $y_{i4} = 1[Na_i > 2300 y_{i6} = 1[Fe_i < 8]$
(5) $y_{i5} = 1[Vit.A_i < 600]$
(6) $y_{i6} = 1[Kcal_i > 2978]$
(7) $y_{i7} = 1[Fat_i > 115.8]$
(8) $y_{i8} = 1[\sum_{k=1}^{8} y_{ik} < 1]$

Where:

i indexes households

k indexes nutrients

The study is interested in characterizing how household and community factors (X) are affecting nutritional outcomes (Y). Similar studies have modeled this demand to be a function of the following categories of variables[105]:

(A) Household head characteristics
  a. Gender
  b. Education
(B) Household characteristics
  a. Size & composition
  b. Income
  c. Asset endowments
(C) Regional variables

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[105] Larissa Drescher et al., "Consumer Demand for Healthy Eating Considering Diversity – an Economic Approach for German Individuals," *International Journal of Consumer Studies* 33, no. 6 (November 1, 2009): 684–96, doi:10.1111/j.1470-6431.2009.00812.x.

a. Geographic regions
b. Urbanization

The household characteristics, household head characteristics, and regional variables that are included in the analysis are:

(1) $x_1 =$ Household head is female
(2) $x_2 =$ Household head education

(3) $x_3 =$ Share of income from wages in total household income
(4) $x_4 =$ Share of income from subsistence in total household income
(5) $x_5 =$ Household cooking energy is from fuel/electricity
(6) $x_6 =$ # of dependents per adult in the household
(7) x_7Household is located in urban region

The relationship between X and Y is modeled using the following expression:

$$y_{ijk} = x_{ij}\beta_k + c_{jk} + \varepsilon_{ijk}$$

Where:

j indexes islands

y represents a nutritional outcomes

x is a vector of household characteristics

c represents an unobserved island effect

ε is a stochastic error term

Island level effects are included in the model for two reasons: first, the study is interested in characterizing the relationship between x and y while accounting for unobserved factors at the island level; and second, the study is interested in characterizing the relationship between urban areas and rural areas. Because the urban and rural designation is made at the EA level, island is the next lowest level of aggregation that can be incorporated in the analysis.

Equations for each element of y (each nutrient) are estimated separately using correlated random effects probit regressions. This regression technique allows model parameters to be estimated while conditioning out the effect of c by specifying the mean of c conditional on x, and a normal distribution of the error term.[106]

Food Rankings

This study calculated the total consumption of each food item within the surveyed sample, and ranked food items in a number of different ways.

[106] Jeffrey M. Wooldridge, *Econometric Analysis of Cross Section and Panel Data: Second Edition* (Mit Press, 2010).

The study produced the top 40 food by the following criteria (Rank each food *j*, by the sum of attribute over households, *i*)

(1) Highest expenditure: $\sum_{i=1}^{N} P_{ij} * q_{ij}$
(2) Highest consumed volume: $\sum_{i=1}^{N} q_{ij}$
(3) Largest source of calories: $\sum_{i=1}^{N} Kcal_{ij}$
(4) Largest source of fat: $\sum_{i=1}^{N} Fat_{ij}$
(5) Largest source of sodium: $\sum_{i=1}^{N} Na_{ij}$
(6) Largest source of protein: $\sum_{i=1}^{N} Protein_{ij}$
(7) Largest source of iron: $\sum_{i=1}^{N} Fe_{ij}$
(8) Largest source of vitamin A: $\sum_{i=1}^{N} VitA_{ij}$

Rankings were replicated on different subpopulations to identify differences in food bundles. The subpopulations analyzed are:

(1) Urban
(2) Rural
(3) RDI compliant
(4) RDI non-compliant
(5) Income (deciles)

Optimum Food Basket

The optimization problem is then to minimize food expenditures by choosing a consumption bundle of food that meets all the nutrient intake requirements for a healthy diet. More formally, the optimization problem is expressed as the following:

(1) The objective is to minimize the cost of food
    a. $\sum P_i * q_i$
       where i indexes food items
       P represents price
       q represents quantity consumed

(2) Individuals must consume at least the recommended daily intake[107] for each nutrient without over-consuming fat or salt. The dietary constraints are expressed by the following expressions

    a. $2978 < \sum Kcal_i * q_i < 4467$
       ($Kcal_i$ represents the caloric content of food *i*)
    b. $\sum Protein_i * q_i > 74.5$
    c. $59.1 < \sum Fat_i * q_i < 115.8$
    d. $1610 < \sum Na_i * q_i < 2300$
    e. $\sum Fe_i * q_i > 8$
    f. $\sum Vit\ A_i * q_i > 600$

(3) Individuals can choose from a set of food items (see Table 9)

[107] World Health Organization, *Vitamin and Mineral Requirements in Human Nutrition* (World Health Organization, 2004).

a. The choice set of food in this study is defined as the 50 most commonly consumed products in Vanuatu
b. Individuals observe the price per 100g
c. Individuals observe the nutrient content per 100g

Table 28: Nutrition composition per 100g

Food item	Calories	Protein	Fat	sodium	iron	Vit A.
Rice	123	2		5		
Bananas (Cooking)	180	2		4	2	17
Island Taro/ Taro Fiji	97	2		28	1	2
Manioc	147	1	1	26		
Island Cabbage	31	4	1	18	2	806
Bread	259	10	3	700	1	
Kumala	117	1		45	1	365
dry Coconut / Copra	283	3	27	16	1	
Yam	65	2		3	1	9
Tinned Meat	124	25	3	417	1	20
Mangoes	68	1		3		133
Tinned Tuna	109	22	2	390	1	15
Water Taro	79	1		72	1	3
Sugar	394			1		
Beef fresh	177	29	7	73	3	
Cabin Biscuits	458	8	18	798	2	11
Laplap (Yam, manioc, etc..)	151	1	1	21		
Chicken (chicken parts)	209	28	11	96	1	10
Chicken/ Local chicken	196	18	14	89	1	12
other fish	110	20	3	73	1	31
Watermelon & Rock melon	24	1		4		13
Cream cracker, biscuits	458	8	18	798	2	11
Paw paws	51	1		6	1	59
Pineapples	53	1		2	1	3
Noodles	99	3	4	1200	1	
Plate of food/ Take away	223	16	18	540	8	284
Corn	116	3	1	17	1	25
Doughnuts, Kato	371	7	21	380	1	5
Green Coconut	16			6		
Cooking oil (incl. salad oil)	878		99			
Peanuts	568	25	47	1	2	
Butter/margarine	727	1	81	720		908

The simplex algorithm implemented by the OpenSolver[108] application is used to solve the system. The solution to the programming task yielded the following results:

(1) q* - this is the optimum quantity of each food item the household should consume
(2) Minimum cost – this is the minimum expenditure possible to consume at least the daily recommended intake of each nutrient

[108] Andrew J. Mason, "OpenSolver - An Open Source Add-in to Solve Linear and Integer Progammes in Excel," in *Operations Research Proceedings 2011*, ed. Diethard Klatte, Hans-Jakob Lüthi, and Karl Schmedders, Operations Research Proceedings (Springer Berlin Heidelberg, 2012), 401–6, http://link.springer.com/chapter/10.1007/978-3-642-29210-1_64.

The reader should heed the following precautions in interpreting linear programming results:

(1) The linearity of the objective function and constraints means that optimization will always yield corner solutions. A marginal change in a price could result in no change at all, or a complete shift to a substitute product. As a result, this method is limited in modeling smooth demand responses to price changes.
(2) This method assumes that the value of food is completely determined by its nutritional content. While this may represent a large proportion of the value of food, the model does not account for other potentially important non-nutritional aspects of food (taste, customs, perishability, etc.). The results should be interpreted as the theoretical behavior of an individual who only values the nutritional content of food and seeks to minimize cost.
(3) The prices used in the model are sample average prices. In reality, the prices that an individual faces in a certain location will not be the sample average of prices. For example, an urban consumer may face lower prices for rice and higher prices for farmed goods than a rural consumer.

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