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Cost of Hunger Study

Nutrition & productivity in Afghanistan

> February 2013 – Final Draft

This publication was prepared with the support of the World Food Programme (UNWFP) Afghanistan and implemented by ***Samuel Hall*.** The views and analysis contained in the publication therefore do not necessarily represent UNWFP's views.

EXECUTIVE SUMMARY

Assessing the "cost of hunger" in Afghanistan: *objective and methods*

Studies conducted in Latin American countries, by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the World Food Programme (WFP) show that undernutrition has a large impact on social and economic indicators[1]. In a similar but more modest way, this study, commissioned by the WFP-Afghanistan in 2012, aims at generating evidence to inform key decision makers and the general public about the *cost* the Afghan society and its international partners are already paying for not addressing the problem of undernutrition and hunger[2].

The methods used to estimate the "cost of hunger" in Afghanistan was not similar to the model used in South-American and African countries. Time and financial constraints have led the review team to adopt a less ambitious macro-economic model: **1)** built by two lecturers of Economics from the University of Oxford; and **2)** fueled by data extracted from the National Risk Vulnerability Assessment 2007/2008 complemented with additional data collected in a household survey of 1002 respondents. As such, this first estimate of the "cost of hunger" shall not be considered either as a financial model (e.g. discounted cash flow method valuation[3]) or as a traditional "cost of hunger" study, as generally understood by the WFP today. This paper has a much more modest purpose: it is only a basic economic approximation based on a simple theoretical model that aims to raise awareness among the general public, policymakers and development partners that Afghanistan, like most developing countries, is paying and will continue to pay for the consequences of child undernutrition.

Addressing the "cost of hunger" in Afghanistan: *findings and recommendations*

Even without using the most alarming figures, our more realistic scenario suggests a negative outcome of under-nutrition on the national GDP.

- Considering the most recent estimate of the Afghan GDP and the specificity of the local nutritional environment, this study finds that, at the national level, when Afghan households can only consume 60% of their optimal nutritional bundle, **the reduction in productivity and GDP loss is around 10.5% and the cost of hunger amounts to US$ 2.1 billion dollars per year**.

- As such, policies and programmes aiming at eradicating child undernutrition are an effective investment in the human capital of Afghanistan and should be listed as top short- and long-term priorities by national and international stakeholders.

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[1] For example, for every 100 cases of underweight children, there are 18 cases of underweight-associated diseases per year (10 cases of diarrhoea, four of anaemia and four of acute respiratory infections). In terms of education, about two school years are lost due to dropout. Economic indicators in Central America show that 1.7 million working-age people (WAP: 15 to 64 yrs) died prematurely because of undernutrition (6 per cent WAP); representing 2,500 million working hours lost. Among Andean countries (Bolivia, Peru, Colombia, Venezuela and Ecuador) and Paraguay, premature deaths account for 3.6 million WAP (4.4 per cent WAP), equivalent to 5,200 million working hours lost.
See: http://www.uneca.org/cfm/2012/documents/English/COM12-The-cost-of-hunger-inAfrica.pdf

[2] See the definitions in Annex 1.

[3] See, for instance, the financial models developed by the World Bank: quality adjusted life years (QALYs) or disability adjusted life years (DALYs).

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1. RESEARCH OBJECTIVES

When children are deprived of the essential nutrients required, in particular during the first "1000 days" of their life, they will suffer from permanent and irreversible physical and mental damage. Compared to children with adequate and height, malnourished children face a higher risk of dying. According to the *National Risk Vulnerability Assessment*, in Afghanistan, the average child mortality rate is almost 134 per 1,000 births[4] – 30 to 50% of those deaths may be attributed to undernutrition, based on benchmarks with other comparable fragile states.

In 2004-2005, a National Nutrition Survey found over half (54%) of children below five years (U5) to be chronically undernourished (growth stunted) and 39% to be of low weight for their age (underweight). About 7% suffered from acute malnutrition (wasting), but this level is now expected to be higher as a result of the rising food prices, prolonged drought, and very harsh winters of 2007-2008 and 2010-2011[5].

Children who are malnourished are more vulnerable to infectious diseases that prolong their undernutrition and further hinder their full cognitive and behavioural development. Intrauterine and child undernutrition affects health, student's performance and adult's productivity because of disease-related deficits and limited learning and intellectual capacity associated with deficient cognitive development. This translates into greater probabilities of: dying prematurely; having higher risk of becoming ill; starting education at a later age; repeating grades; dropping out of school; and ultimately having lower levels of education and productivity.

Each condition implies direct or opportunity costs that can be estimated through secondary data. As a result, undernourished children have reduced ability to learn and concentrate while in school, ending up with fewer opportunities to access better jobs. In the end, the host country suffers monumental losses in productivity and incurs increased societal costs in education and healthcare[6].

In these regards, there is a need to raise awareness of the general population, policy makers and development partners that Afghanistan is paying and will continue to pay for the consequences of child undernutrition. Eradicating child undernutrition is an effective investment in the human capital of the country.

WHAT IS THE OBJECTIVE OF THIS STUDY?

The decision of international actors to withdraw from Afghanistan has awaken interest in better understanding the state of nutrition in Afghanistan, so as not to leave the country in a situation of food insecurity, as this could have a sizeable economic impact and further compromise the current political balance.

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[4] *Poverty Status in Afghanistan: A Profile Based on the National Risk Vulnerability Assessment (NRVA) 2007/8*, Ministry of Economy and the World Bank, Economic Policy and Poverty Sector, 2010; and 48% for the NRVA.

[5] The World Bank, *Overview of Under-nutrition in Afghanistan*, 2009: "Similar to other South Asian countries, undernutrition is not only confined to infants and young children, but is also highly prevalent amongst women of reproductive age. Over 21% of Afghan women 15-49 years of age have been reported to be undernourished (Body Mass Index < 18.5)".

[6] For instance, In a recent study, the World Bank estimated that the negative impact of malnutrition in Afghanistan amounted to 2-3% of the annual GDP (http://siteresources.worldbank.org/INTAFGHANISTAN/Resources/Afghanistan-Reconstructional-Trust-Fund/Malnutrition_inAfghanistan_for_High_level_audience.pdf)

The aim of this paper is to highlight the importance of the analysis of nutrition on macroeconomic outcomes in Afghanistan – through a "Cost of Hunger Study", which captures how much the failure to address under-nutrition 'costs' in GDP losses to the government of Afghanistan. Based on survey data, this paper lays down the links between nutritional outcomes and productivity, and proposes a model to quantify this relationship.

This paper aims at shedding light on the economic cost of malnutrition in Afghanistan. We adopt a multidimensional definition of malnutrition and focus, as far as our preliminary field study allows, on the trade-off between nutritional quality and quantity. Nutritional quantity refers to the amount of calories a person receives – usually cereals are calorie-rich crops. Nutritional quality, on the other hand, refers to the micro-nutrient rich food that contains minerals and vitamins. At a microeconomic level, malnutrition affects an individual's productivity through damaging one's physical and cognitive ability. From a macroeconomic perspective, widespread malnutrition in a country negatively impacts aggregate productivity in the economy. Gross domestic product (GDP) which is the sum of all value-added created in the country within a given period (usually a year), or simply the total value of all goods & services produced, can be a best proxy to measure aggregate productivity. Hence, this paper estimates the economic cost of malnutrition in Afghanistan by studying the impact of malnutrition on GDP.

Furthermore, the literature on economic growth that rationalizes the transition from economic stagnation (a situation of slow growth) to economic growth emphasizes the interaction between the level of technology and the size and the composition of the population as the key drivers behind the importance of human capital in the production process (Galor 2005). The role of human capital (knowledge, skills, and competency of working population) in economic growth has been verified by empirical and theoretical studies. In fact, human capital plays a significant role in growth and development in a country more than what previously believed. The reduction in fertility, jointly with gains in productivity, has led to the rise in demand for human capital during economic transition, and in particular in the phase of industrialization. Technological progress alongside with the reduction in population size enable economies to convert their resources into growth in income per capita, thereby leading to a regime of sustained economic growth, that is characterized by a high level of productivity and low fertility rates. Such economic regime is indeed synonymous of a low/no prevalence of undernutrition.

The analysis of the links between nutrition and productivity (proxied by GDP) requires studying a dual causality that goes from both sides. On the one hand, malnutrition affects GDP through reducing labour productivity, and, on the other hand, a lower GDP and thus a lower income per capita restricts households' consumption of nutritional diets. Our aim is therefore to document this loop of causality based on our survey data and to lay down an economic model that has the potential to allow us to disentangle correlation from causality, so as to estimate the overall effect of improved nutritional diets on aggregate/ sectoral productivity.

This paper starts off by presenting the nutritional situation in Afghanistan in section 3 based on a household survey that was conducted in May and June 2012 in ten provinces (Badakhshan, Balkh, Faryab, Herat, Jawzjan, Kabul, Kandahar, Kunduz, Nangarhar, and Samangan) with 1,002 randomly chosen households to collect specific demographic, social, economic and nutritional information. Based on those insights, we document in section 4 the key economic factors that lead nutritional outcomes to feedback into productivity. In section 5, we present a model that has the potential to quantify the link between improved nutrition and economic growth. Section 6 concludes this paper and opens wider debates of policy discussion and economic research.

2. COST OF UNDERNUTRITION

The sections in annex discuss the links between nutrition outcomes and productivity, and present the main findings of our survey on malnutrition and households' structure and behaviour in Afghanistan. This section intends to quantify and estimate the impact of under-nutrition on productivity in Afghanistan. To do so, we build a quantitative model to capture the households' choices, market conditions and fertility in Afghanistan. The model is a simple overlapping generation growth model that takes into account the following assumptions[7]:

- Households live for two periods – young and old.
- The generations overlap, and consequently they trade with one another.
- We abstract from population growth.
- Households are identical.
- Nutrition affects productivity and thereby output. This captures the effect of nutrition on productivity.
- Household value consumption at young and at old age as well as nutrition. This captures the health effect of nutrition.
- Saving in period t becomes capital in period t+1.
- We assume full capital depreciation.
- Households choose Nutrition, Savings, Consumption when young, and Consumption when old.

Our framework suggests that the returns to improved nutrition outweigh the return to foreign aid intervention in terms of gains in GDP. However, foreign aid policy has a higher impact on the welfare of the representative household than improved nutrition.

A SIMPLE MODEL OF NUTRITION AND GROWTH

In our modeling environment, nutrition affects the productivity of households and determines jointly with capital the production possibility frontier of the economy. We embedded the productivity channel of nutrition in a standard off-the-shelf representative agent growth model[8].

The results that emerge from this analysis are based on three key assumptions. The model assumes constant population growth, identical households, and full capital depreciation. In other words, we assume away household heterogeneity and fertility choice for the sake of simplicity. The notion of full capital depreciation is less critical as our modeling period is a generation[9].

The impact of nutrition on productivity is determined by a parameter ψ that guides the return of nutrition in terms of productivity. We calibrate ψ based on empirical evidence by Alderman and Behrman (2004).[10] In their literature review, they report that moving an infant from low birth weight to normal weight is likely to be associated with a total increase (considering direct and indirect effects via schooling) of about 5 to 10 percent of annual earnings. We will draw inference based on a

[7] Our illustrative calculations are based on a neo-classical growth model to which we append nutrition as a determinant of productivity. For our results to be robust for a realistic policy exercise in a particular country, some assumptions need to be relaxed and more data are required.
[8] See the appendix for more detailed explanations on the model.
[9] We are well aware that those assumptions are critical, and will deal with them at the next stage of our research.
[10] Improving child nutrition for sustainable poverty reduction in Africa - IFPRI - Issue briefs

low return scenario where the returns to moving from under-nutrition to unconstrained nutrition amount to 5% and a high return scenario where the returns amount to 10%.

THE IMPACT OF UNDERNUTRITION ON GDP

In the model, we define under-nutrition as the inability of the household to freely choose the amount of nutrition good it wants to consume. To analyze the impact of under-nutrition on GDP and welfare we therefore constrain the representative household to consume an exogeneously fixed percentage of the nutrition level that it would ideally consume if it were not subject to a nutritional constraint. In other words, we impose a limit on the amount of nutrition that can be consumed by the representative household, and evaluate the consequences in terms of GDP of this nutritional constraint. The reasons behind the emergence of this constraint remain unmodelled, but ways to endogenize this nutritional constraint in such a framework are on our agenda, as outlined in our research proposal.

A constrained level of nutrition leads to higher levels of non-food consumption and capital due to the reduced expenditure on nutrition. The production loss incurred due to the lower productivity generated from lower nutritional intake of the representative household is not compensated by the higher capital level. Therefore under-nutrition leads to reduced output levels and lower welfare. This mechanism is at the core of our analysis, and the quantitative impact of under-nutrition is depicted in Table 1.

Based on this definition of under-nutrition, we compute the losses in terms of GDP when the household is only consuming a certain fraction of its optimal nutrition. In Table 1, we summarize our findings. When returns to nutrition on productivity are low (scenario 1), situations in which the representative household can only consume 60% of its optimal nutritional bundle leads to a reduction in productivity and a GDP loss of around 5%. In an environment with high returns to nutrition (scenario 2), which is closer to the Afghan environment, the GDP loss can be more than twice as great as under scenario 1 (-10.5%).

Table 1: Impact of mal-nutrition on GDP and Welfare (in %)

Under-nutrition (% of optimal nutrition)	50%	60%	70%	80%	90%
Scenario 1 – ψ 1 – lower bound					
% change of GDP	- 9.34	- 4.97	- 2.52	- 1.17	- 0.41
% change of welfare	- 5.57	- 3.09	- 1.60	- 0.70	- 0.21
Scenario 2 – ψ 2 – upper bound					
% change of GDP	- 17.39	- 10.46	- 5.95	- 3.04	- 1.18
% change of welfare	- 8.36	- 4.91	- 2.70	- 1.30	- 0.45

Chart 1: Impact of under-nutrition on GDP and Welfare (scenario 1)

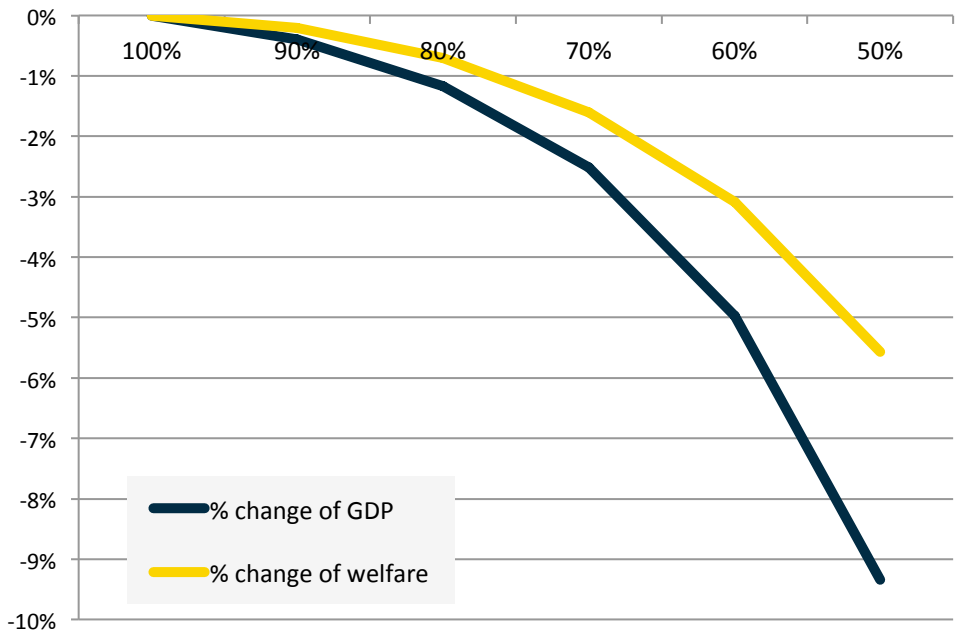
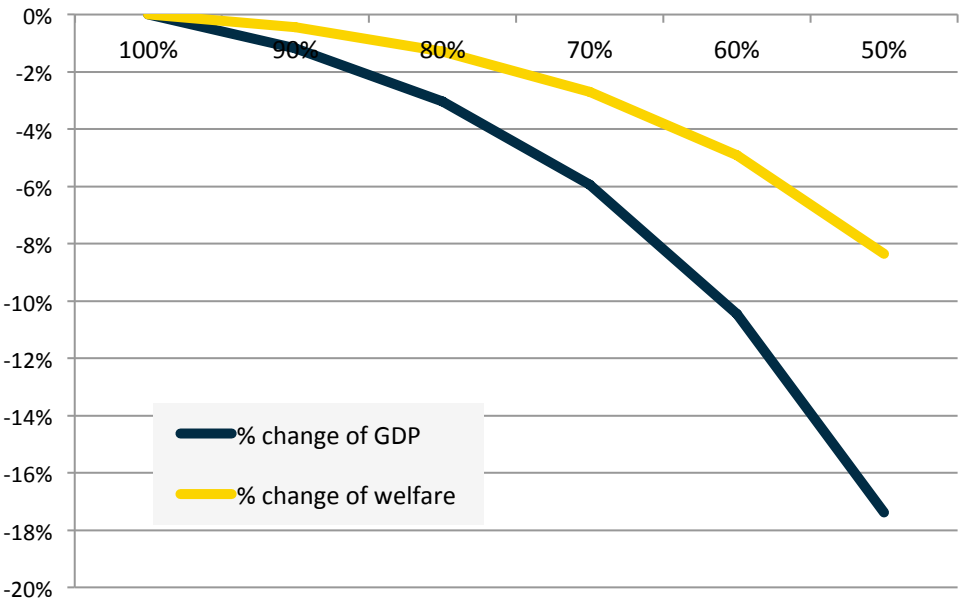


Chart 2: Impact of under-nutrition on GDP and Welfare (scenario 2)



Our 2 scenarios do not use the most alarming figures of under-nutrition. Yet, even without using the most extremes figures, our more optimistic scenario suggests a negative outcome of under-nutrition on the national GDP:

- *When a representative household can only consume 60% of its optimal nutritional bundle, the reduction in productivity and GDP loss is around 5% (10.5% with scenario 2);*
- *When a representative household can only consume 50% of its optimal nutritional bundle, the reduction in productivity and GDP loss is around 9.3% (17.5% with scenario 2).*

Finally, and considering:

1) The most recent estimate of the Afghan GDP (US$ 19.18 billion, according to the World Bank[11]);
2) The specificity of the Afghan environment, which inclines to use the second scenario – with higher returns to nutrition;
3) A situation where a representative household would only consume 60% of its optimal nutritional bundle, on average,

Our study suggests that the actual cost of hunger in Afghanistan amounts to US$ 2.01 billion per year.

Table 2: Impact of mal-nutrition on GDP and Welfare (in US$ billion)

Under-nutrition (% of optimal nutrition)	50%	60%	70%	80%	90%
Scenario 1 – ψ 1 – lower bound					
Change of GDP	- 1.79	- 0.95	- 0.48	- 0.22	- 0.08
Scenario 2 – ψ 2 – upper bound					
Change of GDP	- 3.34	- 2.01	- 1.14	- 0.58	- 0.23

[11] See the World Development Indicators at: http://data.worldbank.org/country/afghanistan

3. RECOMMENDATIONS

A Systemic approach towards nutrition

Eliminating under-nutrition and malnutrition would lead to a substantial improvement in dietary quality and reap benefits in terms of productivity. The main channels are via educational investment, reduced incidence of cognitive and physical disabilities and thereby labor productivity. Increased labor productivity would reap substantial macroeconomic benefits, in particular in terms of labor market allocation. However, it needs to be stressed that one-handed policy interventions on the nutritional front could be short-lived unless they are accompanied by changes that improve the functioning of markets. As we have argued, the current market structure, in particular the presence of transaction costs, could make gains from labor productivity shortlived. The lack of risk-sharing possibilities across villages/regions and the isolation of villages could well lead to household responses (increase fertility, overproduction of staple food) that would impede gains from temporary improvements in nutrition to become permanent. In this respect, the creation of a suitable infrastructure would certainly facilitate the reallocation of goods and labor. Also, regulatory reforms with regard to the creation of land markets, which come along with property rights enforcement, would indeed facilitate the effectiveness of intervention.

Cross-cutting policy recommendations

To progressively eradicate under-nutrition and mitigate its negative impact on the national development and growth, the key informants we have interviewed[12] have suggested the following policy recommendations:

- Make the case for nutrition as a sound investment foundational to the national socio-economic development, through a cross-cutting nutrition strategy and a multi-stakeholder coordination committee;
- Strengthen and coordinate food security surveillance through a continuous support to the NSP programme (especially the water and sanitation community demand) and social protection programmes to vulnerable households;
- Support social protection programs to vulnerable households, including nutrition promotion as a component of a broader food security intervention (e.g. promotion of zinc, micronutrient powders, double-fortified/iodized salt, flour/oil fortification);
- Combine nutrition promotion within BPHS (Basic Package for Health Services) with activities to improve household food security at the community, school and household levels;
- Build greater government capacity/ownership/control over nutrition programs and projects.

Research agenda

Economic research – Beyond the policy dimension of this paper, this paper suggests that the economic literature on growth and development has indeed addressed lots of aspects of economic transition (sectoral transition, home production, human capital development) but has so far

[12] Representatives from the Government of Afghanistan (MoPH, MoLSA, MoWA, MoE), the United Nations (WFP, FAO), the World Bank, international organisations (Aga Khan Foundation), and non-governmental organisations (ACTED, ACF, Solidarités).

neglected the importance of nutrition in the process of economic transition. In particular, this paper has argued that the problem of endogeneity when analysing the links between nutrition and productivity is stringent. When addressing this issue, the literature mostly focuses on instrumental variable strategies. Yet there is no structural model available in the literature that disentangles the various channels through which nutrition affects labor productivity and the feedback effects of increased productivity on the sustainability of nutritional outcomes.

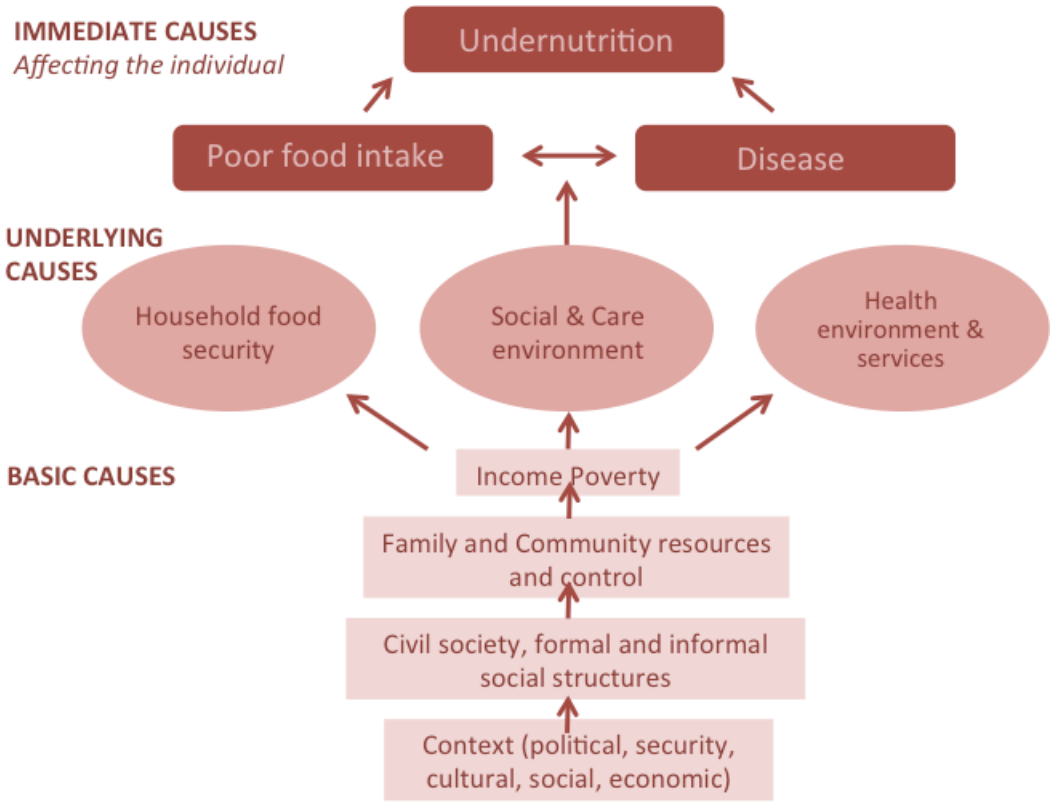
Research – The results and findings of our simple economic model provide evidence to guide policy dialogue and advocacy around the importance of fighting undernutrition in Afghanistan. Ultimately, it is expected that future studies will develop this model to further encourage revision of current allocation practices towards ensuring provision of the human and financial resources needed to effectively combat child undernutrition, in particular, during the first 1,000 days of life, when most of the damage occurs. As such, further research still needs to be done to complement, test and fine-tune the economic model. In terms of strategy and advocacy, such a comprehensive economic approach would strongly help WFP define its multi-year commitment in Afghanistan.

Annex 1: DEFINITIONS & METHODS

DEFINITION AND CONCEPTUAL FRAMEWORK

This report card primarily uses the term **undernutrition**, defined as the outcome of insufficient food intake (**hunger**) and repeated infectious diseases. Undernutrition includes being underweight for one's age, too short for one's age (stunted), dangerously thin (wasted), and deficient in vitamins and minerals (micronutrient malnutrition). The term '**malnutrition**' refers to both undernutrition and overnutrition.[13] The diagram below is based on the UNICEF conceptual framework for undernutrition, developed in the 1990s. This important framework provides a clear depiction of the various factors associated with undernutrition and the distinct levels at which these factors act.

Chart 3: UNICEF Conceptual Framework for Undernutrition (1991)



[13] http://www.unicef.org/progressforchildren/2006n4/index_undernutrition.html

DATA COLLECTION AND METHODOLOGICAL TOOLS

- ***Survey Design –*** The quantitative fieldwork was based on the initial analytical frame discussed with the WFP economic team (Roma) and the *Samuel Hall* technical advisor and Senior Economist. The objective of the survey was to capture reliable figures on household composition, food consumption, resilience to economic shocks and mitigation strategies, education, health, and employment.

- ***Geographic Coverage –*** A quantitative field survey with 1,002 household interviews was thus conducted between May 3 and June 29, 2012 in the provinces of Badakhshan, Balkh, Faryab, Herat, Jawzjan, Kabul, Kandahar, Kunduz, Nangarhar, and Samangan. It should be noted that the surveyed households were not WFP beneficiaries and that the choice of the surveyed villages and community clusters was made after a preliminary discussion with a range of stakeholders (including local NGOs, district governors, and local communities to assess the security situation in all the targeted districts).

- ***Sampling Strategy –*** To draw a better picture of the national situation[14], the review team tried to cover a minimum of 60% of rural districts in each of the ten surveyed provinces. Even if the exact percentage of the rural population may have varied a great deal over the past few years, due to internal displacements and migrations, it still seems that between two-thirds and three-fourths of the Afghan population are living in rural. According to the main official source, the NRVA 2007/8, *"the Afghan population is overwhelmingly rural: 74 percent (around 18.5 million people) live in rural areas and only 20 percent (5.0 million) in urban areas, whereas six percent (1.5 million) belong to nomadic Kuchi"*[15]. The survey methodology took this social and demographic specificity into account by surveying three different types of districts in each province: 1) **Urban:** district of the *markaz* (provincial capital); 2) **Peri-Urban:** districts that have a common border with the provincial capital; 3) **Rural or Remote:** districts that have no common border with the provincial capital.

[14] A full picture, and the possibility to produce population growth rates and population projections, is not possible as of yet, because of the absence of adult mortality indicators, life expectancy estimates and more adequate migration information. See also the Afghanistan Mortality Survey 2010, "The 1979 Census estimated that more than 85 percent of the population lived in the rural areas and about 15 percent lived in the urban areas of the country (CSO, 1979). About half of the urban population lived in Kabul, the capital city. The nomadic population was estimated to be about 2.5 million. Due to the fragility of security, large-scale migration out of the country has been common. The majority of migrants have settled in Pakistan and Iran. Afghanistan has an annual population growth rate of about 2.6 percent. The growth rate is 2.3 percent in rural areas and 4.7 percent in urban areas, reflecting migration to urban centers. The population of Afghanistan in 2010 was estimated at 29.7 million (IMF, 2011). The government of Afghanistan, in cooperation with the international community, has tried since 2008 to initiate a population census. Because of the fluid security situation within the country, this has not been possible" (p.4). Afghan Public Health Institute, Ministry of Public Health (APHI/MoPH) [Afghanistan], Central Statistics Organization (CSO) [Afghanistan], ICF Macro, Indian Institute of Health Management Research (IIHMR) [India], and World Health Organization Regional Office for the Eastern Mediterranean (WHO/EMRO) [Egypt]. 2011. Afghanistan Mortality Survey 2010. Calverton, Maryland, USA: APHI/MoPH, CSO, ICF Macro, IIHMR and WHO/EMRO.

[15] National Risk and Vulnerability Assessment (NRVA) – data from 2007/2008 (Government of Afghanistan, with the assistance of the European Union).

The table below presents the breakdown of respondents per province.

Table 3: Total number of respondents

Frequencies	Household Respondents	Percentage of Rural Households
Badakhshan	98	70%
Balkh	100	76%
Faryab	100	78%
Herat	100	72%
Jawzjan	101	80%
Kabul	100	60%
Kandahar	99	59%
Kunduz	101	60%
Nangarhar	101	75%
Samangan	102	65%
Totals	1002	70%

- ***Sampling Methods –*** As there were generally no official or informal household listings that could be used in the surveyed communities (and especially in rural and peri-urban areas). The sampling methodology followed a cluster-then-random approach adequate with the Afghan context and widely used by *Samuel Hall* for other surveys conducted over the past five years. This multi-stage sampling included the following steps:

    - In each targeted area, the main commercial area (bazaar) was identified to map the existing socio-economic environments and divide the targeted area into a relevant number of subareas;

    - A quota of 10 interviews was allocated to each selected subarea to reduce the effect of homogeneity or bias in sampling;

    - A starting point (typically a mosque or a school) was then chosen in each subarea. Streets were numbered from the starting point and households selected at random with, for instance, odd shops and households of streets 1-3-5-7.

ECONOMIC MODELING

In the model economy output, (GDP) is a function of both productivity and capital. Households' saving in period t become capital in period t + 1. So far we assume that the capital fully depreciates. In this model economy, the representative household chooses nutrition, savings, non-food consumption subject to a budget constraint, which states that the representative household cannot spend more than his resources. If the economy receives foreign aid, this constraint is relaxed, and the resources available for production and consumption are increased by the amount of foreign aid.

The model builds on a representative household, which derives utility from his stream of non-food consumption (C) and nutrition (N). The time preference of the household is given by the discount

factor β, which is set to .3, to mimic the time horizon of a generation (30 years).[16]

The household has access to a technology producing a common good that can be used for consumption and for nutrition. We assume that the technology has diminishing returns to scale with regard to capital. The parameter that guides the returns of the production technology is α, which is set to .5, such that the capital share of the economy amounts to one third of GDP.

We assume that nutrition positively affects the productivity of the representative household. Our choice to model this relationship with an exponential function is based on the fact that strong diminishing returns to nutrition are sensibly bounded above. This relationship is determined by the value attributed to the parameter ψ. To set the level of the parameter ψ, we calibrate the economy based on empirical evidence by Alderman and Behrman (2004). They review the relevant literature and report that moving an infant from low birth weight to normal weight is likely to be associated with a total increase (considering direct and indirect effects via schooling) of about 5 to 10 percent of annual earnings. We will operate with two values of ψ, ψ1 will stand for the lower bound, i.e. when returns to nutrition lead to a 5% increase in annual earnings, and ψ2 for the upper bound (10% increase in annual earnings).

Finally we need to choose θ, which determines the share of total expenditure that the representative household spends on nutrition. The model implies that for a very large A the expenditure share on food converges to θ. We therefore set θ = 0.28, which 1+θ 1+θ represents roughly the consumption expenditure on food in the developing world.

Finally, the variable aid takes positive values when we assess the impact of foreign aid on the economy. aid will be determined as a percentage of current GDP.

$$\max_{Ct,\,Nt,\,Kt} \sum {}^{t}(\log(C_t) + \theta \log(N_t))$$

Subject to the economy wide budget constraint.

$$C_t + N_t + K_t = (1 - \exp(-\psi Nt\text{-}1))\, K_{t-1}^{\alpha} + aid_t$$

Solving the planner problem delivers following optimality conditions at steady state:

$$\theta \frac{C}{N} = 1 - \beta A K^{\alpha} \psi \exp(-\psi N)$$

$$AK^{\alpha}(1 - \exp(-\psi N)) + \text{aid} - C - N - K = 0$$

$$1 = \beta \alpha A K^{\alpha}(1 - \exp(-\psi N))$$

The solution to this system of equations (3 optimality conditions and budget constraint) gives us the equilibrium of the economy, which is fully defined by N,K,C.

[16] Let the annual discount factor be 0.96 to mimic an annual interest rate of 4%. Elevating this annual discount rate to the power of 30 delivers the discount rate of approximately 0.3.

Annex 2: NUTRITION AND PRODUCTIVITY

Nutrition of Afghan households

In this section, we highlight the salient features of nutrition allocation at the household level in Afghanistan. There is ample evidence in our survey that households struggle to satisfy their nutritional requirements at all times. As evidenced by chart 4, only 15% of the surveyed households interviewed report never to have had problems satisfying nutritional needs over the previous year, with about 27% percent struggling with it on a monthly basis, suggesting a severe restriction. Crucially, we can measure the coping strategy of households when faced with problems satisfying nutritional needs.

Chart 4: Problems satisfying nutritional needs over the past 12 months

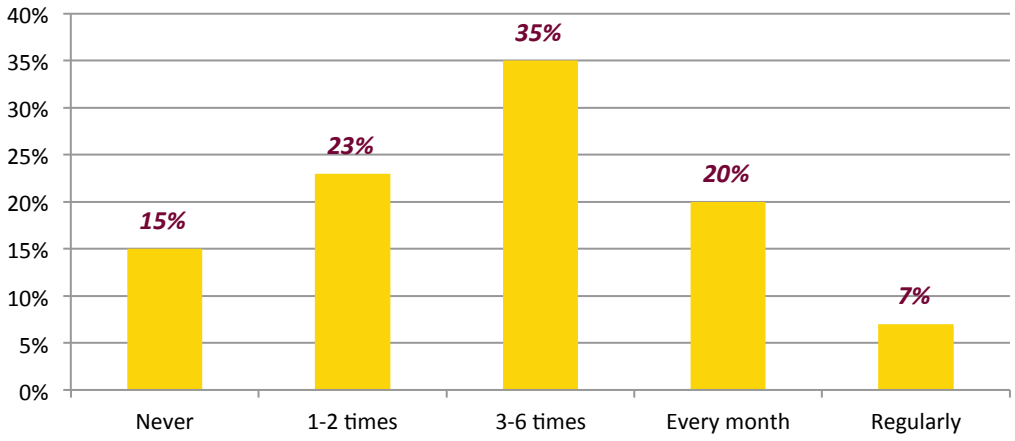
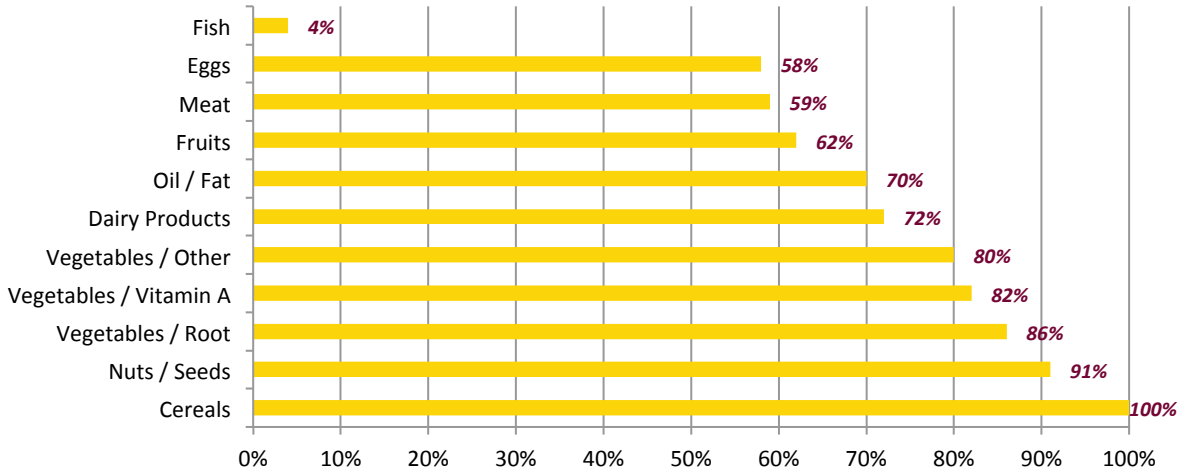


Chart 5 summarizes the nutritional intake of the households. This is based on the so-called recall method: the interviewer asks the household head the ingredients that were consumed over the past week. The chart below suggests that just above half of the interviewed households had a balanced nutritional diet over the past week. A significant proportion (about 40%) of the interviewed households had only eaten staple food and lacked basic micro-nutrient rich food (eggs, meat, fruits).

Chart 5: Nutritional items consumed by the household over the past 7 days



Beyond the fact that a large share of Afghani households face stringent constraints in meeting their required nutritional level, when they manage to meet those needs, dietary intakes are poorly diversified. As will be argued in annex 3, there is ample evidence that most deficiencies are actually due to poor-quality diets characterized by relatively high intakes of food staples but low consumption of non-staple foods that are rich sources of bio-available minerals and vitamins (Bouis, Eozenou and Rahman 2011).

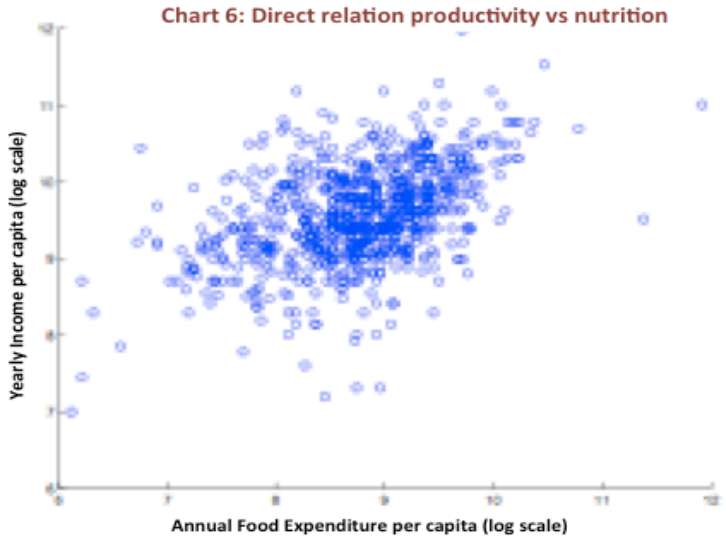
How does productivity affect nutrition outcomes?

The Afghan economy is characterized both by a low aggregate productivity level (technology), and a low degree of diversification (market structure). The first fact translates into lower level of income and is directly responsible for the low level of food consumption and general level of poverty, while the second fact reinforces the first one by impeding strategies that could relax the budget constraints that households face and provide a risk-insurance mechanism for vulnerable households. In fact, diversifying the sources of income enable households to secure a stable and sustained income generation and decreases their vulnerability to shocks in income.

DIRECT RELATIONSHIP BETWEEN INCOME/PRODUCTIVITY AND NUTRITION

As documented in the previous subsection, malnourishment is the result of the incapacity of economic agents to acquire food in sufficient amounts and quality. In Afghanistan, it is primarily the result of (i) an extremely low productivity level in agriculture and (ii) the difficulty to generate sufficient tradables to exchange for imported food (which can be related either to a low productivity level in the production of tradable goods itself or significant artificial or natural trade barriers). It needs to be stressed in this context that malnourishment in Afghanistan - as opposed to many other developing countries - is less a consequence of a disproportionate level of inequality in productivity levels (or assets) across individuals but rather due to a generally low productive capacity of the entire economy. To the extent that a minimum amount of food is an essential subsistence requirement, points (i) and (ii) imply that a large proportion of individuals (80 % in Afghanistan) choose to be active in agriculture, the “problem sector”. This impedes labor resources to be freed to boost other, more productive activities, and is non-trivially responsible for a low level of GDP/productivity in the entire economy, a phenomenon that has attracted much attention in the recent literature (Caselli (2005) amongst others). Such a mechanism is all the more nefarious given that one crucial production factor in agriculture – fertile land – is in fixed supply so that an increase in the size of labour in agriculture will result in less-than-proportionate increase in labour output. This is because agricultural productivity is low and the cultivated land are not expanded; therefore, any increase in labour supply – given fixed productivity level in agriculture – will result in less-than-proportionate increase in agriculture output.

Figure 6 plots the annual expenditure per capita and the annual income level reported at the household level, which acts as a proxy for the productivity level of the household. Figure 6 depicts a positive relationship between the two variables and displays a coefficient of correlation of 38%. This emphasizes the strength of the direct effect of increase productivity on food expenditure level, and most likely on the reduction of low food availability at the household level: variations in income and productivity explains 38% of the variation in food expenditure level at the household level, which suggests a strong and direct correlation between those two variables.



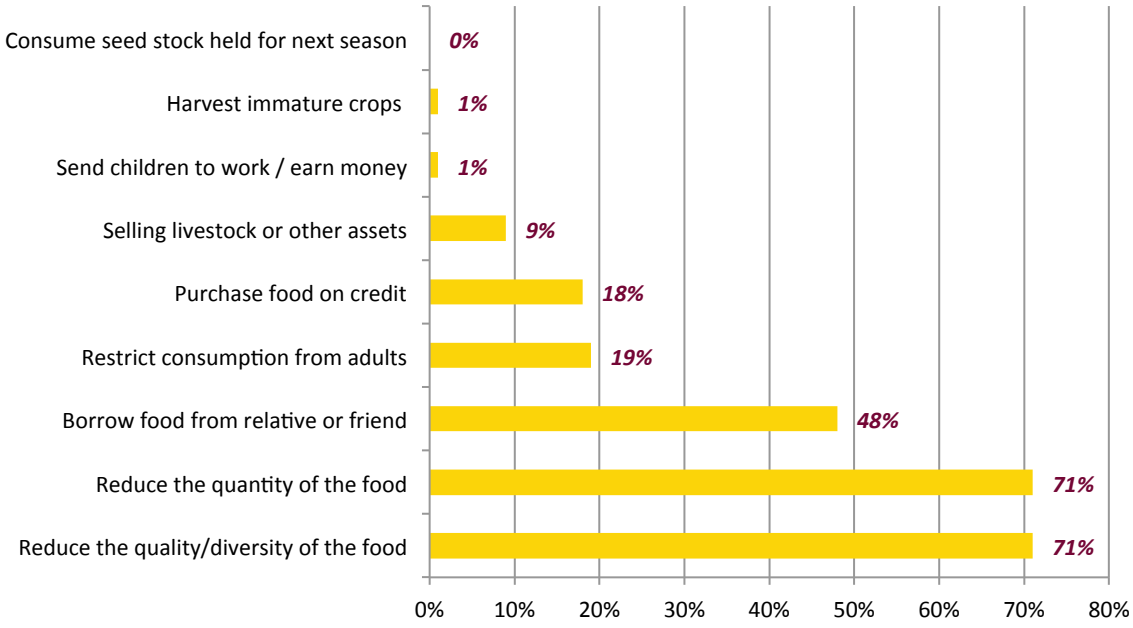
MARKET STRUCTURE

The fact that the rural population is geographically fragmented combined with degraded infrastructure and security risks involved in the transportation of goods and individuals over large distances implies that households and entire village communities are essentially dependent on their own agricultural production in ensuring their food requirements. Moreover, insofar as the trade in goods is feasible, it is reduced by the difficulty to insure on financial markets. As farming households devote a large portion of their time to a risky activity, their possibility to smooth (food) consumption is likely to be strongly dependent on the option to borrow. Alternatively, seasonal or permanent migration of some household members could provide an alternative insurance mechanism (in a way that worker remittances provide another source of income and decreases the risks that households are faced with), yet it is also hampered by the difficulty to move around the country efficiently.

All of these effects imply that workers, and in particular farmers, are likely to choose investment strategies that mitigate the risk rather than maximise the expected outcome. For households that are close to subsistence levels of consumption, full insurance against risks is probably more important than simply receiving higher expected outcomes (see Donovan (2011) for a quantification). In the Afghan context, this could well imply an over-investment in calorie-rich crops (which permit survival) to the detriment of nutrient-rich crops. Also, it could suggest an underinvestment in basic agricultural inputs such as fertilizers, herbicides and insecticides. In the absence of other savings instruments, savings in the form of livestock and grain are also likely to be overemphasized.

Not only is aggregate productivity in agriculture low, it is also subject to large fluctuations due to weather circumstances and the fact that much of the land is not irrigated but rather dependent on rain-fall. Farmers, therefore, face important risks with regard to their crop and thereby to their food consumption. Idiosyncratic risks (risks that affect specific households or individuals) can be mitigated to some extent by the presence of local markets, and exchange/loans within villages. However, households' aggregate risk exposure at the village level are correlated, which a priori allows for little risk sharing. The lack of infrastructure and the high level of transaction costs tied to regional trade, impedes risk sharing across villages/regions. The outcome of such transaction costs in risk markets is well illustrated by figure 7.

Chart 7: Has your household relied on the following copping strategies?



This figure plots the frequency of responses interviewees gave to the their coping strategies when facing nutritional bottlenecks. When facing problems to satisfy the households' nutritional needs, households mostly reduce their food basket downwards (quantity and quality), borrow food or funds to purchase food, reduce the consumption of adult food intake and/or stunt. The fact that only 19% of households consider the reduction of adult food-consumption as an appropriate mitigating strategy hints towards problems tied to intra-household distribution of food. As emphasized in Bouis et al. (2011), a salient feature observed in various countries is that children may receive a disproportionately low share of the household intake of non-staple foods. Consequently poor micronutrient intake has adverse direct consequences on early age development. Similar bias is observed towards women, which reinforces the effect given that the nutritional status of infants is affected during fetal development and lactation. This observation suggests that in time of nutritional risks, young household members and women are more exposed. The appropriate strategy from a nutritional perspective would be to tilt the intra-household nutritional consumption towards young household members and pregnant women, given that under-nutrition and stunting has long-lasting effects on their development. Seemingly too few households do so.

- **Lack of infrastructure and of insurance for goods markets can lead to over-investment in calorie-rich crops to the detriment of nutrient rich crops.**
- **When facing nutritional risk household rarely adjust the intra household distribution of food towards those who need it most.**
- **High transaction costs impede risk sharing across villages/regions.**

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