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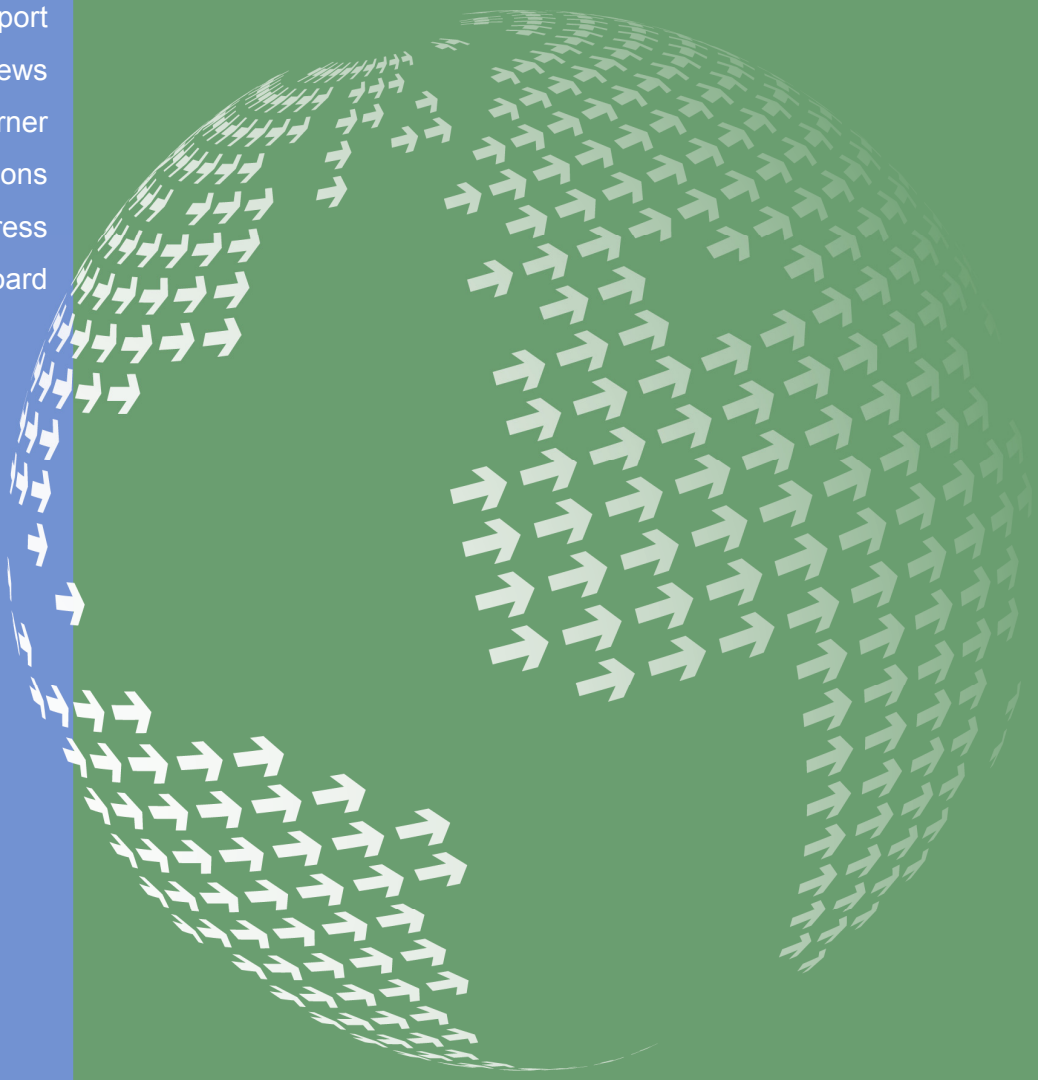

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Addressing Undernutrition and Climate Change in the Millennium Villages: Enhancing Resilience of Rural Communities

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Need for integrated nutrition and climate approaches

Climate change is a defining challenge of our time. Its impact and implications will be global, far-reaching and largely irreversible. Climate change is already increasing the risk of exposure to hunger, malnutrition and food insecurity among the poorest and most vulnerable people (Nelson et al. 2009, Parry et al. 2009, WHO 2009). Natural disasters are becoming more frequent and intense, land and water are becoming more scarce and difficult to access, and increases in agricultural productivity are becoming more difficult to achieve (Nelson et al. 2009, Parry et al. 2009). By 2050, the number of people at risk of hunger as a result of climate change is expected to increase by 10 to 20% more than would be expected without climate change; and the number of malnourished children is expected to increase by 24 million – 21% more than without climate change (Parry et al. 2009). Sub-Saharan Africa is likely to be one of the worst affected regions, especially the semi-arid regions north and south of the equator. This is mainly because of projected increases in aridity resulting from climate change and because of high vulnerability consequent on low levels of income. Without drastic changes in our global food system complemented with large-scale strategies to address malnutrition, taking into account the ongoing demographic and epidemiological shifts and the nutrition transition, it is predicted that climate change will eliminate much of the improvement in child malnourishment levels that would occur with no climate change (Nelson et al. 2009, Parry et al. 2009).

We are already in a state of emergency with more than one billion people hungry (an increase of 250 million over the previous five years), 195 million children stunted, and more than one billion people suffering from overweight or obesity, diabetes or other food-related health issues (WHO 2006, Popkin 2008, FAO 2009). At the same time, agricultural practices and food systems are pushing our ecosystems beyond sustainable boundaries and are important factors contributing to climate change (IPCC 2007, Rockstrom et al. 2009). Almost 15% of global anthropogenic greenhouse gas emissions are due to deforestation much of which is attributed to agriculture conversion, while another 14% of the emissions are directly attributed to agricultural practices (Morton et al. 2006, IPCC 2007). Food prices continue to rise as energy and other inputs drive up production costs (FAO 2009, OECD-FAO 2009). Biofuel has caused controversy during a time in which the world food system is under siege (Searchinger et al. 2008, Tilman at al. 2009). High meat demand adds pressure because it requires more energy and landmass to produce (Weber and Matthews 2008) with global inventories of grain at all time low levels (FAO 2009, OECD-FAO 2009).

There is an urgent need for integrated nutrition approaches that are able to address nutrition insecurity and climate change simultaneously and thereby tackle tradeoffs and enhance synergies between nutrition and climate change adaptation and mitigation strategies. To fully address undernutrition, it is crucial not to limit actions to short-term treatment tools but to simultaneously address the long-term determinants that impact nutrition, i.e. poverty, food production and supply systems, population growth, gender, health care, education, infrastructure, environment and this, in the face of a changing climate.

The Millennium Villages

The Millennium Villages (MVs) (Sanchez et al. 2007) was launched to establish a “proof of concept” for broad-based, community-led development strategies to achieve the Millennium Development Goals (MDGs) in rural Africa, including MDG 1, to eradicate extreme poverty and hunger, and MDG 7, to ensure environmental sustainability. Drawn from the UN Millennium Project’s recommendations to scale-up efforts to address development challenges using proven technologies, the project works with communities to deliver integrated, science-based interventions in health, education, agriculture, environment and infrastructure (UN Millennium Project 2005, Sanchez et al. 2007). The range of interventions adheres to a cost ceiling of $110 per capita sustained over a period of 5 to 10 years, reflecting the full value of contributions from government, external donors, local communities, and the project itself (Sanchez et al. 2007).

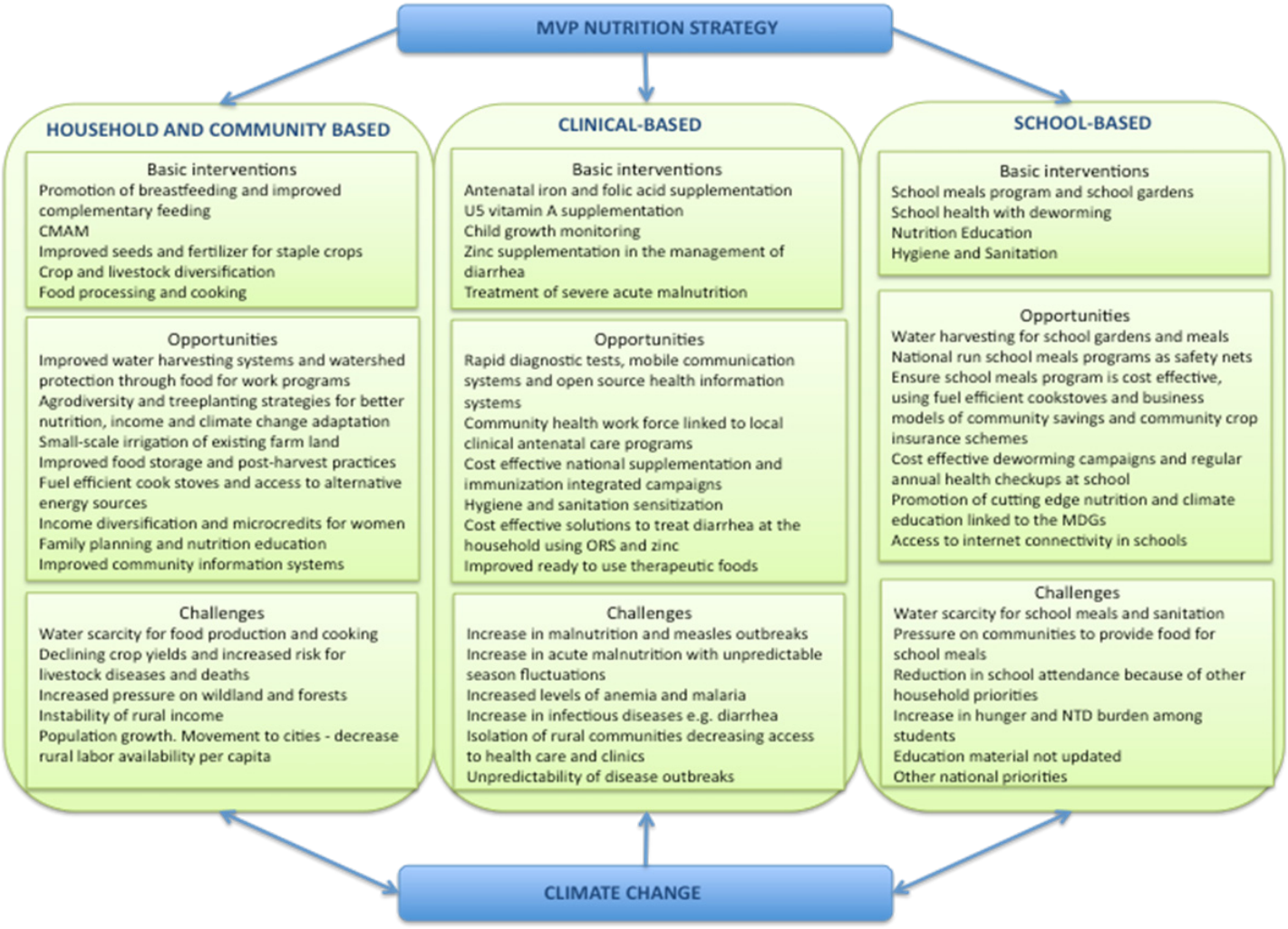
The MVs are situated in ‘hunger hotspots’, where at least 20% of children are malnourished and where severe poverty is endemic (Sanchez et al. 2007). The MVs were chosen to reflect a diversity of agro-ecological zones, representing the farming systems found in over 90% of sub-Saharan Africa. Sites range from slash-and-burn in rainforest margins to pastoralism in deserts, reflecting varied levels of population density, soil conditions, climate instability, water access, disease profiles, environmental degradation,

nutritional deficiencies and food availability, market access, education levels, cultural traditions and religious norms.

The nutrition strategy adopted within the Millennium Villages is cross-disciplinary and multi-sectoral in nature and centers upon an integrated food- and livelihood-based approach. The strategy has three main components (Figure 1). First, household, community- and livelihood-based interventions engage longer-term realities of food and livelihood security. These consist of subsidized seed, fertilizer, livestock vaccination and treatment to increase agricultural productivity; the introduction of high-value crops for both income generation and improved household diet quality; the promotion of livestock marketing; agro-processing initiatives and microfinance programs to stimulate small-business development. This approach is complimented by a community health worker (CHW) program to promote exclusive breastfeeding, family planning and improved complementary feeding practices and foods, home-based fortification, food preparation, hygiene and sanitation, and proper food storage techniques. Second, clinical interventions focus on persistent macro and micronutrient deficiencies in children, including vitamin A supplementation, treatment of severe acute malnutrition and regular growth monitoring. For cases of moderate malnutrition, families receive nutritionally improved food commodities. In addition, basic maternal health interventions such as basic antenatal care and institutional delivery are supported by efforts to promote adequate weight gain and improve coverage with iron and folic acid supplementation. Third, school- and education- based interventions include homegrown school meals programs, school gardens, and nutrition activities after school, along with deworming campaigns. School meals not only serve to decrease hunger among primary-age school children, but have been demonstrated to increase school enrollment and attendance. Adult education, especially for women, is also a critical intervention addressed.

Taken together, these efforts are an attempt to enhance nutritional intake and diet diversity, while affording households the additional income required to address nutritional needs in a sustainable way. Each of these three components faces particular challenges related to climate change but also offers unique opportunities to address challenges of malnutrition and climate change simultaneously (Figure 1). Several examples within

Figure 1. Nutrition strategy of the Millennium Villages Project: Three key components, their particular challenges related to climate change and opportunities to address malnutrition and climate change simultaneously.



the villages clearly illustrate some of these challenges and opportunities.

School meals in Koraro, northern Ethiopia

Until July 2008, the Koraro MVP School Meal Program (SMP) was feeding a meal consisting of 100 g of wheat, maize and pulses to 15 500 children in 22 schools. The World Food Programme (WFP) has supported two other schools in the Koraro MV cluster. All primary school children received a meal for 220 schooldays per year. The cost of the program was US$ 0.08 per child per day in recurring costs. The community contributed 70% of the US$0.08 per day mainly in direct contributions from food inputs. In June - September of 2008, the Koraro community was hit by a drought, resulting in low crop yields and leaving the community with minimal food reserves at the household level, and no community cereal banks, as it is not widely practiced. The household grain reserves had been sold to finance the SMP in previous years (teff was sold to purchase maize and wheat). As a result, the community and the MVP team had to make the difficult decision to downscale the SMP, leaving only two schools in the program and providing meals to only 1 860 children. Despite considerable community support for the SMP, households were simply unable to contribute to the cereal bank as food security at the household was a greater priority.

While SMPs are promoted as social safety nets (WFP 2009, Bundy et al. 2009), the SMP in Koraro was the first program that the community discontinued under drought conditions. How can these community-led SMPs become more resilient to climate shocks? The Koraro community and MVP team act in three major ways to enhance SMP resilience. First, by strengthening the community's own safety net program. This includes investments in improved water harvesting systems, school gardens, promoting savings in village level microfinance schemes and more efficient post-harvest storage and processing. Implementation of a system of 'saving' during periods when food supply is high, stabilizes supply and allows the community to accumulate grain in peak periods. These reserves can be sold when food prices are high and cash reserves can be used to buy food for the SMP during times of shortage. Initially there was resistance to grain banking and saving. Most savings and credit facilities are avoided by farmers who prefer to use traditional 'asset' acquisition as a way of preserving wealth – buying cattle for instance. But community sensitization, mobilization and ownership helped initiate savings at household level. Establishing communities own safety net program is not a quick fix solution but requires a holistic approach to community resilience and development. Second, a recent partnership between MVP and WFP has been established, which will provide the opportunity for exploring new implementation models and "best practices" of home-grown school meals programs. Third, crop insurance schemes (Hellmunth et al. 2009) are being developed to reduce risks of future crop failures caused by drought.

Mobile technology for health, business and climate

A key challenge in climate change adaptation is a lack of knowledge for communities to be proactive or rapidly change course. This is particularly true for isolated rural communities such as the sites where MVP is implemented. Climate change is predicted to increase the risk of acute malnutrition, to reduce the reliability of water resources and increase the risk of some infectious diseases such as diarrhea (Parry et al. 2009, WHO 2009). Moreover, climate change reduces the predictability of seasonal fluctuations of malnutrition and infectious diseases, and therefore urges efficient early-warning systems and rapid response kits. If a community can detect and respond rapidly and appropriately to increasing rates of malnutrition or infectious disease, many lives can be saved and major outbreaks prevented.

Mobile technology offers unique opportunities for community-based, inexpensive early- warning and response systems to tackle malnutrition and disease in the community. An example of an early-warning system based on mobile technology can be found in ChildCount (www.childcount.org), piloted in the Millennium Villages. ChildCount is an mHealth platform developed by the Earth Institute to improve child survival and health by providing support to community-based nutrition screening programs (Berg 2009). Community Health workers monitor mid‐upper-arm circumference measurements (MUACs) and oedema checks to diagnose children with severe acute malnutrition simultaneously with diarrhoea screening. ChildCount uses SMS text messages to coordinate the activities of the CHWs and refer children rapidly for treatment. Using any standard mobile phone, CHWs are able to use text messages to register patients and report their health status to a central web dashboard that provides a real‐time view of a community's health. Powerful messaging features help facilitate communication between the members of the health system and an automated alert system helps reduce gaps in treatment. ChildCount has been piloted in the Millennium Village of Sauri, Kenya. In its first three months, ChildCount was used by 100 CHWs to register over 9 500 of the 10 000 estimated children under five living in the community. This forms the basis of a "living" registry that helps the CHW to closely monitor and track the children's health status and rapidly detect trends in malnutrition or diarrhoea incidence.

Another example of a mobile technology application in the MVs which increases community knowledge to adapt to climate change, is the addition of weather monitoring devices on community cellular communication towers, providing a whole new source of data to enhance the MVP's climate science, information and adaptation efforts.

Livestock management in Dertu, northern Kenya

Semi-arid pastoral areas are particularly susceptible to climate variability and change with household alternatively vulnerable to droughts and floods. In the Dertu Millennium Village in the nomadic region of northern Kenya, rains have failed since December 2006. This has led to deteriorating pasture forage and grasses and water supplies for both humans and livestock. With another failure of the rains in April/May 2009, the distance to pasture and water increased, as open water surfaces and pastures dried up. A few thousands bales of hay, which had been made locally, and pods stored by the community in early 2007 were already gone by September 2008. Responses to the drought included the slaughter of calves and lambs, rare evergreen trees were lopped for animal feed, and livestock migrated to far, isolated pastures. Over 30% of the goats, sheep, cattle and donkeys in surrounding villages were lost. Even camels, the most drought tolerant animals, died during this drought period. As the animals became weak, diseases started to spread among the livestock. This was further aggravated by the salinity of the water from the few reliable boreholes. The value of animals dropped by more than 70% compared to the usual market prices because of the cost and challenge to keep animals alive. Human undernutrition was evident, particularly amongst the vulnerable members of the community (children under five years of age, pregnant and lactating mothers and the elderly).

To overcome recurrent droughts, the MV of Dertu commenced mass treatment and vaccination of livestock within the community and neighboring villages with support of the Ministry of Livestock. A total of over 100 000 heads of livestock were treated or vaccinated in the past three years to prepare them to overcome drought and unexpected floods that causes the emergence of the contagious Rift Valley Fever (RVF). The project has also established monthly mobile integrated health outreach services to reach the most marginalized pastoralists with immunization and treatment services. In the Dertu clinic, the project is providing free medical services and essential drugs. As drought intensity increases, a local disaster response committee, formed by the community and the MVP team and ready to act whenever needed, mobilized emergency response kits. This committee identified nomadic drought response sites, deep in the hinterland where support in the form of water, food, human medicine, livestock drugs and animal feeds are to be delivered to the vulnerable and their livestock. Additionally, pit latrines are dug and access to water is improved through piping and the establishment of water kiosks close to the settled parts of the community.

In addition, multiple long-term initiatives are being implemented in Dertu to increase community food and livelihood security under climate change. Mobile communication technology including a cell tower, mobile phones and internet in the mobile schools, now connects the Dertu community with the outside world and provides information on weather, health, security, education, market prices, status of boreholes and water surface availability, which allows the community to act more pro-actively to droughts. Further, the Dertu Renewable Energy Project was launched which will bring biogas (starting from livestock manure) and solar energy to the community. This offers opportunities for new sources of income (e.g. selling green energy, charging radio and cell phones, internet kiosks) that are less risky to the threats of climate change such as livestock and grassland production. Simultaneously, biogas and solar installations provide alternative energy for cooking, boreholes and efficient food storage (e.g. refrigeration) and thereby reduce the demand for fuel and firewood, which poses high pressure on the environment. Kenya is facing an imminent power shortage related to unreliable rainfall and decrease in the volume and reliability of hydropower; along with this is an anticipated increase in the cost of energy. Alternative energy sources such as biogas and solar energy will become increasingly important. The new energy project in Dertu is a unique pilot project illustrating potential synergies between food- and livelihood and climate change adaptation strategies in vulnerable areas like northern Kenya. However, regardless of these long-term development strategies, an emergency response kit should always be an integral part of any development and research activity within the arid and pastoral land use system. The international community has a role to contribute to such kits in order to overcome the impact of climate change.

Improved cook stoves

The landscape of the MV of Ruhiira in Uganda is dominated by banana plantations with few remaining indigenous trees. Women in Ruhiira have commented that they regularly lack firewood to prepare harvested beans which require prolonged cooking. Diet diversity and quality in Ruhiira is directly impacted by firewood shortage. In this environment, fuel scarcity is an important energy challenge for households which rely primarily on collected wood. Fuel wood collection represents a potential pressure on an already stressed

environment. Also, reduced indoor air quality due to smoke from cooking fires poses a major health risk to women and their families. The World Health Organization (WHO) estimates that indoor air pollution from solid fuel use is responsible for 1.6 million deaths due to pneumonia, chronic respiratory disease and lung cancers and is responsible for 2.7% of the global burden of disease.

The MVP team introduced fuel efficient improved cook stoves of the "rocket" design, which have demonstrated fuel wood savings of 30 to 40% in field testing (Modi et al. *in preparation*). The improved cook stoves were introduced with the aims of reducing the household burden of fuel wood collection (particularly on women and children), local environmental pressure due to use of non-renewable biomass as fuel, and emissions of harmful pollutants indoors. Additionally, improved stoves may, by reducing overall fuel wood demands, help reduce barriers to cooking food items with high fuel wood requirements, such as beans. Fuel savings may also translate into reduced overall energy costs allowing additional expenditures in other areas (education, nutrition, and health).

In Ruhiira, 400 fuel-efficient stoves have been purchased by households (Modi et al., *in preparation*). Meanwhile, institutional stoves have been installed and tested in other MV sites (notably Sauri, Kenya) to reduce the collection burden and costs of fuel wood usage for the School Meals Program. In some MV sites, mud/clay stoves, made from local materials, have also been constructed, most often in homes. Fuel wood savings from these stoves is still being tested. In Sauri for example, testing of mud/clay household rocket stoves has been undertaken, with preliminary results of 10 to 20% fuel savings, though these data are under review. In Koraro, Ethiopia, household *injera* cookers have been installed in 1 950 homes under a program with technical support from the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The project is also exploring how financing through carbon credits may offer a means of support for subsidy schemes for household cookstoves.

Further, across the MVs, investments in solar and grid expansions aim to provide improved access to alternative energies and are expected to reduce the heavy dependency on firewood, an important cause of environmental degradation. The Millennium Village Project currently prioritized solar and grid extension of schools, health facilities, farmer training and community centers. Demand for energy will definitely grow as households income increases as a result of improved production of crops and livestock and production of high value crops using small-scale irrigation.

Crop and livestock diversification and tree planting

Increased crop production during the Asian Green Revolution prevented mass starvation in many countries. The focus, however, was primarily on cereal crops (rice, wheat, and maize), consisting mainly of carbohydrates, modest amounts of protein and a few other nutrients essential to meet human nutritional requirements. The change in agricultural production from diversified cropping systems towards ecologically more simple cereal -based systems may have contributed to poor diet diversity, significant micronutrient deficiencies and resulting malnutrition (Frison et al. 2006, Graham et al. 2007). Moreover, ecosystems low in biodiversity are more vulnerable to environmental shocks (Elmqvist et al. 2003). The importance of nutrient diversity for human well-being as well as the importance of biodiversity for resilience to climate change calls for diversification in food production systems.

Agrobiodiversity provides a key resource for nutrient diversity and adaptation to climate change. Agrobiodiversity is systematically maintained and used by rural communities (PAR 2009). It is part of traditional knowledge systems and seed networks with respect to key traits and responses of diverse crop species and varieties to changing production environments and needs. For example, in the Sauri MV (Kenya), 53 different edible crop species were identified with an average of 15 edible species per farm. In the Ruhiira MV (Uganda), 34 different varieties of banana were identified with an average of 10 varieties per farm. The management of this agricultural biodiversity plays a central role in providing different nutrients for human well-being and adaptation to climate change. Diversity helps coping with the increasing frequency of extreme weather events, both through the provision of some buffering and enabling farmers to respond after droughts, floods, hurricanes and other disasters. Over the last 20 years the cultivar diversity of millet and sorghum for example has been maintained by farmers who require an extended range of maturation dates to meet early or late onset of rains and increasing frequency of droughts (PAR 2009).

Two diversity management strategies (PAR 2009) to adapt to climate change and improved nutrition are implemented by the MVP with local communities. One strategy is to restore or maintain high levels of local diversity to ensure adaptability at the local level and to improve resilience in local production systems. A second strategy involves the adaptation of new varieties and crops with new and different characteristics that fit the new conditions, e.g. drought resistant varieties, bio-fortified crops like orange flesh sweet potatoes. Change is happening so fast that traditional knowledge systems and seed supply or breeding stock cannot

evolve quickly enough to meet local needs. Investment in small-scale irrigation projects of existing farmland supports these diversification efforts.

Additionally, special efforts are made to maintain and increase the number and diversity of trees in the MV landscape. Tree species are often selected for the variety of ecosystem services they provide, e.g. fruits for human nutrition, firewood, income generation, animal feed, shade for social meetings, soil fertility, watershed protection and carbon sequestration, thereby providing smart and simple solutions for nutrition security and climate mitigation. In the Sauri MV, groups of farmers are sponsored for tree-planting business, and farmers have planted more than 2.3 million trees in two years. In the same period, youth groups have planted 172 000 trees and schools have planted 55 000. The total number of trees planted in the Sauri cluster is an estimated four million.

It is beyond the scope of the paper to evaluate the economic returns to these interventions, however some observations can be made. The Millennium Villages Project itself is designed to meet the criteria of sustainability over time and potential for replication over locations. The total cost of the combined interventions is budgeted at US$ 120 per capita per year for the first five years, with US$ 60 per year provided by outside donors, US$ 30 per year by government and the local community, and US$ 20 per year by nongovernmental and corporate partners. The US$ 60 per capita per year from outside donors is, by design, within the envelope of 0.7% of GNP in official development assistance committed by donor nations to developing countries to support the Millennium Development Goals (UN Millennium Project 2005), and well within the G8 Gleneagles Commitments on aid to Africa, adopted in 2005 for the year 2010, which are on the order of US$ 80 per person per year. The project aims to unleash self-sustaining economic growth over a ten-year period, by promoting business development (including commercial agriculture) alongside the social interventions with a climate adaptation lens.By investing in the elimination of the poverty trap, the MVP anticipates a benefit-to-cost ratio far above one.

Conclusion

Malnutrition and climate change pose significant risks to the development of poor rural communities, particularly in sub-Saharan Africa. Integrated development approaches such as the MVP create opportunities to address malnutrition and climate change simultaneously and enhance synergies between various strategies. The cross-sectoral MVP nutrition model, represented by the examples provided here, illustrates how to translate such opportunities into on the ground solutions. Alongside the interventions, the MVP is underpinned by a monitoring and evaluation platform that involves detailed socio-economic, agriculture, nutrition, infrastructure, environment and health surveys complimented with biological data collection. Cross-site and cross-sectoral analysis using this research platform will further enhance the understanding of climate – nutrition interactions in the MVs.

From the MVP experience, some key components to tackle malnutrition and climate change simultaneously can be identified, all related to resilience of rural communities, including i) strengthen rural information, knowledge and communication systems; ii) diversify food production, income and diet; iii) combine new technologies and local knowledge to improve management of natural resources key for local food systems, i.e. biodiversity, water, soil and energy; iv) empower women; v) utilize technology and tools to be more proactive , less reactive. In addition, more cross-sectoral, multiple scale and cross-site research is needed to identify and tackle potential tradeoffs between nutrition and climate change. Now, more than ever, we need to apply our knowledge on the interactions between social, economic and environmental sustainability, into on the ground action.

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