The Interaction between Health and Farm Labor Productivity in Africa

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Abstract
Agriculture and health are linked in various ways. These links are bidirectional: agriculture influences health and health influences agriculture. Good health is an asset for agriculture, as healthy people can produce more and good nutrition contributes to it. In fact CAADP pillar 3 recognizes good health as one of the solutions to food security challenges in Africa. Conversely, agriculture is an asset which contributes to good health and nutrition, and make people resilient. When both health and agriculture thrive, a reinforcing cycle of health can result, but when either suffers, the cycle becomes one of lowered agricultural productivity and lowered health. Agricultural development and practice can exacerbate the incidence of disease through an interaction with disease vectors and parasites. When disease afflicts farmers, their productivity is reduced and they remain in poverty. Beyond the direct impacts due to loss of labor, illness undermines long-term agricultural productivity in a number of ways: when illness leads to long-term incapacitation, households may respond through withdrawal of savings, the sale of important assets (such as jewelry, textiles, breeding animals, farm equipment, and land), withdrawing children from school, or reducing the nutritional value of their food consumption. All of these responses can have adverse effects on the long-term labor productivity of household members. Based on a survey of empirical literature, this paper tries to understand the causality between health and farm labor productivity in the context of African agriculture. The findings suggest that agricultural systems could expose farm labor to various occupational health hazards such as accidents, diseases (including malaria, zoonoses, soil-transmitted helminth infections and schistosomiasis) and poisoning from pesticides. On the other hand, agriculture affects health through availability of nutritious food for healthy and productive life and also contributes medicinal plants which help treat diseases. The paper also highlighted the importance of good health for productive farm activities as health status affects the duration of labor force participation and the intensity of work effort.

Key words: Agriculture, productivity, health, farm labor, Africa

1. Introduction
Agriculture provides a livelihood for most of the three-quarters of the world’s poor who live in rural areas, particularly in Asia and Africa (Ravallion et al., 2007). Most of the farms are small holdings. Africa has approximately 33 million small farms (less than 2 hectares per farm), representing 80% of all farms in the region. Due to the small sizes of farms and low incomes, the agricultural sector depends largely on manual labor which is invariably obtained from household members or hired from the local community. The farms are therefore vulnerable to household labor disruptions. One of the causes of the disruptions is ill-health in the household.

Agriculture and health are linked in various ways. These links are bidirectional: agriculture influences health and health influences agriculture. As depicted in the framework developed by Hawkes and Ruel (2006), the entire agricultural supply chain—agricultural producers, agricultural systems, and agricultural outputs—has implications for health through critical intermediary processes, which are the labor process, environmental change, income generation, and access to food, water, land, and health-related services. Poor agricultural households tend to be vulnerable to malnutrition and poor health; agricultural systems interact with the environment, and by so doing affect human health; and
agriculture produces foods, fibers, and plants with medicinal properties essential for human life and health.

Disease causes ill health and prevents people from fully engaging in their work activities or education and training or recreation. Ill health can lead to death, and the labor contribution of the dead person to household production is permanently lost. Ill-health may take labor away from the farm to treat the ailment or care for the sick person or divert money that could have been used to engage hired labor to pay for the cost of health care. Total household production is reduced and poverty is perpetuated. Health care expenditures may also affect the adoption of technology and use of inputs by poor households which negatively affects total factor productivity. Depending upon the severity of disease, these interruptions can seriously affect the livelihood of these people if the necessary adjustments are not made to replace lost time due to illness.

Figure 1. Framework for linkages between agriculture and health.

Agriculture’s role in human livelihood also means that, agricultural development has strong linkages with other fields of development practice and research, including health and nutrition. The importance of good health is summarized in a popular saying, “The wealth of a nation is the health of its people.” In fact, the Commission on Macroeconomics and Health (2001) concluded in its report that diseases are a barrier to economic growth. The success of agricultural livelihoods depends on the health of its workforce. The Comprehensive African Agriculture Development Programme (CAADP) pillar 3 also recognizes the importance of health for food security challenges in Africa. It states that “…some of the solutions to addressing hunger and malnutrition may lie outside of direct agricultural interventions and that not all households will attain food security through agricultural production, but that widespread agricultural growth depends on active and healthy people, and that agricultural growth has widespread indirect benefits”, AU/NEPAD (2009, P.4). At the same time, different agricultural production systems have different impacts on health, nutrition, and well-being of the people. Households can use income from agricultural production for improved access to health products and services, and agriculture provides food and nutrients for energy and maintenance of good health; but on the other hand, agriculture associated infections affect nutrient absorption and people’s nutritional status. Hence, knowledge and understanding of these interactions and their consequences will be useful in planning development programs in agriculture and health. The interaction between health and farm labor productivity has received growing attention among stakeholders especially recently. Notable of these is IFPRI’s 2020 conference on Leveraging Agriculture for Improving Nutrition and Health in Delhi, India in 2011, various studies
including Strauss (1986), Strauss and Thomas (1998), McNamara et. al. (2010), Asenso-Okyere et. al. (2009, 2010, 2011a, 2011b), and Audibert (2011). This paper draws mainly, among others, on the most recent literature reviews including by the author and colleagues.

2. The role of agriculture in health – empirical evidence
Agricultural production is a determinant of health, primarily through the consumption of food produced and through intermediary processes related to income and labor. Agriculture’s major output, food, carries diseases caused by contamination by pathogens during production. Consumption of milk contaminated by *Mycobacterium bovis*, which is present in animals in most developing countries, has long been regarded as the principal mode of TB transmission from animals to humans (Acha and Szyfres, 1987). *M. bovis* and *Mycobacterium tuberculosis* have been found in milk samples in Ethiopia, Nigeria, and Egypt, highlighting the serious public health implications of potentially contaminated milk and milk products in developing countries where proper food hygiene practices are lacking (WHO, 1994; Idrisu and Schnurrenberger, 1977; Nafeh et al., 1992). One way of reducing the effects of the contaminants is to boil the milk before consumption, but in many milk-producing communities, milk is consumed fresh.

Agricultural output also affects health through availability of nutritious food. Quality and diversity of food produced influence access to micronutrients and dietary diversity. Food that is poor in micronutrients cannot provide adequate nutrition for people, making them susceptible to disease. Mycotoxins are toxic secondary metabolites of fungal origin and contaminate agricultural commodities before or under post-harvest conditions. When ingested, inhaled, or absorbed through the skin, mycotoxins cause lowered performance, sickness, or death of humans and animals (Wagacha and Muthomi, 2008). High on the list of mycotoxins is aflatoxins, which pose serious health, economic and agricultural problems in developing countries (Bankole and Adebajo, 2003). Aflatoxin chemical poisons are produced mainly by the fungus *Aspergillus flavus* and are found as contaminants in foods such as cassava, peanuts, corn, rice, cottonseed, and other grains that underwent stress factors during plant growth, late harvesting of crops, high ambient humidity preventing thorough drying, and poor storage conditions. Aflatoxins give rise to diet-related diseases.

There is a high level of aflatoxin exposure in countries in Sub-Saharan Africa and Southeast Asia (Jolly et al., 2007). Data from several West African countries show that, more than 98% of children and adults have detectable amounts of aflatoxin in their blood (Montesano et al., 1997; Wild and Turner, 2002). Aflatoxin contaminated diet has been linked with the high incidence of liver cancer in Africa (Oettle, 1964; Bababunni et al., 1978). According to Miller, 40% of the productivity lost to diseases in developing countries is due to diseases exacerbated by aflatoxins (Miller, 1996).

Agriculture also contributes medicinal plants which help treat diseases. In areas where orthodox medicine is not available or where they are available but the people cannot afford it, they seek disease treatment from traditional herbalists who use medicinal plants. For instance, because of the high treatment costs and difficulties with access, only a small percentage of households with people living with HIV or AIDS are currently using pharmaceuticals and supplements and instead depend on local capacities and resources, including plant-based medicine sourced from the forest (Willumsen and Kettaneh, 2005; FAO, 2003). Examples of medicinal plants include the bark of *Prunus africana* tree which is used in the treatment of prostrate disorders; *Artemisia annua* (sweet wormwood) used in treating malaria, and the African tree *Melaleuca alternifolia* (tea tree) which contains an antifungal substance
that combats *Candida albicans*, the bacteria responsible for fungal skin problems and mycosis (a condition that commonly affects the eyes of AIDS patients). The WHO estimates that, about two thirds of the world’s population, and 80% of Africa’s population, sometimes use herbal or traditional medicine. Therefore, medicinal plants constitute a fundamental component of traditional healthcare systems in rural communities throughout Africa.

Water for agriculture is critical for food security. However, in many parts of the world agricultural production is threatened by water scarcity. Most farmers construct wells or harvest water and store it in dugouts and bunds. These water storage receptacles provide favorable aquatic habitats for mosquitoes. A study in Kumasi, Ghana to assess the impact of irrigated urban agriculture on malaria transmission revealed higher adult anopheline mosquito densities in peri-urban and urban agricultural locations, with more reported malaria episodes than in the non-agricultural locations in the city. The study found high levels of parasitemia among children living in communities closer to agricultural sites (Afrane, 2003). Projects aimed at providing water for agriculture through dams and irrigation schemes have also led to increased breeding of disease-carrying vectors. In Burundi, malaria parasite prevalence was estimated at 24-69% in irrigated rice fields compared with 5-30% in nearby non-irrigated fields (Mutera et al., 2006).

Similar findings were obtained from studies in East and West Africa (Mutero et al., 2004). An increase in the soil moisture associated with irrigation development in the southern Nile Delta after the construction of the Aswan Dam caused a rapid rise in the mosquito population and the consequential increase in the disease Bancroftian filariasis (Harb et al., 1993; Thompson et al., 1996). In Ethiopia, a study reported that the introduction of microdams for irrigation resulted in a seven-fold increase in the incidence of malaria (Ghebreyesus et al., 1999). Fish ponds have also been found to contribute to malaria transmission, as evidenced by a study in the Peruvian Amazon (Maheu-Giroux et al., 2010) and Côte d’Ivoire (Matthys et al., 2006). Schistosomiasis which causes chronic illness is often associated with water resource development projects, such as dams and irrigation schemes, and rivers where the snail intermediate hosts of the parasite breed. The parasite then spreads to people and causes disease as farmers collect water to irrigate their fields, women and children collect water or stand in the water to wash clothes, people wade through the water to cross from one bank to another, or children swim in the water for recreation.

The health of farmers and farm workers may be at risk if they work with animals as they contract zoonotic diseases. More than three-quarters of the human diseases that are new, emerging, or re-emerging at the beginning of the 21st century are caused by pathogens originating from animals or from products of animal origin (FAO/WHO/OIE, 2004). Disease ecology shows that, disease spread and the emergence of zoonotics are largely the product of human activity, and therefore, of human choices. Intensification of animal production tends to increase disease risk. The consequences of animal diseases include direct economic costs, such as the loss of animal production and products. In the 1980s, a foot and mouth outbreak caused the Kenyan dairy farming sector to suffer a 30 percent loss of milk production (Le Gall, 2006). In 1997 to 1998, abortion by cows caused by Rift Valley fever virus undermined birth of calves and milk production, and milk exports declined by 75% in East Africa (Le Gall, 2006). The 2003 to 2004 outbreak of highly pathogenic avian influenza in Southeast Asia resulted in more than 140 million dead or destroyed birds and losses exceeding US$10 billion (OIE/FAO/WHO, 2007). Since late 2003, the H5N1 strain of avian influenza has been responsible for 4,544 documented outbreaks in poultry farms in 36 countries. These outbreaks have been associated with 269 human cases and 163 fatalities (as of January 2007) (World Bank, 2007).
Pesticide use has been increasing in developing countries and so has pesticide poisoning in farmers. In addition to increased use of pesticide, farmers use stronger concentrations of pesticides, they have adopted increased frequency of pesticide applications, and they increasingly mix several pesticides together to combat pesticide resistance by pests (Chandrasekera et al., 1985; WRI, 1998). Due to lack of training in pest management or in safe methods of storage, handling, and application, many farmers contract pesticide-related diseases (Antle and Pingali, 1994). Farm workers who do not wear protective clothes or equipment are in danger of inhaling the fumes from chemicals and damaging their skin and eyes. Deaths resulting from exposure to pesticides are not uncommon. Estimates from the Food and Agriculture Organization (FAO) (2000) show that, approximately 3 million people are poisoned and 200,000 die from pesticide use each year. Evidence also points to negative health and productivity impacts resulting from pesticide use. For example, in Tanzania, a study of vegetable farmers reported that 68% of farmers who used pesticides reported having felt sick after routine pesticide application (Ngowi et al., 2007).

In Zimbabwe, it was found that pesticide acute symptoms significantly increased the direct cost of illness in cotton growers (Maumbe and Swinton, 2003). The time spent recuperating from illnesses attributed to pesticides average 2 to 4 days during the growing season. Combining production data from a farm-level survey and health data from the same population of farmers in two rice-producing regions of the Philippines, Antle and Pingali (1994) found that, pesticide use has a negative effect on farmer health, while good farmer health has a significant positive effect on productivity. A study of potato production in Ecuador showed similar results (Antle et al., 1998). In that study, results indicate that despite the role that insecticides play in controlling the Andean weevil insect pest, a reduction in the use of the principal insecticide (carbofuran) used to control the pest, could raise productivity of potato production and also improve farmers’ health.

Pesticides also contaminate drinking water and food crops, especially fruits and vegetables receiving higher doses of pesticides, thus posing serious health hazards to consumers (Pimental et al., 1992). According to the U.S. Food and Drug Administration, approximately 35 percent of the foods purchased by consumers have detectable levels of pesticide residues and 1–3 percent of the foods have pesticide residue levels above the legal tolerant levels.

3. Empirical evidence on the role of health on farm labor productivity
In low-income countries, work often relies more heavily on strength and endurance and, therefore on good health. The labor market consequences of poor health are likely to be more serious for the poor, who are more likely to suffer from severe health problems and to be working in jobs for which strength (and therefore good health) has payoff (Strauss and Thomas 1998). In fact, the U.S. Government Accountability Office (GAO, 2008) cites the impact of poor health of the agricultural workforce as one of the major causes of chronic malnourishment (food insecurity) in Sub-Saharan Africa.

Health also affects agricultural output, particularly its demand. Malnutrition and disease patterns influence market demand for food quantity, quality, diversity, and the price people are able or willing to pay. Nutrition affects people’s health and is an important factor in farm labor productivity. Past nutritional status predicts the probability of developing chronic diseases and consequently influences labor force participation (Sur and Senauer, 1999). The nutrition and health status of adults affects the duration of labor force participation and the intensity of work effort. Poor health will result in a loss of days worked or in reduced worker capacity, and is likely to reduce output (Antle and Pingali, 1994).
Limited access to food may occur in a household if individuals are too ill or overburdened to produce or earn money to buy food (Keverenge-Ettyang, Neumann, and Ernst, 2010).

A common mechanism households adopt to cope with the burden of high medical costs is reducing consumption of basic needs, including food (Pitayanon, Kongsin, and Janjaroen, 1997). If consumption reduction is substantial, this can lead to malnutrition which increases susceptibility to opportunistic diseases for AIDS patients. Malnutrition weakens the immune system, increasing the risk of ill-health, which in turn can aggravate malnutrition. The World Health Organization identifies malnutrition as "the single most important risk factor for disease." In developing countries, poor nutrition is a massive problem making people more susceptible to diseases.

A study on the effect of nutrition on labor productivity in rural Sierra Leone was one of the first attempts to test the nutrition-productivity relationship using total farm output as the measure of productivity. A Cobb-Douglas production function was estimated to test the hypothesis that farm output is influenced by effective family and hired labor hours, variable non-labor inputs, fixed capital, and land. It was found that calorie intake had a significant positive effect on farm labor productivity with a calorie-output elasticity of 0.34 at the sample mean (Strauss, 1986).

Using household survey data in India, Deolalikar (1988) estimated both a wage equation and a farm production function to examine the empirical relationship between nutrition and productivity. It was found that calorie intake or short-term nutritional status was not a significant determinant of wages and farm output, but that weight-for-height, which was used as a medium-term indicator of health and nutritional status (measured in kg/cm), significantly influenced both the wage and production function equations. The study concluded that the medium-term effects of better nutrition are quite large and positive although the short-term effects are insignificant. In a Sri Lankan study that analyzed the effect of nutritional status on rural wages, it was found that per capita calorie intake had a positive significant effect on farm labor productivity with a calorie-output elasticity of 0.34 at the sample mean (Strauss, 1986).

Re-examining the nutrition-productivity relationship taking seasonal variability into consideration using data from India, Behrman and Deolalikar (1989) found that calorie intake is an important determinant of wages in peak seasons, while weight-for-height is a more important determinant during lean months. During peak seasons energy is required to carry out strenuous and time consuming work and so calorie intake becomes very important. Examining the link between nutrition and productivity in the Philippines with height as the predictor of long-term nutritional status, Haddad and Bouis (1991) found that while height is a significant determinant of wages, energy intake as determined from a 24-hour food recall survey was not a significant predictor of wages.

Research carried out in Ethiopia estimated the impact of health and nutritional status on the efficiency and productivity of cereal growing farmers (Croppenstedt and Muller, 2000). Results showed that the distance to the source of water as well as nutrition and morbidity status affects agricultural productivity. Ulimwengu (2009) used a stochastic production function to analyze the relationship between farmers’ health impediments and agricultural production efficiency in Ethiopia. Healthy farmers were found to produce more per unit of inputs, earn more income, and supply more labor than farmers affected by sickness. As expected, the model results show that production inefficiency increases significantly with the number of days lost to sickness. Ajani and Ugwu (2008) examined the impact of health conditions on farmers’ productivity in north-central Nigeria and found that a one percent improvement in a farmer’s health condition led to a 31 percent increase in efficiency. Using a quasi-experimental design along with
a generalized linear model (GLM) for longitudinal data, Audibert and Etard (2003) estimated the worker productivity benefits of health in Mali. They assumed that the family members and the hired labor who are working in the fields are imperfect substitutes because of the cost of hired labor and the low agricultural yield. Results showed an increase of 26 percent in the production per family labor person-day in the experimental group who received treatment for schistosomiasis relative to the control group who received a placebo. Unlike other studies which looked at health indicators related to past and time-invariant health (e.g., such as height due to investment during childhood), current health and changes in health caused by unexpected illness or external input were considered in their study.

Empirical evaluation of morbidity impacts on individual labor productivity has been limited to a few diseases. As quantity and quality of labor are affected during duration of an illness, capacity to produce agricultural output often is reduced, resulting in lower labor productivity. As suggested by theoretical literature, household farm production will decline (and shift to less labor-intensive crops) because of loss of productive labor due to illness. While numerous studies have focused more on estimating the economic burden of illnesses (direct and indirect costs), the available empirical literature evaluating effect of morbidity on agricultural production has shown varying results.

**HIV/AIDS.** Attempts have been made to estimate the extent of rural labor loss due to AIDS mortality. The U.S. Department of Agriculture has estimated that the reduction in numbers of agricultural laborers in Southern Africa will reduce agricultural labor productivity by 12 percent per year, which will result in a 3.3 percent loss in grain output (ILO, 2004). Moreover, FAO (2004) using epidemiological data, projected that by 2020 the nine most severely hit Sub-Saharan African countries would lose from 13 to 26 percent of their agricultural labor force to HIV and AIDS.

A survey in Zambia found that heads of HIV-affected households reduced their cultivated land area by 53 percent, resulting in reduced crop production (ILO, 2000). A study in western Kenya that examined the impact of HIV and AIDS on labor productivity found that HIV-positive workers plucked 4 to 8 kg/day less tea in the last year and a half before they died compared to HIV-negative workers (Fox et al., 2004). Absenteeism also occurs as a result of time reallocated to care for an ill household member, including children. A household impact study of HIV and AIDS on families in the Free State province of South Africa found that household members spend 7.5 hours a day or about 2700 hours per year which is equivalent to 113 person days a year taking care of the ill (Booysen and Bachman, 2002). In rural Zimbabwe, the average time spent in taking care of bed-bound AIDS patients is 38.5 hours per week or about 2,000 hours per year which is equivalent to 83 person days a year (Woelk, 1996). A study in Rwanda indicated that reduced labor time as a result of HIV-related illness among women and increased time women devote to caregiving to members living with AIDS resulted in a decline in production of beer bananas (a cash crop), a source of income for women (Donovan and Bailey, 2006).

**Malaria.** Compared to HIV infection, which generally causes steadily deteriorating health, lost labor time due to malaria is lesser, because malaria affects children more than adults, whereas it is the opposite for HIV. Studies have shown that per malarial attack, depending on the severity, typically entail a loss of four working days, followed by additional days with reduced capacity for about four episodes per year (Brohult et al., 1981; Picard and Mills, 1992). This means about 16 working days are lost in a year. Another study found that a bout of non-fatal malaria will typically last for 10–14 days, including 4–6 days of total incapacitation with the remainder characterized by headaches, fatigue and nausea (Hempel and Najera, 1996). In Oyo State of Nigeria, the estimated average number of workdays lost per malaria episode by productive adults in agrarian households was 16 days for an average of 4 bouts per year which is about 64 days per year (Alaba and Alaba, 2009).
Meanwhile, farmers engaged in intensive vegetable production in Côte d'Ivoire suffering from malaria were absent from work for up to 26 days in a 10-month period or about 31 days per year (Girardin et al., 2004). In rural households of Nigeria, farmers lost an average of 22 days of farm labor to malaria illness in a year (Ajani and Ashagidigbi, 2008). A study of farmers engaged in intensive vegetable production in Côte d'Ivoire showed that those suffering from malaria produced about half the yields and received half the incomes of healthy farmers (Girardin et al., 2004). Time lost per year to take care of a child with malaria varied from 42 days (Cropper et al, 1999) in Ethiopia, to 17.5 days in Ghana (Asenso-Okyere and Dzator, 1997) and 14 days in The Gambia (Aikins, 1995). Variations in number of productive days lost to malaria depend on the severity of the malaria episode, a person’s general health and nutritional status, proximity to health facilities, and ability to seek healthcare during malaria episodes (Brinkmann and Brinkmann, 1991; Chima, Goodman, and Mills., 2003; Asenso-Okyere et al., 2009).

Based on field data collected from rural households in 21 villages between 1997 and 1999, Audibert et al. (2003a, 2003b, 2009) studied the economic effect of malaria in Cote d'Ivoire but found less consistent results. The authors used two malaria morbidity indicators: Plasmodium falciparum infection rate and high parasite density infection rate. The first two studies confirmed that: malaria is a limiting factor for property accumulation by reducing the living standards of households (Audibert et al., 2003a); and, malaria had a negative effect on technical efficiency of farmers in cotton crop (Audibert et al., 2003b). In contrast, Audibert et al. (2009) found no effect on coffee and cocoa productions and yields, neither directly through the production or indirectly, through a coping process such as the resort to hired labor.

**Tuberculosis.** A survey in Uganda on subsistence farmers found that 95 percent of them reported a decline in production due to reduced capacity to work due to Tuberculosis (TB) (Saunderson, 1995). A study in urban Zambia found that before treatment, about 46 percent of TB patients and 30 percent of caregivers were absent from work due to illness, missing an average of 48 days of work in a year. About 31 percent had to cease work completely (Needham et al., 1998). A study in India looking at rural and urban areas found that the number of work days lost to TB depended on age, literacy, type of income and region. The average number of work days lost per year was 83 days (82 days for females and 85 days for males), with 48 days before treatment and 35 days during treatment (Rajeswari et al., 1999). Patients in rural areas who were between 15–25 years old had the lowest number of mean days lost (61 days) in a year. For those aged 26–45 years, about 94 workdays were lost in a year. And it was highest for individuals aged 46 or more, at 105 days in a year. In the same study, the impact on children of TB patients was examined. It was found that about 8 percent of schoolchildren in rural areas of parents with TB discontinued their studies due to the burden caused by their parent’s illness.

**Soil-transmitted helminth infections and schistosomiasis.** Schistosomiasis causes chronic illness that can damage internal organs and, in children, impair growth and cognitive development, which can negatively affect their productivity and income earning ability during adulthood. Available literature seems to show that not all types of diseases have significant negative labor productivity effects. One study in Santa Lucia examined the productivity effects of five parasitic diseases (schistosomiasis, ascariasis, trichuriasis, strongyloidiasis, and hookworm infection) using earnings per week as a measure of productivity and the parasite load as measure of disease morbidity (Baldwin and Weisbrod, 1974). Results show that parasitic infections, except schistosomiasis, appear to cause few statistically significant adverse effects on agricultural labor productivity. A follow-up study three years later still found that schistosomiasis negatively influences productivity but its estimated impact was lower than the earlier study (a loss of 14 percent of the daily earnings of male workers) compared to the previous
study of 30 percent) (Weisbrod and Helminiak, 1977). Looking at schistosomiasis disease alone, an experimental study of sugarcane workers in an irrigated estate in Tanzania found a significant difference in economic productivity of about 3 to 5 percent between uninfected and infected schistosomiasis workers (Fenwick and Figenshou, 1971). A study of schistosomiasis in the northern and southern portions of Leyte province in the Philippines found that total days lost per person per year was 45.4 days (Blas et al., 2006).

In southern Ghana, adult male farmers untreated for guinea worm disease were estimated to lose about 35 days per year (Belcher et al., 1975), while people infected with the same disease in Nigeria were estimated to lose an average of 117 days (3.9 person months) per year. Research in the Ondo state of Nigeria in 1997 involving 500 cocoa farmers infected with guinea worm, found that on average, a cocoa farmer infected with guinea worm disease lost 19 bags of potential harvest due to disease morbidity, which was valued at about 4,884 naira at that time (about US$ 64 in present value terms) (Adewale, Mafe, and Sulyman, 1997). This would be substantial amount of loss of (9,566 bags) of potential harvest for the 500 farmers worth about 2,442,000 naira at that time (or US$31,845 in present value terms). A study in a coffee plantation in southwest Ethiopia also found that disease has negative labor productivity effect (Kim, Tandon, and Hailu, 1997). Male workers suffered significant losses in economic productivity (in the form of lower daily wages earned) as a result of onchocercal skin disease (OSD). Specifically, it was found that depending on the severity of OSD (and controlling for such factors as age), daily wages were 10 to 15 percent lower than workers without OSD (Kim Tandon, and Hailu, 1997).

4. Summary and conclusion
Evidence of the literature on the interaction between health and farm labor productivity is inconclusive. Methodological issues including estimation, definition and measurement of health variables, choice of economic outcomes, single-equation versus multiple-equation approach, and static versus dynamic approach, etc made it challenging to determine the causality between health measures and both income and labor productivity (McNamara et. al. 2010). The problem partly stems from endogeneity of health outcomes. Yet, based on a review of micro level studies, McNamara et. al. (2010) suggested that inexpensive health interventions can have a very large impact on labor productivity. Moreover, beyond the population well-being, the economic benefits of disease control program or health improvement was considered as one criterion among others for local or national policy-making (Audibert, 2011). This is because bad health has a cost, both direct and indirect.

Micro level evidence reviewed in this paper suggest that productivity enhancing innovations and poorly managed agricultural systems, including an expansion of irrigated areas, application of pesticides, intensification of animal production, water pollution and food contamination, etc, could be the source of negative health and environmental effects. These would lead to poor health and low labor productivity which could eventually result in low agricultural productivity and reduced livelihoods. In contrast, agriculture also affects health through availability of nutritious food and also contributes medicinal plants which help treat diseases. On the other hand, the evidence also highlighted the importance of health of farm labor as health status affects the duration of labor force participation and the intensity of work effort. Otherwise poor health will result in a loss of days worked or in reduced worker capacity, and is likely to reduce output.

Overall, this review has shown that the household’s vulnerability or ability to cope with a shock is based on its asset portfolio, which includes human, physical, and financial assets, and intangible social resources. Health is treated as both an investment and consumption asset, as is agriculture. A situation
by which these investments and consumption activities erode the asset base of agriculture and leave farmers without a means of livelihood should be avoided. When both health and agriculture thrive, a reinforcing cycle of health can result, but when either suffers, the cycle becomes one of lowered agricultural productivity and lowered health status.

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