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Health and agricultural productivity: Evidence from Zambia

Günther Fink[a,*], Felix Masiye[b]

[a] Harvard School of Public Health, USA
[b] Department of Economics, University of Zambia, Zambia

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ABSTRACT

We evaluate the productivity effects of investment in preventive health technology through a randomized controlled trial in rural Zambia. In the experiment, access to subsidized bed nets was randomly assigned at the community level; 516 farmers were followed over a one-year farming period. We find large positive effects of preventative health investment on productivity: among farmers provided with access to free nets, harvest value increased by US$ 76, corresponding to about 14.7% of the average output value. While only limited information was collected on farming inputs, shifts in the extensive and the intensive margins of labor supply appear to be the most likely mechanism underlying the productivity improvements observed.

1. Introduction

Despite the rapid speed of urbanization over the past decades, rural small-scale farming remains the primary source of food and income for a majority of the population in developing countries (World Bank, 2007). In most settings, the degree of agricultural mechanization is limited, so that agricultural production remains primarily dependent on the availability and productivity of human labor. While labor is abundant in principle in most developing countries (Pitt and Rosenzweig, 1986), labor inputs can be compromised by episodes of ill health and can result in output losses if absent labor cannot be replaced immediately.

In this paper we investigate the economic impact of short-term morbidity on agricultural output in the context of small-scale farming in Zambia. The study setting is representative of many rural areas in the developing world both in terms of the general lack of advanced farming technology and in terms of the dominant role of farming as source of nutrition and income. With farming land available free of charge in most communities, a large majority of the working-age population engages in agriculture, while formal sector jobs are generally scarce. Despite major government efforts to reduce the burden of the disease in recent years (NMCC, 2010; Zambia Ministry of Health, 2006), malaria continues to be the primary cause of short-term morbidity in the country, with children and adults experiencing up to five episodes of malaria per year (NMCC, 2010; WHO, 2009). Since the planting season tends to overlap with the malaria season, health related absences from field work are frequent, and are commonly cited by local farmers as primary cause of lost field work and income.[1]

To evaluate the degree to which health affects agricultural productivity, we conducted a cluster-randomized field experiment with 516 farmers in Katete District, Zambia, from December 2009 to August 2010. As part of the experiment, farmers were randomly selected for bed net programs, which allowed them to obtain long-lasting insecticide treated nets (LLITNs) through agricultural loan program schemes at differentially subsidized prices. The basic intuition underlying the experiment is relatively straightforward: as long as household labor and consumption decisions are non-separable from household production decisions[2] (Benjamin, 1992),

* Corresponding author at: Harvard School of Public Health, Boston, MA 02115, USA. Tel.: +1 6174327389.
E-mail address: gfink@hsph.harvard.edu (G. Fink).

[1] On average, farmers surveyed at baseline claimed that their harvest would increase by 30% if field work was not interrupted by episodes of ill health.
[2] If consumption and production decisions were perfectly separable, family labor could be perfectly substituted for by hired labor.

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decreased exposure to malaria should increase the time and energy farmers can spend on their fields, and thus also increase the final harvest amounts.

In a first paper based on this experiment, we analyzed the impact of the additional LLITNs distributed on self-reported morbidity (Fink and Masiye, 2012). In this paper, we analyze the impact of the net programs on agricultural productivity, the main outcome variable of the trial. In the first part of our analysis, we analyze the impact of the interventions on net ownership and usage. Consistent with recent work by Tarozzi et al. (2014), we find a substantial fraction of farmers to be willing to purchase LLITNs at full or partially subsidized prices when financing options are provided. On average, farmers in the loan group acquired 0.9 nets, resulting in a 24% point increase in the average fraction of sleeping spaces covered at the household level.

In the second part of the paper, we estimate the impact of the bed net programs on agricultural production. In order to facilitate a rapid distribution of bed nets, treatments were randomly assigned at the cluster level *prior* to the collection of baseline data in the experiment. The non-stratified cluster-level randomization resulted in a rather unbalanced sample, with treated farmers on average both larger and more productive than farmers in the control group. To address these imbalances, we focus on analyzing changes in production outcomes between the 2009 (pre-intervention) and the 2010 (post-intervention) farming seasons. The point estimates from our preferred specification suggest that the returns to bed nets in the study sample were large: on average, we find that access to free bed nets (three nets for a typical household) increased agricultural output by US$ 76, which corresponds to 14.7% of the average annual harvest value. To address omitted variable bias concerns, we include a large set of covariates in our empirical models, and run an extensive series of robustness and heterogeneity checks. Overall, treatment effects appear largest among more educated farmers as well as farms with more diversified portfolios, and larger for cotton (as the more labor intensive crop) than for maize.

In the last part of our analysis, we explore potential mechanisms underlying the productivity impacts observed. Unfortunately only limited and self-reported data on malaria incidence (and no data on parasitemia or asymptomatic malaria) was collected as part of this project. However, the general patterns observed in the data suggest that the programs likely induced substantial reductions in the days of field work lost due to ill health. Given that full recovery from acute malaria is often slow, reduced exposure to malaria can increase the marginal product of labor (Nur, 1993), particularly in cases where malaria induces anemia (Ehrhardt et al., 2006). While there is theoretically also the possibility that the reduced exposure to ill health may have been associated with a reduction in direct medical expenditure, most malaria treatment in the area appears to be provided for free, so that no evidence of lower health expenditure was found.

Even though this paper is to our knowledge the first one using experimental data to evaluate the productivity effects of malaria, several studies have analyzed agricultural output in the context of nutrition and other diseases. Following the initial work by Strauss (1986) as well as Pitt and Rosenzweig (1986), Behrman et al. (1997) document a rather robust association between nutritional improvements and production in agricultural settings. Loureiro (2009) and Ulimwengu (2009) find positive associations between health and productivity using stochastic frontier regression techniques. Audibert and Etard (2003) examine the effect of schistosomiasis among rice-growers, and find that exposure to schistosomiasis reduces production by 26%. Fox et al. (2004) analyze the productivity declines associated with HIV positivity, and find that HIV-positive workers earn on average 16–17% less over a two year period. Similarly, Baranov et al. (2012) show that maize production increases by up to 31% with HIV treatment, and attribute this increase to increased overall labor supply and improved physical and mental health. Similar effects were, however, not found for iron supplementation and deworming among tea pluckers in Bangladesh (Gilgen et al., 2001). Most similar to the results presented in this paper are two cross-sectional studies using harvest data to compute the agricultural output effect of malaria: Girardin et al. (2004) analyze vegetable farming in Côte d'Ivoire, and find that farmers who reported being sick more often had 47% lower yields. Morel et al. (2008) use total farming output to quantify the agricultural loss generated by work days lost due to malaria in Vietnam, and find an average cost of US$ 11 per case of malaria, suggesting returns to malaria prevention similar to the ones identified in this paper. Conceptually, an overwhelming majority of this literature suggests strong links between health and agricultural production in low-income setting; this suggests that household production, labor and consumption decisions are generally not separable (Benjamin, 1992), a finding which is also supported by recent evidence from Zambia (Fink et al., 2014).

While this study primarily focuses on household-level outcomes, the results presented here naturally also link to the broader literature on the relation between health and income. Most of the micro-level literature in this area has focused on the long term benefits of improved childhood health in terms of education and labor market outcomes (Bleakley, 2007; Bleakley and Lange, 2009; Clarke et al., 2008; Kremer and Miguel, 2004). This paper highlights a more immediate and direct effect of health on income similar to the results shown in Thomas et al. (2010) for iron supplementation; this effect will clearly not apply in all low resource settings, but may be of particular importance among rural and frequently impoverished populations.

The rest of the paper is structured as follows: we provide a detailed description of the study site and local agriculture practices in Section 2. In Section 3, we present the study design and provide details on study implementation. In Section 4, we analyze the effects of the bed net programs on net ownership and net usage. In Section 5, we estimate the impact of the net programs on productivity. Section 6 shows some evidence on the mechanisms underlying the main productivity results. We conclude with a short summary and discussion in Section 7.

2. Study background

Fig. 1 shows the geographic location of the study site within Zambia. Katete district is one of eight districts within Zambia's Eastern Province. Eastern Province is one of the least developed regions of Zambia, with a majority of the population living below the one-dollar-per-day poverty line, and an estimated under-5 mortality rate of 151 per 1000 live births (Macro International, 2007). Katete district is similar in its topography to the Western part of Malawi, which is located about 100 km east of the district. The current district population is estimated at 250,000, approximately half of which live in the urban centers of Sinda and Katete (Zambia Central Statistic Office, 2011a).

Malaria is endemic in most parts of Zambia, and the primary cause of short term morbidity in the country (Zambia Ministry of Health, 2012). The regional climate displays pronounced seasonal fluctuations, with virtually no rainfall from May to November, followed by a period of major rainfall from December to April. The strong seasonal patterns are directly reflected in the seasonal fluctuations of malaria. Malaria in the area is considered endemic and seasonal, with a majority of the transmission occurring between December and May, when continued rainfalls support the breeding of the *Anopheles* mosquito larvae. According to the latest round of the Malaria Indicator Survey, Eastern region is among the areas