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Impact of national health insurance enrolment on farm investments in Sub-Saharan Africa: empirical evidence from Ghana

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Abstract

Purpose – The study aims to explore the impact of National Health Insurance Scheme (NHIS) enrolment on farm investments in a developing country setting. We classify farm investments into (1) soil and land investments and (2) hired adult labour.

Design/methodology/approach – This study used data on 5,883 farm households from the sixth round of the Ghana Living Standard Surveys (GLSS), which is nationally represented data at the household level. The data also includes a Labour Force Survey module. The sample frame was divided into a primary and secondary sampling unit, with interviews taking place in 1,200 enumeration areas (EAs). The estimation of impacts was carried out using ordinary least squares (OLS) estimations and addressed endogeneity concerns using propensity score matching (PSM) and instrumental variable (IV) estimators.

Findings – The study finds a strong positive association between the NHIS enrolment status of farm households and investments in agricultural land and soil health improvement. Precisely, farm households who are enroled in the health insurance system tend to invest about 32% more in soil and land improvement activities and 30% more in hired farm labour than households who are not enroled in NHIS.

Practical implications – The overall evidence from our study suggests that instead of high investments in fertilizer and other input subsidy programmes in Africa, sustainable smallholder agricultural investments can be achieved if concerns and issues of farmers' health coverage are adequately addressed.

Originality/value – This is one of the first papers that have explored the impact of NHIS in developing countries on farm investments.

Keywords Ghana, Sub-Saharan Africa, Smallholder farmers, Health insurance coverage, Hired labour, Soil and land investment

Paper type Research paper

1. Introduction

Improving the quality of agricultural lands in developing countries is a core requirement for reducing poverty and food insecurity. Several studies have associated the low agricultural productivity in Sub-Saharan Africa with low levels of investments to improve soil and land health (see Jayne and Sanchez, 2021; Klauser and Negra, 2020; Cotula and Vermeulen, 2009). Others also find that climate change has further exacerbated the quality of agricultural soils and land in Sub-Saharan Africa (Sulser *et al.*, 2015; Wiebe *et al.*, 2015). However, recent evidence from the climate literature shows that investments in agriculture and agricultural lands can more than compensate for the negative effects of climate change (Mason-D'Croz *et al.*, 2019).

Therefore, the policy question that needs an answer is how best to effectively and sustainably improve agricultural investments among smallholder farmers. Past studies have hypothesized that the low investment is because smallholder farmers face nontrivial credit constraints, high production risks and lack the necessary insurance to mitigate such risks (Balana *et al.*, 2022; Demi and Sicchia, 2021; Andersson and Isgren, 2021; Lakhan *et al.*, 2020).

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As such, international and non-governmental organizations and governments have devoted a large amount of resources to provide credit and recently agricultural insurance to residents in low-income regions (Cai *et al.*, 2015). However, the expansion of agricultural credit and index insurance as solutions to low investments has been mixed (see Ding *et al.*, 2024; Chantarat *et al.*, 2017; Jensen *et al.*, 2016; Carter *et al.*, 2016; Takahashi *et al.*, 2016; De Janvry *et al.*, 2014; Barnett and Mahul, 2007). High loan default levels and poor loan terms are often found to affect the potential impacts of agricultural credits, whereas demand for index insurance has been found to impact positively only when combined with other services or households receiving payouts (see Chandio *et al.*, 2018; Giné *et al.*, 2012; Karlan *et al.*, 2014). In addition, the poor quality of index-weather insurance products available in Sub-Saharan Africa has impacted the demand by smallholder farmers (Jensen *et al.*, 2016). Fertilizer and other input subsidy programmes implemented by many governments in Sub-Saharan Africa have also been found to be unsustainable due to poor targeting and high cost (for review, see Banful, 2011).

Given the mixed results for credit and index insurance, we explore how insured health risks could impact agricultural farm investments in Sub-Saharan Africa by focusing on Ghana. Thus, we extend the literature by answering the question: Can health insurance coverage provide a sustainable means to drive agricultural investments among smallholder farmers? Several countries in Sub-Saharan Africa, including Ghana, Rwanda, Tanzania, Kenya and Nigeria, have recently introduced National Health Insurance Schemes (NHIS) to (1) reduce out-of-pocket expenditures and (2) improve access to quality and affordable healthcare (Adjei-Mantey and Horioka, 2023; Okunogbe *et al.*, 2022; Hooley *et al.*, 2022; Salari *et al.*, 2019). The peculiarity of Sub-Saharan Africa and Sub-Saharan Africa's agriculture makes expanding health coverage to the poor even more critical. The high prevalence of diseases such as malaria, Buruli ulcer, guinea worm and HIV/AIDS directly impacts farmers' productivity in Sub-Saharan Africa, increasing household health costs and subsequently lowering potential agricultural investments.

To exacerbate the problem, World Bank (2007) estimates show that about 355,000 people die yearly from unintentional chemical poisoning from exposure to pesticides and other chemicals. Two-thirds of these victims are found in developing countries, with many of them being smallholder farmers. The intensity and vulnerability of smallholder farmers to health shocks both from the disease environment and from agricultural activities could undermine willingness to invest in productivity-enhancing inputs. However, there is very little empirical evidence on how health insurance could impact agricultural investments. Thus, this paper attempts to contribute to this area using household-level data on 5,883 farm households in Ghana by investigating the potential effect of health insurance coverage on farm investments, focusing on investments in (1) soil and land and (2) hired adult labour.

The rest of the paper is structured as follows: Section 2 presents a background of Ghana's National Health Insurance Scheme (NHIS) and the agricultural sector. Section 3 presents related literature. Section 4 presents the data and the empirical strategy adopted for our empirical estimation. Section 5 discusses the empirical results. Finally, Section 6 provides a summary of our key findings, conclusion and recommendations.

2. Institutional setting – background to Ghana's national health insurance scheme and the agricultural sector

Ghana launched the National Health Insurance Scheme (NHIS) in 2003 with the passage of the National Health Insurance Act 650. The mandate of Ghana's health insurance scheme is "to ensure equitable universal access for all residents of Ghana, to an acceptable quality of essential health services without out-of-pocket payment being required, at the point of service" (MOH, 2004). In 2012, the NHIS Act was amended from ACT 650 to ACT 852 with the objective that every Ghanaian is expected to enrol in the scheme, including residents in Ghana and non-residents visiting Ghana. This amendment moved the scheme towards achieving universal health coverage (NHIA, 2013).

The revised Act (ACT 852) culminated in the formation of the National Health Insurance Authority (NHIA). The NHIS is financed mainly by a sales tax levy (a 2.5% earmarked addition to the value-added tax referred to as the National Health Insurance Levy) and a 2.5% of formal sector workers' contributions to the Social Security and National Insurance Pension Trust Fund (SSNIT) (Escobar *et al.*, 2010). Overall, 80% of the financing is done through tax revenue and donor funds, and the rest is a contribution by policyholders (MOH, 2004). Even though policyholders' yearly contribution to the NHIS is very small, it still poses an obstacle for many poor households. It is therefore not surprising that some political actors and health practitioners have argued for 100% financing of the Ghana NHIS through taxation. For 2024, it costs 28 GHS (2.5US$) to renew a person's health insurance coverage for a year. In real terms, there have not been any significant increases in NHIS policyholders' contributions since 2018. Policyholders in 2018 paid 27 GHS yearly (5 USD) to renew their coverage.

In terms of eligibility, all Ghanaians and foreigners who are residents of Ghana qualify to enrol in the NHIS. Some groups and individuals are, however, exempt from premium payment. These groups include pregnant women, children under 18 years, public pension contributors (SSNIT contributors), retirees who were contributors to the public pension scheme, persons with mental disorders, persons who are 70 years and above and categories of differently-abled persons determined by the Minister responsible for social welfare (Asenso-Boadi, 2009). Enrolment is *de facto* voluntary, and individuals can visit any NHIS office or digitally enrol themselves and make payment using mobile money (see also Blanchet *et al.*, 2012).

Regarding benefits, the NHIA says that over 95% of the diseases are covered under the NHIS. Health services that are also covered include diagnostic testing and hernia repair, specialist care, most surgeries, generic medicines, oral health treatments, all maternity care services (such as caesarean deliveries and emergency care), hospital accommodation and all drugs on the centrally-established NHIA Medicines List are covered [1] (Escober *et al.*, 2011; Blanchet *et al.*, 2012). However, procedures such as cancer treatment or dialysis and the like are not covered (Adjei-Mantey and Horioka, 2023). Nsiah-Boateng and Aikins (2018) using the administrative data from the NHIA documented growth in enrolment in the NHIS from 33% (8.2 m) to 41% (11.3 m) between 2010 and 2015. Enrolment declined to 35% (10.3 m) in 2017 [2]. In a sample of 39,262 randomly selected households, Kwarteng *et al.* (2020) found that about 50% had enrolled in the NHIS, and for the non-enroled, about 93% of them mentioned the cost of enrolment as an obstacle. In this paper and for our empirics, we define NHIS farm households as households with at least 50% of household members enroled in the NHIS.

An important focus of this study is the impact of health insurance coverage on smallholder farmers and their households. Understanding the agricultural sector in Sub-Saharan Africa is critical to understanding the importance of health insurance coverage. We now turn our attention to the activities and practices of smallholder farmers in Ghana and the potential benefits of health insurance coverage for such farmers.

Agriculture in Sub-Saharan Africa in general, and Ghana to be specific, is characterized by a large number of smallholder farmers. Approximately 38% of the labour force is engaged in agriculture, making the sector the second largest employer after the services sector, which employs 43.5% of the population (GSS, 2019). However, the average farm sizes are very small (<1.6 hectares) (SRID, 2021). The main crops cultivated by farmers in Ghana include maize, rice, cassava, yam, plantain and cocoyam, which are cultivated largely for subsistence to ensure household food security. Cash crops cultivated in large quantities by farmers include oil palm, rubber, cocoa, citrus and pineapple. Many smallholder households intercrop their food crops with cash crops (mixed farming). Many farmers still depend on rainfall for irrigation (FAO, 2015).

With regards to farming practices, the system of farming in Ghana still involves the use of hoe and cutlass (traditional farming). Mechanization is very minimal, which makes farming a laborious job and compromises the health of farmers very early. The soils are also predominantly light-textured, but lower soil horizons tend to have slightly heavier textures varying from coarse sandy loams to clays. Heavier textured soils occur in many valleys; however, most soils contain abundant coarse material, either gravel and stone or concretionary materials, which affect their physical and organic properties (see SRID, 2021). Credit support to the agriculture sectors in Ghana is very low, approximately 3.4% of total credit (see SRID, 2021). The lending rates to the agricultural sector in Ghana are also very high. For example, the average bank lending rate by the agricultural-based bank in Ghana (the Agricultural Development Bank) of 23.52% is the second highest in Ghana, making it very difficult for smallholder farmers to borrow and invest to improve their farm operations (see SRID, 2021). Thus, whereas the farming practices in Ghana are laborious and can compromise the framers' health and his/her ability to invest thereof, the soils also require constant investments to maintain their quality, in the midst of minimal access to credit.

The disease environment in Sub-Saharan Africa and Ghana in particular also exacerbates the health challenges that smallholder farmers face and the importance of health insurance coverage. The harmattan, which is a desert wind that blows through Ghana from December to March, comes with dryness and dust, lowering humidity and increasing the general disease environment. Specifically, the risk of spread of infections or diseases such as dry skin, severe cold, cough, catarrh, asthma, meningitis, bronchitis and pneumonia increases with the harmattan in Ghana, particularly for those who work with the soil. Smallholder farmers' exposure to chemicals such as insecticides, pesticides, fertilizers, etc. increases their risk of poisoning and ill health, making it imperative for health insurance coverage.

3. Summary literature review

Existing empirical studies have focused heavily on the impact of agricultural credit and index-weather insurance on investments in agriculture. The evidence, however, on these financial products has been mixed (see Jensen *et al.*, 2016). While researchers such as Ozdemir (2024) and Mushtaq and Mushtaq (2023) find positive impacts of agricultural loans at the macro-level, several studies at the micro-level focusing on smallholder farmers find that the gains from such loans are quickly eroded by high interest rates and inflexibility in the loan terms (see Ding *et al.*, 2024; Odhiambo and Upadhyaya, 2021; Chandio *et al.*, 2018). Such loans are also tailored to more educated and wealthier farmers, with very little access by the poor (Odhiambo and Upadhyaya, 2021).

Aside from credit, lack of access to formal insurance markets can similarly prevent farmers from making the right investments. For many rich countries, formal financial risk management products that allow farmers to mitigate production risks are well-developed (see Benami *et al.*, 2021; Jensen *et al.*, 2016; Ifft *et al.*, 2015; Weber *et al.*, 2015). However, for many developing countries, insurance products tailored to the needs of smallholder farmers are nonexistent or at best underdeveloped (Kramer *et al.*, 2022; Jensen *et al.*, 2016; Hazell *et al.*, 2010). Experimental tests of the impact of agricultural insurance on smallholder farmers in developing countries have been mixed. Karlan *et al.* (2014), using experimental data from Ghana, respectively, show that smallholder farmers are more likely to purchase agricultural-based insurance when they or people in their social networks received payouts in the previous year. Furthermore, Cole *et al.* (2014) find for rural India that the network effect in agricultural insurance demand is strongest in the subsequent season but the individual-level effect of receiving a payout is strongest after two or three years. Beyond the experimental evidence, Jensen *et al.* (2016) argue that the track record of making index insurance coverage available to large numbers of smallholder farmers in low-income countries has not come to pass due to affordability concerns, an inadequate regulatory environment and poor product quality (see also Binswanger-Mkhize, 2012). Basis risk, the discrepancies between the measured insurance index and the events and losses experienced by the insured, is also found to dampen demand for and impact of agricultural-based insurance (Clarke, 2016; Karlan *et al.*, 2014; Binswanger-Mkhize, 2012).

Lack of access to health insurance markets can similarly prevent farmers from pursuing productive investments. Both practically and academically, there has been much less effort devoted to (1) providing health insurance coverage to farmers in developing economies and (2) evaluating its impacts. The introduction of the NHIS in Ghana presents an ideal context to study the effect of insured health risk on agricultural investments.

Risk and shocks are an ever-present feature of life for smallholder farmers, with dire consequences for those without products that can help them to manage (Jensen *et al.*, 2016). High medical costs in the event of shocks can deplete household assets, but smallholder farmers can manage household outcomes better with health insurance coverage (Kharazmi *et al.*, 2021; Morton, 2020; Gillespie and Johnson, 2010). Osei-Akoto *et al.* (2013) found that due to the associated high cost of healthcare due to out-of-pocket payments in Ghana, ill health decreases investments in seeds, chemicals and tools. The effect is driven by a movement of funds from potential investments in agriculture to the payment of healthcare expenses.

There are also indirect costs of ill-health associated with loss of income from off-farm employment, which could have been invested in agriculture (see Chima *et al.*, 2003 for details on the computation of direct and indirect costs of ill-health in Sub-Saharan Africa). Mwaniki (2006) found that disease incidences among smallholder farmers reduce available labour hours for agriculture, decrease farmers' access to food and perpetuate poverty. Audibert *et al.* (2003) study evaluated the impact of malaria on the rice cultivation systems in the savannah zones of Cote d'Ivoire and estimated high levels of inefficiency on farms cultivated by households that experience malaria frequently, and this limits asset accumulation. Thus, the economic burden of diseases such as malaria for smallholder households in developing countries with no health insurance coverage can be significant.

Even though there is scanty evidence on the impact of health insurance on smallholder farmers' investment behaviour, there is a large body of literature that has explored health insurance in the context of (1) health insurance and healthcare utilization (Kitole *et al.*, 2023; Sekyi *et al.*, 2022; Djahini-Afawoubo and Aguey, 2022; Tungu *et al.*, 2020), (2) determinants of health insurance enrollment (Adjei-Mantey and Horioka, 2023; Osei Afriyie *et al.*, 2022; Salari *et al.*, 2019; Duku, 2018), (3) health insurance and health expenditures (see Okunogbe *et al.*, 2022; Hooley *et al.*, 2022; Jung *et al.*, 2022) and (4) health insurance, human capital accumulation and child labour (Acharya *et al.*, 2020; Guarnizo-Herreño *et al.*, 2019; Landmann and Frölich, 2015). There is little empirical evidence on the impact of NHIS enrolment on smallholder farmers in developing economies. We set out with detailed farm household-level data in Ghana to examine the impact of insured health risk on farm households' agricultural investment.

4. Methodology

In this section, we describe the data, the theoretical, conceptual and analytical considerations of the paper, and how they are linked to the relationship between health insurance coverage and agricultural-related investments. We also discuss and address the endogeneity issues related to the estimation of this relationship.

4.1 Data

The data used for the empirical analysis is from the sixth wave of the Ghana Living Standard Surveys: GLSS 6 (2012/13). The GLSS is a nationally representative household survey that is designed to generate information on the economic activities and conditions in Ghana [3]. One unique aspect of this round of data is that it included a Labour Force Survey module with additional sections on child labour. This allowed us to measure households' expenditure on hired farm labour. The sampling frame for the survey was the population living in households in Ghana. The sample frame was divided into a primary and secondary sampling unit. The primary sampling unit was defined as the census enumerated areas (EAs) that are stratified into the ten administrative regions of Ghana based on proportional allocation, while the second sampling unit represented households living in each of the EAs. In practice, 15 households were randomly selected per EA. In the end, 1,200 EAs were selected, leading to a total of 18,000 households. Out of this, 16,772 representing 93% were successfully interviewed, with 5,883 representing 35% indicating having a farm. Thus, for this study and analysis, we restrict the sample to 5,883 farm households. Therefore, the nationally representative nature of the data ensures that the farm households interviewed reflect the population of farm households. Here, we defined farm households as those who indicated cultivating a farm in the previous year.

4.2 Theoretical and conceptual considerations

Agriculture in developing countries is inherently risky. The decision to purchase health insurance is not different from the decision to purchase any formal insurance product. The decision is essentially a comparison of (1) the expected utility lost from paying the premium when healthy and (2) the expected utility gained from the income transfer if ill (Nyman, 2003). From the expectation utility (EU) theory, we assume that people are risk averse and make choices between taking a risk that has different implications for wealth. Consumers are uncertain at the point of making a decision, whether an event like a shock will happen, and the related financial consequences. Insurance, therefore, reduces this uncertainty and levels out income, consumption and investments over two different states, i.e. with a shock and without a shock (Schneider, 2004). The rationale, therefore, for providing any form of insurance to smallholder farmers is to reduce exposure to risk at a much lower cost. Lack of access to a formal insurance market may prevent farmers from pursuing investments with potentially large returns and risks (Cai *et al.*, 2015). In theory, insurance transfers a portion of the income risks out of the household's portfolio, allowing households to increase investments in higher-risk/higher-yield technologies (Jensen *et al.*, 2016).

Conceptually, health risks contribute to farm investments in three ways. First, *ex ante* poor health reduces labour productivity, agricultural yields and profitability, decreasing the resources available for investing in productive agricultural inputs. Second, ex-post health insurance coverage enhances coping responses to severe health shocks, allowing households to smoothen both consumption and investments. For some households, having health insurance coverage will dampen the uncertainty regarding the future, thereby reducing precautionary savings in favour of productive investments. Third, when health shocks hit, health insurance coverage can also help to improve household asset resilience, i.e. households not selling off assets to address health shocks. Assets are critical as collateral to accessing credit in many low-income countries, and therefore, through improved household assets, health insurance can crowd in the needed credit for agricultural investments (see also Jensen *et al.*, 2016; Carter *et al.*, 2016).

4.3 Analytical considerations

xIn this section, we describe our empirical specifications used to examine the association between health insurance coverage and farm investments and try to address the potential endogeneity issue related to enrolment in the national health insurance scheme in Ghana. In order to estimate the association between health insurance coverage and agricultural investments, we consider the following econometric specifications:

$$\begin{aligned} InsL\_invest_i = \beta_0 + \beta_1 NHIS_i + \beta_2 Mar_i + \beta_3 Edu_i + \beta_4 InHHInc_i \\ + \beta_5 HHSize_i + \beta_6 FSize_i + \beta_7 Male_i + \beta_8 Age_i + \varepsilon_i \end{aligned} \quad (1)$$

where $InsL\_invest_i$ denotes the amount of money spent on agricultural inputs (such as fertilizer, herbicides, pesticides, insecticides, irrigation, purchased seedlings, hired technological inputs such as hired tractors, ploughs, etc. in the past one year, *NHIS* dummy, which takes a value of one (1) if more than half of the household members are enroled on NHIS and zero (0) if otherwise [4], *Mar* represents the marital status of the household head, *Edu* represents the educational level of the household head, variable *Age* represents the age of the household head, $InHHInc_i$ denotes household income, *HHSize FSize* represents the farm size of the household and *Male* represents the gender of the household head. β_0 is the intercept. Furthermore, the subscript "i" represents a household. The coefficient on the respective parameters varies from β_1 to β_8, and ε_i is the error term for each household in the model. The key coefficient of interest is β_1.

We also examine the relationship between health insurance coverage and hired labour employment in agriculture. Agricultural activities in developing countries can be labour-intensive. Theoretically, one would expect that savings from health expenditures or savings against unexpected health shocks could be channelled into hiring labour. On the other hand, the indirect effect of health insurance on health status could mean that farmers are healthy enough to carry out farm activities and therefore lower their expenditure on hired labour. To this end, we modify slightly our specification (1) and estimate the following specification to examine the association between health insurance coverage and farm households' expenditures on hired labour:

$$\begin{aligned} lnHired\,Lab_i = \varphi_0 + \varphi_1 NHIS_i + \varphi_2 Mar_i + \varphi_3 Edu_i + \varphi_4 InHHInc_i + \varphi_5 HHSize_i \\ + \varphi_6 FSize_i + \varphi_7 Male_i + \varphi_8 Age_i + \mu_i \end{aligned} \quad (2)$$

where $lnHired\,Lab_i$ represents the amount of money spent on adult-hired labour for agricultural farm activities in the past one year. We focus solely on adult-hired labour due to the sensitivity and potential underreporting of child labour activities. Any data on expenditure on child labour wages will therefore be very noisy to use. The key coefficient of interest is φ_1.

To identify the causal effects in equations (1) and (2), we must assume that farm households' NHIS enrolment is exogenous and uncorrelated with the error terms. However, due to selection problems, this may not be the case since the NHIS status of the household could be related to both observable and unobservable household characteristics. Although the health insurance scheme is available in all regions, the small yearly fee of approximately 5 USD may prove very high for some poor households. Therefore, even though we will control for income in the ordinary least squares (OLS) estimations, as a robustness check and to improve the observed associations, we apply a series of matching estimators and instrumental variable (IV) estimations. Precisely, first, we use propensity score matching (PSM) techniques to construct a counterfactual based on observable household characteristics and match households based on their propensity scores to improve our estimated effects. Thus, the difference in investments is obtained by matching households with different NHIS statuses but similar household characteristics; as such, any remaining difference after matching can be attributed to the NHIS status (treatment) of households:

$$p(H_i) = \Pr[(T_i) = |H_i| = E[(T_i)|H_i]; P(H_i) = F\{z(H_i)\} \tag{3}$$

where H_I denotes a vector of pre-treatment characteristics of the household i, T_i, a binary variable that indicates if the household has NHIS or not [T_I = (1,0)], E is the expectation operator and $F\{\cdot\}$ represents a logistic or normal cumulative distributive frequency.

The propensity score matching procedure is a two-stage process. In the first (1) stage, a logit or probit estimation model is used to generate the p-scores – the propensity of a household to enrol in NHIS based on observables (Rosenbaum and Rubin, 1985). The approach uses a probit model to estimate the factors that influence NHIS adoption and predict the scores (Sianesi, 2004). The predicted scores are then used to examine the impact by matching households with similar p-scores but different enrolment outcomes. The majority of scholars have argued that the Average Treatment effect (ATE) is a very good estimator which is used to measure the mean difference in outcomes across the two groups (control and treatment group) (Heckman *et al.*, 1999; Becker and Ichino, 2002; Khandker *et al.*, 2009). The Average Treatment effect on the treatment group (ATT) and the Average Treatment for the Untreated (ATU) are mostly used in studies reviewed. The ATE captures the treatment effect for the whole sample; ATT represents the treatment effects on participants in the intervention and ATU represents the treatment effect on the non-participants. ATT has been highlighted as the best parameter of interest for the estimation of the propensity score (Becker and Ichino, 2002).

Given the $p(H_I)$, the effects are examined as;

$$ATE = E\left[E\{y_I^*|(T_I) = 1, p(H_I)\} - E\{y_I|(T_I) = 0, p(H_I)\}\right] \tag{4}$$

where y_I^* is the counterfactual outcome of households with "NHIS" and y_I is the counterfactual outcome of households without "NHIS", the counterfactual estimates denote what the investment level in agricultural input or expenditure on hired labour would be if they did not have NHIS. Several matching methods have been recommended for such an estimation, including the nearest-neighbour matching, radius matching, weighted kernel matching and stratification matching. Matching is usually employed to eliminate overbiasness. The nearest-neighbour and kernel matching are adopted for robustness purposes in this paper.

As a further robustness check and to improve estimates from both the OLS and PSM estimations, we implemented a two-stage instrumental variable (IV) estimation, in which we instrument health insurance enrolment with the year in which the household was interviewed and a household visit to a health facility in the two weeks preceding the interview. Evidence shows that awareness and confidence in the health insurance system increased over time, leading to an increase in enrolment (see Witter and Garshong, 2009), and as such, households interviewed in 2013 are more likely to be enroled than those interviewed in 2012. We argue that the timing of the survey among households across 2012/2013 is random and, as such, provides us with a good instrument for health insurance enrolment. As indicated earlier, the data collection took place from the 18th of October 2012 to the 17th of October 2013. We, therefore, exploit the variation in the timing of the survey across 2012 and 2013 to instrument for household health insurance enrolment. Secondly, we argue that farm households who have visited the hospital two weeks prior to the survey are also more likely to be enroled in health insurance than those who did not. Subsequently, our two-stage equation system equations can be specified as follows:

The first stage equation is:

$$NHIS_i = \beta_0 + \beta_1 Mar_i + \beta_2 Edu_i + \beta_3 Age_i + \beta_4 InHHInc_i + \beta_5 HHSize_i + \beta_6 FSize_i + \beta_7 Male_i + \beta_8 Surveyyear_i + \beta_9 HealthfacVisit + \varepsilon_i \quad (5)$$

The second stage equation is:

$$lnLinvest_i = \propto_0 + \propto_1 \widehat{NHIS}_i + \propto_2 Mar_i + \propto_3 Edu_i + \propto_4 Age_i + \propto_5 InHHInc_i + \propto_6 HHSize_i + \propto_7 FSize_i + \propto_8 Male_i + u_i \quad (6)$$

where *Surveyyear* captures the timing of the survey, or in other words, when the household was interviewed (2013 = 1, 2012 = 0). *HealthfacVisit* is a dummy that denotes whether somebody in the household visited a health facility two weeks prior to the survey. The definitions of all other variables are the same as already defined. A similar set of two-stage equations is estimated for the hired adult labour outcome variable.

Following standard specifications, keeping in mind the need to identify the system through reasonable exclusion restrictions, we do not include the timing of the survey and a visit to a health facility in the past two weeks prior to the survey in the second-stage farm investment model (equation 6). We argue that this is a reasonable exclusion restriction: whether a farmer is interviewed in December 2012 or January 2013 should not drive differences in investment in the past one year prior to the survey. Likewise, a visit of a household member to the hospital in the past two weeks should not impact aggregate investments over a year.

5. Results

5.1 Descriptive statistics

Table 1 presents the descriptive statistics for the key variables used for the analysis. As indicated, the data includes 5,883 household respondents. For estimation, we classified all households who have more than half of their members enroled or covered under the NHIS as NHIS households and non-NHIS households if otherwise. Based on this classification, about 64.1% of the farm households are classified as NHIS households, whereas 35.9% can be classified as non-NHIS households. In terms of household demographic characteristics, approximately 72% of agricultural households are headed by males, whereas 28% are headed by females.

Table 1 also shows that household size, household income and farm sizes are not statistically different between NHIS-enroled and non-enroled households. However, household heads of NHIS-enroled households are slightly more educated than NHIS-enroled households. In addition, whereas the average age of household heads' in NHIS-enroled households is 48 years, the average age of household heads' in non-NHIS households is 42 years. These differences are controlled for in our regression model.

In terms of the main outcome variable of interest – farm investments – we measure that by the amount of money spent on agricultural inputs such as mulch, fertilizers, irrigation, purchased of seeds and seedlings, herbicides, pesticides, insecticides, hired technological inputs for land preparation/tillage such as hired tractors, ploughs, etc. for the past planting year. As shown in the descriptive Table 1, comparing NHIS-enroled households to non-NHIS-enroled households, we find significantly higher agricultural investments in NHIS-enroled

Variable names	Pooled	With NHIS Mean	Without NHIS Mean	Min	Max	Differences in mean Mean	*t*-value
Treatment variable							
NHIS Yes = 1, No = 0		0.641	0.359				
Outcome variables							
Soil and land investment	494.78	560.692	375.299	1.2	15,720	185.39***	−5.195
Hired labour	183.16	210.502	102.256	15.0	3,500	108.25***	−3.735
Independent variables							
Age head	46.245	48.441	42.325	15	98	6.116***	−14.23
Male head	0.720	0.681	0.789	0	1	0.108***	8.912
Educational level head	1.272	1.328	1.215	0	4	0.175***	−6.110
Marital status	0.673	0.665	0.688	0	1	0.023**	1.815
Farm sizes	5.011	5.782	3.441	0.045	1497.37	2.341	−1.382
Household income	7,546.2	7789.27	7112.43	−98320.6	788,349	676.84	−1.072
Household size	1.789	1.790	1.786	1	4	0.0043	−0.185

Note(s): ***$p < 0.01$ and **$p < 0.05$
Source(s): Authors' own work

Table 1. Descriptive statistics on the enrolled and non-enroled farm household

households than non-NHIS-enroled households. While enroled households invest 560.69 GHS (259.58 US$) on soil and land improvement activities, non-enroled households invest approximately 375.30 GHS (173.75 US$) [5]. In terms of hired labour, as presented in Table 1, households enroled in NHIS spent 210.50 GHS (97.45 US$) on hired adult labour in the past planting year, whereas households not enroled in NHIS spent 102.25 GHS (47.34 US$) on hired adult labour. Due to potential differences in observable characteristics of enroled and non-enroled households, the observed descriptive difference in investments and hired labour cannot be conclusive without controlling for endogeneity (see Waters, 1999). We will attempt at a later stage to address the potential endogeneity.

5.2 Empirical results

Table 2 presents our results of the association between health insurance and agricultural land investments using OLS estimations. As indicated in the methodology section, this estimation represents an initial step in our empirical analysis. We report in column 1 of Table 2 the marginal effects of soil and land-related investment in the agriculture model, whereas column 2 reports the results for the hired labour model, respectively. From column 1 in Table 2, we find the coefficient on the variable of interest (NHIS) to be positive and significantly different at the 1% level. Thus, farm households who are enroled in the health insurance system tend to invest about 32% more in soil and land improvement activities than households who are not enroled in NHIS. This result, even though it cannot be considered causal (at best partial correlation), provides the first suggestive evidence of the relationship between NHIS enrolment and agricultural soil and land improvement investments.

Regarding our control variables from the OLS estimation, we found that the coefficient on education is not significant even at the 10% level. The effect of education on soil and land-related investments could be through NHIS enrolment and not direct, and as such, controlling for NHIS enrolment makes the descriptive differences in education between enroled and non-enroled households disappear. In terms of the other control variables, we find the coefficient on the age of

Table 2.
Ordinary least square estimates of the impact of NHIS on farm investment and hired labour in agriculture

Dependent variables: Soil and land-related investment in agriculture (lnsL_invest); hired labour		
Variables	lnsL_invest	Hired labour
NHIS	0.324***	0.294***
	(0.064)	(0.082)
Age head	−0.004**	−0.004*
	(0.002)	(0.002)
Male head	0.402***	0.423
	(0.097)	(0.116)
Farm size	0.007**	0.029
	(0.004)	(0.067)
Household size	0.125***	0.055
	(0.035)	(0.050)
Marital status	0.149*	0.111
	(0.090)	(0.097)
Educational level	−0.039	−0.081**
	(0.026)	(0.036)
Household income	0.155***	0.166***
	(0.027)	(0.036)
Constant	−0.925**	−0.734
	(0.412)	(0.149)
R-Squared	0.224	0.235
Prob > *F*	(0.000)	(0.509)

Note(s): ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$. Robust standard errors are in parenthesis
Source(s): Authors' own work

the household head to be negative and significant, whereas the coefficient on the male dummy variable is positive and significant. For age, this may be because older people may be more vulnerable to health shocks and are likely to save more to address their current poor health status or against possible future health shocks. The latter suggests that male-headed households tend to invest more in soil and land improvement than households headed by females. Precisely, male-headed households tend to invest about 40% more in agricultural land and soil health improvement than female-headed households. Discussing other drivers of investment in agricultural land and soil health improvement, we find farm size, household size, being married and income to be important positive and significant drivers of soil and land investments.

Now we turn our attention to the association between health insurance coverage among farm households and hired labour employment. Column 2 of Table 2 presents the results for the relationship between health insurance coverage and expenditure on hired labour. As shown in Table 2, the coefficient on the NHIS dummy is positive and significant. Precisely, the magnitude of the coefficient suggests that investment in hired farm labour is approximately 30% higher in NHIS-enroled farm households than non-NHIS households. About other control variables, we find age and education to be negatively related to expenditure on hired labour, whereas expenditure on hired labour is positively correlated with household income. After controlling income, we do not find a significant impact of household head gender, farm size and family on hired labour employment. Thus, from our OLS estimations, we find positive impacts of health insurance enrolment on investments in soil and land as well as on hired employment.

We now turn our attention to PSM results. Due to the underlying principles and conditions of PSM as stated by Heckman *et al.* (1999), Augurzky and Schmidt (2001), Lechner (2001) and Bryson *et al.* (2002), the probit treatment model is adopted to estimate the probability of a farm household enroling in NHIS. Table 3 presents the observable variables used to predict the probability of enrolment, the estimates from the associated probit model, and the marginal effects.

Variable	Dependent variable: National health insurance scheme (NHIS) Coefficient	Std. err.	$p>(t)$	Margin	$p>(z)$
Age head	0.013***	0.002	0.000	0.0048	0.000
Male head	−0.458***	0.963	0.000	−0.163	0.000
Educational level head	0.130***	0.029	0.000	0.046	0.000
Marital status	0.0012	0.915	0.989	0.0005	0.989
Farm size	0.010*	0.006	0.077	0.004	0.075
Household income	0.000	0.026	0.999	0.000	0.999
Household size	−0.035	0.036	0.340	−0.012	0.340
Constant	−1.915***	0.407	0.000		
Log likelihood	−1220.6524				
$p > \chi^2$	0.0000				
Pseudo R2	0.0583				

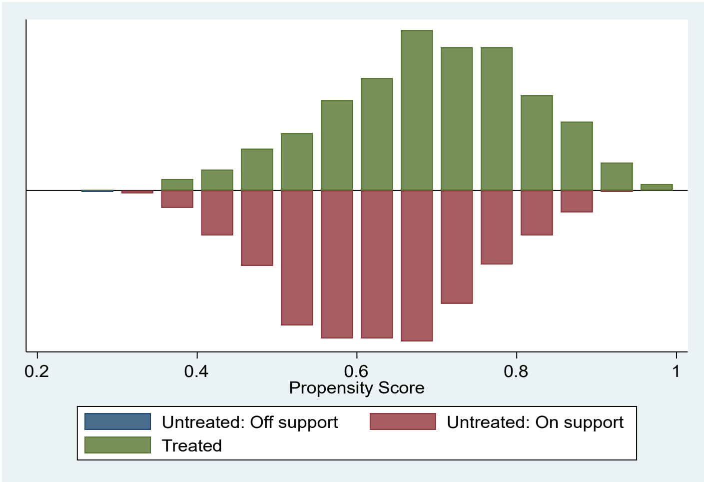
Note(s): ***$p < 0.01$ and *$p < 0.1$
Source(s): Authors' own work

Table 3. Results from the probit treatment model under PSM

Even though under the OLS estimation (as presented in Table 2), we find income to be a significant driver of soil and land investments, as shown in Table 3, income is not a significant driver of farm households' enrolment in NHIS. NHIS enrolment among farm households is driven positively by the age of the household head and the educational level of the household head. Enrolment in NHIS is marginal at the 10% level, positively driven by the size of the farm. There seem to be gender differences in NHIS enrolment. Precisely, farm households headed by males are significantly less likely to have more than 50% of their members covered under NHIS than households headed by female household heads. These first-stage probit results from the PSM estimation, from the policy perspective, already guide who to target to improve NHIS enrolment among smallholder farmers in Ghana.

With the probit model result estimated, the propensity scores are evaluated for both enroled and non-enroled farm households. The common support in propensity scores is bounded within 0.293–1 for households that have enroled and households that are not enroled. Figure 1, which presents the "distribution of the p-scores", shows a good match between the insured and not insured across all ranges of the p-score distribution.

Table 4 below presents additional indicators for the quality of the matching process. Here, a reduction in the mean absolute standardized bias between the unmatched and matched samples is used to determine the balancing powers of the estimation. From Table 5, the mean bias before and after matching is 18.0 and 2.0, respectively. As shown in columns 4 and 5 of Table 4. It is observed that after matching, the mean bias in the covariates is below the 20% level of bias reduction suggested by Rosenbaum and Rubin (1985). Hence, we argue that the covariates are significantly balanced by using the propensity score matching algorithms. The before and after Pseudo R^2 are shown in the second and third columns with their respective p-values in parenthesis. The Pseudo R^2 is fairly low, and the diagnostic statistics are not significantly different from zero after matching, suggesting that there are no significant differences between farm households enroled in NHIS and farm households not enroled (Pseudo R^2 before and after matching 0.054 and 0.004, respectively). The p-value reduced from a highly significant level ($p = 0.000$) before matching to an insignificant level of 0.174 after matching. Hence, we also argue here that there is no systematic variance in the distribution of covariates between farm households enroled in NHIS and those not enroled (see Sianesi, 2004).



Source(s): Authors' own work

Figure 1.
Distribution of propensity score for the matched samples

Table 4.
Indices of the matching quality

Variable	Pseudo R^2 (Unmatched)	Pseudo R^2 (Matched)	Mean bias (Unmatched)	Mean bias (Matched)	Bias reduced (%)
Soil and land	0.054	0.004	18.0	2.0	51.6
Investment	(0.000)	(0.174)			

Note(s): *p*-values in parenthesis
Source(s): Authors' own work

Table 5.
Effect of NHIS on soil and land-related investment in agriculture (nearest-neighbour matching)

Variable	Sample	Treated	Control	Difference	Std. error	*T*-stats
Soil and land investment	Unmatched	5.540	5.144	0.396	0.069	5.75
	ATT	5.493	5.144	0.348	0.078	4.46

Source(s): Authors' own work

We now proceed to present estimates of the impact of the NHIS enrolment on soil and land-related investments under the PSM method. Tables 5 and 6 present results for nearest-neighbour matching and kernel matching, respectively. The tables present the mean of the natural log of soil and land investments for both the control (no health insurance households) and treated groups (health insurance households). It also presents the differences in investment between the two groups and their corresponding t-statistics. Row 1 of Tables 5 and 6 presents the results for the unmatched sample (similar to the OLS estimates), whereas Row 2 presents the estimates for the matched sample.

From the nearest-neighbour matching as presented in Table 5, we found that farm households enroled in NHIS invest about GH₵ 242.93 (112 US$) in agricultural soil and land health improvement activities per year, while farm households without NHIS invest about

GH₵ 171.45 (79 US$) [6]. A difference of 0.348 in logs implies that farm households with NHIS invest roughly GH₵71.48 (33 US$) a year in soil and land improvement activities more than farm households who do not have more than 50% of their members enroled in NHIS [7]. This difference of 33 US$ investments per year is non-trivial in a rural setting in Sub-Saharan Africa, where income levels are low.

Estimates from kernel matching show qualitatively similar results. See Table 6 for the kernel-matching estimated results. Thus, under the kernel estimation, the results suggest that farm households with NHIS tend to invest about GH₵ 251.14 (116 US$) in soil and land improvement activities, whereas farm households with less than 50% of their members enroled invest about GH₵ 183.09 (85 US$). Thus, the estimated impact of NHIS enrolment under the kernel estimation is similar to the results obtained under the nearest-neighbour matching.

We now turn to the PSM estimates of the impact of NHIS enrolment on the employment of hired labour. The estimates are presented in Tables 7 and 8. Specifically, Table 7 presents the nearest-neighbour matching estimates, whereas Table 8 presents that for the kernel matching. Based on the nearest-neighbour matching, the result shows that farm households that have more than 50% of members enroled in the health insurance scheme spend about GH₵ 200.60 (93 US$) on hired labour a year, whereas non-enroled NHIS households spend GH₵ 146.57 (69 US$). The implication is that NHIS-enroled households invest roughly GH₵ 54.02 (25 US$) more on hired labour than non-enroled farm households.

The kernel matching estimates as presented in Table 8 are similar to those of the nearest-neighbour matching estimates. From Table 8, specifically, NHIS-enroled households invest approximately GH₵ 200.60 (93 US$) on hired labour while non-enroled farm households NHIS invest about GH₵ 153.85 (71 US$). Almost like the nearest-neighbour matching estimates, NHIS-enroled households invest roughly GH₵46.75 (22 US$) on hired labour than farm non-enroled farm households. The 25 US$/22 US$ can employ about three (3) farm labourers for weeding an acre of land, which is significant.

Variable	Sample	Treated	Control	Difference	Std error	*T*-stats
Soil and land Investment	Unmatched	5.540	5.144	0.396	0.069	5.75
	ATT	5.526	5.210	0.316	0.076	4.16

Source(s): Authors' own work

Table 6. Treatment effect of NHIS on soil and land-related investment in agriculture (Kernel matching)

Variable	Sample	Treated	Control	Difference	Std. error	*T*-stats
Hired Labour	Unmatched	5.320	5.036	0.284	0.084	3.39
	ATT	5.301	4.986	0.314	0.146	2.15

Source(s): Authors' own work

Table 7. Effect of NHIS on hired labour (nearest-neighbour matching)

Variable	Sample	Treated	Control	Difference	Std. error	*T*-stats
Hired labour	Unmatched	5.320	5.036	0.284	0.084	3.39
	ATT	5.301	5.036	0.265	0.089	2.98

Source(s): Authors' own work

Table 8. Effect of NHIS on hired labour (kernel matching)

We now turn to our two-stage IV results. As mentioned earlier, the relationship between national health insurance coverage soil and land improvement activities and hired labour employment using OLS is likely to be biased due to possible unobserved factors that affect both enrolment and the outcomes. As a further robustness check for our OLS and PSM results, we estimated a two-stage IV model. The estimated results for Equations (5) and (6) (two-stage IV regressions) for soil and land improvement agricultural investments are presented in columns (1) and (2) of Table 9. Column 1 presents the first-stage results, while column 2 presents the second-stage results. For the first-stage results, the key coefficients of interest are those that capture the effect of the instruments (*Surveyyear* and *HealthfacVisit*) on health insurance enrolment (*NHIS*), and for the second-stage the effect of health insurance enrolment (*NHIS*) on soil and land-related investment (*lnLinvest*/ *lnHired Lab*).

We find that the instruments are statistically relevant, i.e. correlate with the endogenous variable (Bound *et al.*, 1995). The results reported in Table 9 indicate the NHIS enrolment variable is endogenous – the Durbin–Wu–Hausman tests strongly reject the null. We find both the coefficients on survey year and health facility visit variables to be positive and statistically significant at the 1% level. The joint F statistic for the excluded instruments is 20.17. The F statistic exceeds the 10.00 benchmark value, which is widely used as a cut-off value to determine the strength of an instrument (see Kennedy, 2008). Our test of overidentification does not reject the null hypothesis that all instruments used are valid. The effect of the other covariates in the first-stage model mirrors the effects estimated for the drivers of enrolment under the PSM (see Table 3). The only exception is the observed negative and significant effect of household size on the NHIS enrolment status of the household.

We now turn our focus to the second-stage equation, which estimates the impact of household health insurance enrolment status on agricultural soil and land improvement investments, presented in Column 2 of Table 9. The coefficient on the NHIS status variable as presented in Column 2 of Table 9 is positive and significant. The IV results provide evidence on the impact of NHIS enrolment status on soil and land investments that is positive and consistent with that of the PSM estimate. Thus, the OLS, PSM and two-stage IV estimates all point to a positive impact of the impact of NHIS enrolment status on soil and land investments.

We now turn our attention to the effect of some of the important covariates in the second-stage model. We find that while the age of the household head positively impacts the health insurance enrolment status of the farm household, the age of the household head negatively impacts soil and land improvement investments. Interestingly, while the coefficient on the male dummy variable is negative in the first-stage model, it is positive in the soil and land investments model. These results show that while on average households headed by women are more likely to be enroled in NHIS, health insurance enrolment does not bridge completely the gender difference in investments. Thus, more needs to be done to bridge the gender differences in agricultural investments in developing countries.

Focusing on the hired labour outcome, Table 10 presents the 2SLS-IV estimated results. Consistent with the soil and land improvement investment model, Column 1 displays the strong first-stage positive relationship between the instruments (survey year and health facility visits) and health insurance enrolment, as shown in Table 10. The results reported in Table 10 indicate the NHIS enrolment variable in the hired labour model is also endogenous – the Durbin–Wu–Hausman tests strongly reject the null. The F statistic in that model for the excluded instruments is 12.88, which exceeds the cut-off value of 10. Our test of overidentification does not reject the null hypothesis that all instruments used are valid. Column 2 of Table 10 shows the subsequent impact of NHIS status on hired labour expenditures. The coefficient on the NHIS dummy variable is positive and significant. This

Variables	First-stage (health insurance)	Second-stage (soil and land investments)
HealthfacVisit	0.041*** (0.007)	
Survey year (2013)	0.024*** (0.007)	
NHIS		0.358*** (0.693)
Age head	0.0008*** (0.0002)	−0.006*** (0.001)
Male head	−0.060*** (0.011)	0.589*** (0.064)
Educational level	0.034*** (0.003)	−0.160*** (0.026)
Marital status	0.037*** (0.011)	0.064 (0.056)
Farm size	0.0005*** (0.0001)	0.006*** (0.001)
Household income	0.003 (0.003)	0.133*** (0.011)
Household size	−0.013*** (0.003)	0.190*** (0.017)
Constant	−48.082*** (13.506)	−1.779*** (0.202)
F (227,005)	20.17	
Prob > F	0.000	
Durbin–Wu–Hausman endogeneity test, χ^2	14.640	
Reject the null?	Yes***	
Overidentification test	5.895	
Reject the null?	No	

Note(s): Standard errors in parentheses, ***$p < 0.01$
Source(s): Authors' own work

Table 9. 2SLS instrumental variable (IV) estimation of NHIS enrolment status on soil and land investments

result could be suggestive of the potential labour expenses which could have been incurred without NHIS coverage for the household. Our IV results overall can be considered as intention-to-treat (ITT) effects of NHIS enrolment on farm investments.

Variables	First stage (health insurance)	Second stage (hired labour expenditures)
HealthfacVisit	0.049*** (0.011)	
Survey year (2013)	0.032*** (0.110)	
NHIS		0.842*** (0.649)
Age head	0.002*** (0.0003)	−0.005*** (0.002)
Male head	−0.083*** (0.015)	0.501*** (0.073)
Farm size	0.0008*** (0.0002)	0.009*** (0.003)
Household size	0.002 (0.005)	0.108*** (0.017)
Marital status	0.064*** (0.015)	0.064 (0.063)
Educational level	0.047*** (0.004)	−0.114*** (0.033)
Household income	−0.009** (0.004)	0.171*** (0.014)
Household expenditure	0.050*** (0.007)	0.380*** (0.040)
Constant	−65.052*** (22.093)	−1.321*** (0.236)
F (210,171)	12.88	
Prob > F	0.000	
Durbin–Wu–Hausman endogeneity testχ^2	4.825	
Reject the null?	Yes**	
Overidentification test	3.937	
Reject the null?	No	

Note(s): Standard errors in parentheses, ***$p < 0.01$ and **$p < 0.05$
Source(s): Authors' own work

Table 10. 2SLS instrumental variable (IV) estimation of NHIS enrollment on hired labour expenditures

6. Conclusion

Low investments in agriculture can pose serious and varied challenges to smallholder households' resilience to climate change (Sustainable Development Goal 13) and eradicating hunger (Sustainable Development Goal 2). Applying a series of estimators, including PSM and the 2SLS-IV estimator, on a sample of 5,883 farm households in Ghana and taking advantage of the timing of national health insurance enrolment and the timing of the survey, we explore the impact of national health insurance coverage on agricultural soil and land improvement investments as well as hired labour expenditures. We found a strong positive relationship between the NHIS enrolment status of the household and agricultural soil and land improvement investments. To be precise, enroled NHIS households tend to spend about US$33 per year more on agricultural soil and land improvement than similar households that are not enroled. For hired labour expenditure, we find that NHIS-enroled farm households tend to spend about US$22 more per year on hired labour than households that are not enroled. The magnitudes of the impact of NHIS enrolment for soil and land investments as well as hired labour are not trivial in the context of smallholder farmers in Sub-Saharan Africa.

From the policy perspective, many farmers do not benefit from input support programmes due to poor targeting, corruption and smuggling of agricultural inputs across borders. Overall, our findings show that low-cost health insurance coverage for smallholder farmers can contribute greatly to enhancing investment in agriculture. Therefore, subsidizing health insurance for rural farm households may provide a more sustainable way to increase agricultural investments in developing countries.

Notes

1. https://www.nhis.gov.gh/
2. The population of Ghana in 2017 was about 30 m people. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=GH
3. https://www.statsghana.gov.gh/gssmain/fileUpload/Living%20conditions/GLSS6_Main%20Report.pdf
4. Redefining health insurance households as households with at least one person covered would mean all households in our data are covered. This is because aged people above 70 years and children below 18 years are covered for free.
5. The exchange rate at the time in 2013 was 1US$–2.16 GH₵.
6. $\ln x = 5.493$ and therefore x equals 242.93. Note that Log(x/m) equals Logx – Logm and not x-m.
7. The exchange rate at the time in 2013 was 1US$–2.16 GH₵.

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