

Removing Supply Side Constraints and Targeting Poor Farmers to Increase Improved Seed Adoption-Towards Creating Household Technology Adoption Safety-Net Programme (HTASNP)

I. Introduction: The Problem

In Ethiopia, agriculture contributes about 50% to the gross domestic product and is a means of livelihood for nearly 85% of the people (WDIs, 2013)¹. In addition, a study by (Diao & Pratt, 2007) reveals that agriculture can play substantial role in decreasing poverty in Ethiopia especially with an emphasis on cereals while Gollin and others also emphasise the relevance of agriculture in Africa as a way out to poverty (Gollin, Parente, & Rogerson, 2002). Mellor and Dorosh also argue that agriculture in Ethiopia is promising in transforming the nation (Mellor & Dorosh, 2011). However, agriculture is yet at its subsistence level and its productivity is very limited. Moreover, it is highly dependent on natural rainfall. This low productivity of the sector can explain, at least partly, as to why the country is still not food self-sufficient. Besides to lack of ample rainfall, one of the primary reasons for low productivity of agriculture could be lack of application of modern technology. For instance, ploughing, by most of the farmers in Ethiopia, still takes place in the form of traditional methods-using man power and ox.

In addition, poor farmers lack infrastructural, financial and know-how capacity (Zerfu & Larson, 2010) limiting access to use modern technology (Croppenstedt, Demeke, & Meschi, 2003; Wubeneh & Sanders, 2006); for instance, adoption of fertilizer and improved seeds; which might boost agricultural productivity if properly utilized. Even worse, in the presence of access, poor farmers could be resistant to adopt new technology-they could be highly risk averse. Dercon and his co-author found that there is a likelihood of low consumption outcomes when return to crop fail and this further discourage the use of fertilizer in Ethiopian farmers because there is no alternative mechanism such as insurance to keep consumption smooth ending up in low investment in technology and hence poverty trap (Dercon & Christiaensen, 2011). Thus, it might be helpful to design policies that enable farmers to perceive safety-net. Yagura (2009) find empirical evidence from Cambodia that farmers accept risk when they perceive a safety net and hence conclude that it is not only a lack of capital that prevents poor households from investment, but also the perceived lack of a safety net. (Yagura, 2009)

Household level data from Ethiopian farmers indicates that fertilizer adoption rate is about 30-40 percent and is slightly improving from time to time. However, improved seed adoption remains, on average, at about 5% throughout in Ethiopia. Similarly, percentage of cultivated area under improved seed remains to be as low as 5% (Chamberlin & Schmidt, 2011; Spielman, Kelemwork, & Alemu, 2011). What's wrong with this? This policy intervention proposal proposes some experimental intervention to shed light on answering this question.

The prevalence of poor farmers' low level of technology adoption has to do with both demand and supply side. First, broadly speaking, it's suggested that poor farmers have less tendency in adopting new technology due to risk of harvest failure since their agriculture is based on rainfall which exhibits high degree of variability from time to time. For instance, Alem and his co-authors found that fertilizer use responds to rainfall variability while Kassie and his co-researchers also found that production risk had significant impact on adoption and extent of adoption of fertilizer in Ethiopia (Alem, Bezabih, Kassie, & Zikhali, 2010; Kassie, Yesuf, & Köhlin, 2009). Thus, farmers' demand could be quite low in a way of avoiding risk ex-ante.

¹ <http://data.worldbank.org/data-catalog/world-development-indicators>

Second, the access (Croppenstedt et al., 2003) and supply of improved seed by itself was (is) very limited (Chamberlin & Schmidt, 2011; Spielman et al., 2011). There is only one major public enterprise (probably also a few private enterprises with limited capacity) which can distribute improved seeds-Ethiopian Seed Enterprise-which is not sufficiently accessible by poor farmers. Especially, Teff is the main staple crop. However, its area coverage under improved seed is quite low and its demand shortfall is one of the highest (Chamberlin & Schmidt, 2011; Spielman et al., 2011).

There are safety-net programmes being implemented in Ethiopia-for instance, the Household Asset Building Programme (HABP) and Productive Safety-Net Programme (PSNP) by The World Bank and other collaborating donors and research institutes. The first is targeted at increasing productive assets and diversification of income of poor households while the second includes food for work programme for people able to work and direct support in kind and cash for those unable to work (Gilligan, Hoddinott, & Taffesse, 2009; Sharp, Brown, & Teshome, 2006). However, there are no programmes, as to my knowledge, in particular, that target poor farmers in terms of access to improved seed and ensure against risk of harvest failure. That is, ensuring farmers with such a potential risk and/or removing supply side constraints may help increase the demand for new technology adoption and hence may enhance agricultural productivity provided that the improved high yield seed varieties supplied are scientifically suitable for the existing agro ecological climate of poor farmers.

Therefore, this design for policy intervention (HTASNP) is intended in experimenting whether poor farmers' poor technology adoption could improve by either relaxing the constraint of access to improved seed through provision of credit or provision of insurance or both. I will focus on a particular crop which is Teff because it is one of the most widely grown cereals and almost consumed by everybody in Ethiopia. It also has several health benefits such as being gluten free, high in fibre, iron and calcium.² Moreover, previous study (or data) show that farmers face serious unmet gaps between demand and supply of improved seed especially for Teff among other cereals (Spielman et al., 2011).

The rest of proposal is organized as follows. Section two presents key research questions while section three describes the intervention. Section four briefly presents the methodology and final section highlights the promise of the proposal in terms of answering the research questions and hence influences public policy as well as the limitations thereof.

II. Research questions

In this experimental setting, I propose to address the following two basic research questions:

- Will adoption of improved seed increase if farmers gain access to credit and/or are insured; if so, to what extent? Will this be large enough to influence public policy?
- Will social learning take place between farmers overtime? Is learning by doing (from own experience) happening overtime? If so what matters for this? Who are learning from own experience and who from others? What could be the policy implications of these findings?

² For knowing more about "Teff" you may visit: <http://www.ata.gov.et/programs/value-chain-programs/tef/>
And <http://ethnomed.org/clinical/nutrition/more-about-ethiopian-food-teff>

III. The Intervention

To answer the key questions stated above, there will be two different interventions, addressing both the supply and demand side of the problem. The control group receives neither of these treatments. The first treatment (T_1) is provision of credit payable at the end of harvest season (most likely next year January) at a certain rate. Let the loan size equal to be L and interest rate is denoted as R . The total amount payable will then be $(1+R)L$.

The second treatment (T_2) is, in addition to the first treatment, to make insurance available to mitigate the risk of harvest failure that could be caused by drought. There will be two possibilities assumed for simplicity-periods of low or very extreme rainfall call 'bad weather' and reasonably high rainfall say 'good weather'. Farmers will be initially required to buy an insurance premium rate of P of their choice such that $P_1 = P \cdot 1/2[(1+R)L]$ (covers 50% of the principal plus interest rate), $P_2 = P \cdot 3/4[(1+R)L]$ (covers 75%) and $P_3 = P \cdot [(1+R)L]$ (full coverage). That is, in times of bad weather (drought or extremely high rainfall), farmers who bought full insurance, will be forgiven fully (i.e., all $(1+R)L$); whereas farmers who bought 75% and 50% coverage, are required to pay only 25% and 50% of the loan (principal plus interest) respectively. In case of normal harvest season (high rainfall), farmers will pay full amount plus interest rate, i.e., $(1+R)L$. Somewhat similar approach is used by Gine and his co-author but their interest is to see the impact of insurance on the demand for loan for using new technology (Giné & Yang, 2009).

Thus, control group (G_0) receives nothing while the first experimental group (G_1) receive one treatment (credit, call this ' T_1 ') and the second (G_2) (both credit and provision of insurance, call this ' T_2 '). Who provides credit and insurance? Well, I propose that the credit should be administered by the already existing local Saving and Credit Cooperatives (called SACCOs) while insurance should be by Development Bank of Ethiopia. Details of the estimation techniques are explained in the next section-methodology.

IV. Methodology

Initially, by administering a stratified sampling³ from each of the four Teff growing Regions (namely Tigray, Amhara, Oromia and SNNP)⁴, their respective Zones, Weredas and finally PA⁵, a list of participant farmers will be developed. Then each PA, will be randomly assigned into 9 groups after which the 1st, 4th and 7th groups will be allocated to the control groups in phase I, II and III respectively. Similarly, the 2nd, 5th and 8th groups will be allocated to treatment one (credit only) while the 3rd, 6th and 9th are allocated to treatment two (credit plus insurance) in each phase respectively. Thus, there will be three phases of the program. Then after, I describe the data to see if there is no systematic difference between control and experimental groups using baseline survey.

Baseline data on PA, farmer household and farm characteristics should be collected on November/December resulting a preliminarily describing characteristics of farmers associated with new technology adoption, to get the overall picture of initial farmer characteristics. For

³The stratification will take into account both agro-ecological and previous existing programs such as Productive Safety Net Programs as well as interventions by NGOs that focus on especially farm productivity.

⁴The reason to take all regions is because the risk to mitigate is covariate risk (absence of rainfall) which may happen in all farms of a given village or even region. However, it's unlikely that drought will occur in all regions, making insurance plausible.

⁵ PA means Peasant Association, the smallest administrative unit

instance, what are the characteristics of farmers highly associated with low level of technology adoption, say, Teff improved seed? Farmers with relatively small farm size, lower education, low access to any credit, lower wealth, higher risk averse behaviour, higher coincidence of consecutive shocks etc? Then, the intervention will be administered on January/February since improved seed will be used for next 'kiremt' season, which starts at May/June.

In both of the treatment cases, it is possible to force people neither to take credit nor buy insurance even though they are randomly allocated to treatment groups and hence, despite randomization, people end up in self-selecting either to take loan or buy insurance. There will be takers and non-takers of both treatments in each treatment PAs. To alleviate this problem, therefore, I use 2SLS estimation technique where credit take-up and credit and insurance take-up are instrumented by discount coupon, financial training and 30 minutes motivational film.

The discount coupon is randomly given to each farmer in each treatment PAs because the discount coupon includes values ranging from 0 to 80% of the loan. The financial training and film are administered to half of the farmers within each treatment PAs. The story of the film is about three farmers.

One is a story of successful farmer who used micro credit and bought insurance; and applying to his farm appropriately and finally got higher yield and become happy. The second farmer who took loan, bought improved seed, applied to his farm, and unfortunately drought happened and lost his harvest, but became 100% safe of his loan obligation due to full insurance he bought ex-ante. He thought what would have happened to him hadn't he bought insurance. As a result, he become happy that he bought insurance. The third farmer face same situation like the second farmer except that he bought only 50% coverage and hence appreciated that he bought insurance for at least 50% of his loan but then become not as happy as that of the second farmer. He, therefore, concluded that he should have bought full insurance scheme because he could have forgiven fully.

I now go to estimation technique of the impact of insurance/credit on technology adoption. The outcome variable is whether the farmer adopts new technology or not. The 2SLS will be:

$Y_i = c + \alpha.Cr_hat_i + \beta.ICr_hat_i + \gamma.X_i + \mu_i \dots \dots \dots (1)$; where insurance (plus credit) denoted by 'ICr' and credit only (denoted by 'Cr') are instrumented using the following equation respectively:

$$ICr_i = c_a + \theta_1.educ_i + \theta_2.dcoupon_i + \theta_3.film_i + \theta_4.X_i + U_i \dots \dots \dots (2a);$$

$$Cr_i = c_b + \eta_1.educ_i + \eta_2.dcoupon_i + \eta_3.film_i + \eta_4.X_i + V_i \dots \dots \dots (2b);$$

$Y_{ij}=1$ if farmer adopted Teff improved seed, $ICr=1$ if farmer bought insurance and took credit, $Cr=1$ if farmer took credit, $educ=1$ if farmer received financial training, $film=1$ if farmer seen motivational film; 0 otherwise; and $dcoupon=0.0, 0.2, 0.4, 0.6, 0.8$; X_i =additional farmer level controls; $\mu_i U_i$ and V_i are well behaved error terms.

In this model, α gives us the impact of credit on technology adoption. The larger α would then imply that giving access to credit only is effective enough to enable farmers to adopt new technology. β gives us the impact of insurance because we control for the impact of credit by

including in our regression equation. The relative difference in the estimated value of these two parameters would suggest as to which intervention is the most important reasons for farmers to adopt or not to adopt new technology-improved seed.

To further estimate the learning effect overtime from others (social learning from neighbours) and learning by doing (from own experience overtime), I set up the following model, which is similar to the one used by (Conley & Udry, 2010). We might say learning from others takes place if previously non-adopting treatment group farmers adopt new technology this year (i.e., took credit/insurance/improved seed), given that they have observed other farmer(s) who took treatment have benefited from it. In addition, farmers could also learn from own experience if, for instance, their decision to increase insurance coverage has increased overtime. For social learning effect within PA, we can estimate the following model. Analogously, we can apply this to learning that takes place across PAs.

$$L_{ijt+1}=1 \text{ if } (A_{ijt+1}=1 \text{ and } \pi_{kjt} > E_{ij}\pi_{kjt} \text{ or } A_{ijt+1}=0 \text{ and } \pi_{kjt} < E_{ij}\pi_{kjt}) | A_{ijt}=0 \dots\dots\dots (a) \text{ and}$$

$L_{ijt+1}=0$ if $(A_{ijt+1}=1 \text{ and } \pi_{kjt} < E_{ij}\pi_{kjt} \text{ or } A_{ijt+1}=0 \text{ and } \pi_{kjt} > E_{ij}\pi_{kjt}) | A_{ijt}=0 \dots\dots\dots (b)$ where L_{ijt+1} is learning by farmer i in PA j at time $t+1$ (next period) and if equal to 1 we say learning takes place; 0 if not. A_{ijt+1} is next period adoption decision of farmer i at PA j and this is equal to 1 if adopted and 0 otherwise. π_{kjt} is this years' realized profit (output) of other farmer k at PA j . $E_{ij}\pi_{kjt}$ is farmer i in PA j 's expectation of profit about other farmer k in PA j .

By rearranging, equations (a) and (b) can be re-written as:

$$L_{ijt+1}=1 \text{ if } A_{ijt+1}=1 \text{ and } \pi_{kjt} - E_{ij}\pi_{kjt} > 0 \text{ or } A_{ijt+1}=0 \text{ and } \pi_{kjt} - E_{ij}\pi_{kjt} < 0 \dots\dots\dots (c) \text{ and}$$

$$L_{ijt+1}=0 \text{ if } A_{ijt+1}=1 \text{ and } \pi_{kjt} - E_{ij}\pi_{kjt} < 0 \text{ or } A_{ijt+1}=0 \text{ and } \pi_{kjt} - E_{ij}\pi_{kjt} > 0 \dots\dots\dots (d)$$

Thus, social learning takes place if previously non-adopting farmer chooses to adopt if his neighbours realized profit is more than his expectation⁶ (or chooses not to adopt if neighbour's realized profit is less than his expectation). Alternatively, if a farmer adopt while neighbour's profit is less than his expectation, or chooses not to adopt while neighbour's profit is greater than his expectation, then a farmer is not learning.

For a farmer to say he is learning from own experience, we can see his adoption decision over time by observing past value of his own profit. This has an important implication because farmers may tend to learn a lot (especially from their own decision) if, based on experience, they perceive future safety net.

$$OL_{ijt+1}=1 \text{ if } (A_{ijt+1}=1 \text{ and } \pi_{ijt} > E_{ij}\pi_{ijt} \text{ or } A_{ijt+1}=0 \text{ and } \pi_{ijt} < E_{ij}\pi_{ijt}) | A_{ijt}=1 \dots\dots\dots (e) \text{ and}$$

$OL_{ijt+1}=0$ if $(A_{ijt+1}=1 \text{ and } \pi_{ijt} < E_{ij}\pi_{ijt} \text{ or } A_{ijt+1}=0 \text{ and } \pi_{ijt} > E_{ij}\pi_{ijt}) | A_{ijt}=1 \dots\dots\dots (f)$ where OL refers to own learning and the rest are similar notations as in (a) and (b).

⁶ Expectation of own profit and other farmer's profit could be known by asking a given farmer to fill in a certain slot say ranging from 0 to 10 of his expectation of own and other farmers' profit using the improved seed.

V. Expected outcomes

After careful implementation of these interventions, it's expected that the research questions will be tested empirically using the methods described earlier. Particularly, this research proposal will propose to address the question of whether which side of the main constraint is stronger challenge for farmers in adopting new technology i.e., lack of access versus lack of insurance (and hence lack of own demand) or even both. In addition, it will also investigate whether poor farmers will feel safe ex-ante in investing in new technology because of the insurance they bought and hence overtime will tend to buy insurance to effectively mitigate the problem of risk. This should be the main issue in poor farmers' context because policy interventions should create some sort of perceived safety net in the eye of the farmers inducing to take risk to be able to adopt new techniques of production which may result in high investment-high return equilibrium. If this is so, poor farmers can move out of poverty, which otherwise could have stayed in low technology-low return poverty trap.

However, the proposed research might encounter some possible problems arising from both the subjects of the intervention as well as the implementation. One challenge could be that it may be difficult to convince government officials to allocate certain PAs to treatment while others not.

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