

# **Interlinking weather index insurance with credit to alleviate market failures and improve agricultural productivity in rural Ethiopia**

A seed grant proposal from the I4 initiative

April, 2010

Principal Investigator:

Craig McIntosh

Associate Professor of Economics

The Regents of the University of California; University of California, San Diego

Graduate School of International Relations and Pacific Studies

University of California, San Diego

9500 Gilman Drive

La Jolla, CA 92093-0519

Telephone (+1) 858 822 1125

Fax (+1) 858 534 3939

Email: [ctmcintosh@ucsd.edu](mailto:ctmcintosh@ucsd.edu)

Co-Investigators:

1. Alexander Sarris

Director, Trade and Markets Division

Food and Agriculture Organization of the United Nations

Via delle Terme di Caracalla

00153 Rome, Italy

Telephone: (+39) 06 5705 4201, (+39) 348 870 5340

Fax: (+39) 06 5705 4495

Email: [alexander.sarris@fao.org](mailto:alexander.sarris@fao.org)

(from August 1, 2010) Professor, Department of Economics, University of Athens, Greece

Department of Economics, University of Athens

8 Pasmazoglou street, Athens 10559, Greece

Tel. (+30) 210 8031571, (+30) 6944 291796

Fax. (+30) 210 8031571

Email: [alekosar@otenet.gr](mailto:alekosar@otenet.gr)

2. Shukri Ahmed

Senior Economist, Trade and Markets Division

Food and Agriculture Organization of the United Nations

Via delle Terme di Caracalla

00153 Rome, Italy

Telephone: (+39) 06 5705 3737

Fax: (+39) 06 5705 4495

Email: [shukri.ahmed@fao.org](mailto:shukri.ahmed@fao.org)

3. René Gommès

Senior Agrometeorologist

Leader Climate Impact Team

Climate, Energy and Tenure Division

Food and Agriculture Organization of the United Nations

Via delle Terme di Caracalla  
00153 Rome, Italy  
Telephone: (+39) 06 5705 4121  
Fax: (+39) 06 57053369  
Email: rene.gommès@fao.org

(from June 1, 2010) Senior Scientist, European Commission (EC) Joint Research Center (JRC), Ispra, Italy

4. PI from Ethiopian University (to be identified during period of seed grant)

5. Others (if needed). To be determined during seed grant phase

**Abstract.**

Smallholder farmers are beset by an interlocking set of market failures. Credit, insurance, and therefore the very use of costly inputs such as fertilizer can remain underdeveloped when only one market failure can be addressed at a time. This pilot proposal seeks funds to develop a fully scaled product innovation in the provision of insured credit. Rather than addressing only a credit constraint (in which case risk rationing can remain a barrier) or insurance failures (which reverse the time-inconsistency problem and ask farmers to pay now in faith of a future benefit), we seek to test a form of insured credit. Through collaboration with Nyala Insurance of Ethiopia, already in its third year of operation as an insurer, we will seek to provide insurance through credit contracts. Local cooperatives that borrow in order to make in-kind loans of fertilizer would be the target population for the product. In years at which an index insurance mechanism indicates a payout, loans will be repaid by the insurance to the cooperatives. The innovation would be evaluated through a randomized controlled trial, and additional price variation will be injected at the individual level in order to study demand elasticities. By implementing an experiment in this new interlinked product we hope to nail down the theoretical impediments to the successful provision of index insurance as well as to pioneer a product that will serve to provide insured credit to one of the world's most vulnerable farming populations.

## **Project Narrative**

### **1. Background and context**

One of the well known problems of African agriculture is its low productivity, despite its acknowledged potential. Agricultural growth in Sub Saharan Africa has been primarily a result of area expansion, rather than productivity growth in crops and livestock. Nevertheless, rates of return to agricultural research have been almost as high in Africa as in other Regions. Well above 25 percent of the cropped area now benefits from improved varieties and hybrid seeds. However, yield gains associated with high yielding varieties are much smaller than in other regions, owing to the heterogeneity of agriculture, the inadequate input and output markets, poor smallholder services, and poor infrastructure. As a consequence the use of irrigation, fertilizers and pesticides is much less than in other regions, sharply limiting the yield gains. Improvements in available technology will continue to lead to lower productivity gains, if services, inputs and output markets are not significantly improved, and rural finance, which is also insufficiently developed, does not expand (Binswanger-Mkhize, 2009). The idea behind this seed grant proposal is to develop a project for implementing and assessing the potential of index insurance to crowd in credit, so as to improve agricultural productivity and incomes among Ethiopian smallholders.

Agriculture is the main sector of the Ethiopian economy. It accounts for a little under 50 percent of the gross domestic product, provides employment for 80 percent of the population, generates about 90 percent of the export earnings and supplies about 70 percent of the country's raw material to secondary activities. Crop production is estimated to contribute on average around 60 percent, livestock accounts for around 27 percent and forestry and other subsectors around 13 percent of the total agricultural value. The livelihood of 85 percent of the population is dependent on renewable natural resources. Over 95 percent of the cultivated land is under small-holder peasant agriculture. Low input use, and degradation of the natural resources resulting from the cumulative impact of the actions of these small land users has resulted in the exposure of small-holders to food insecurity and generally, limited agricultural growth. Any prospects of growth in Ethiopia must deal with improving smallholder farm productivity.

Most of Ethiopian agricultural production takes place under rainfed conditions and is subject to considerable weather variations. Furthermore, the use of improved inputs, such as fertiliser and improved seeds are very low. According to the Ethiopian Rural Household Survey 1994-99 (ERHS) only around half of wheat farmers use fertilizer and less than 40 percent of the other permanent crop farmers do so. The overwhelming reason for low use of modern inputs is that they are considered too expensive or that there is lack of cash (op. cit.). The high cost of credit adds to the cost of fertilizer. According to the ERHS, in 1999 71 percent of those purchasing fertilizer used formal seasonal credit, provided via parastatals, and the implicit median interest rate was calculated at 57 percent (Dercon and Christiaensen, 2009). However, as Dercon and Christiaensen showed, fertilizer use, while profitable, is risky. They showed that the lack of insurance leads to low input use and inefficient production choices. These results provide the motivation for the proposed project.

### **2. Conceptual framework and hypotheses to be tested**

Risk avoidance in the face of incomplete insurance may be key in understanding limited fertiliser use (Lamb, 2003). Uninsured risk can directly distort economic decisions on the use and accumulation of assets. In addition, risk can undercut the development of rural financial intermediation and credit institutions, creating a second round of indirect effects of risk on innovation. Modern input use, including fertiliser, is an important determinant of agricultural productivity, and continuing low agricultural productivity is an important contributor to

poverty persistence especially in agriculture based countries such as in Sub Saharan Africa (Christiaensen and Demery, 2007). If so, there would be substantial synergies in complementing interventions that foster access to productive credit with interventions that help households cope with shocks (e.g. insurance).

Despite their compelling logic, stand-alone weather index insurance contracts that transfer risk from smallholder farmers and pastoralists have met with sometimes indifferent demand and low uptake by the intended beneficiary populations (see for instance the recent studies by Cole, et. al. (2009) and Gine and Yang (2008)). These results confound the increasing evidence that risk plays an important role in the creation and perpetuation of rural poverty, that demands further efforts to solve this problem. Conventional economic theory suggests that individuals are averse to fluctuations in their levels of consumption and that therefore they will be willing to trade off some consumption on average in return for lower variation in consumption. While this standard perspective is unassailable on its own grounds, it overlooks the mass of evidence that indicates that risk is costly for reasons that run much deeper than sporadic fluctuations in families' levels of consumption. Economic behaviour of poor rural households in the presence of the many risks faced has evolved into production and institutional structures which maybe robust and not easy to change in response to any new and untried intervention, especially interventions that may affect the underlying riskiness of households' income and consumption structures.

The link of the provision of insurance and higher fertiliser uptake has been examined recently by Hill and Viceisza (2009) in an experimental setting in Ethiopia. They examined how smallholders' decisions to purchase fertiliser would be affected by the availability of weather index insurance. They found some evidence that fertiliser purchases were positively affected by the availability of index insurance. Their experimental design, however, did not consider the issue of whether or not the availability of credit would influence the uptake of fertiliser.

The absence of productive credit is admittedly one of the main reasons for the low use of improved inputs and hence higher productivity among Ethiopian and also African rural smallholders. Many studies have found that small farmers in developing countries are credit constrained and as a consequence use low amounts of modern purchased inputs (for surveys of the extensive literature on rural credit markets and/or their absence in developing countries see Besley, 1994 and Conning and Udry, 2007 among many others). The absence of credit can come from both the supply side as well as the demand side. On the supply side, banks may find it very risky and expensive to provide credit to rural smallholders, thus rationing the supply of credit or making available contracts that maybe too expensive or too demanding on collateral. On the demand side, apart from the situations where farmers may not have adequate collateral, even in situations where credit is available farmers may find it too risky to borrow (Boucher, Carter and Guirkinger, 2008).

In this context the idea proposed for research and a pilot application here involves the interlinkage (namely the combination or joint offer) of rural credit with weather index insurance. Apart from the weather risk that farmers are very well aware of, the assumption of a loan obligation by the farmers, albeit may lead to higher average income under normal weather, nevertheless creates additional risk. This risk arises because a case of a bad state of nature may result in very low welfare as the farmer will have to deal not only with the resulting low farm income, but also with the added obligation to repay the loan. The risk of non-repayment in such a state may create an indebtedness and obligation that may persist over time, thus creating a poverty trap, and hence may make it highly unattractive and risky for the farmer to take the loan. The idea and hypothesis to be tested is that the simultaneous provision of index weather insurance in conjunction with credit, will make it much less risky and hence

more attractive for the farmer to use modern inputs and hence improve overall productivity and income. On the supply side, the hypothesis to be tested is that the simultaneous provision of weather index insurance along with credit, will lessen the portfolio risk of the credit extending institution, and hence will render the interest rate offered (or the collateral) lower than what it otherwise might be. Hence this may enhance the market for credit on the supply side.

From a production possibility perspective, there is considerable potential in Ethiopia, as the bumper year of 2004 (when a modern input package was delivered under the Sasakawa initiative) manifested. However, as indicated above, Ethiopia is a country where rural credit markets are almost totally absent, save for the inputs provided by the cooperatives and guaranteed by the government through advances by the government owned banks. Hence productivity is low. However, this structure came under severe test in 2009, when bad weather forced many farmers to not pay back their input loan costs, with the consequence that cooperatives built large arrears. As a consequence in 2010 the Government of Ethiopia (GOE) decided that all inputs provided through cooperatives would be sold to farmers for cash. During an exploratory visit by two of the FAO principal investigators (PIs) to Ethiopia in March 2010, it became evident that this policy may lead to no or very low use of fertiliser and improved seeds, with a consequence that the whole production in the country may suffer in 2010. At the same time, there appeared to be considerable interest for index insurance by farmers, as the insurance contract offered in that same year by Nyala Insurance, the only insurance company in Ethiopia (a private company) that has offered weather insurance to farmers to date, resulted in low or no losses by those who insured, and this information seems to have been spread quite widely in rural areas. This background renders the Ethiopian case not only attractive but a fertile ground for testing whether rural credit and input markets can be jump started or at least deepened through the provision of index insurance.

The mechanism of when and how index insurance can enhance the functioning of agricultural credit markets and enhance farmers' expected income even as it reduces the variance of income has been examined recently by Carter et. al. (2010). Drawing on the market interlinkage model of Braverman and Stiglitz (1982), the paper explored how index insurance can function as a mechanism that modifies the liability or default clause that farmers face in choosing their production technology. It was shown that the more favourable implicit default that exists under index insurance creates a type of positive moral hazard as it crowds in greater risk taking and moves producers towards a socially optimal choice of technology.

### **3. Research questions**

Given the above background, the envisioned project will address the following research questions, which may need to be modified in the course of the seed grant proposal phase.

3.1 Does the simultaneous provision of index weather insurance in conjunction with credit make it less risky and hence more attractive for the farmer to use modern inputs and hence improve overall productivity and income?

3.2 Does the simultaneous provision of weather index insurance along with credit lessen the portfolio risk of the credit extending institution, and lead to increased lending to farmers?

3.3 How well do the insurance and credit recipients need to be informed about the details of the insurance when it is bundled with the credit contract? Does the insurance component need to be pushed explicitly to the borrower, or is it sufficient to provide it to the lender?

3.4 What is the optimal design of index insurance to minimize basis risk and at the same time extend provision of the contracts to as large a group of farmers as possible around a given weather station.

3.5 What is the best mechanism for delivery of the interlinked credit and insurance contracts?

#### **4. Preliminary strategy and priorities in developing the index insurance contracts**

The preliminary strategy for developing the index insurance contracts and their interlinkage with the financing mechanisms is the following. The first thing that will be assessed is the overall institutional framework of credit and insurance provision in Ethiopia and especially in the areas or the project intervention, in order to design the contracts and interventions appropriately. In Ethiopia the current institutional structure in the rural sector involves considerable involvement of the GOE in all aspects of finance, and input provision, but a mixed public private system has emerged. While the main rural finance institutions are the two public banks, there are a variety of microfinance institutions that have emerged, and which operate alongside the larger and more formal financial institutions. Furthermore, there are several private banks, some of whom also lend to the agricultural sector. The first objective, which will be dealt in the duration of the seed grant, is to assess the most appropriate rural financial institution with which to collaborate in the interlinkage of weather insurance with credit.

Concerning insurance, Nyala is the first, and currently the only, insurance company in Ethiopia offering agricultural insurance. There are two other public insurance companies, and several other private ones, but as Nyala has been the pioneer in providing agricultural insurance they are a natural partner. As Nyala Insurance has already started offering weather insurance to high potential but underfinanced areas in Ethiopia, the logical target areas and households will also be in these areas. From a first assessment, these areas are located in a radius of about 250 km from the capital Addis Ababa, and comprise a large number of agricultural households. The exact locations of project intervention will be determined during the period of the seed grant, and will depend on a variety of criteria, such as the density and nature of farmers living there, the potential for upscaling, the nature of risks faced, the institutional setup, etc.

Similarly, a partnership will be sought with a local university, both in order to collaborate on the baseline survey and analysis, but also to build local technical capacity to expand the project activities. There are two such candidate universities, both located within the radius of envisioned interventions, that will be contacted during the seed grant phase.

In terms of developing the appropriate contract, there is a need to assess the household structures and risks involved in order to design index insurance contracts with the minimum basis risk. This will be done in the early implementation phase of an eventual project, through a baseline survey of the areas and the households targeted. The baseline survey will also be used to design an evaluation, as laid out in Section 5. A preliminary strategy on considerations to follow in order to set up an appropriate evaluation design is indicated below. During the seed grant phase, the various data sources available will be assessed, in order to plan the scale and resources required for the baseline survey.

Needless to say, one of the key aspects of the index insurance contract will be the design of the index itself. Nyala Insurance has been using in its first insurance contracts a contract which triggers payments based on cumulative rainfall measured at one of the official rainfall stations located in the area of contract offers. These stations, albeit numerous (there are about 600 such stations in the country, monitored by the Ethiopian National Meteorological Agency) are rather crude, and considerable attention will need to be paid by the project team

on whether they offer sufficient measurements for the project needs, or whether they need to be supplemented with new automatic stations. The construction of the weather indices will, however seek to exploit other methodologies and data sources, as well as projects which may be available and operational in Ethiopia (on this see below)

The weather index envisioned for this project will be linked to a detailed agroecological zoning (AEZ) in order that the production pattern of those insured match the characteristics of the AEZ for a specific cropping pattern. The index designed will allow for the reduction of yields under climatic variations of crops in the AEZ, and will depend on sowing dates for a specific area having a specific type of soil, etc.

The proposed project clearly relates to priority 1 identified in the RfP of the I4 (interlinking index insurance with accumulation and income growth). It aims at exploring not only the demand side of this interlinkage, namely how farmers will react and change production structures and input use, when offered insurance combined with seasonal credit, but also how rural financial institutions which are engaged in agricultural finance, may react to the availability of weather index insurance and use it to expand their loan portfolio in areas currently underfunded and underemphasized in their activities.

The proposal also relates to priorities 2 (livelihood focused contract design), 3 (insuring households versus intermediate institutions), 5 (behavioural economic insights), and 6 (creating contractual understanding and trust). Concerning priority 2 the proposed project will try use micro data in order to tailor the most feasible contract options, and will try to explore the use of hybrid and flexible contracts to make them robust to an array of livelihood activities. Concerning priority 3 it is clear from the proposal that the contracts designed will be made so as to be attractive to the lenders as well as the households. On priority 5, the main behavioural issue to be explored relates to research issue 3.3 above. In other words whether households need to be informed about all the details of an interlinked contract, in the context of severe constraints in the availability of markets for either credit or insurance is an interesting and important issue. Furthermore, the project may link with research on alternative ways to view decision making under uncertainty.

#### **4. Partnerships with the private sector and other institutions**

The research team has already ensured the support of and partnership with Nyala Insurance, one of the private insurance companies in Ethiopia, and the only one currently engaged in agricultural insurance in Ethiopia, and which is looking to expanding its weather index insurance business in a variety of dimensions. The second key institution will be the financial institution which will be the credit provider of the interlinked contract. Several such institutions were approached during the preliminary visit, and several possibilities have been identified, and will be explored in the course of the seed grant. As mentioned above there is a variety of financial institutions linked to the rural sector in Ethiopia, and the one that will be selected is the one that seems closest to the farmers, has the financial and technical capacity to implement the project ideas, and has the possibility to scale up or expand the use of the contracts to other areas of Ethiopia.

In addition to Nyala and the financial institution, the following other partnerships are envisioned. First the team will make sure that the cooperatives and cooperative unions, through which most farmers operate and obtain their inputs, are partners and are involved in the project design and delivery. Initial contacts indicated enthusiasm on the part of these partners to the idea and concept of the project. Second the GOE must be involved in the context of Ethiopia in order for the project not to face policies what may work against the logic of the project. For instance credit related policies and policies vis a vis input markets and output markets maybe crucial in this context, and the GOE needs to be involved. A



preliminary visit indicated that the GOE is very interested in this project idea, as it views it as an idea with considerable potential, but which needs to be tested before wider application.

The team will partner with the Ethiopian National Meteorological Agency (NMA) so as to work within their existing system and incorporate whatever index design is proposed into their operational strategy. Members of the team have already been collaborating with NMA on a variety of projects (see below). A third partner mentioned above will be the department of economics or agricultural of one of the main universities in Ethiopia.

Needless to say that FAO through the two Divisions participating (the Trade and Markets And the Climate, Energy and Tenure Divisions) is a key institution interested to expand its analytical and capacity building activities in this area in Ethiopia and elsewhere. FAO already has implemented and currently implements several related projects in Ethiopia relating to early warning, and weather related food security information systems, which relate considerably to the ideas and requirements of this project. Several of the PIs in this proposal have been involved in such projects, and there will be considerable relevant synergies and complementarities that will be exploited.

### **5. Preliminary impact evaluation strategy**

For the envisioned project we intend to conduct a randomized evaluation of the new financial product. During the seed grant period, we will elaborate in detail on the nature of this evaluation in conjunction with the realities in the target areas.

The design of the evaluation must consider both the voluntary nature of credit/insurance decisions and the multi-level decision making problem between the provider, the cooperative, and the farming household. Our proposed design would seek to measure the intention-to-treat effect in a sample of cooperatives offered the product. Surveys would be conducted both at the cooperative management level (institutional survey), as well as the household and plot level, within a random sample of cooperative members. Using information from pilot surveys to be conducted during the seed grant phase, we may choose to oversample cooperatives deemed likely to take up the product.

First for sampling at the cooperative level, we will select the study organizations. A cooperative-level baseline survey can be conducted, and stratifying from this information we create treatment and control groups of cooperatives. A sample of member households will be chosen from within the study cooperatives, and we will apply a baseline survey. The survey instrument would collect data on household welfare, pre-existing contract use, and agricultural practices. This design will give the intention-to-treat on cooperative member households in the study frame. We anticipate high intra-cluster correlations among members of a given cooperative, and so the power of the experiment will be driven more strongly by the number of clusters than the sample per cluster. We therefore require a large experiment, which makes it crucial to collaborate with institutions such as Nyala and the cooperative unions that are already working at scale on the ground.

Our other strategy for working around the high anticipated clustering is to inject individual variation into product pricing. Within a random half of the treatment cooperatives we will additionally pursue a ‘coupon’ strategy, having a public drawing in which cooperative members choose coupons that decrease the price of the insured credit. This coupon experiment gives us power at the household level, and to the extent that the coupon is paid in the future (as a discount on the future interest rate if the loan is repaid), represents a promising potential instrument for short-term credit impacts.

A critical point for any evaluation of insurance products is the state-dependency of the post-treatment treatment/control differential. In a trivial way, those who purchased insurance are

better off than those who didn't if the insurance triggered, and not otherwise. The core outcomes for the study should therefore be centered on the *decisions* taken by the agents covered by insured credit versus those not offered, rather than on the *outcomes* that obtained once the state has been revealed. We intend the research to be product-focused in the sense that we will track outcomes such as rates of return in the lending institution, product uptake continuation rates, and price elasticities of demand (using the coupon experiment). In this way we hope to both field and to field test a novel financial contract.

## References.

- Besley, T. (1994), "Savings, Credit and Insurance", in J. Behrman, and T.N. Srinivasan (editors) *Handbook of Development Economics*, vol. III, Elsevier-Science, Amsterdam, pp. 2123-2207
- Binswanger-Mkhize H.P. (2009)", "Challenges and Opportunities for African Agriculture and Food Security: High Food Prices, Climate Change, Population Growth, and HIV and AIDS" A report prepared for the Food and Agricultural Organization of the United Nations.
- Boucher, S.R., M.R. Carter, and C. Guirkinger (2008), "Risk rationing and wealth effects in credit markets: Theory and implications for agricultural development", *American Journal of Agricultural Economics* 90(2), pp. 409-423
- Braverman, A. and J.E. Stiglitz. (1982). "Sharecropping and the Interlinking of Agrarian Markets." *The American Economic Review*. 72 (4):695-715
- Carter, M.R. (2008), "Inducing innovation: Risk instruments for solving the conundrum of rural finance", keynote paper presented at the 6<sup>th</sup> Annual Conference of the Agence Francaise de Developpement, and the European Development Network, Paris November 12.
- Carter, M. R., A. Sarris, and L. Cheng (2010), "The economics of interlinking credit with insurance: Part 1. the demand side", paper presented at the Scientific Committee Meeting of the Index Insurance Innovation Initiative (I4), Rome, 15-16 January 2010.
- Christiaensen, L., and L. Demery (2007). *Down to Earth: Agriculture and Poverty Reduction in Africa*, Directions in Development, World Bank: Washington D.C.
- Cole, S., X. Gine, J. Tobacman, P. Topalova, R. Townsend, and J. Vickery (2009), "Barriers to household risk management: Evidence from India", Harvard Business School Finance Working Paper No 09-116, Federal Reserve Bank of New York Staff Report No 373.
- Conning, J. and C. Udry (2007), "Rural financial markets in developing countries", in R. Evenson and P. Pingali (editors), *Handbook of Agricultural Economics*, vol. 3, Agricultural Development: Farmers, farm production and farm markets, North-Holland, pp. 2857-2908.
- Dercon, S. and L. Christiaensen (2009), "Consumption risk, technology adoption and poverty traps: evidence from Ethiopia", ESRC World Economy and Finance Research Programme, Birkbeck, University of London, WEF Working Paper No 0035
- Gine, X. and Yang, D. (2009), "Insurance, credit, and technology adoption: Field experimental evidence from Malawi", *Journal of Development Economics* 89 (2009), pp. 1-11.
- Hill, R. V., and A. Viceisza (2009), "An experiment on the impact of weather shocks and insurance on risky investment", IFPRI unpublished paper, July.
- Lamb, R., (2003), "Fertiliser Use, Risk and Off-Farm Labor Markets in the Semi-Arid Tropics of India, *American Journal of Agricultural Economics*, 85-2: pp. 359-371.