

<b>Institution:</b> Imperial College London		
<b>Unit of Assessment:</b> 14 – Geography and Environmental Studies		
<b>Title of case study:</b> C14-4 Research that has secured supply chains for Africa's smallholder farmers		
<b>Period when the underpinning research was undertaken:</b> 2007-2018		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b> Prof Sir Gordon Conway  Dr Zen Makuch Dr Enrico Biffis  Dr Erik Chavez	<b>Role(s) (e.g. job title):</b> Chair in International Development Reader Associate Professor of Actuarial Finance Research Fellow	<b>Period(s) employed by submitting HEI:</b> GC – 2005 – present ZM – 1996 – present EC – 2013 – present  EB – 2013 – present
<b>Period when the claimed impact occurred:</b> 1 <sup>st</sup> August 2013 – 31 <sup>st</sup> December 2020		
<b>Is this case study continued from a case study submitted in 2014? N</b>		
<b>1. Summary of the impact</b> (indicative maximum 100 words)		
<p>Research by Imperial College's Conway and colleagues identified critical climate-driven weaknesses in the agricultural supply chain for smallholder farmers in sub-Saharan Africa. Chavez and Biffis developed new financial instruments and Biffis, Makuch and Chavez negotiated and piloted an innovative, multi-stakeholder insurance and loan de-risking programme, which directly benefitted 50,000 Tanzanian smallholder maize farmers, field workers and their families (400,000 in all). As a result, 88% of these farmers had a bank loan for the first time, receiving \$13 million in loans and \$5 million in insurance coverage. Biffis, Makuch and Chavez introduced this solution to financial stakeholders, generating projects that extended the programme to Tanzania, Uganda, Ghana and Zimbabwe and to new commodities, involving enduring commitments from two major reinsurers, three national banks and multilateral funders.</p>		
<b>2. Underpinning research</b> (indicative maximum 500 words)		
<p>Conway began research on building resilient and robust agri-food systems in sub-Saharan Africa in the early 2000s, based on new forms of integrated agricultural practice. As such, he was one of the pioneers of ecologically sustainable agriculture focused on building productivity using affordable technology within agricultural supply chains (work summarised in [1, 2]). Over the period from 2000 to 2015, Conway and colleagues' policy analyses showed how social, legal and economic mechanisms could be redesigned to improve productivity, integrated pest and nutrient management and resilience to extreme weather events [1, 3, 4]. In 2015, Conway, Chavez and a team at Imperial College showed the vicious cycle into which smallholder farmers are trapped by lack of access to credit and the resulting inability to adopt efficient production technologies [4]. Chavez, Biffis, Conway, Makuch and colleagues improved the models for weather-driven crop losses, financial incentives and re-insurance options and then, importantly, ensured their impact by negotiating multi-stakeholder financial de-risking arrangements. The insured weather and climate risks were initially modelled based on research undertaken by Chavez supervised by Conway and Makuch following Conway's research connecting weather and climate change to food security [4].</p> <p>Building on their earlier developments at Imperial College on general insurance risk products [5], Biffis and Chavez developed a weather-within-climate model that would predict the impact of extreme weather events across a range of agricultural settings and hydro-ecological situations.</p>		

Building on their earlier developments at Imperial College on general insurance risk products [5], Biffis and Chavez identified a need for a weather-within-climate model which would predict the impact of extreme weather events across a range of agricultural settings and hydro-ecological situations. Given the limitations of global climate models to simulate local hydro-meteorological variability (e.g. local daily rainfall, or maximum temperatures), work undertaken by the WINnERS Project team (see below) in 2016 and 2017 drew on historical records to parameterise distributions of specific hydro-meteorological variables. The researchers used a semi-supervised learning approach coupled with a process-based model to map crop productivity and its susceptibility to extreme weather events [6].

Biffis, Chavez, Makuch and WINnERS Project colleagues adapted the modelling framework to quantify the risk of crop loss due to weather variability under a range of climate change scenarios and designed and implemented risk transfer mechanism which could be used by banks and insurance companies in sub-Saharan Africa and other jurisdictions to estimate the exposure to risk of individual farmers during a specific cropping season, providing a framework for de-risking the agriculture portfolio of banks and therefore facilitating improved lending conditions for farmers. Chavez, Makuch and Biffis designed and implemented novel loan, insurance, re-insurance, legal and commercial contractual strategies to manage and share crop loss risk along the value chains, from farmers through insurance companies to buyers. The insurance policy launched in Tanzania protects farmer-level needs, while being managed as a country-level risk transfer instrument, is possible because of the technological innovation based on machine learning used to design the policy, which provides unrestricted upscaling capability. It also embeds the lower risk profiles (and therefore lower premiums) resulting from the use of more sustainable agricultural inputs (seeds, fertilisers, herbicides) that were not previously used.

### 3. References to the research (indicative maximum of six references)

- [1] Conway, G. (2007). A doubly Green Revolution: ecology and food production. In, *Theoretical ecology: principles and applications*, May, R.M., and McLean, A.R. (eds). Chapter 12, p. 158-171. Oxford University Press, Oxford. 978-0199209996
- [2] Conway, G., Badiane, O. and Glatzel, K. (2018). *Food for all of Africa*. Cornell University Press, Ithica and London. ISBN13: 978-1501744426
- [3] Collier, P., Conway, G. and Venables, T. (2008). Climate change and Africa. *Oxford Review of Economic Policy* 24(2), 337-353. <https://doi.org/10.1093/oxrep/grn019>
- [4] Chavez E, Conway G, Ghil M, Sadler M. (2015). An end-to-end assessment of extreme weather impacts on food security. *Nature Climate Change* 5, 997-1001. <https://doi.org/10.1038/nclimate2747>
- [5] Biffis E, Chavez E. (2014). Tail risk in commercial property insurance. *Risks* 29, 393-410. <https://doi.org/10.3390/risks2040393>
- [6] Biffis E, Chavez E. (2017). Satellite data and machine learning for weather risk management and food security. *Risk Analysis* 37, 1508-1521. <https://doi.org/10.1111/risa.12847>

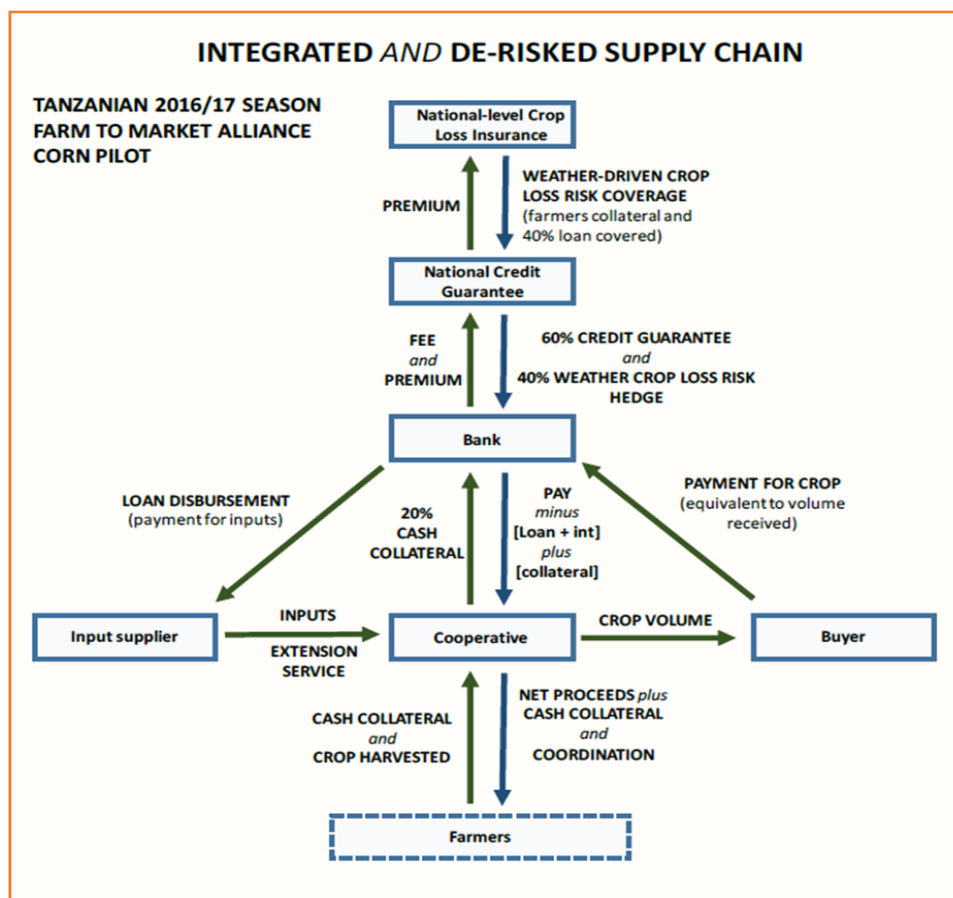
### 4. Details of the impact (indicative maximum 750 words)

The 2011 UN Global Hidden Hunger Index is designed to measure and track hunger comprehensively. Of the 20 countries with the highest index scores, 18 were in sub-Saharan Africa [A]. The region is susceptible to inherent agricultural supply chain nutritional deficiencies and to escalating climate variability [1-3].

Working with Biffis and Makuch, researchers Chavez and Conway [4] identified a critical gap which meant that bank lending decisions and insurance policies did not serve the needs of many smallholders in the economically marginal and climate exposed sub-Saharan Africa [B]. Agricultural insurance in emerging economies suffers from poor data quality, limited claims experience, high monitoring costs and low uptake [4, B].

Building upon Conway's foundational research in integrated agricultural practice for resilient food systems and supply chains for sub-Saharan Africa [1,2], Chavez extended his PhD research and

with Makuch, secured the WINnERS Project [C]. This project implemented a parametric insurance mechanism, integrating agricultural science and economics with weather-related risk insurance, which together with the loan and institutional arrangements make up the basis for this Impact Case Study [D]. The structures that provided the pathway for impact are represented in the following WINnERS Project diagram:



In sub-Saharan Africa, banks and insurers, are powerful players in the food system. The integration of satellite datasets, models, financial schemes and stakeholder engagement enabled an evidence-based risk instrument which lending institutions and insurance companies could use to justify changes in lending behaviour [6]. By bundling farm loans with WINnERS’ national crop loss insurance mechanism, the value of insurance could be recognized at a bank’s portfolio level, resulting in lower collateral requirements, thus increasing the credit worthiness of smallholder farmers [E]. The insurance policy launched in Tanzania was the first to protect farmer-level needs, while being managed as a country-level risk transfer instrument.

Chavez, Makuch and Biffis worked closely with private sector institutions to form novel agreements, negotiating under the auspices of the EU’s Climate KIC programme, with each of the World Food Programme, CRDB Bank, NMB Bank, Akiba Bank, Munich Re and Private Agricultural Sector Support (PASS), a Tanzanian Trust offering credit guarantees on agribusiness loans and promoting improved local agricultural practices [F]. Willis Towers Watson conducted due diligence of the WINnERS project, noting that it would unlock a key barrier to insurance and loans for African smallholder farmers [D, E]. Munich Re and Tanzania Re, together with the WINnERS Project (Chavez, Biffis and Makuch), brought to market a cost-effective solution (35% cheaper than the closest alternative) [G].

Jubilee Insurance brokered the insurance policy in Tanzania. Three national banks placed the insurance policy in their loan programmes and PASS offered a partial guarantee for the loans. The pilots resulted in a total of \$13m bank input loans and \$5m of insurance coverage [H]. The decision

in 2017 by MunichRe to issue a country-wide reinsurance policy for Tanzania was directly informed by Willis Towers Watson [E]. The Global Agricultural Risk Lead for MunichRe, notes in their letter that the WINnERS team's innovations, '*...tailoring insurance prices to the risk profile induced by the production technology adopted yields greater product customization, including the ability to promote climate resilient crop production*' [G].

WINnERS Pilot team members together with the World Food Programme and the World Bank, quantified the impact of the two pilots carried out during 2015-17. They estimated that a total of 50,000 Tanzanian households and nearly 400,000 individuals involved in agricultural production benefited [I]. The World Bank noted that 88% of households gained access to finance for the first time [I]. By accessing funding based on the purchase of better agricultural inputs (and associated extension services), smallholder farmers were able to double their average yield [J]. As smallholders had an average farm size of only 2.1 hectares, the boosted yield was transformational, pushing production levels considerably above the survival (and hence default) line, and allowing part of the crop proceeds to be saved and re-invested [D, H]. PASS notes in their letter, "*The presence of both insurance and credit guarantee delivered sizeable credit enhancement to smallholder farmers usually excluded from the financial system...*" [K].

The success of these ventures led to three new investments developed by Chavez, Makuch and Biffis [D]. The EU Climate KIC's second Imperial College parametric insurance investment (Arise Project €3.2 million) builds on the WINnERS approach, deepening farm-level resilience and sustainability responses. The second, funded by the New Venture Fund, deploys the de-risking solutions developed by the Imperial team to assist women farmers to access finance, promoting gender inclusion. The third project, funded by the African Development Bank, extends the de-risking solution to a larger pool of banks in Tanzania, Ghana, Uganda, Zimbabwe [L], providing financial and climate de-risking for up to 1.6 million maize and sunflower farmers. Jubilee Insurance states that Imperial's "*novel up-scalable insurance scheme has allowed the company to expand its offering to smallholder farmers by 70% year-on-year and to reach a much larger pool of prospective customers, given the involvement in agricultural production of entire households and villages*" [F].

##### 5. Sources to corroborate the impact (indicative maximum of 10 references)

- [A] World Bank (2010). Economics of adaptation to climate change. Synthesis Report 70267. World Bank, Washington, DC. ([Archived here](#))
- [B] Conway, G., Badiane, O., Glatzel, K., Chavez, E. and Singh, S. (2017). Creating resilient value chains for small holder farmers. Chapter 5 in Africa Agriculture Status Report. <http://www.ifpri.org/publication/creating-resilient-value-chains-smallholder-farmers> ([Archived here](#))
- [C] Weather Index-based Risk Services (WINnERS) website: <http://www.winners-project.org/> ([Archived here](#)) & <https://www.climate-kic.org/success-stories/winners/> ([Archived here](#)); see also <https://www.imperial.ac.uk/news/177074/imperial-experts-launch-climate-friendly-food-production/> ([Archived here](#))
- [D] Letter from ClimateKIC International Programmes Lead, which includes WINnERS Project-derived additional funding for Tanzania, Uganda, Ghana and Zimbabwe [EU Climate KIC Arise Project €3.2 million, WINnERS Diversity Programme New Venture Fund (\$550k) and African Development Bank (\$980k)].
- [E] Letter from Managing Director, Risk & Analytics, Willis Towers Watson (insurer).
- [F] Letter from Jubilee Insurance's Head of Underwriting and Head of Agribusiness
- [G] Letter from Global Agricultural Risk Lead, MunichRe
- [H] Letter from the Director of Credit, CRDB Bank PLC
- [I] Vandercasteleen, J., and L. Christiaensen (2018). Baseline report: Smallholder impact evaluation of maize value chain development in Tanzania. The World Bank Group and Let's Work Tanzania. ([Archived here](#))
- [J] Buffett, H.W., Chavez, E. and Conway, G. (2016) 'How partnerships can create resilient food supply chains', Aspen Journal of Ideas, Aspen Institute. Online. Available at:

<https://www.aspeninstitute.org/aspens-journal-of-ideas/partnerships-create-resilient-food-supply-chains/> (Archived [here](#))

[K] Letter from the PASS Managing Director

[L] Letter from the Minister of State for International Affairs, Uganda.