# Adapting Food Production to Climate Change: An Inclusive Approach

**Cristian Timmermann[1] and Georges F. Félix[2]**

Instituto de Investigaciones Filosóficas, Universidad Nacional Autónoma de México
Farming Systems Ecology, Wageningen University

cristian.timmermann@gmail.com

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# Adapting Food Production to Climate Change: An Inclusive Approach

Cristian Timmermann[1] and Georges F. Félix[2]

[1]Universidad Nacional Autónoma de México
[2]Wageningen University

It has become common knowledge that major efforts will have to be undertaken to adapt agriculture to climate change (Cline 2007). To address the human right to adequate food in the upcoming years and decades, policy-makers have assigned the globalized knowledge economy the task to deliver the necessary technological solutions. In international discourse, the role of the biotechnology industry is perceived as vital, leaving little or only auxiliary roles to other knowledge-intensive farming styles (cf. Tittonell 2014). Concentrating on biotechnological fixes as the essential strategy to adapt food production to climate change ignores the fact that climate change affects not only the right to food but also other human rights that are variously related to food production and availability, such as the right to self-determination and the right to participate in scientific and cultural life.

It is important to remember that climate change will have its harshest effects on agriculture in the already food insecure and mostly financial resource-poor tropical regions of the world. A food production system that heavily relies on imported inputs creates severe dependency and increases vulnerability for societies who are unable to offer sufficient resources in exchange. In a world of extreme inequality, a strong reliance on biotechnological solutions to adapt our food system to climate change may negatively affect people's self-determination, especially in regard to pursuing their economic, social and cultural development (cf. both International Covenants 1966, art. 1). Due to the little and irregular disposable income smallholders possess and the extreme poverty faced by an overwhelming majority of the world population, we have a moral obligation to focus on innovations that can be reproduced with spare local parts and as little external inputs as possible to assure that these reach the neediest (cf. Gupta 2010).

Failing to include the inventiveness and scientific capacities from people all over the world to adapt to climate change goes against the human right to participate in cultural and scientific life (Timmermann 2014). Article 27 of the Universal Declaration of Human Rights (1948) does not only demand access to the benefits of scientific advancements, but also stresses the importance of enabling participation in scientific and cultural endeavours. Agriculture as a scientific and cultural practice of day-to-day importance is a central element allowing life in society. The possibility to significantly include farmers' knowledge and know-how is strongly dependent on the type of agricultural research we concentrate in around the world. An agricultural innovation system that values small-scale incremental innovation as much as break-through science does a far better job in valuing contributions coming from the over 2.5 billion smallholders worldwide.

Fortunately, already a lot of work has been done in the field of agroecology to allow farms to be more resilient to climate change and to serve as larger carbon sinks (Altieri et al. 2015). We will discuss briefly three case studies from the tropics that show how farming families have come up with their own innovations to counter climatic variability while maintaining crop production.

**Case 1. 'Slash-and-mulch' of native evergreen woody shrubs in West Africa** (Félix 2015).

In semi-arid Burkina Faso, population growth in rural areas has increased the demand for farming lands. Whereas fallows were historically a practice to replenish soil fertility, nowadays farming families practice continued cultivation, with serious depletion of soil fertility. A known fact is that soils in the area are naturally poor in nutrients and organic matter contents. Although manure and crop residues are organic materials that may be used to amend soils, their availability is often not sufficient to be applied on all fields. To counter further degradation on distant fields, farmers manage naturally-occurring woody vegetation, in particular native woody shrubs. The presence of shrubs on the fields during dry seasons benefits the crops by creating 'fertility islands' and at the same time acting as carbon sinks. Prior to cropping season, farmers prune these shrubs, using the biomass (leaves and branches) as a soil amendment on degraded fields. This allows the restoration of degraded lands, resulting in an increase of sorghum yields. The physical, chemical, and biological processes governing woody mulch practice benefit crop growth and productivity, even with low applications of woody biomass. The mulch not only maintains soil moisture during dry spells, it also increases soil organic matter content and activates termite activity, thus leading to increased soil porosity, enhanced infiltration capacity, and increased carbon stocks. In this manner, soil productive capacity can be restored on marginal lands, through smart and ecologically-sound ways of learning how to produce food from nature.

**Case 2. Shade trees in coffee plantations of Central America** (Perfecto et al. 2005)

Using woody components in agricultural production is in fact a matter of plot design. Planned biodiversity (e.g. trees) may lead to increased ecosystem services (e.g. pest suppression) as a result of the provision of high quality habitat for unintended biodiversity (e.g. birds and beneficial insects). In the humid tropics, the example of shaded coffee in Central America is remarkable. Coffee is a woody shrub that grows well and yields best under the shade of sparse canopies. This is how coffee is traditionally grown in these areas. However, recent trends in coffee production seem to point towards the direction of yield maximisation by eliminating shade, exposing the shrubs to full sun. As the production system is simplified, the contribution to ecosystem services derived from planned biodiversity disappears. On-going research in Chiapas (Mexico) and Turrialba (Costa Rica) has proved that growing coffee under the shade of trees may decrease productivity slightly, in comparison to non-shaded coffee. Nevertheless, shade trees increase coffee resilience and stability in the face of climate uncertainty, especially during dry spells. Moreover, shade trees may be sold as timber, if managed for that purpose, in order to contribute to family revenue. Increasing complexity by diversifying the agricultural system seems to be a cornerstone of coffee production adaptation to climate change. Trade-offs exist, of course, between the *amount* of biodiversity and the acceptable yields, calling for deliberation among farmers, agronomists, and policy-makers to reach common consent.

**Case 3. Complex rice-duck-fish production systems in Indonesia** (Khumairoh, Groot, and Lantinga 2012)

One of the technological innovations disseminated by the so-called Green Revolution was the intensified use of external inputs, especially synthetic fertilizers. Short-term effects might result in increased yields, but long-term sustainability of high (external) input use in agricultural systems is still questioned. Additionally, costly technologies are not accessible to the majority of smallholders around the world. Rice production in East Java (Indonesia) is currently characterized by crop monoculture and intensive use of chemical fertilizer. However, enhancing complex wetland rice production systems can be achieved through combinations of rice, ducks, fish, compost application, and azolla (a floating fern). Although the more complex designs require higher investment efforts (e.g. labour), an increase in yields of rice grain can be achieved, consequently bringing higher incomes. Azolla, in symbiosis with green blue algae *Anabaena azollae,* contributes to atmospheric nitrogen fixation while fish and duck feed on azolla ferns. These animals produce manure that ultimately enhances crop growth and productivity. Moreover, the commercialization of fish and ducks contribute to an increase in family income. This low external input innovation was first observed on farmer fields, as a fruit of participants' creativity. It is currently being studied as an option to address climate change, increase agricultural resilience and increase benefits to society, improving food security through optimized use of locally-available resources.

## Final Remarks

As a complex problem, climate change requires a wide array of interconnected solutions. In order for our global innovation capacity to reach its full potential we should not ignore the social dimension of agriculture. We should embrace it and promote research schemes that include indigenous knowledge to develop locally-adapted options. Farming innovations are used and further developed by a very large number of farmers who have impressive observation skills and are quite inventive in attempting to fulfil their needs and wants. In order to be efficient and sustainable, an innovation system has to be able to stimulate and harvest such creative efforts and welcome the fact that humans have by their very nature a craving to build and develop tools. Innovations that can be customized and further developed by their users enable a cascade of follow-up user innovations that ultimately end-up increasing the pool of knowledge available to all (Torrance and von Hippel 2015).

Our brief description of three cases of farmers' innovation with great potential to address climate change demonstrate that adaptation efforts do not have to come exclusively from scientific laboratories in the Global North focusing on break-through innovation. We can adapt our food production system to climate change with a wide array of options that include the inventive capacity of smallholders and seek their active involvement. This in turn will increase self-determination by reducing the dependency on external inputs and diversifying the "scientific" community – an approach that follows the spirit of the Universal Declaration of Human Rights. This inclusive approach, however, needs adequate investments in research and development pointing towards low external input agriculture, something we are currently very far away from (Tittonell 2014).


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