Climate is changing - Food and Agriculture must too

Towards a "*new food and agricultural revolution*"

I feel quite optimistic about the future of pessimism.
Edmond Rostand, biologist and moralist (1894-1977)

I'm a pessimist because of intelligence, but an optimist because of will.
Antonio Gramsci, writer and political theorist (1891-1937)

The theme of the 36th World Food Day is "Climate is changing - Food and Agriculture must too". This paper aims at exploring in which direction our food system will need to change to reduce its impact on the climate and to adapt to the changes in climate that are already occurring.

1. Food and agriculture's contribution to climate change

Apart from a few people who defy evidence, there is a general consensus that our climate is changing and that human activity is a major factor of this change. There is increasing evidence that our food system, including agriculture, is responsible for a major share of the Greenhouse Gas (GHG) emissions that impact our climate by causing our atmosphere to retain heat.

Data published by the IPCC[1] (**see Figure 1**) on GHG emissions show that a large part of concerned gasses are of a potential agricultural origin.

According to the IPCC, every year, a total of 49 billion tons of carbon dioxide (CO_2) equivalent is emitted into our atmosphere through human activities:

- 76% of these emissions are of CO_2 coming
  - either from the use of fossil fuel (65%),
  - or from the way land surface is being used - FOLU (11%).
- 16% of the emissions are in the shape of methane (CH_4) generated in great part by animal fermentation, paddy fields as well as from forest and peatland fire[2].

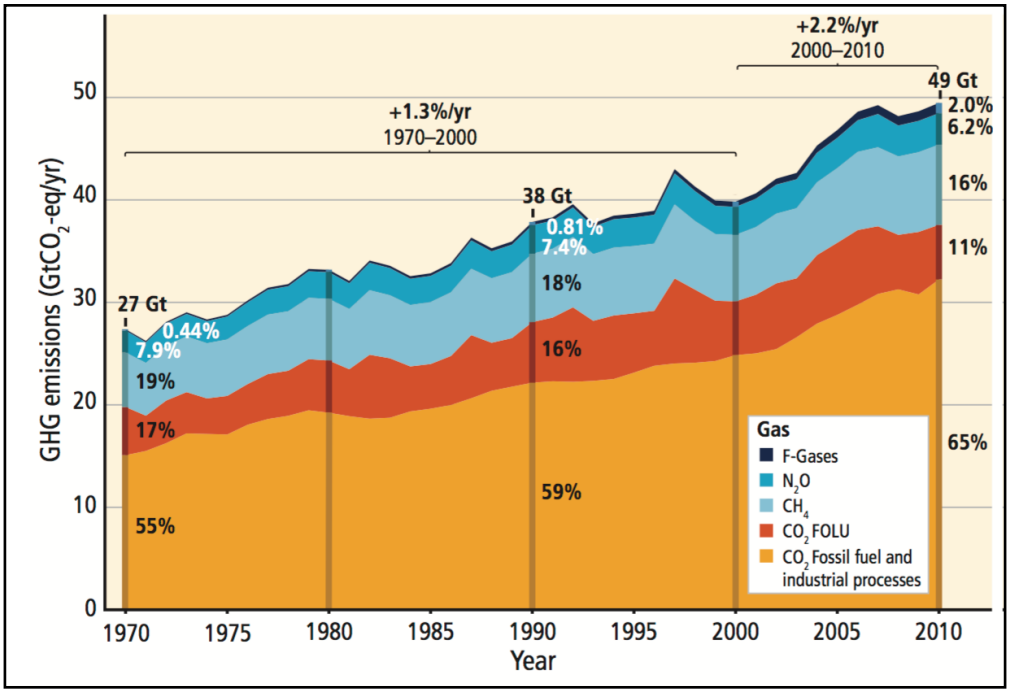
[1] Intergovernmental Panel on Climate Change (IPCC), Climate Change 2014 - Synthesis Report, WMO/ UNEP, 2014

[2] Peatland fire produces a huge amount of CH_4. For example peatland fire generates more than ten times the amount of CH_4 than forest fire and CH_4 has 21 times more greenhouse effect than CO_2. As a consequence at their peak in 2015, peatland fires in Indonesia generated daily as much as the whole of the US economy and in three weeks the equivalent of the GHGs produced by Germany in one year! (World Resources Institute, 2015)

- 6,2% are of nitrous oxide (N_2O) produced mainly by industrial activities but also by degradation of the huge mass of nitrogen fertiliser[3] used every year.
- The remaining part (2%) is made of fluorinated gases coming from the industry.

The IPCC attributes 24% of these emissions to agriculture, forestry and other land uses that include land-based CO_2 emissions from forest fires, peat fires and peat decay.

Figure 1: Total annual anthropogenic GHG emissions by gases, 1970–2010



(IPCC, 2014)

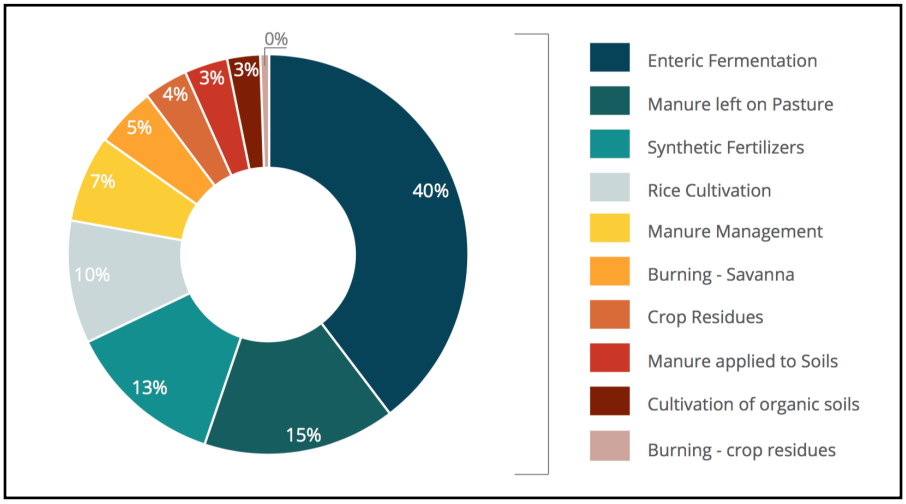
Data published by FAO[4] give some more details on the specific origin of the GHGs emitted by agriculture, forestry and other land use. The bulk of these gases come from agriculture (50%), followed by net forest conversion (38%), peat land cultivation and fires (11%) and biomass fires (1%). Within agriculture, 40% of the GHGs come animal fermentation, 15% from degradation of manure and 13% from the use of chemical fertilizer (see **Figure 2**).

Moreover FAO estimates that GHG emissions by agriculture *increased by 14% between 2001 and 2011*. One important factor of agricultural emissions and their increase has been livestock production and the way animals and their dejections are being managed.

[3] Around 100 million tons of nitrogen are consumed yearly through fertiliser (FAOSTAT), and estimates are that 1% of this amount (one million tons) ends up in the atmosphere in the shape of N_2O which has 300 times more greenhouse effect than CO_2.

[4] Food and Agriculture Organization of the United Nations, Agriculture, Forestry and Other Land Use Emissions by Sources and Removals by Sinks, FAO, 2014

Figure 2: Agriculture emissions by sub-sector, 2001-2011



(FAO, 2014)

Our food system's contribution to GHG emissions is however much more than just what agriculture emits. It also includes emissions resulting from:

- Processing and storage of food and agricultural products - the share of food being processed has been continuously growing and cold storage of perishable food requires a lot of energy;
- Transport of food and agricultural products;
- Food waste.

It is possible to make rough estimates of the GHG emissions resulting from these activities:

- The food industry representing between 15 and 20% of total industrial activity (depending on sources) and industry contributing to 32% of total emissions (IPCC 2014), it is possible to estimate that food industry generates between 4 and 6% of GHG emissions.
- Trade of food and agricultural commodities representing approximately 20% of world trade (wto.org) and transport weighing 14% in GHG emissions, a rough and conservative[5] estimate of the contribution of transport of food and agricultural products is an additional 2% of GHG emissions.
- It is important to remember here that around one-third of the food produced in the world is lost or wasted and that the degradation of this wasted food is thought to produce around 8% of GHGs generated by human activities[6].

Adding altogether these various amount, a plausible estimate is that **food and agriculture contribute to 35 to 40% of GHG emissions**.

[5] Considering that transport of food and agricultural commodities is not just transport for international trade.

[6] FAO, FAO's work on climate change, United Nations Climate Change Conference 2015

2. Why should food and agriculture change?

There are two main reasons why food and agriculture should change:

- To adapt to climate change.

  Climate change means change in average temperatures, in timing of seasons, in prevailing pests and diseases, and increased risks of extreme meteorological events (droughts, floods, hurricanes). Failing to adapt to these changes will bring decrease in production and increased global and local food insecurity.

- To mitigate climate change by reducing GHG emissions.

  With the Agreement reached during the Paris Conference in December 2015 to "*undertake rapid reductions*" of GHG emissions, it is clear that there will be a need to mitigate the role of food and agriculture in climate change by reducing considerably their GHG emissions and through "*removals by sinks*".

3. How can food and agriculture change to adapt to climate change?

Adapting to climate change means essentially modifying agricultural production to make it appropriate for prevailing local agro-ecological conditions as they evolve and while anticipating further evolution.

a) *Change species, varieties and breeds*

Each species, variety or breed is adapted to a certain range of agro-ecological conditions. As conditions evolve, some crops or animals find themselves in conditions where they do not perform well any more. They should then be replaced by those who fit better to the situation. This implies having a large stock of species, varieties and breeds available within which producers can choose the most suitable ones for new conditions.

Agrobiodiversity is therefore a key precondition for adaptation. Unfortunately, evolution of our agriculture has been towards a loss of agrobiodiversity and a narrowing down of the genetic materials being used on farms, mainly because of the priority given to private interests and profits: this trend has to be reversed[7].

Change in species can also be useful in cases where crops have been introduced that are not well adapted to local conditions and have to rely on irrigation. They become increasingly difficult to produce as climate gets warmer and dryer and they exert an increased pressure on limited water resources. The case of maize in France is a good illustration of a crop that has developed since the 1960's under conditions that do not really suit it, in support of the development of industrial animal production and now meets serious problems because of water availability[8].

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[7] Genetic resources: acceleration of privatisation of living organisms is a threat to food security and biodiversity, p. 6-8, hungerexplained.org, 2013. The recent take over of Monsanto by BASF does give much hope for an easy reversal of trend.

[8] Maize production in France grew from 2.5 million tons in 1961 to 18.5 million tons in 2014.

b) *Diversify to reduce risk*

Over the last decades, our agriculture has evolved towards an activity relying on a limited number of varieties and monoculture. This has made the system extremely vulnerable to pests, diseases and meteorological events. Income of individual farmers has become very sensitive to these hazards, to which are added those risks emerging from higher volatility of prices of agricultural commodities. A solution to achieve more security is to diversify varieties or breeds for each species and adopt crop associations or rotations that use complementarity among different crops (e.g. cereals and leguminous crops) and bring additional benefits in terms of combatting pests and diseases, improving soil fertility and reducing the use of toxic chemical inputs. Polyculture rather than mono-cropping also reduces economic risks related to price fluctuations, as a given farm is less dependent on one sole product.

c) Improve drainage and irrigation facilities

Drainage and irrigation infrastructure has been historically the most visible means humans have used to adapt their agriculture to the vagaries of climate and resulting excess or shortage of water. In recent times, the green revolution has made extensive use of this type of infrastructure and of massive quantities of chemical inputs, in order to achieve record growth in food production. This infrastructure has represented the lion share of investment in agriculture during the last 5 decades. As a result, agriculture today consumes around 70% of the water used by humans. But irrigation is a fragile, wasteful and inegalitarian solution and its further expansion will prove extremely costly and risky[9]. However, it may still be a solution in some specific and limited cases, provided technologies adopted are not energy intensive.

d) Change in research priorities

[9] The "all-out irrigation" strategy has led to a fragile, wasteful and inegalitarian system, hungerexplained.org, 2013

Rather than spend billions on irrigation infrastructure or on subsidising the use of toxic agrochemicals, public policy should reorient these resources towards agricultural research so as to protect and improve agrobiodiversity, develop new varieties able to cope with drought or excess of water[10], exploit crop/microorganism symbiosis[11], test crop associations and other ecologically sound techniques[12] that can help making agriculture more resilient through complementarity of crops, biological combat against pests, prevention of crop and animal diseases, regeneration of degraded land, improved fallow, agroforestry, conservation agriculture and sustainable land management. Developing this type of technology would also have the advantage of promoting knowledge-based improved practices that are not costly to adopt and are therefore more accessible to the mass of small farmers who do not have the means to purchase expensive inputs, provided efforts are made to inform and train them. The difficulty in doing this "*new food and agricultural revolution*" is that technologies required will need to be location specific, and, as they are low-input technologies, they will not attract private investment as there are no huge profits to be made as in the case of the building of large infrastructure or selling green revolution-type inputs. They will therefore need a strong public involvement[13].

4. Which changes in food and agriculture can mitigate climate change?

Adapting to climate change will not be sufficient. Depending on sources, it is estimated that the commitments made in Paris during COP21 to reduce GHG emissions in order to keep increase in temperature "*well below 2 degrees*" would imply a reduction of 40 to 70% of 2010 emissions. Food and agriculture representing more than one-third of total emissions, it is clear that it will be indispensable to considerably reduce GHG produced by the sector.

So what does that mean in concrete terms?

The answer to this question requires the identification of practical ways of reducing emissions caused by food and agriculture by examining successively each main source of GHGs.

a) *Protect forests and peatland and increase their capacity to act as carbon sink to reduce impact of forest conversion, peat land cultivation and fires that generate 12% of total GHG emissions*

It is estimated that agriculture is responsible for almost 80% of the 1.2 million hectares of land that are deforested every year (63% are due to expansion of family farming and 16% to expansion of agricultural plantations). This reduction of area under forests is

[10] Biodiversity or GMOs : how to increase plant resistance against drought?, hungerexplained.org, 2014

[11] To produce more: build an alliance with nature rather than combat it, hungerexplained.org, 2016

[12] See for example the Push-pull technology developed by ICIPE - African Insect Science for Food and Health.

[13] Seven principles for ending hunger - Fourth principle: Development of research, hungerexplained.org, 2013

only partly compensated by various types of forest plantations and regeneration programmes that are implemented on approximately 800,000 hectares every year[14].

Combatting deforestation caused by agriculture requires to increase productivity of agricultural land and ensure a fairer distribution of land so that all rural dwellers have access to sufficient land for securing their livelihoods and are not obliged to encroach on forests. It also necessitates protecting forests and even more so peatland - by banning its destruction to grow oil palm[15] - and improving forest management so as to increase the amounts of carbon sequestered by trees and the soil. This strategy should be supported by remunerative payments for carbon storage that really provide effective compensation to rural communities[16] and by programmes that generate genuine development opportunities and jobs for them.

b) *Reduce and improve management of livestock production that generates 16% of GHG emissions by reducing consumption of animal products, changing feeding technology for livestock and improving manure and waste management*

Recent years have seen a rapid increase of consumption of animal products (particularly of meat) the production of which generates GHG emissions and is a major cause of deforestation. Total world meat production grew from 71 million tons in 1961 to 179 million tons in 1990 and 311 million tons in 2013 (FAOSTAT), thus quadrupling in little over 50 years and increasing manifold the pressure exerted on our environment. Moreover, excessive consumption of meat and meat products has proven to have a negative impact on human health. Massive intensive livestock production creates additional environmental hazards such as pollution due to inadequate manure and animal waste management that, *inter alia*, affects drinkable water and creates

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[14] Forests: rural communities caught between markets and the objective of conserving the planet, hungerexplained.org, 2013

[15] Fire in South-East Asia: a highly visible consequence of our failing food system, hungerexplained.org, 2015

[16] *Ibid.*, p.10-12, hungerexplained.org, 2013

proliferation of algae in some costal areas. Industrial livestock production also competes with humans for food and reduces availability of some basic food items for human consumption. It also lowers overall efficiency of agriculture as a source of food[17]. For all these reasons, livestock production should be controlled by stricter environmental rules, and consumption of animal products discouraged by massive consumer information and nutrition information campaigns, as well as by higher prices to reflect their full real cost and provide proper income to producers. Improved feeding technologies and feed mixes that reduce enteric fermentation should be adopted, based on results of on-going research.

c) *Reduce food waste and loss that generates 8% of total GHG emissions*

This requires changes of consumer behaviour to reduce amounts of food that are thrown away. It also requires changing grading standards - that imply that a sizable share of production is thrown away at harvest -, rules for food management by retail shops and supermarkets, increased flexibility in shelf life regulation and incentives for donations to associations and food banks that support vulnerable population groups[18].

d) *Reduce energy consumption for cultivation, processing, storage and transport that generate 7-9% of total GHG emissions*

This requires adopting less energy consuming technologies (e.g. zero/minimum tillage) that also have other agronomic advantages, using less agrochemicals (for example, nitrogen fertiliser that is produced by a very energy-intensive process[19]), adopting less energy intensive technologies and improving energy management in food processing plants (e.g. recycling waste as source of energy). This can be achieved by progressively removing subsidies on energy[20] and especially on fuel, removing fertilizer subsidies, and reorienting public resources towards research, and particularly towards the development of locally specific low-input agricultural techniques[21]. These policy changes should be supported by more favourable conditions for Community Supported Agriculture and more information for consumers so as to change their behaviour and orient them towards consuming more local and seasonal food rather that commoditized food, 'food from nowhere' (untraceable, creating obscure relationships and often, unfortunately, cheaper).

e) *Increase the carbon storage capacity of agricultural land*

This can be achieved by adopting agricultural technologies that increase the biomass in surface (e.g. agroforestry) and organic matter stored in the soil (e.g. regenerative organic agriculture). Estimates show that if half of all cropland shifted to such

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[17] Intensive livestock production relies on extensive consumption of crop products (cereals and oilseeds in particular), often transported over long distances, which are inefficiently transformed into animal products, animals thus becoming our competitors for crop products.

[18] Seven principles for ending hunger - Third principle: Battle against wastage, hungerexplained.org, 2013

[19] Food, Environment and Health, p.4, hungerexplained.org, 2014

[20] In their 2012 paper on Reforming Energy Subsidies, the International Monetary Fund (IMF) estimated at $1.9 trillion (2.7% of world GDP, almost equivalent to the GDP of Italy in 2011), the amount of energy subsidies paid in the world.

[21] Promoting climate smart agriculture: why be so shy about policies?, hungerexplained.org, 2013

technologies, the equivalent of one year of world GHG emissions could be stored in the soil[22].

5. Opportunities exist, but the challenge is to reverse well-established on-going trends

It is interesting and encouraging to note that there are synergies and no contradiction between measures aiming at reducing GHG emissions and those seeking to adapt our food system to climate change as they contribute to making the food system more sustainable (See **Table 1**).

But implementing required changes will necessitate a radical re-engineering of our food system, including a profound modification of agricultural production management methods and a fundamental transformation of our consumption patterns: a "*new food and agricultural revolution*". These changes will neither occur overnight, nor will they happen "*naturally*". Rather they will need extensive explanation, information and education of all stakeholders (producers, transformers, traders and consumers) and will require a sharp turn in public policy to provide the proper legal framework, incentives and support to all.

The difficulty in implementing these changes is that they will threaten the interest of powerful economic forces that strongly influence policies throughout the world.

Table 1: Synergies between climate change mitigation and adaptation measures

Mitigation/ Adaptation	Protection of forests and peat-land	Reduce and improve management of livestock production	Reduce food waste and loss	Reduce energy consumption for cultivation, processing, storage and transport	Increase carbon storage capacity
Change species and varieties, breeds		+++		+++	
Diversify to reduce risk		+++	+++	+++	
Drainage/ irrigation facilities	+++			+++	
Modify timing of cultivation				+++	
Change research priorities	+++	+++	+++	+++	+++

On the production side:

Over the last 70 years, all efforts have been geared towards the promotion of one particular type of food system: a system that is extremely energy intensive throughout the food chain, the development of which has supported the emergence of the chemical and

[22] A solution to combat climate change: an agriculture that stores carbon in the soil, hungerexplained.org, 2015

public works industries. And today, rules and incentives protect that system and act as barriers for developing a more climate friendly food system (see Box 1)[23].

Box 1: Obstacles to the development of local sustainable food systems - the case of France

1. Space is rare and expensive near cities and it is difficult to find locations where to grow food within a limited distance of large consumer centers.
2. Access to finance is difficult, as local food schemes are usually not eligible because of the requirements (minimum area, diploma/training, collateral, etc.).
3. Subsidies are designed to support large industrial agriculture (support to investment in mechanisation, funding of the use of chemical inputs…).
4. Research and technological development is large scale oriented and in the hand of large private corporations who promote technologies that can be embodied in equipment or inputs for sale.
5. The training offer is large-scale oriented, as it is controlled by farmer unions supporting industrial agriculture.
6. Regulations on seed production and marketing, on the creation of new production units and on sales and marketing are generally not adapted and unfavourable to those who want to create local food production schemes, and these undertakings are often targeted by inspectors.
7. Local food systems are not represented and involved in the policy process.
8. The intrinsic characteristics of local food systems act as a constraint: lack of diversity and seasonality of products limit attractiveness to consumers, labour intensiveness increases costs, low volume makes it difficult to bid for providing food to collective catering outfits.

Even though this existing system has shown its limitations in rich countries, it is still being promoted in poor countries through huge programs that are supported by public as well as by private interests, funded by public resources and that tend to marginalise the mass of peasants who is not able to join the bandwagon because poor family farmers do not have the basic means to adopt the proposed technologies or because they are ruthlessly deprived from the natural resources (land, water and genetic resources) on which their livelihoods depend. (see Box 2 below)[24].

Box 2: The G8's New Alliance for Food Security and Nutrition

The "package" promoted by the New Alliance comprises:

- Promotion of private sector investment and contract farming.
- Promotion of the Green Revolution technology.
- Land demarcation and registration leading to the delivery of individual land titles and the creation of open land and land-lease markets, undermining community land ownership.
- Reformed forestry governance to give more space to private interests.
- New seed laws based on the creation of seed catalogues on the model of those existing in rich countries, to limit informal seed management and exchange by small producers and easing the promotion of patented 'improved' seed that requires monoculture and use of chemical inputs.
- Tax reform for private investors and trade liberalisation that exposes local producers to the competition of highly subsidised imported goods.
- Reform of public funding to support private investment and subsidise purchase of commercial inputs.

[23] Are existing food and agricultural policies supportive to local sustainable food systems?, hungerexplained.org, 2015

[24] Based on *Ibid.*, hungerexplained.org, 2015 and on The European Union investigates on the New Alliance for Food Security and Nutrition, hungerexplained.org, 2016

On the consumption side:

Changes observed in consumption patterns show a tremendous increase in reliance on processed food. This trend has been effective for decades in rich countries where processed foods and snacks have become common and eating in fast food and other restaurants, particularly but not exclusively for lunch, is becoming more and more frequent. This is also reflected in the change in trade flows of which processed food represent a growing share.

Until recently, it was thought that this was not the case for the majority of consumers in poor countries whose main change in diet was thought to consist in a shift from basic staples towards higher-value livestock products, when income allowed it. A recent study shows however that, following the recent food security crisis, consumers in poor countries, including very poor people, are eating an increasing amount of processed foods and snacks to save time so as to be able to work more, and because industrial foods with high sugar, fat and salt content tend to become addictive, particularly for young people, and provide their consumers with status and identity.[25] Apart from having serious implications on health and social cohesion that are well known in rich countries, this change also contributes to boost trade flows and goes against the idea of consuming local, as consumer preference then increasingly turns towards diets based on "food from nowhere" that can come from anywhere.

These few examples show that there is indeed a need to change radically the direction of evolution of the food system if it has to take its fair share in mitigating climate change and if it has to adapt to climate modifications. **Table 2** below sums up the main points raised so far in this paper.

Table 2: Intrinsic characteristics of our food system and how they relate to climate change

Characteristics of the system /consequences	Use of fossil fuels	Reduced biomass storage	Pollution	Reduced capacity to adapt to climate change
Expansion on forests and peat-land		xxx		
'Industrial' production	xxx		xxx	
Waste or losses			xxx	
Energy intensive	xxx			
Mechanisation	xxx	xxx		
Agrochemicals (fertiliser and pesticides)	xxx		xxx	
Long value chains	xxx			
Monoculture				xxx
Reliance on limited genetic material				xxx

[25] Scott-Villiers, P.; Chisholm, N.; Wanjiku Kelbert, A. and Hossain, N., Precarious Lives: Food, Work and Care after the Global Food Crisis, Brighton: IDS and Oxfam International 2016

6. So what should be done to re-engineer our food system and make it more climate-friendly?

The point of view of selected global stakeholders

According to FAO, climate change affects in the hardest way the "*world's poorest - many of whom are farmers, fishers and pastoralists*" and "*agriculture and food systems will need to adapt to the adverse effects of climate change and become more resilient, productive and sustainable*" as world demand for food is growing. The solution proposed is the adoption of "climate-smart" agriculture, illustrated by a series of techniques. In its key messages for World Food Day 2016, the Organization gives emphasis to the need to change food and agricultural systems, assigns objectives to the change required but remains mute on what needs to be done for these objectives to be achieved[26]. FAO has been hosting for two years the Global Alliance for Climate-Smart Agriculture which groups several countries, a few farmer organisations, a number of international organisations, environmental as well as pro-fertiliser associations as well as two private corporations, the fertiliser giants Yara and Mosaic. This Alliance has been interpreted by some as an effort to counter interest for ecological agriculture[27]. But so far, in its work, the Organization has said very little on what needs to be done for the proposed technical solutions to be adopted and it shyly avoids explaining that there is a need to change existing food and agricultural policies[28]. In fact, its focus appears to be more on "neutral" adaptation rather than mitigation that would imply more fundamental changes.

In its publication entitled "Alternative Futures for Global Food and Agriculture", OECD analyses three scenarios, one of which, named '*Citizen-driven, sustainable growth*', puts the emphasis on technologies that save natural resources and preserve the environment, including the climate, and formulates several useful recommendations among which:

- To influence consumption, conduct "*reform of subsidy and tax systems and consumer awareness campaigns*" to "*accelerate movement towards more sustainable lifestyle and consumption patterns*" while preserving regional cultural specificities.
- To influence production, re-evaluate policies in place that support the use of fossil-fuels and other energy-intensive inputs in agriculture and other sectors, and consider as indicator of productivity not only yield but also eventual degradation of natural resources and emission of green-house gases.[29]

But here too, OECD's analysis does not elaborate on all the implications of these recommendations, and in particular it does not explain how more climate friendly technologies could be further developed or suggest how to ensure that policy reforms recommended are favourable to the poor and hungry.

According to the International Food Policy Research Institute (IFPRI), governments need to adopt 'climate-smart' policies, but what that means in concrete terms remains rather vague, apart from a general recommendation to reform policies and replace subsidies that

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[26] FAO, World Food Day 2016 - Communication Handbook, 2016

[27] The Global Alliance for Climate-Smart Agriculture: a new tool for an enlightened capitalism? hungerexplained.org, 2014

[28] Promoting climate smart agriculture: why be so shy about policies? hungerexplained.org, 2013

[29] How do rich countries see the future of food and agriculture? hungerexplained.org, 2016

encourage "*farmers to overuse valuable resources like water and energy.,, used to produce more grains at the expense of nutritious crops like pulses, fruits and vegetables, which have grown progressively expensive*" by policies that "*encourage farmers to produce as much nutrition* (?) *as possible with the resources available*".[30]

The European Union, through its reformed Common Agricultural Policy implemented from 2014 onwards, decided to divert some of its huge subsidies to agriculture (EUR 50 billion - approximately $65 billion - every year) towards encouraging a more environment-friendly agriculture. The objective is to use up to 30% of direct subsidies paid to farmers to make European agriculture more sustainable and 'climate-smart', but the complexity of the policy and latitude left to 'nationalise' policies at country level makes it impossible to assess up to now the extent to which this has translated into reality and will actually help European agriculture to mitigate and adapt to climate change[31]. But the reform is based on a valid ideal: provide incentives to producers to adopt more climate friendly technologies.

In "Climate Change, Global Food Security, and the U.S. Food System"[32] the US Department of Agriculture (USDA) recognises the challenges climate change poses to the food system, but its general recommendations boil down to increasing the efficiency of the existing food system, without attempting in any way to question the paradigm on which it rests which is that of conventional agriculture and commoditisation of food.

During the COP21 meeting in Paris, end 2015, a consensus could be achieved by all stakeholders on the Paris Agreement, which has since been ratified by an increasing number of countries[33] but is not yet in force at the time this text is being drafted. What does the Agreement say about the food system? Not much if anything, the word "food" appears three times in the text[34] and the word agriculture is absent…

A few ideas to chart the way forward

Below are a series of changes that would transform fundamentally our food system to make it more resilient to climate change and at the same time that would reduce its own impact on the climate. They could trigger a much-needed "*new food and agricultural revolution*".

- Change the incentive framework:
    - Tracking and removal of all subsidies that support practices generating GHG emissions. This includes subsidies on fossil fuels, on chemical inputs and machinery

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[30] Shenggen Fan, Climate-smart agriculture is key to ending hunger, IFPRI/Huffington Post, 2015

[31] European Commission, Overview of CAP Reform 2014-2020, 2013

[32] Brown, M.E. *et al.*, Climate Change, Global Food Security, and the U.S. Food System, USDA 2015

[33] By 4 October 2016, 62 countries had ratified the Agreement, but more countries will have to ratify for Agreement to enter into force, as GHG emissions of signing countries have not yet reached 55% of world total. It is impossible to say, at this stage, what the implications of this Agreement will be on the food system.

[34] In the preamble: "*Recognizing the fundamental priority of safeguarding **food** security and ending hunger, and the particular vulnerabilities of **food** production systems to the adverse impacts of climate change.*"
In Article 2,b.: "*Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten **food** production.*"

operating on fossil fuels (including electricity, as long as most of the electricity is generated through burning fossil fuels), in primary production and all along value chains.
- Support through subsidies of climate-friendly practices that, for the time being, are at a disadvantage as they have to compete with practices that generate negative externalities[35] for which they are not taxed[36], on the pattern experienced by the European Union but with a considerably expanded scope.
- Allow some increase in the price of food to reduce waste and compensate the poorer sections of the population through an enhanced social protection system[37].
- Offer tax exemption to retail shops and supermarkets for donations to associations and food banks.
- Grant incentives for recycling of waste.
- Reevaluate amounts paid to local communities who accept to preserve their forests and support them to create climate-friendly activities that can help them develop their economy.
- Protect effectively land rights of local communities.

- Change the regulatory framework:

  - Impose rules that ban certain particularly harmful practices in food value chains that generate a large amount of GHGs.
  - Modify/adapt the regulatory and institutional framework to remove hurdles to the development and operation of local and sustainable agriculture and Community Supported Agriculture (see Box 1).
  - Preserve agrobiodiversity by protecting the freedom of producers to use and exchange their seeds and supporting research into developing new varieties.
  - Re-visit food handling regulations in retail shops and supermarkets to reduce waste.
  - Develop and apply stricter environmental norms for large-scale industrial livestock production.
  - Ensure effective protection of peatland including banning of oil palm expansion on peatland.

- Invest in research, development and dissemination of climate-friendly technologies:

  - Develop research activities into technological innovations that do not generate negative externalities (including GHG emissions) and do not require investment in infrastructure for which the construction is energy intensive. Priority should be given to knowledge-intensive (rather than capital intensive) technologies so as to facilitate access by poor producers and reduce costs to the benefit of consumers. This will contribute to increasing productivity of agricultural land, reducing pressure on forests

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[35] An externality corresponds to a situation where the act of producing or consuming by an economic agent has a positive or negative impact on one or several other agents not directly part of the act, and where these affected agents do not have to pay for all the benefits that have accrued to them or are not fully compensated for the harm they have suffered. In practical terms, this often means that the costs of such externalities end up being met by future generations.

[36] On this topic, read The dark side of chocolate: a comparative study of 'conventional', 'sustainable' and 'fair trade' cocoa value chains, hungerexplained.org, 2016 and Researchers show that organic agriculture generates more economic value than conventional agriculture, hungerexplained.org, 2015. See also A. MacMillan, Hasn't the time come for some brave new thinking on food management?, 2014

[37] A. MacMillan, *Ibid.*, 2014

and increasing carbon storage in sols. This requires more public funding of research as resulting technologies will not be easy to embody in marketable goods and thus will not be attractive for the private sector.
  - Conduct more local specific research to develop technological packages that are well adapted to local conditions.
  - Strengthen research into how agrobiodiversity can be used for better soil fertility management and combat against pests and diseases.
  - Develop less energy intensive food processing and storage technologies and techniques for recycling waste with a view to producing energy that will be used for food processing and storage.
  - Invent improved forest management techniques for increasing biomass storage and preserving biodiversity.
  - Invest in research in agroforestry so as to use its benefits in terms of microclimate management, soil fertility improvement and increasing surface biomass for carbon storage.
  - Implement programs to disseminate and help the adoption of new technologies resulting from boosted research efforts.

- Promote rural development through programs that help create jobs and opportunities for rural communities so as to reduce pressure on agricultural land and forests.

- Implement information campaigns on food for the public to influence their consumption choices and behaviour and reduce consumption of commoditised and off-season foods.

7. Conclusions

This review of the food/climate relationship shows that it is complex and that it has two main aspects: food is a cause of climate change and climate change is a threat to our food security. There is therefore a need to act ***both*** on the reduction of emissions produced by the food system ***and*** on the adaptation of the system to change of climatic conditions. Interestingly, one can note that this second aspect is usually dealt with quite explicitly in what the main global food and agriculture stakeholders say. It denotes a will to 'manage and preserve' our food system, but without questioning it and the paradigm on which it has been resting for over a century, as if the evolution of the food and agriculture system had been a 'natural event', when we very well know that it was a process that was driven by specific objectives[38].

Solutions to the problem are known and have been listed here. They amount to engaging in a real "*new food and agricultural revolution*". To apply them requires addressing several issues:

- The need to sort out the politics of implementing them because, as is usually the case when there is a change in policy, there will be winners and losers. What makes dealing with the political problem more difficult is that many potential losers are large and powerful companies that can mobilise huge resources to influence policy[39]. Also it means

[38] *Ibid.*, p.4, hungerexplained.org, 2014

[39] In the US, the industrial food and agriculture sector spent hundreds of millions on communication to influence the media, consumers and policy. What about in Europe? hungerexplained.org, 2015

that all of us will have to change our personal behaviour and it is not sure that we are ready to do so until we are either encouraged through information and incentives, or obliged through rules and regulations. Many of us will also be beneficiaries of this change, through improved health and better jobs, but there will be even more beneficiaries in the future, generations that have yet to come, but they are voiceless and have no means to influence the policies of today…[40]

- The need to think global and not national, and the current trend almost everywhere in the world is a reaction to globalisation and a tendency to be more country centered, if not nationalistic.
- It will take time…, one aspect being the time required to obtain results of renewed efforts and investment in research, and even more time to feel the impact of putting them in practice.
- It will require resources, which puts countries in different situations: rich countries have the means to do the job, but not poor countries. According to the Paris Agreement, rich countries committed to help finance efforts in poor countries through a financial mechanism[41] that was to mobilise $100 billion per year by 2020 (for all sectors) but for which actual moneys have been forthcoming very slowly and have reached little more than $60 billion of which only $9.9 billion through the Green Fund at the time of drafting this report[42].

In other words, until there is a strong mobilisation to put all these ideas in practice, climate will continue to change and our food system will remain based on the same paradigm while all deadly consequences that can be foreseen will not be avoided.

There is hope from the numerous local initiatives of many kinds that go in the right direction such as the development of CSA, the rapid growth of organic and ecological agriculture. But the change in our food system will be of sufficient depth only on the day when the regulatory and incentive framework will have been restructured so as to allow the coming of the "*new food and agricultural revolution*" that is so vital for preserving our future.

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[40] This question is dealt with from different points of view on our page "Intergenerational Equity", hungerexplained.org, 2012-2015

[41] "*Developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation in continuation of their existing obligations under the Convention*". Paris Agreement, Article 9.

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