

Agriculture at a Crossroads: Food for Survival



GREENPEACE

campaigning for sustainable agriculture

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Table of Contents

Part I Introduction	5
Getting there from here: five policy cornerstones	6
The IAASTD process	7
Part II Two big challenges	9
Hunger in a world of plenty	10
Climate change	12
Part III Foundations	18
Small farmers are feeding the world	19
Multiple ecological functions of agriculture	21
Food sovereignty	23
Part IV Business as usual is not an option	25
How industrial and chemical-intensive farming destroys our planet	26
How industrial farming destroys rural livelihoods	31
Drivers of industrial and chemical-intensive farming	34
Part V Tomorrow's knowledge and technologies	41
Agroecology: a diversity of solutions	42
The case for organic agriculture	44
Research and development priorities	47
Patents and control vs. participatory and shared knowledge	49
Biotechnology and genetic engineering	51
Part VI The way forward	54
Prioritising the resource needs and knowledge of the world's small-scale farmers	55
Supporting ecological farming systems with public research and investment monies	56
Supporting the multiple ecological functions of agriculture through policies that value and protect ecosystem services	57
Addressing climate change through the agricultural sector with support for ecological farming	58
Recognising the inter-related principles of food sovereignty and the right to food	59
Conclusions: simple steps in the right direction	60

01



image Planting Rice Seeds in Jinghong

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Part I Introduction

Climate change, hunger and poverty, loss of biodiversity, forest destruction, water crises, food safety – what all these threats have in common is that a principal cause for each of them is in the way we produce, trade, consume and discard food and other agricultural products. However, agriculture is not high on the agenda of media, politicians, financial institutions or many environmental organisations. Yet, none of the major global challenges ahead of us will be met without profound and lasting changes of today's dominant agricultural practices and food policies.

Our perception of the challenges and the choices we make at this juncture in history will determine how we protect our planet and secure our future. (**Synthesis Report, p. 3**)

Public neglect for primary production and rural life is probably at least as old as industrialisation. At the point where for the first time in history more people will be living in cities than in the countryside we come to realise the price of the urban habit of looking at agriculture with a peculiar mixture of disregard and romanticism.

Overcoming this fundamental disconnect from the very basis of our existence is a long-term cultural challenge. As the present multiple economic, environmental and social crises have built up over a long period of time, it will probably require several decades - and the hard work and commitment of more than one generation in thousands of different environments - to achieve a situation which would warrant calling our agricultural and food practices economically, socially and ecologically sustainable.

To reach this goal entails changes and adaptations at all levels: farming methods, consumption patterns, trade relations, production, storage and processing technologies, human rights and gender balance, tradition and values, education and sharing of knowledge, innovation and conservation and lifestyle patterns.

Lasting results will have to be measured by the length of life cycles of trees, soil, watersheds and eco-system development, as well as generational cultural adaptation. However, immediate recovery from overexploitation and vicious cycles of destructive management, including of our own health, relief from hunger and despair, debts, serfdom and addiction, providing hope and confidence and liberating the creative and productive potential of millions of families in a better future, can be accomplished within years, if we start today.

“If we do persist with business as usual, the world's people cannot be fed over the next half-century. It will mean more environmental degradation, and the gap between the haves and have-nots will expand. We have an opportunity now to marshal our intellectual resources to avoid that sort of future. Otherwise we face a world nobody would want to inhabit.”

Professor Robert T. Watson, Director of the IAASTD

Getting there from here: five policy cornerstones

As Professor Robert Watson, director of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) warns, business as usual is not an option. The way humanity has nearly tripled agricultural outputs over the past 50 years has come at unbearable costs for the environment, public health and social welfare. Industrial farming, with its dependency on fossil fuels, toxic inputs and ignorance for common goods, has proven to be a dead-end road. Indeed, as concluded by the IAASTD and as we detail in Section IV of this report, business as usual threatens to undermine the basis of our food supply and the web of life upon which we all depend.

To feed the world sustainably into the future, fundamental changes are needed in our farming and food systems. Greenpeace believes that the results of the IAASTD must be the starting point for an urgently needed thorough and radical overhaul of present international and national agricultural policies. From the findings of the IAASTD we derive five policy cornerstones that provide direction for the changes that need to be made to ensure food security for all in the 21st century. Governments must *actively create* the transition to sustainable ecological farming systems through:

- 1. Prioritising the resource needs and knowledge of the world's small-scale ecological farmers.** Focus special attention on the knowledge, capacity and needs of the world's small-scale farmers, especially women. Fighting hunger and poverty as well as environmental destruction depends upon ensuring their secure access to and control over land, water, seeds, markets, capital, and basic human rights.
- 2. Supporting ecological farming systems with public research and investment monies.** Redirect research and investment funding towards ecological farming systems that can increase productivity in a sustainable manner, while strengthening ecosystem health and lessening the environmental impacts of agriculture. Special emphasis should be placed on reducing the reliance of agriculture and the food chain on fossil fuels (for agrochemicals, machinery, transport and distribution). Governments must halt public funding for the development of genetically engineered crops.

3. Supporting the multiple ecological functions of agriculture through policies that value and protect ecosystem services.

Governments must shift public sector financial support away from subsidies and programmes that promote unsustainable input-intensive industrial agriculture. In their place, governments should utilise agricultural policy tools that internalise environmental externalities, including policies rewarding conservation, stewardship and protection of ecosystem services and imposing taxes on carbon emissions, agrochemical use and water pollution.

4. Addressing climate change through the agriculture sector with support for ecological farming.

Agricultural research, investment, public policies, and trade should be directed towards ecological farming practices that mitigate greenhouse gas emissions from agriculture, protect the quality and improve the efficiency and management of water resources, and enhance the resilience and adaptive capacity of agricultural systems.

5. Recognising the inter-related principles of food sovereignty and the right to food.

Food sovereignty is defined as the right of peoples and sovereign states to democratically determine their own agricultural and food policies; the right to adequate food and freedom from hunger is enshrined in Article 11 of the International Covenant on Economic, Social and Cultural Rights. Domestic agriculture policy and international trade regimes must be designed to support, not undermine, these basic principles.

The IAASTD process

The IAASTD is the first and most comprehensive global assessment of agricultural knowledge, science and technology

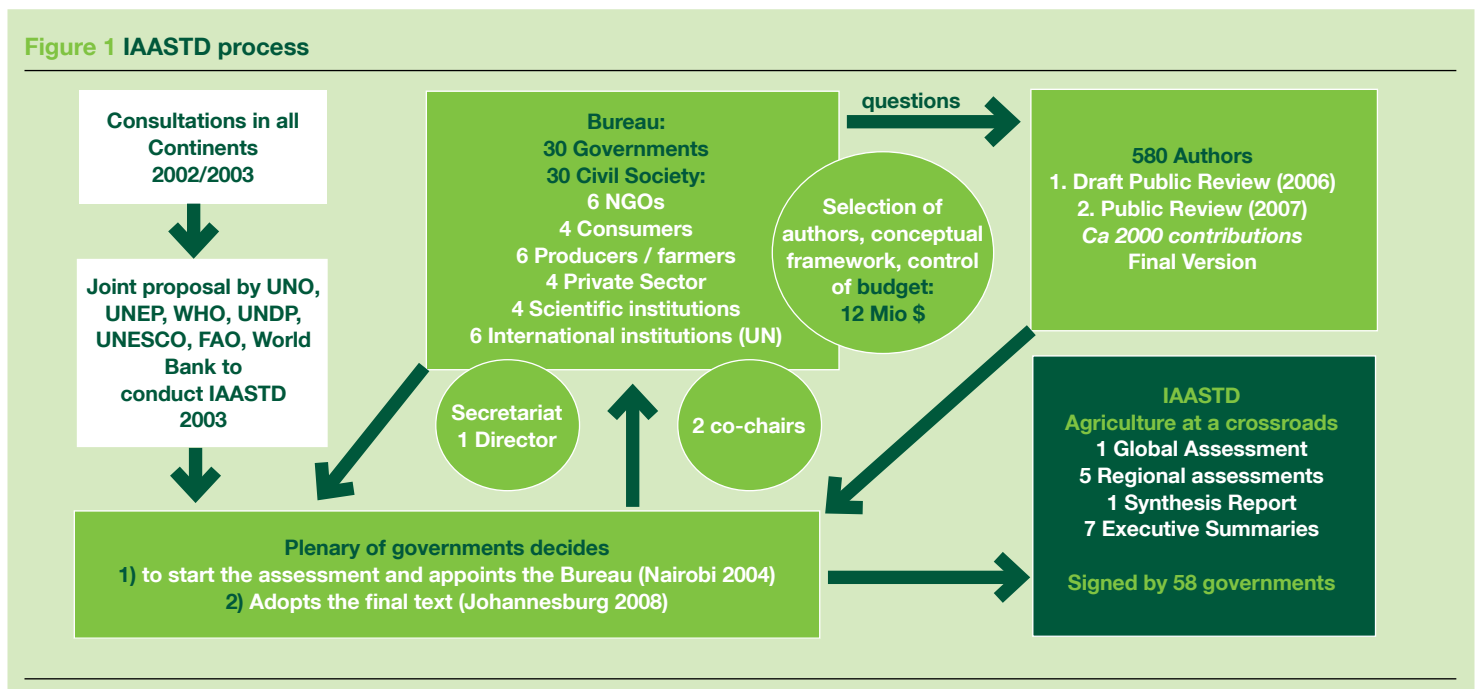
Initiated during the Earth Summit 2002 in Johannesburg, the intergovernmental process of the IAASTD reflected a changing perception of the role and importance of agriculture for development within the World Bank and all major agencies of the United Nations.

The objective of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) was to assess the impacts of past, present and future agricultural knowledge, science and technology [AKST] on the

- reduction of hunger and poverty,
- improvement of rural livelihoods and human health, and
- equitable, socially, environmentally and economically sustainable development.

(Global Report, Foreword, p. viii)

Figure 1 IAASTD process



The process started with 11 stakeholder consultations in all regions of the world. Their proposal was adopted by an intergovernmental plenary in Nairobi in 2004. The participating governments installed a Secretariat and a Bureau to oversee the process. This Bureau's multi-stakeholder composition of 30 government representatives and 30 representatives of civil society from all realms was an innovative step. The Bureau then agreed unanimously on the basic questions to be answered and the conceptual framework of the assessment. It jointly selected over 400 lead authors from all disciplines to answer these questions in one global as well as five sub-regional assessments. Great care was taken to achieve a suitable regional and gender balance and to ensure a diversity of backgrounds and views.

The Bureau agreed that the scope of the assessment needed to go beyond the narrow confines of S[cience] & T[echnology] and should encompass other types of relevant knowledge (e.g., knowledge held by agricultural producers, consumers and end users) and that it should also assess the role of institutions, organisations, governance, markets and trade.
(Global Report, Preface, p. ix)

During the following years, the authors produced two subsequent drafts which were made public and circulated for review and additional contributions by colleagues, government institutions as well as the public at large. More than 2,000 comments were taken into account and followed up by special review editors assigned to each chapter. A synthesis report and executive summaries for decision makers were distilled from over 2000 pages of the assessments and finally adopted by the concluding intergovernmental plenary in Johannesburg in April 2008.

The summaries were adopted, negotiated line by line, and the overall assessment approved by 58 out of 61 participating governments. Three governments (USA, Canada and Australia) welcomed the assessment, but felt unable to fully endorse its conclusions. In a last-minute move before the final plenary, representatives of Syngenta and CropLife International, the association of global agrochemical companies, withdrew from the process after years of active participation and contribution. Among the most contentious issues

at stake was the role of global trade, of genetic engineering, and of intellectual property rights, as well as the overall assessment of industrial agriculture as compared to small-scale farming.

The long and meticulous process of collection and discussion of evidence among scientists of a very broad spectrum of disciplines, as well as practical experts and holders of traditional and indigenous knowledge, has made the IAASTD the most comprehensive and interdisciplinary exercise in the field of agriculture conducted so far. It provides bold evidence that change is feasible and inescapable. It is a compendium of the present global situation and gives insight into its different regional aspects. Looking at the history over the past 50 years, which has led us to today's dramatic situation, and laying out conceivable options for the upcoming four to five decades, it allows lessons to be drawn and realistic plans for the future to be made. It provides a compendium of readily available solutions without falling into the trap of losing an overall perspective of the complex social, economic, cultural and ecological interrelations within the agricultural context. And, it warns us against any kind of 'silver bullet' solutions, showing how and why a diversity of measures in different environments and their proper mix is actually the most innovative and appropriate way forward.

This report does not attempt and claim to summarise all the findings of the IAASTD but rather highlights a selection of facts and recommendations that we have found most compelling, urgent and useful to address the enormous tasks ahead of us.

During the six years from the first steps to the adoption of the final report in Johannesburg in April 2008 the number of people suffering from hunger has increased by more than 100 million people. Since then, the World Food Organisation estimates another 100 million people have fallen victim to hunger. The use of pesticides and artificial fertiliser, meat consumption, soil degradation, water pollution, deforestation and loss of species have further increased at unabated rates.

We know the solutions. We have the power to change. What are we waiting for?

02



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image Rice Screening in Honghe

Part II

Two big challenges

Two formidable challenges seem to overarch agriculture and food production in this century: how to end hunger and how to keep global warming at a level that will allow humanity and the agroecosystems we depend upon to adapt in a non-catastrophic way. Two outstanding paradoxes mark these challenges: Modern agriculture is producing too much and still a billion people on this planet suffer from hunger, while many more are not nourished properly. At the same time, agricultural production and our food system accounts for more than 25% of global greenhouse gas emissions while the plants and soil it is based upon have the potential to reduce rather than increase global warming.

Hunger in a world of plenty

A matter of political choice – not of increased production

Despite constant increases in agricultural production, the number of hungry has steeply increased over the past three years and reached an historic peak of about one billion victims. The solemn commitment of the World Food Summit in 1996 to halve the number of the then 830 million undernourished to 415 million by 2015 and its continued reiterations during the past ten years sound preposterous in light of these developments. The fact that one-seventh of the world population suffers from hunger, and five million children die from hunger every year, is probably the worst global assault on human rights and dignity. It is a threat to peace and a source of national instability, displacement, migration and violent conflict and the most important impediment to social progress in the regions affected. It is also a driver of environmental degradation and depletion in many regions of the world.

In India, the total food available to each person actually increased, but greater hunger prevailed because of the unequal access to food and resources. The remarkable difference in China, where the number of hungry dropped from 406 million to 189 million, begs the question, which has been more effective in reducing hunger, the Green Revolution or the Chinese revolution? (**East and South Asia and the Pacific (ESAP) Report, p. 46**)

There are 54 million people suffering malnutrition in the region, while the amount of food produced is three times the amount consumed ... Hunger and malnutrition in LAC [Latin America and the Caribbean] are not the result of the inability to produce enough food; therefore, increasing production will not solve the problem of hunger and malnutrition in the region. (**Latin America and the Caribbean (LAC) Report, p. 2**)

Sufficient levels of production are a prerequisite to ensure the right to food. However, from a global perspective, lack of food supply is not the cause of hunger. While world population has doubled over the past 40 years, agricultural production has increased about 2.5 times. At present, it is more than sufficient to provide all citizens of the world with enough healthy food and will also be able to nurture a population of 9 billion, predicted to inhabit this planet in 40 years time. Most hungry people today actually live in countries that are exporters of agricultural products. Over 70% of them live in rural areas and about 50% are small-scale farmers, especially in Asia and Africa.

This analysis provides a clear focus where and how to fight hunger in the coming decades: enable the rural poor to produce sufficient and healthy food for their families, communities and local markets by providing them with the basic means to do so: access to land, water, know-how and education, human rights, including gender equality, as well as to minimum financial means and regional markets.

These simple and straightforward recipes are obstructed by a plethora of national political obstacles and failures. Among these are wars and violent conflicts, increasing inequity, discrimination, exploitation, corruption, and ignorance of the urban elites towards rural development. They are complemented by global market forces and international policies fuelling and exacerbating these failures on a global level. These forces and policies include unfair terms of trade and subsidies, concentration of market power, speculation in land and commodities as well as imposition of flawed economic and development strategies by international financial institutions and foreign investment in detrimental projects and ventures. Neither of these two sets of obstructive forces has been and will be overcome by means of technologies. However, different technologies tend to serve different political and economic interests and purposes.

Global trends of malnutrition

Hunger as a lack of access to sufficient quantities of food calories and energy is complemented by a much more widespread lack of access to a sufficient quality of food. Beyond those suffering from acute hunger and permanent undernourishment, the number of people suffering from micro-nutrient deficiencies is estimated to total over 3 billion people, most of them women, infants, and children in resource-poor families in low-income countries. But inadequate diet also affects large parts of the population of industrialised and industrialising countries. The greater supply of and demand for energy-dense, nutrient-poor foods is leading to obesity and related diseases in both high and low income countries. Obese adults worldwide today have outnumbered those suffering from hunger. (**Global Report, p. 348**)

Although the world food system provides an adequate supply of protein and energy for over 85% of people, only two-thirds have access to sufficient dietary micronutrients. The supply of many nutrients in the diets of the poor has decreased due to a reduction in diet diversity resulting from increased monoculture of staple food crops (rice, wheat, and maize) and the loss of a range of nutrient dense food crops from local food systems. **(Synthesis Report, p. 54)**

These different forms of malnutrition are the main cause of premature deaths, diseases, physical and mental disabilities and have an enormous bearing on people's well being and productivity as well as public expenditures and income.

AKST has focused on adding financial value to basic foodstuffs (e.g., using potatoes to produce a wide range of snack foods). This has resulted in cheap, processed food products with low nutrient density (high in fat, refined sugars and salt), and that have a long shelf life. Increased consumption of these food products that are replacing more varied, traditional diets, is contributing to increased rates of obesity and diet-related chronic disease worldwide. This has been exacerbated by the significant role of huge advertising budgets spent on unhealthy foods. **(Synthesis Report, p. 54)**

Food versus other uses of agricultural products

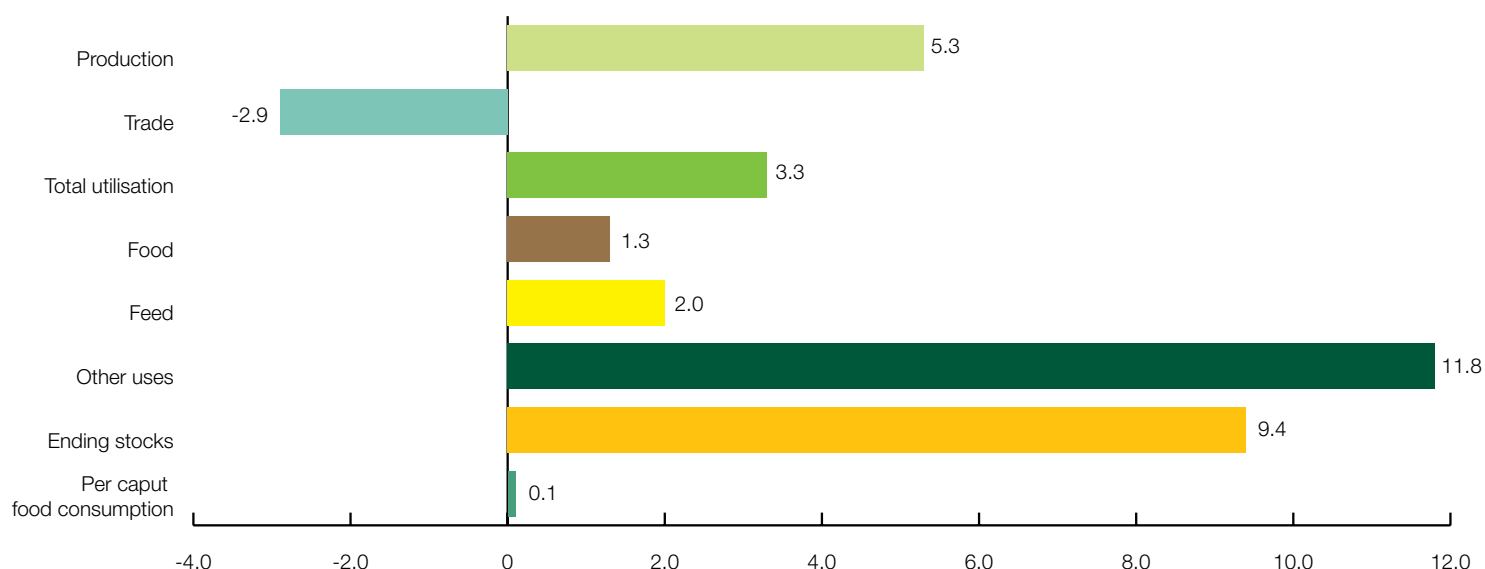
The challenges ahead no longer allow for an increasing distraction of agriculture from its primary duty to produce enough and healthy food for everyone. This is not only true for traditional agricultural non-food production, such as fibre, tobacco, rubber or timber plantations.

A new component in the food security debate is increasing malnutrition in agricultural areas where cash-crops, including biofuel crops, replace local food crops. **(Global Report, p. 10)**

A constantly increasing share of cereal production is no longer used as food but absorbed either as animal feed or for industrial purposes, namely biofuels. In addition, the share of agricultural land devoted to oilseed production (especially palm oil and soybean) and sugar cane have expanded substantially at the expense of forests as well as land devoted to grazing and food production.

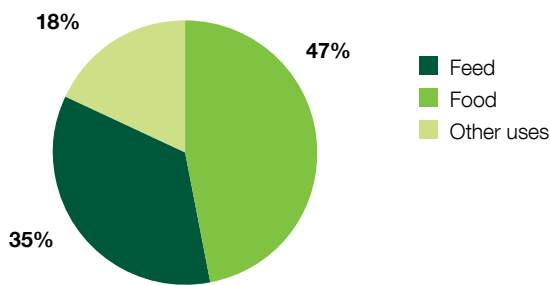
The expansion of crops for biofuels, such as sugar cane, oil palm, soybean and timber, is diminishing food production with a negative impact on food security in some regions and with a detrimental impact mainly on small-scale producers, indigenous populations and other traditional communities. **(Latin America and the Caribbean (LAC) Report, p. 4)**

Figure 2 Change from 2008/09 over 2007/08 in percentages



Source: FAO Food Outlook November 2008

Figure 3 Cereal use



Source: FAO Food Outlook November 2008

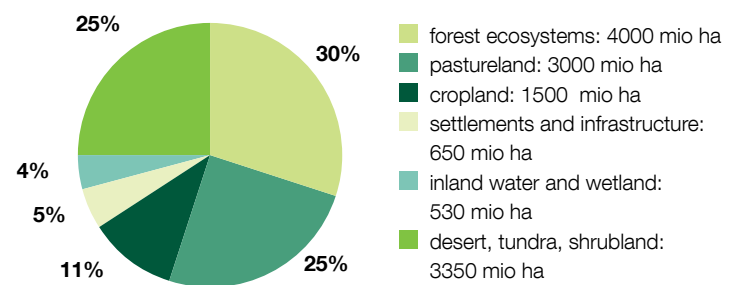
Less than half of the total global cereal production (not including oilseed where the ratio is even lower) is presently being used as food. As a consequence, according to the FAO, the predicted increase of cereal production of 5.3 % for 2008/2009 will result in only 0.1% increase in food availability per capita. 'Other uses' comprise fuel and energy production as well as industrial purposes.¹

An explosion of food prices in 2007-2008 has been attributed to, among other factors, an increased demand for biofuels under detrimental harvest conditions, exacerbated by global market speculation. Such price volatility has an immediate bearing on the prevalence of hunger but also on the conversion of land for cash-crop production, competing with food production. The poorest food-importing countries as well as the urban poor dramatically felt the impact of their dependency on global food prices and oil price developments.

Conclusions

To conclude, strategies to fight hunger and poverty, while maintaining and restoring the natural resources upon which all of our livelihoods depend and stimulating sustainable economic development, need to shift efforts from increasing overall bulk commodity production and productivity and global trade to improving local availability of food and sustainable productivity where it is needed.

Figure 4 Global land surface



Source: 'Adapted from Global Report, page 6' *

Climate Change

Agricultural production and consumption are among the most important contributors to climate change

According to recent carbon footprint analysis,² the entire chain of food production and consumption accounts for 20% of global greenhouse gas (GHG) emissions. In addition, indirect emissions resulting from land use changes predominantly driven by agriculture are responsible for another 6-17% of global GHG emissions,³ making the sector one of the most important contributors to climate change.

Agriculture covers about half of our planet's land surface (excluding Antarctica) and more than three-quarters of its biologically most-active land (as opposed to deserts, sealed surfaces). Because of the capacity of soils to actually sequester carbon long-term, it is one of the only economic sectors with the potential of reducing rather than increasing human greenhouse gas emissions by absorbing CO₂. However, at this point agricultural activities and the subsequent processing, storage, transport and disposal of its products are some of the most important sources of human-induced climate change. Reducing these greenhouse gas emissions and increasing the long-term storage of carbon in the soil are therefore essential measures to prevent a climate catastrophe.

* Today's land use patterns in general reveal the importance of agriculture as a major land management system, transforming and making use of natural ecosystems. Given a global land surface (without Antarctica) of 13,430 million ha (FAOSTAT, 2006), there is still about 30% forest ecosystems (nearly 4,000 million ha), part of which is the least converted in a biological sense. About a further 26% (3,400 million ha) is pastureland (FAOSTAT, 2006), of which about half was converted from natural grassland and the rest from forestland or woodland. About 11.5% is cropland (1,500 million ha) (FAOSTAT, 2006), most of which was also converted from forestland. The remaining share of the global land surface includes deserts, shrubland and tundra (about 25%), inland water surfaces and wetlands (about 4%), and built-up land for human settlements and other infrastructure (about 5%).

1 Adapted from FAO Food Outlook, global market analysis, November 2008 <http://www.fao.org/docrep/011/ai474e/ai474e01.htm>

2 Hertwich, E.G. and Peters, G.P. 2009. Carbon footprint of nations: a global, trade-linked analysis. Environmental Science and Technology 43: 6414-6420.

3 Bellarby, J., Foeroid, B., Hastings, A. and Smith, P. 2008. Cool farming: climate impacts of agriculture and mitigation potential. Greenpeace International: Amsterdam, Netherlands.

Hunger quotes over 45 years

So long as freedom from hunger is only half achieved, so long as two-thirds of the nations have food deficits, no citizen, no nation can afford to be satisfied. We have the ability, as members of the human race, we have the means, we have the capacity to eliminate hunger from the face of the Earth in our lifetime. We only need the will.

President J. F. Kennedy, World Food Congress, Washington D.C., 1963

.....

The profound comment of our era is that for the first time we have the technical capacity to free mankind from the scourge of hunger. Therefore today we must proclaim a bold objective: that within a decade no child will go to bed hungry, that no family will fear for its next day bread and that no human being's future and well-being will be stunted by malnutrition.

Dr. Henry Kissinger, World Food Conference, Rome, 1974

.....

We believe that it is indeed possible to end world hunger by the year 2000. More than ever before, humanity possesses the resources, capital, technology and knowledge to promote development and to feed all people, both now and in the foreseeable future. By the year 2000, all the world's people and all its children can be fed and nourished. Only a modest expenditure is needed each year - a tiny fraction of total expenditure which amounts to \$650 billion US dollars a year. What is required is the political will to put first things first and to give absolute priority to freedom from hunger.

FAO World Food Colloquium, 1992

.....

We pledge our political will and our common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015.

Rome Declaration on World Food Security, World Food Summit, 1996

.....

We resolve further: To halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of people who suffer from hunger and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water.

United Nations Millennium Declaration, New York, 2000

.....

We renew our global commitments made in the Rome Declaration at the World Food Summit in 1996 in particular to halve the number of hungry in the world no later than 2015, as reaffirmed in the United Nations Millennium Declaration. We resolve to accelerate the implementation of the WFS Plan of Action.

Declaration of the World Food Summit: five years later, Rome, 2002

.....

We reaffirm the conclusions of the World Food Summit in 1996, which adopted the Rome Declaration on World Food Security and the World Food Summit Plan of Action, and the objective, confirmed by the World Food Summit: five years later, of achieving food security for all through an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing by half the number of undernourished people by no later than 2015, as well as our commitment to achieving the Millennium Development Goals (MDGs).

Declaration of the High-Level Conference on World Food Security, Rome, June 2008

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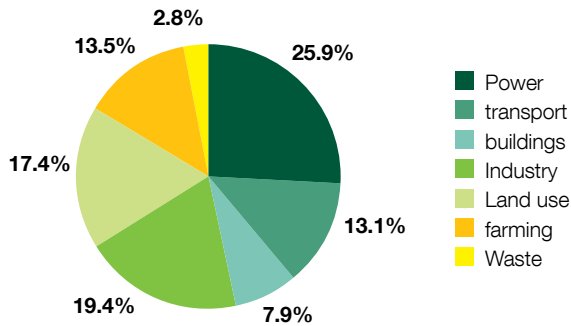
The 2000 Millennium Declaration aimed to halve the proportion of the world population facing poverty and undernourishment by the year 2015; the world is very far from reaching this goal according to the alarming data provided by the relevant international bodies.

We reiterate our determination to defeat hunger and to ensure access to safe, sufficient and nutritious food for present and future generations.

Declaration of the G8 agricultural ministers meeting, Cison di Valmarino, April 2009

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Figure 5 Greenhouse gas emissions in 2004 by source

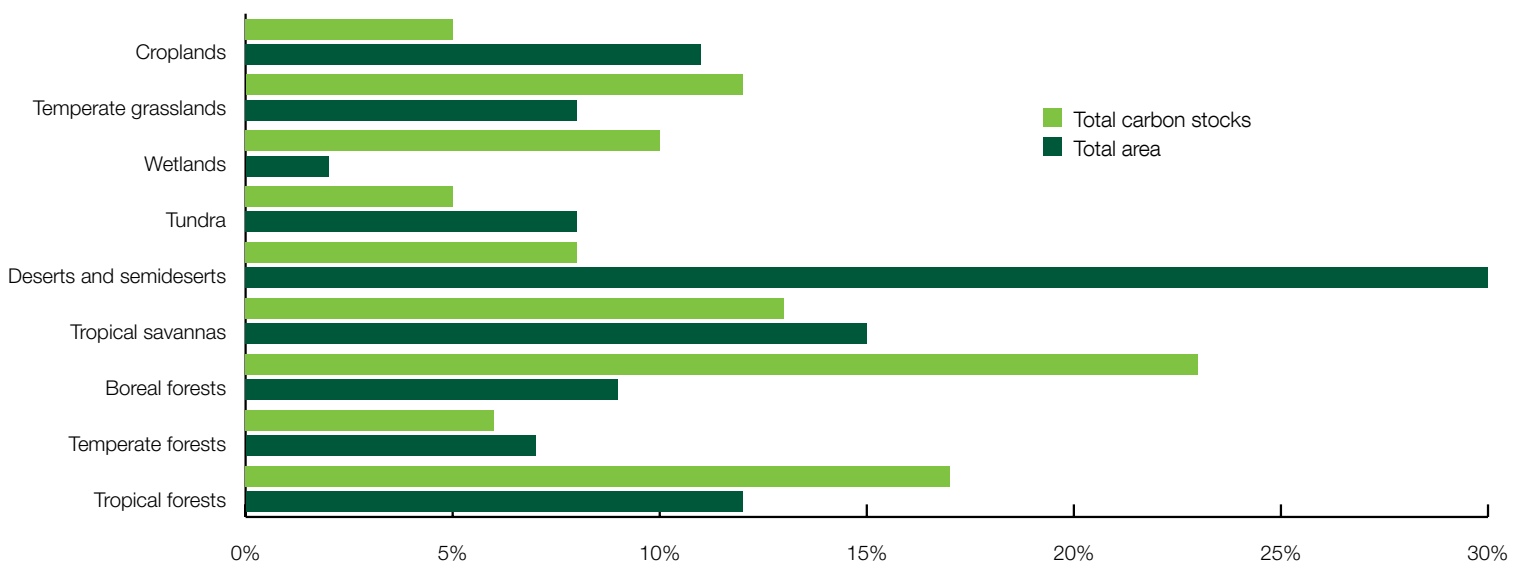


Source: IPCC, Working group 1, 2007

Agriculture contributes to climate change in several major ways including:

- Land conversion and plowing releases large amounts of stored carbon as CO₂ from vegetation and soils. About 50% of the world's surface land area has been converted to land for grazing and crop cultivation resulting in a loss of more than half of the world's forests. Deforestation and forest degradation releases carbon through the decomposition of aboveground biomass and peat fires and decay of drained peat soils.
- Carbon dioxide (CO₂) and particulate matter are emitted from fossil fuels used to power farm machinery, irrigation pumps, and for drying grain, etc., as well as fertiliser and pesticide production.
- Nitrogen fertiliser applications and manure applications as well as decomposition of agricultural wastes results in emissions of nitrous oxide (N₂O).
- Methane (CH₄) is released through livestock digestive processes and rice production.
- Altered radiative fluxes and evaporation from newly bare soils.
- Increased geographical distance between producer and consumer, together with regional agricultural specialisation, has resulted in greater energy use for transportation. (**Synthesis Report, p. 46**)

Figure 6 Global carbon stocks in vegetation and top one metre of soils.



Sources: IPCC 2001, Land use, land use change and forestry; Climate Change 2001: Working Group I: The Scientific Basis; <http://www.ipcc.ch/ipccreports/tar/wg1/099.htm#tab32>

The complete cycle of global meat production alone accounts for about 18% of global greenhouse gas emissions.⁴ Any additional meat production would have to be largely based on additional grain feed rather than grassland. Given conversion rates from grain to animal ranging between 7:1 (cattle) and 2:1 (chicken), a continued rise of meat production would be the single most important contributor to further global warming from agriculture and could hardly be offset by other measures.

This is obvious when looking at two major sources of primary GHG emissions from agriculture: methane (CH₄, 23-fold global warming potential of CO₂) primarily emitted from ruminants and paddy rice cultivation, and nitrous oxide (N₂O, 296 times CO₂ potential) emitted from soil fertilised with nitrate or manure. Their emissions have increased substantially over the past decades and are projected to steeply increase with extended livestock production and use of chemical fertiliser.

The highest emissions of greenhouse gases from agriculture are generally associated with the most intensive farming systems. (Synthesis Report, p. 47)

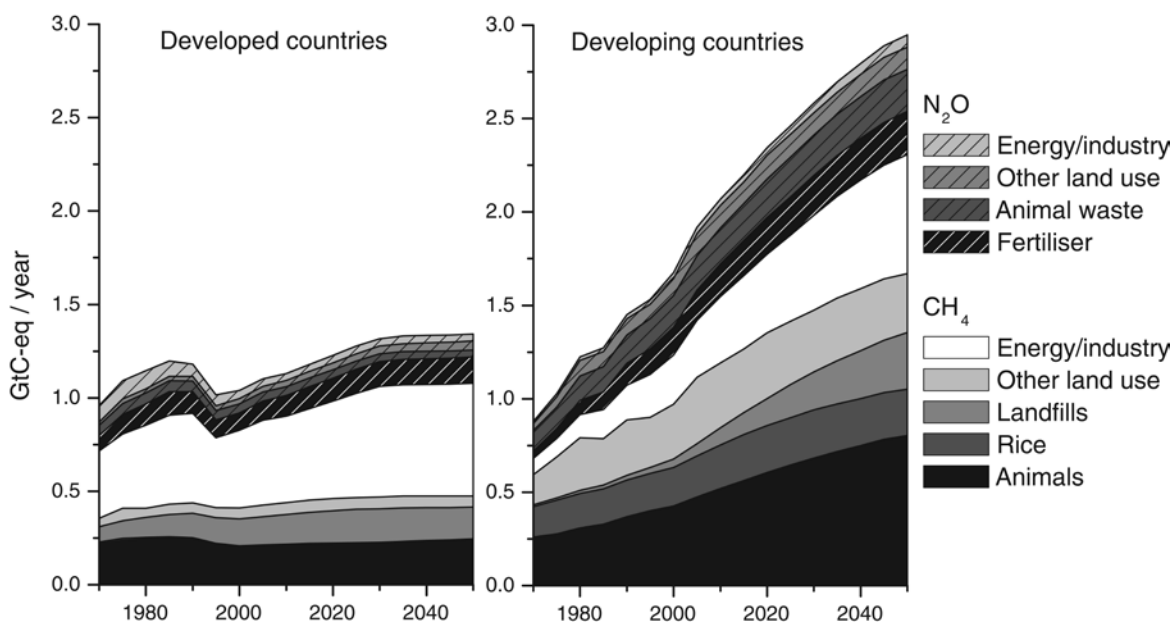
The IAASTD emphasises the fact that different agricultural systems vary enormously in their respective global warming impacts with respect to their direct emissions and carbon storage properties, as well as with respect to their inputs and consumption of fossil fuels at the level of production and at subsequent levels of transport, storage, processing, packaging, distribution and disposal.

In general, small-scale, agroecological farming and consumption systems producing for local markets at low levels of processing and packaging have substantially less global warming impacts than large-scale commodity production for global markets.

Some 'win-win' mitigation opportunities have already been identified. These include land-use approaches such as lower rates of agricultural expansion into natural habitats; afforestation, reforestation, increased efforts to avoid deforestation, agroforestry, agroecological systems, and restoration of underutilised or degraded lands and rangelands and land-use options such as carbon sequestration in agricultural soils, reduction and more efficient use of nitrogenous inputs; effective manure management and use of feed that increases livestock digestive efficiency. (Synthesis Report, p. 9)

4 Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and De Haan, C. 2006. Livestock's long shadow: environmental issues and options. United Nations Food and Agriculture Organisation: Rome, Italy. <http://www.fao.org/docrep/010/a0701e/a0701e00.HTM>

Figure 7 Estimated historical and projected N₂O and CH₄ emissions from 1970-2050



Source: Van Vuuren et al., 2007., Global Report page 288

The IAASTD emphasises the need to fully include agricultural practices in future international negotiations and capture the opportunities of mitigation, including carbon storage, as well as the enormous challenges of adaptation.

Most agricultural systems will have to adapt to climate change

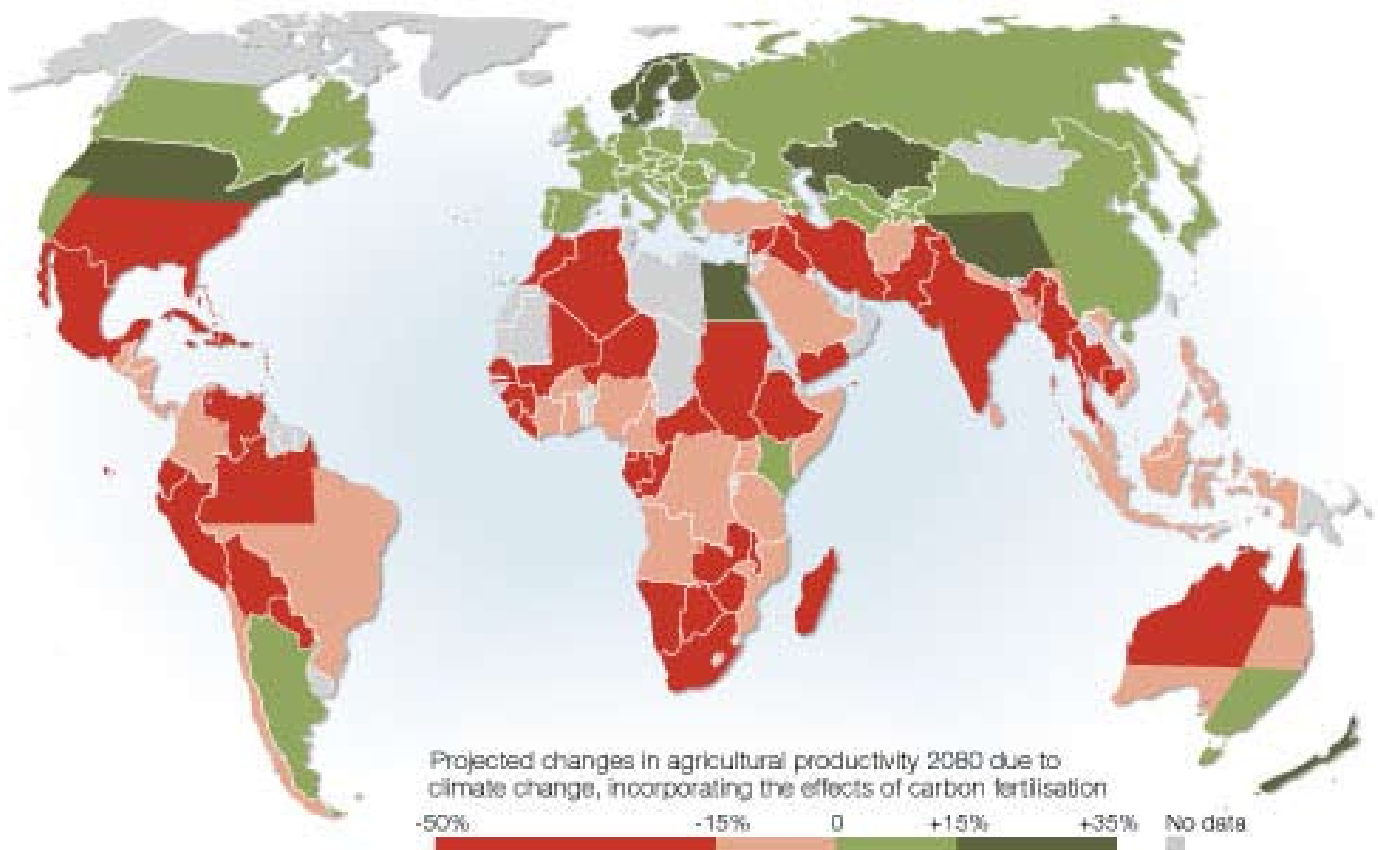
Agriculture is already substantially affected by climate change in some regions of the world and will have to adapt to further changes predicted to affect two-thirds of agricultural land world-wide. If global temperature rise could be kept around 2°C, overall impacts are predicted to be mixed for different regions of the world with some gains in higher latitude regions and losses in tropical and arid regions. Any temperature increase above this level will severely distress agricultural production on a global scale.

There is a serious potential for future conflict, and possible violent clashes over habitable land and natural resources, such as freshwater, as a result of climate change, which could seriously impede food security and poverty reduction. An estimated 25 million people per year already flee from weather-related disasters; global warming is projected to increase this number to some 200 million before 2050, with semiarid ecosystems expected to be the most vulnerable to impacts from climate change refugees. (Synthesis Report, p. 49)

Regions such as sub-Saharan Africa and Southeast Asia, which are under severe hunger stress today and whose societies are among the lowest per capita contributors to GHG emissions, will probably be among the first and most severely affected.

Assessing the impact of climate change on agriculture is still too complex a task to make reliable predictions, especially at

Figure 8 Projected losses in food production due to climate change by 2080.



Source: *The environmental food crisis - the environment's role in averting future food crises. A UNEP rapid response assessment. United Nations Environment Programme, February 2009, www.grida.no, page 46, quoting: Cline, W. R. (2007). Global warming and agriculture: Impact estimates by country.*

regional and local levels. However, the range of potential and likely consequences in different regions is sufficiently severe to start preparing for the most likely changes and worst cases well in advance. Initial impacts are already observed in many regions of the world. Droughts and floods, storms and tornados, rising sea levels and salinisation of groundwater, change of rainy season patterns, increased frequency of extreme weather conditions, depletion of glacial water reserves, loss of species, change of distribution of pests as well as disease vectors all will affect plant, animal and human health.

Climate change will increase heat and drought stress in many of the current breadbaskets in China, India, and the United States and even more so in the already stressed areas of sub-Saharan Africa. Once plants are weakened from abiotic stresses, biotic stresses tend to set in and the incidence of pest and diseases tends to increase. **(Global Report, p. 317)**

Present projections see major bread baskets of the world threatened with substantial losses of agricultural productivity, predicting especially grim prospects for sub-Saharan Africa as well as semi-arid regions in North Africa and Central Asia.

Linking early warning to more effective response requires a people-centered approach to climate change. The quest for early warning must be more than just an 'exercise in understanding how what is happening over there comes to be known by us over here'. Instead, the international community should focus on the real stakeholders and add to their capacity for social resilience. **(Global Report, p. 417)**

The ability of communities and farmers to adapt to changing climate strongly depends on local information and awareness levels as well as means of investment in appropriate action, which are clearly exceeding available national and regional capacities. Advanced technologies for early warning systems and bold means of coping with increased frequencies of extreme weather conditions must go hand-in-hand and much will depend upon local and regional communities' abilities to jointly organise emergency responses as well as long-term strategies to improve resilience. In many cases combined mitigation and adaptation strategies are available.

There is abundant scientific evidence that crop biodiversity has an important role to play in the adaptation to our changing environment. While oversimplified farming systems, such as monoculture, would not be able to cope with a changing climate, increasing the biodiversity of an agroecosystem can help maintain its long-term productivity, contribute significantly to food security and reduce risks

of crop failure.⁵ Such strategies include the use of a greater diversity of seed varieties and their local adaptation to environmental changes, as well as broadening the spectrum of crops and other plants for agricultural use, including the 're-discovery' of traditional food crops, sometimes dubbed as 'orphan crops' as they presently receive little attention by research and global trade. These efforts should be based upon fair and participatory modes of farmer-to-farmer exchange of experience with climatic and environmental conditions that may be new in one region, but familiar in other regions of the world.

Adaptation has a cost and often requires investments in infrastructure. Therefore, where resource endowments are already thin, adverse impacts may be multiplied by the lack of resources to respond. Farmers are masters in adapting to changing environmental conditions because this has been their business for thousands of years. This is a knowledge base farmers will need to maintain and improve, even if climate change may pose challenges that go beyond problems tackled in the past. **(Global Report, p. 41)**

The IAASTD also calls for appropriate global mechanisms to share the costs of climate adaptation as well as mitigation among societies and differently affected regions of the world. As those most severely affected are among those who contributed least to the present climate crisis, this is a matter of global justice. But it is also simply a matter of urgency of the world community's response to this global challenge in terms of most efficient and appropriate use of resources to mitigate and adapt to this unprecedented challenge.

Industrialised agriculture, generally situated at high latitudes and possessing economies of scale, good access to information, technology and insurance programmes, as well as favourable terms of global trade, is positioned relatively well to adapt to climate change. By contrast, small-scale rain-fed production systems in semi-arid and sub-humid zones presently contend with substantial risk from seasonal and interannual climate variability. Agricultural communities in these regions generally have poor adaptive capacity to climate change due to the marginal nature of the production environment and the constraining effects of poverty and land degradation. **(Global Report, p. 416)**

Presently available financial mechanisms and funds are far from adequate to provide meaningful resources to this urgent task. However, the sooner these resources are available, the lower the overall costs of mitigation and adaptation and the better the chances to meet the challenges ahead.

⁵ Cotter, J. and Tirado, R. 2008. Food security and climate change: the answer is biodiversity. Greenpeace International: Amsterdam, Netherlands. <http://www.greenpeace.org/eu-unit/press-centre/reports/food-security-and-climate-change>

03



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image Traditional Milapo farming, Okavango delta, North Western Botswana, the world's largest inland delta.

Part III Foundations

More than a third of the world's population still depends on farming as its main source of income and livelihood. Small farmers produce the lion's share of what we eat, but they produce much more. They maintain the ecosystems and biodiversity upon which we all depend, our landscapes and natural resources, the healthiness and wholesomeness of our food and the diverse cultural traditions, knowledge and wisdom of generations. Understanding and appreciating the multifunctionality of agricultural systems is the key to the change we need. Replacing quantitative concepts of food security with a qualitative and democratic approach of food sovereignty is the key to equitable perspectives of rural development and the promise that no child will go to bed hungry within the time of our generation.

"It is not too soon to provide by every possible means that as few as possible shall be without a little portion of land. The small landholders are the most precious part of a state."

Thomas Jefferson to James Madison, 28 October 1785

Small farmers are feeding the world

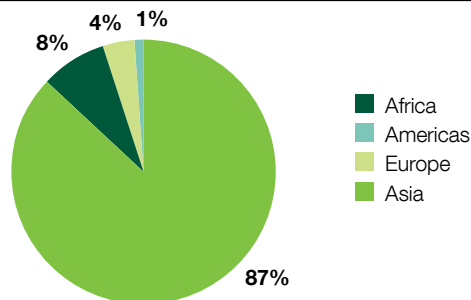
Agriculture is by far the biggest business of the world. Despite the global trend of urbanisation decreasing the percentage of small-scale farmers in the global population in recent decades, their absolute number is still increasing and is estimated to include approximately 2.6 billion people or 40% of the world's population. Small farmers produce most of the food consumed worldwide. The large majority of them cultivate less than 2 hectares in rural as well as increasingly in urban and peri-urban areas. Their number and share in the total population varies substantially throughout the world and is especially high in those Asian and African regions where hunger is still most prevalent.

Small farms occupy about 60% of the arable land worldwide and contribute substantially to global farm production. In Africa, 90% of agricultural production is derived from small farms. If a high percentage of a country's population is engaged in agriculture and derives its livelihood from small-scale farming, the whole sector is predominantly subsistence-oriented, which makes livelihoods extremely vulnerable to changes in direct drivers such as diseases, pests, or climate, even though its sensitivity to indirect drivers such as markets, infrastructure and external inputs is less pronounced. (Global Report, p. 8)

Small-scale and subsistence farming has traditionally been perceived as a backward trend and was utterly neglected by policy makers, institutions and academia during the past decades. National and international investment in small-scale farming and rural development

has steeply declined over the last decades of the past century from an already deplorably low starting point. With low accessibility and little purchasing power, small farmers and their communities, especially in remote areas, are not attractive targets and partners for modern agribusinesses and global markets and even tend to escape the statistical departments of governments (calling into question many assumptions about the true situation of global food and agriculture).

Figure 9 Distribution of small farms



Source: Global Report, page 8 (figure 1.3)

Note: Small-scale farms are defined as those of less than 2 hectares. The total number of small-scale farms is 404 million.

Putting small farmers back into the focus of agricultural development and highlighting their pivotal role in eradicating hunger and poverty as well as in addressing the most pressing challenges of environmental sustainability is one of the major paradigm shifts suggested by the IAASTD.

While the trend in industrial countries has been an increase in average farm size (from about ten to more than 100 ha), it has been the opposite in densely populated developing countries (from about 2 to <1 hectare). In some contexts small farm size may be a barrier to investment, however, small farms are often among the most productive in terms of output per unit of land and energy. As yet they are often ignored by formal AKST. Historical trends suggest that small-scale farms will continue to dominate the agricultural landscape in the developing world, especially in Asia and Africa, at least for the coming two to three decades. (Global Report, p. 9)

The fundamental reason to re-focus AKST towards the needs of small-scale farmers is the simple fact that they form the larger part of global agricultural land, produce most of the global food and at the same time host the majority of poor and hungry worldwide. Improving the performance of small-scale farms in terms of nutritional productivity, resilience to natural and economic threats and environmental sustainability is therefore the most important and most urgent approach to sustainable farming and food systems.

The means to achieve this goal are rather simple and straightforward: secure access to land and water, to appropriate seeds, know-how and basic technologies of water and nutrient management combined with improved extension services, a basic social security net as well as access to minimal health and education services. In addition, improving rural infrastructure, such as transport and storage facilities, access to local and regional markets and availability of micro-finance services for basic investments in higher productivity and basic processing facilities are fundamental means of progress, presently not available to millions of rural poor in developing countries.

Many small-scale systems have not been able to compete with industrialised production systems for a number of reasons, including subsidies given to farmers in industrialised countries, cheap fossil energy in mechanised systems compared to metabolic energy in small-scale systems, stabilised market prices in industrialised countries as opposed to completely liberalised prices in developing countries, and the inability to access inputs on favourable terms as compared to large-scale systems. **(Global Report, p. 9)**

The majority of small farmers worldwide have not benefited from most of the technology breakthroughs in agricultural research and development, or from the development of a global market for agricultural products. On the contrary, millions of smallholders have been entangled in a vicious downward cycle of “decapitalisation” over the past decades that deprived them from the means to secure

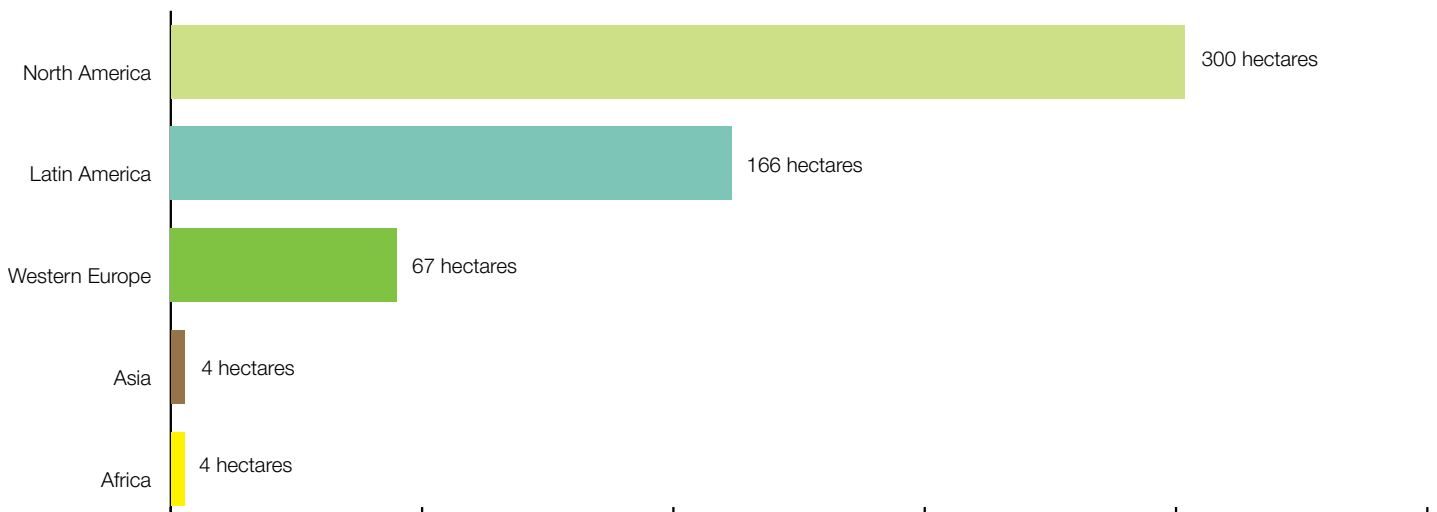
the food for their communities, maintaining their traditional roles and investing in improvement and adaptation of their farming operations.

Decapitalisation (e.g., through sale of livestock and equipment), deterioration of infrastructure and natural capital (e.g., soils), and the general impoverishment of peasant communities in large areas in developing countries remains a serious threat to livelihoods and food security. The loss or degradation of production assets is linked to the overexploitation of scarce resources (land, water, labour), markets that are inequitable and difficult to access, competition from neighboring farms, and in some instances the combined effects of competition from the industrialised sector (leading to low prices), and the direct and indirect taxation of agriculture. **(Global Report, p. 14)**

In addition to these socio-economic realities, which must be addressed by any meaningful attempt to overcome poverty and hunger, the IAASTD emphasises the pivotal role the traditional and local knowledge of smallholder farmers will have to play in addressing the major challenges of mitigating and adapting to climate change, maintaining biodiversity and developing the low-input agricultural systems required to overcome fossil fuel and pesticide dependency.

Though the productivity per unit of land and per unit of energy use is much higher in these small and diversified farms than the large intensive farming systems in irrigated areas, they continue to be neglected by formal AKST. **(Synthesis Report, p. 22)**

Figure 10 Comparison of average farm size in different regions in hectare



Source: Global Report, page 8

As we will explore over the next chapters, small farmers according to the IAASTD are neither backward, doomed to extinction by agro-industrial progress nor are they in need of patronising alleviation to 'modern' standards of production. Their ingenuity and adaptive capacities, their fundamental social and cultural role in rural societies and their traditional and local knowledge are actually key ingredients of post-industrial concepts of sustainable, biodiversity-based agri-food systems of the future. Where science and technology, financial institutions and development agencies start to learn from and adapt to the needs of small-scale farming and develop participatory concepts of combining their strengths we can probably expect the truly leading edge of sustainable AKST.

AKST research and development has failed to address the 'yield gap' between the biological potential of Green Revolution crops and what the poor farmers in developing countries typically manage to produce in the field. The challenge is to find ways to close this yield gap by overcoming the constraints to innovation and improving farming systems in ways that are appropriate to the environmental, economic, social and cultural situations of resource poor small-scale farmers. An additional requirement is for farm products to be fairly and appropriately priced so that farmers can spend money on the necessary inputs. **(Global Report, p. 223)**

The IAASTD sees an enormous potential in appropriate investment in small-scale farming systems, which will not only provide the highest return on investment regarding food security and poverty eradication, but also offers the best hope to achieve the necessary productivity gains while avoiding the typical environmental and social costs at which such increased productivity came in industrial farming systems.

Multiple ecological functions of agriculture

Among the most important merits of the IAASTD is probably its attempt to provide a holistic picture of the different services and challenges of agriculture. Agriculture is the most important business in the world, both with respect to its economic and social role and as regards the maintenance of the world's surface, natural resources and myriads of ecosystems. Agriculture accounts for a major part of the livelihood of 60% of the world's population. More than half of the Earth's surface is intensively used for agricultural purposes. The quantity and quality of food production and consumption are the most important drivers of public health, with respect to under-nutrition, over-nutrition and various forms of malnutrition.

Small-scale diversified farming is responsible for the lion's share of agriculture globally. While productivity increases may be achieved faster in high input, large scale, specialised farming systems, greatest scope for improving livelihood and equity exist in small-scale, diversified production systems in developing countries. This small-scale farming sector is highly dynamic, and has been responding readily to changes in natural and socioeconomic circumstances through shifts in their production portfolio, and specifically to increased demand by increasing aggregate farm output. Small-scale farmers maximise return on land, make efficient decisions, innovate continuously and cause less damage to the environment than large farms [...]

AKST investments in small-scale, diversified farming have the potential to address poverty and equity (especially if emphasis is put on income-generation, value-adding and participation in value chains), improve nutrition (both in terms of quantity and quality through a diversified production portfolio) and conserve agrobiodiversity. In small-scale farming, AKST can build on rich local knowledge. Understanding the agroecology of these systems will be key to optimising them. The challenges will be to: (1) to come up with innovations that are both economically viable and ecologically sustainable (that conserve the natural resource base of agricultural and non-agricultural ecosystems); (2) develop affordable approaches that integrate local, farmer-based innovation systems with formal research; (3) respond to social changes such as the feminisation of agriculture and the reduction of the agricultural work force in general by pandemics and the exodus of the young with the profound implications for decision-making and labour availability. **(Global Report, p. 379)**

Last but by no means least, agriculture ensures the delivery of a range of ecosystem services. In view of a globally sustainable form of development, the importance of this role may increase and become central for human survival on this planet. **(Global Report, p. 15-16)**

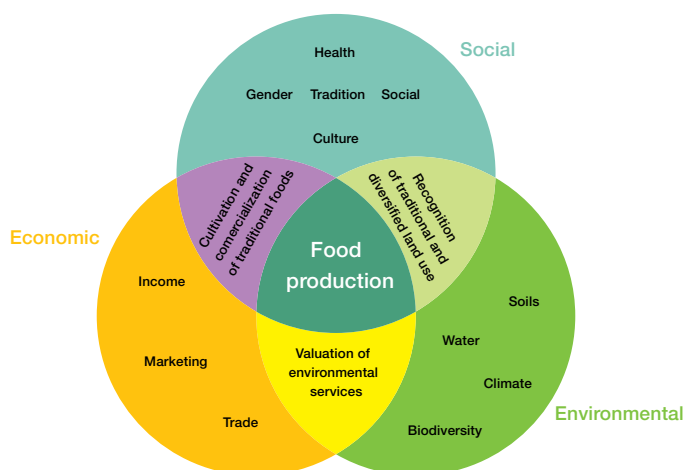
The IAASTD's aspiration of bringing all these aspects together in order to allow for coherent policy choices and integrated priority setting at international and national levels has yielded probably more questions than answers. Scientists still do not have a comprehensive framework within which to integrate these various dimensions of agriculture's multifunctionality and often seem to even lack common language and terms of reference, not to speak of concepts for how to systematically interrelate the different goals, risks and benefits, choices and stakeholders.

By definition, the principle of multifunctionality in agriculture refers to agriculture that provides food products for consumers, livelihoods and incomes for producers and a range of public and private goods and services for citizens and the environment, including ecosystem functions. Existing specialisation in the global agri-food system, coupled with government investments and policies in production and trade has led to a view of agriculture as an exclusively economic activity, measured in commodity-based, monetary terms. **(Synthesis Report, p. 23)**

The use of the term 'multifunctionality', already highly contested within different 'schools' of participating scientists, is even more so among government representatives, as it plays a specific role within the World Trade Organisation's negotiations.

In a world governed from cities, by people sitting in front of computer screens, and living in a global economy driven by urban activities, decision-makers tend to overlook the unique and pivotal role of agriculture not only providing the very basis of our lives, food, but also managing the lifelines of our macro- and micro-systems of survival. Overcoming this neglect and ignorance at the level of policy, economic investments, research and development, culture, media and public discourse is imperative to address the environmental and economic challenges ahead. It is certainly indispensable for any meaningful action to combat hunger and poverty in times of climate change and depleting natural resources.

Figure 11 A multifunctional perspective of agriculture



Source: IAASTD Summary for Decision Makers of the Global Report, page 12

The term multifunctionality has sometimes been interpreted as having implications for trade and protectionism. This is not the definition used here. In IAASTD, multifunctionality is used solely to express the inescapable interconnectedness of agriculture's different roles and functions. The concept of multifunctionality recognises agriculture as a multi-output activity producing not only commodities (food, feed, fibres, agrofuels, medicinal products and ornamentals), but also non-commodity outputs such as environmental services, landscape amenities and cultural heritages. (...)

The use of the term has been controversial and contested in global trade negotiations, and it has centered on whether 'trade-distorting' agricultural subsidies are needed for agriculture to perform its many functions. Proponents argue that current patterns of agricultural subsidies, international trade and related policy frameworks do not stimulate transitions toward equitable agricultural and food trade relation or sustainable food and farming systems and have given rise to perverse impacts on natural resources and agroecologies as well as on human health and nutrition. Opponents argue that attempts to remedy these outcomes by means of trade-related instruments will weaken the efficiency of agricultural trade and lead to further undesirable market distortion. **(Synthesis Report, p. 4)**

As an activity, agriculture has multiple outputs and contributes to several ends at the same time. Agricultural resource management thus involves more than maintaining production systems. Services such as mitigating climate change, regulating water, controlling erosion and support services such as soil formation, providing habitats for wildlife, as well as contributions to cultural activities such as use and preservation of landscapes and spiritual sites are some of the positive functions that agriculture provides. **(Global Report, p. 6)**

The concept of multifunctionality acknowledges public services provided by farmers, especially small-scale farmers to their communities, nations and humankind. These services must be properly rewarded and have to be subject to fair and equitable negotiations and tradeoffs, involving all their providers and beneficiaries. Agricultural products are traded and have a market price. Most of the other services are public goods and commons for which there is no market. This does not imply that they are less valuable, especially not where they cannot be easily replaced and replenished. But it makes them vulnerable to neglect, destructive exploitation and unregulated appropriation.

When looking at the bulk of data, evidence and detailed analysis provided by the IAASTD and realising their alarming message, a lack of simple conclusions, rules and imperatives derived from this knowledge may strike readers as a major deficiency of the report. While this has its roots in the basic agreement that this assessment should not be 'policy prescriptive', this laudable approach may also conceal a certain level of understandable helplessness of the experts and an enormous deficit of present science: integration of different scientific disciplines and conceptual dimensions is urgently needed in order to address the multiple natural, economic and social crises with which humanity is faced. This may also be one of the strongest reasons for a continuation of the IAASTD's assessment.

Farmers and their communities are used to thinking and deciding in a multifunctional context at a local level. This perspective allows for a site-specific, pragmatic reduction of complexities. Scientists and politicians could learn a lot from such a farming or gardening approach to the problem.

The enormous social and cultural challenges, as well as economic and environmental threats and risks, can probably best – though certainly not exclusively – be met and integrated by improving resilience, reducing as much as feasible dependency on external factors and by keeping alive and building strong, reliable capacities, competence and innovative potential at the smallest possible level. The multifunctionality of agriculture calls for a bottom-up approach and should humble the hubris of global market and governance regimes, which have so far proved unable, if not unwilling, to address and resolve the basic exigencies of survival and human rights. However, in the globalised world we live in, this approach in itself needs world-wide support. Efforts to facilitate and back up the re-localisation of agriculture are urgently needed to secure the full range of its services and to no longer grind down peasants' and communities' enormous potential for innovation and adaptation.

Food sovereignty

Food sovereignty is defined as the right of peoples and sovereign states to democratically determine their own agricultural and food policies. **(Global Report, p. 10)**

The IAASTD is the first intergovernmental, UN-led process to introduce and promote the concept of food sovereignty. The assessment credits the international peasant and smallholders association 'La Via Campesina' with coining the term and defining the right to food as a fundamental human right to be based upon constitutional guarantees, equitable access to land and land reforms, protection of natural resources, reorganising of food trade, control of transnational companies, social peace and democratic control, including small-scale farmers' and especially womens' direct input to agricultural policies at all levels.

The concept of food sovereignty has come about as a reaction to the definition of food security, which promotes the notion that everyone should have food, but doesn't specify where it will come from, or who will produce it, allowing control of food by large multinational companies, which may contribute to creating more dependency, poverty and marginalisation. **(Latin America and the Caribbean (LAC) Report, p. 20)**

Food sovereignty is based upon the rights of small farmers and their communities in the first place. It also entails a concept of national sovereignty with respect to food policies and questions the legitimacy and efficacy of international trade agreements as well as international structural adjustment programmes imposing trade liberalisation measures and increased dependency from imported food upon national governments.

The structural adjustment policies were aimed at helping countries cut down their debt. Many SAPs required developing countries to cut spending. As a result, centralised seed distribution programmes, price supports for food and farm inputs, agricultural research, and certain commodities (often locally consumed foods) were eliminated or downsized. While national support systems protecting traditional livelihoods (maintaining native crops, landraces, etc.), food security, rural communities, and local cultures suffered, private corporations were given loans to partner with developing countries to develop industrial agriculture with crops mainly for export. Such financial mechanisms controversially promoted monocultural cropping that required farm inputs such as commercial seeds, chemicals, fossil-fuel based machinery, as well as requiring an increase in water usage. **(Global Report, p. 220)**

Food sovereignty is a bottom-up concept to secure the universal right to food, enhance rural livelihoods and maintain natural resources. It confronts inequities and market failures as well as discrimination against peasants, especially women and indigenous communities, on regional, national and international levels. It is probably best understood as a social movement to guarantee and protect people's space, ability and right to create and define their own models of production, food distribution and consumption. It aims to regenerate and improve a diversity of autonomous food systems based on equity, social justice and ecological sustainability, starting at the household level and expanding to neighborhood, community, municipal and regional levels.

The food sovereignty movement is rooted in the long history of thousands of communities and social movements, including landless peasants, defending localised food systems against corporations, military and militias, landlords, corrupt politicians, middlemen and moneylenders. The concept of food sovereignty has been spelled out at an international level, especially in the follow up to the WTO's Uruguay Round's inclusion of agricultural trade and the ongoing negotiations in the Doha Round and in bilateral trade agreements. It was presented by NGOs and social movements at the World Food Summit 1996 and has expanded to disputes about intellectual property rights over seed, animals and germplasm derived from traditional and indigenous knowledge.

Food sovereignty has a broader dimension, since it incorporates issues such as agrarian reform, territorial control, local markets, biodiversity, autonomy, cooperation, debt and health, all of which have to do with local food production. Advocates of the concept of food sovereignty argue that to attain a world without hunger one must place the communities centre stage [...]

For civil society, food sovereignty, as a different paradigm, is needed to ensure that the developing countries can attain food security, rural employment and the goals of sustainable development. For the developing countries, food sovereignty encompasses the demand that the World Trade Organisation (WTO) put an end to its control over food and agriculture. Food sovereignty basically recognises that small farmers and landless peasants will never be able to compete in the entrepreneurial agricultural paradigm. **(Latin America and the Caribbean (LAC) Report, p. 20)**

The IAASTD's recognition and embracing of the food sovereignty concept is a significant step out of science's ivory tower and towards trans-disciplinary co-operation of all stakeholders involved.

04



© GREENPEACE / DANIEL BELTRÁ

image Amazon Deforestation Documentation (Brazil: 2006)

Part 4

Business as usual is not an option

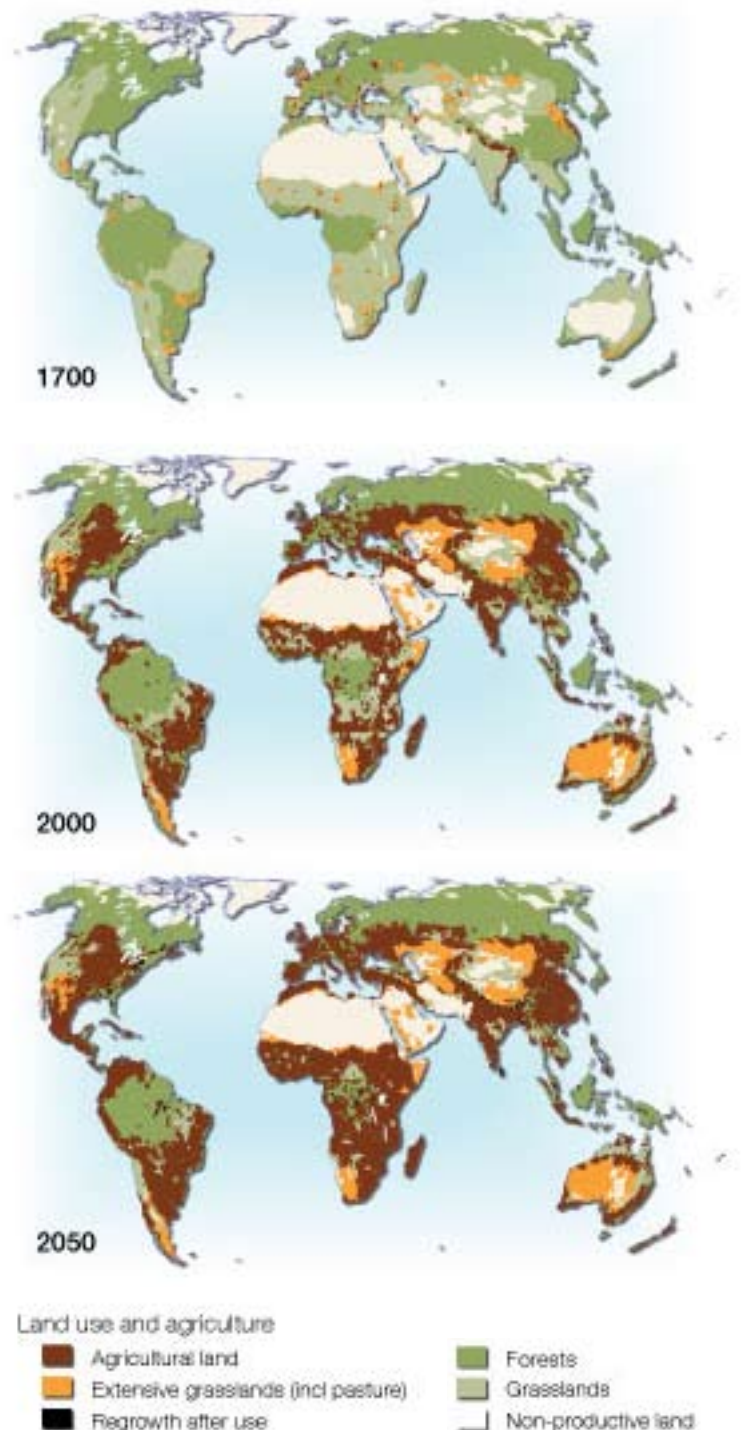
The way humanity has nearly tripled agricultural outputs over the past 50 years has come at unbearable costs for the environment, public health and social welfare. Industrial farming with its dependency on fossil fuels, toxic inputs and ignorance for common goods has proven to be a dead-end road. What are the drivers of this flawed concept of progress and what made this concept so attractive to global and national decision makers?

How industrial and chemical-intensive farming destroys our planet

Over the past 50 years humankind has altered the face of the Earth to an unprecedented extent, leading us to understand that our planet's bearing capacities are limited and humanity's path of industrial progress has taken us to these limits, in many respects even beyond. The industrial revolution, which has enabled enormous productivity gains of a steeply rising number of humans on this planet over the past 150 years, was largely based upon the extraction and exploitation of fossil energy sources on one side and a massive conversion of land to agricultural use on the other.

Ever since the Neolithic agricultural revolution, the rise and fall of civilisations has been closely linked to their success or failure to combine increased agricultural productivity with sustainable natural resource management. While historic examples had always been regional, globalisation of our industrial agricultural production systems has taken the risks of failure to a global level. However, the environmental consequences of different agricultural practices in different ecosystems vary enormously. There is no inevitable link between the environmental impact of agricultural systems and their productivity, even less their nutritional efficacy.

Figure 12 Projected land use changes



Designed by Hugo Ahlenius, Nordpil

Source: *The environmental food crisis - the environment's role in averting future food crises. A UNEP rapid response assessment. United Nations Environmental Programme, February 2009, www.grida.no*

Today, agriculture accounts for over 70% of our total freshwater withdrawal and is the most important source of water pollution; it has generated most of past and present deforestation and biodiversity loss; it is a major emitter of greenhouse gases and toxic substances and it is the key driver of soil erosion and soil fertility losses as well as desertification. Most environmental threats of global magnitude are actually directly rooted in present industrial agricultural practices.

The fundamental failure of the economic development policies of recent generations has been reliance on the draw-down of natural capital, rather than on production from the 'interest' derived from that capital and on the management of this capital. Hence there is now the urgent challenge of developing and using AKST to reverse the misuse and ensure the judicious use and renewal of water bodies, soils, biodiversity, ecosystem services, fossil fuels and atmospheric quality. (Global Report, p. 223)

The patterns associated with the now dominant global agricultural model known as 'industrial agriculture' are not clearly defined. They implement principles of industrial production, such as continuous growth, constant improvement of profitability and labour productivity as well as competitiveness on an ever-expanding market and range of comparative cost advantages. They also entail a concept of producing standardised commodities for industrial processing, which allow for exchangeable inputs sourced from a global market to provide the components of a diversity of final products. Economies of scale in production, trade, processing, retail and branding are a driving force of industrial agriculture. Recently, this has been complemented by transnational strategies of vertical integration of agricultural inputs, primary production, transport, storage and the various steps of processing and distribution.

Figure 13 Global trends in cereal and meat production

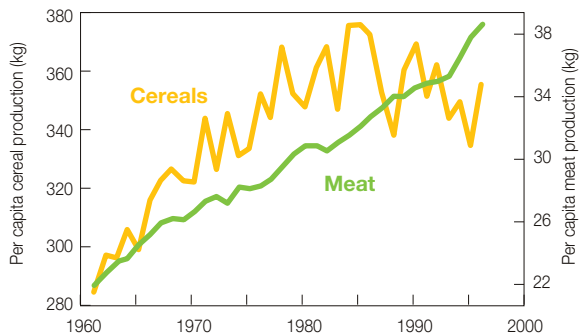


Figure 14 Global total use of nitrogen and phosphorus fertilisers

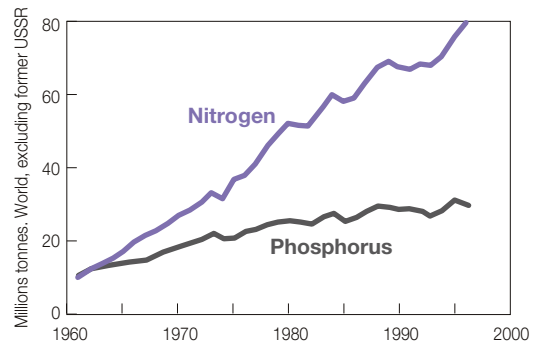


Figure 15 Increased use of irrigation

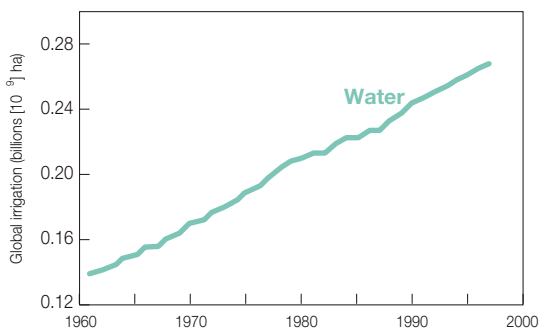
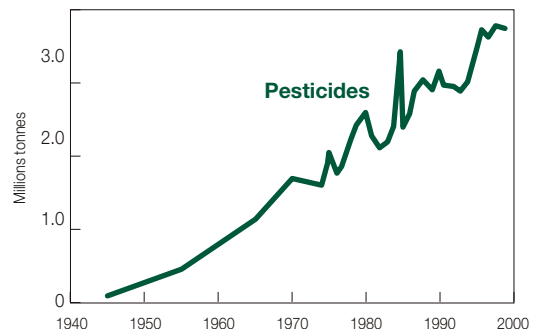


Figure 16 Total global pesticides production



Source: Tilman et al., 2002

In this concept human exchange with nature in primary production is but one component to be adapted to the overall requirements of an increasingly complex process, usually by means of standardisation and rationalisation. Hence, instead of adapting agricultural production to the opportunities and limits of different ecosystems, it rather attempts to adapt ecosystems to the needs of industrial mass production. Where such adaptation does not appear to be profitable, it eventually abandons entire areas or modes of production. As a result, some of the overarching patterns of industrial agriculture are:

- Exclusive focus on maximising production and productivity of individual commodities and products
- Monocultural agricultural practices, depending on chemical (fertiliser and pesticide) and fossil fuel input
- Overexploitation of limited natural resources
- Externalisation of environmental, social and other costs not priced on the market
- Concentration on national and international markets and their control
- Loss of local and regional knowledge, including common values
- Disregard for agriculture's prime purpose of providing food and livelihood
- Loss of community and farmer control over land use

A major problem of global, market-driven industrial agriculture is its inability to pursue overall social, environmental and equity goals and objectives, which are only partially or not at all reflected in conventional market rules and terms of trade. Its inability to appropriately address the multifunctionality of agriculture and its many services beyond production for the market leads both to the depletion of common natural and social resources and failure to provide the level of public goods and commons which only agriculture can provide.

The introduction of high-yielding varieties combined with artificial fertilisers, pesticides, higher levels of mechanisation and in many cases irrigation systems has resulted in substantial increases of yield during the second half of the last century, especially in industrialised countries, as well as large parts of Asia and Latin America.

The establishment of profitable markets for these inputs led among other things to the development of a powerful input industry, providing those farmers with sufficient purchasing power with agrochemicals, seed and machinery. The combined influence of this industry and large-scale farmers and landowners on national and international agricultural policies has been remarkable. Supported by public policies and substantial amounts of subsidies,

in industrialised and industrialising countries, a booming market for agricultural inputs and commodities has been captured by large transnational agrochemical and commodity trade corporations. They have recently also incorporated the lion's share of commercial seed production worldwide. Private research, development and extension subsequently outpaced, often replaced and profoundly shaped remaining public investment in agricultural R&D in industrialised countries.

Industrial agriculture's apparent productivity boosts also attracted increasing shares of national and international public research and development investments in some developing countries of Asia and Latin America. Concentrating on favourable agricultural areas and sometimes supported by massive infrastructural investments in irrigation, transport and storage, industrial monocultures of rice, maize and wheat, as well as cotton and oilseed cash-crops replaced traditional agri-food systems. Introduction of high-yielding varieties combined with artificial fertiliser, pesticides and machinery increased agricultural output dramatically, yet not necessarily food security in those regions.

However, this success story of the so-called 'Green Revolution' has come at a high price with respect to its environmental, social and cultural consequences, as well as the basic resources upon which it fundamentally relies: soil and water. Moreover, it has also substantially reduced the available options to respond to new challenges and changing conditions. Public involvement, control and decision making at local, regional and national levels on the way we produce and consume our food has been eroded and essential decisions on food security, land use and natural resource management have been entrusted to an alarmingly small number of companies and actors on the field. Conflicting interests and disconnects from agriculture's primary functions have resulted in ill-devised public policies, destructive market dynamics and outright market failures.

The history of chemical control illustrates a phenomenon in agricultural science and technology development, in which early success of a technical innovation (often measured by a single agronomic metric such as productivity gains), when accompanied by significant private sector investment in advertising and public relations and by direct and indirect policy supports from dominant institutional arrangements, translates into narrowing of organisational research and extension objectives, widespread if uncritical grower adoption and delayed recognition of the constraints and adverse effects of the technology (e.g., resistance, health hazards, etc.). (Global Report, p. 99)

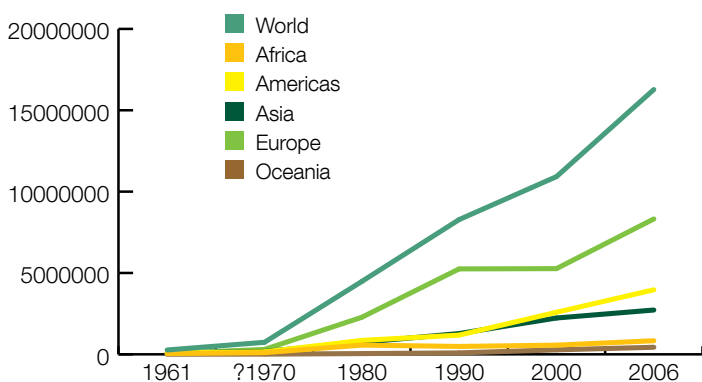
The use of pesticides may serve as a typical example. While farmers have a natural interest in optimising longer term productivity and profitability of their agricultural operations, including protection of their own health and maintenance of customer satisfaction, pesticide producers on the other hand are primarily concerned with optimising and expanding sales of their products.

Chemical control had its roots in US and German chemical research before and after both World Wars and was driven by formal interagency collaboration between military and public sector chemists and entomologists. The emphasis on crop protection and risk minimisation supported pest control, rather than management and pest eradication using synthetic chemicals. The approach underpinned the priorities of industrial countries: maximising food and fibre production, increasing efficiency and releasing labour to other economic sectors. Research and extension efforts directed at biological, cultural and mechanical management of risk dropped sharply at this time. The pesticide industry grew rapidly, initially financed through government contracts and then loans, a practice that necessitated constant product innovation and marketing to repay debts. Significant concentration has occurred; by 2005, the top six multinational pesticide corporations accounted for 75% of the US\$29,566 million global pesticide market. (Global Report, p. 98)

With bold support from government agencies, the large-scale introduction, following World War II, of the concept of chemical control - rather than diversified management of unwanted insects, plants and fungi in the field, as well as in storage and processing - has served as a cornerstone of industrial agriculture. Pesticides allow for monocultures that would be unmanageable with natural means. A chemical crusade was waged against weeds and pests, which are the inevitable result of large-scale planting of single crops. Pesticide use also allows for dramatically reduced labour input, economically reflected as increased labour productivity. However, this 'chemical warfare' was soon retaliated against by pesticide resistance, necessitating constant 'product innovation', which in turn was met by equally constant adaptation of pests and resulting in what is now called the 'pesticide treadmill'.

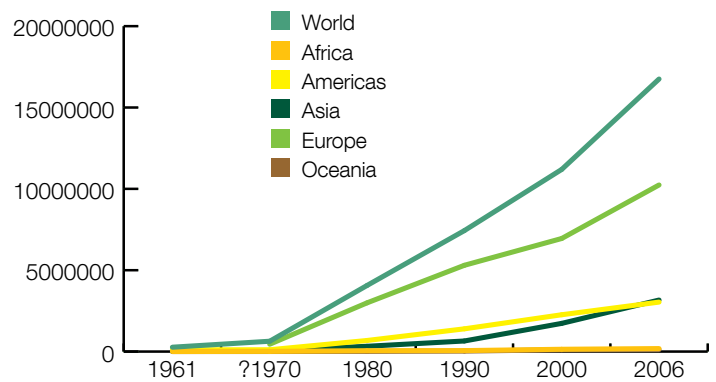
Breeding efforts, built on the assumption of effective chemical control and neglecting needs of diversity and natural resistance, were adapted to this concept of chemical control as well as chemical fertiliser availability. A global agrochemical industry today provides resource-rich farmers with essential products for their success: herbicides, insecticides, fungicides, chemically treated and conditioned high-yielding hybrid or patented seeds, complemented by private extension services and information networks. Lately these inputs include seed varieties genetically engineered to withstand some broad-spectrum herbicides, thus allowing for their permanent and relentless application throughout the growing season as well as pre- and post-harvest clearing of the land.

Figure 17 Pesticide imports 1961 - 2006 in 1000 US \$



Source: FAO STAT / Resource STAT / Pesticides Trade. <http://faostat.fao.org/site/423/default.aspx#ancor>

Figure 18 Pesticide exports 1961 - 2006 in 1000 US \$



Source: FAO STAT / Resource STAT / Pesticides Trade. <http://faostat.fao.org/site/423/default.aspx#ancor>

The WHO has estimated that between two and five million cases of pesticide poisoning occur each year and result in approximately 40,000 fatalities. **(Global Report, p. 34)**

When the unacceptable detrimental impacts of pesticide use for human health and the environment became apparent, it proved and still proves to be extremely difficult to implement the necessary and in most cases well-known and proven remediation measures against the bold dynamic of economic interests established and thriving on this system. Organic solutions, bio-control measures, integrated pesticide management concepts and others threaten the sales and profitability of a powerful industry. They also tend to require more knowledge and in some cases higher labour input at the farmer's end. As a result their implementation at the farmer level as well as in education and training, research and development is a constant and bitter-fought struggle rather than a welcome and jointly supported innovation. Conversion to reduced or no pesticide use appears as a formidable challenge, if not impossible to millions of farmers, not because there are no alternatives, but because these alternatives are neither systematically promoted and made available, nor supported by the appropriate level of research, development and extension. The required systemic changes of prevailing industrial farming methods to this end would be massive in many cases and are difficult to accomplish on an individual basis. However, sufficient market incentives and structures and government investments and programmes, including regulations and tariffs, that would reflect public costs of pesticide use are lacking.

Despite the tightening national and international regulatory environment around synthetic pesticides and notwithstanding the documented success of ecological pest management in most crops and a fast-growing market for organic products, sales and use of synthetic pesticides is still growing, especially in developing countries. These trends continue to result in pesticide-induced pest outbreaks and an unacceptably high level of unintentional pesticide poisonings under conditions of actual use, mostly but not solely in the developing world. Public sector commitment to pesticide reduction efforts and investments in IPM and other ecological approaches has not been consistent over time. The prevalence of the use of synthetic pesticides today reflects their immediate results, path dependency at farm and institutional support levels, and the significant political and economic influence of agribusiness interests, trade associations and lobbying groups in the regulatory and policy arena. This influence has sometimes downplayed research findings on harmful effects and weakened regulatory assessment of risks. **(Global Report, p. 106)**

In recent years, changes in pesticide use have been implemented more rapidly and readily in industrialised countries such as the US and those in the EU, where consumer concerns as well as environmental activism are more powerful factors in the overall decision making arrangement, and democratic control of government regulations and investments, including public subsidies, plays a more important role than in many developing countries.

A key constraint in this context appears to be that most alternatives to chemical controls are not tradable products but rather changes in production methods. In addition, many of these changes (e.g., crop rotation, mixed cropping and diversification) do not fit the needs of most export-oriented cash-crop systems and are more easily applied by more labour-intensive small-scale farms than larger units with higher levels of mechanisation.

Pesticide use is increasing on a global scale, but increases are not universally observed; several of the most hazardous materials are being phased out in well-regulated markets. In constant dollars, global expenditures on agricultural pesticide imports has increased more than 1000% since 1960 with some estimates placing recent growth rates for pesticide use at between 4.0 and 5.4% per annum. **(Global Report, p. 152)**

Consumer concerns in general play a more important role as driver of agronomic practices wherever they have a direct bearing on the quality of the final product (e.g., fruits and vegetables) rather than where this connection is more intermediate (e.g., cotton, oilseed, coarse grains). This is not only true for health threats but also with respect to environmental impacts. Where the use of agrochemicals has a direct bearing on the quality of life, from health threats to impacts on water quality, wildlife or landscape encountered by consumers and informed citizens, their handling and regulation is driven by a different set of concerns and caution than where such connections can either not be made at all or where they are more remote, more complex and difficult to trace to their sources.

Scientific and technological progress has not been linear; successful pathways (e.g., in biocontrol) have gained and lost popularity according to the economic and political priorities of dominant institutional arrangements. Advances in ecological sciences (e.g., population, community, landscape ecology) have contributed to development of pest management options, but have been underutilised by most conventional extension systems. Genetically engineered crops were expected by many to reduce the need for and therefore use of synthetic insecticides. However, their impact on both insecticide and herbicide use has been mixed, in some cases leading to increased recourse to synthetic controls. **(Global Report, p. 106)**

Similar patterns of market dynamics coupled with powerful lobby efforts and their impact on public policies, trade agreements and research priorities can be observed with respect to many other aspects of agricultural practice, especially where impacts are still less immediate and well understood by the public. Also, while at least some of the detrimental impacts of pesticide use tend to either travel with the products or can be observed at a global level, many other destructive impacts of industrial agriculture unfold at the local and regional level in areas far away from those who purchase their products.

How industrial farming destroys rural livelihoods

While the absolute number of people living in rural areas and depending on farming income is still increasing worldwide, their proportion compared to the urban population has continuously declined. Rural exodus has been a frequent companion of industrialisation in the history of most societies and continues to be so, especially in fast-growing economies of global relevance, such as contemporary China and India.

One of the important social effects of modern agriculture has been demographic change, due to the substitution of a considerable part of the agricultural labour force by machinery, the increase in the area per worker and the consequent reduction in the number of farms, which has unleashed an intense rural exodus, also driven by the reduction in related activities (the trade in primary products, processed goods and crafts, as well as public services). This decline in the rural population has made it difficult to maintain the services (mail, schools, stores, physicians and pharmacies) and social life. **(Latin America and the Caribbean (LAC) Report, p. 60)**

The underlying reasons cannot exclusively be captured by economic trends, but also have strong cultural components: the attraction of the modern, free, exciting and challenging city, the gateway to a new world, is irresistible to millions of young people in hundreds of thousands of villages around the globe who may not have access to basic health services, safe drinking water and education, but do have a satellite dish and a TV to convey pictures and dreams of western consumption standards. The average age is substantially higher in rural than in urban populations in most industrial and developing countries. Reverse 'back-to-the-countryside' trends are still marginal.

However, today's industrial economies no longer need massive influxes of labour forces and the fast growing mega-cities of developing countries pose nearly irresolvable challenges of environmental sustainability, social peace, health and welfare management. Further concentration of the global population in the cities is less than desirable from all aspects of sustainability.

The problem has grown worse in recent years owing to unequal trade relations which, in most cases, have led to unfair competition and situations where local producers had to compete with producers of other countries where production is either subsidised or takes place with more sophisticated technology. 'Dumping' has played a role in the displacement of many small producers and has prompted a rural exodus. **(Summary for Decision Makers of the Latin America and the Caribbean (LAC) Report, p. 7)**

Maintaining and enhancing rural livelihoods of billions is the baseline of any meaningful policy to fight hunger, poverty, social, cultural and environmental degradation.

Creating new livelihoods in rural areas and developing their full economic potential as well in non-agricultural economic fields, including new opportunities such as specialised food and non-food products of local origin, tourism, eco-services and IT-based businesses, is therefore an important development goal. It can only be achieved based on healthy regional agricultural economies and markets, which provide food security, fundamental social wealth, security and community life as well as cultural identity to build upon.

Industrial Agriculture: Form of agriculture that is capital intensive, substituting machinery and purchased inputs for human and animal labour. **(Global Report, Glossary, p. 563)**

Industrial agriculture's single-minded concentration on increasing commodity outputs at decreasing costs of labour fundamentally contradicts these development goals. In addition to this structural contradiction, traditional and newly-emerging structures of exploitation, corruption and increasing social inequity, illicit appropriation and expropriation of land and water rights, frequently enforced by brute force and violence of military and paramilitary means, has added to the misery of rural populations in many regions of the world, including gender-specific forms of denial of basic human-rights, and suppression of self-organisation of peasants and farmers. While suppression, exploitation and enslavement of peasants has a long feudal and colonial history, international market opportunities and lucrative partnerships with transnational companies as well as international agencies today offer new and modern incentives to apply such primitive forms of primary accumulation. As these interests typically concentrate on the most productive agricultural land, displacement of the rural poor to marginal areas is a frequent result.

For those farmers who were able to join the conversion to industrial agriculture over the past decades, success was not guaranteed. In industrialised as well as developing countries participation in the agricultural treadmill required ever increasing competitiveness and investments in rationalisation and growth.

In industrialised countries, the majority of farmers failed and either gave up farming or converted to part-time farming after off-farm work, preferring to subsidise the farm rather than draw income from the operation. Heavy government subsidies of the agricultural sector concentrated on production output and were shared between large-scale farms, downstream processing agro-industries and trade. Over the past 50 years the number of farmers in North America and Europe has decreased dramatically while their average size has increased and dependency from off-farm labour has become the norm for the large majority of small farmers.

Table 1 100 years of structural change in US agriculture

	1945	1970	2000/02
Number of farms (millions)	5.9	2.9	2.1
Average farm size (acres)	195	376	441
Average number of commodities produced per farm	4.6	2.7	1.3
Farm share of population (percent)	17	5	1
Rural share of population (percent)	36 (1950)	26	21
Off-farm labor* (percent)	27	54	93

*1945, percent of farmers working off-farm; 1970 and 2000/02, percent of households with off-farm income.
Source: Dimitri and Effland, 2005..

In Latin America similar effects of industrial agriculture can be observed, though under differing social conditions and at enormous disparities and inequity.

Export-driven vast monocultures controlled by a small number of extremely large farmers and a fully integrated transnational processing and trade industry dominate large parts of Brazil, Argentina and Paraguay. This shift has radically changed the landscape and depopulated and degraded rural life in entire regions of these countries.

The region has 576 million hectares, equivalent to 30% of the arable land [...]. Nonetheless, the region has the greatest inequality in land distribution in the world. Historically, the land tenure systems in LAC were based on private property, the concentration of agricultural lands in the hands of a few families and the existence of a large number of peasant families or landless workers, in what was called the latifundia-minifundia complex and the plantation economy. [...] In several countries large haciendas have given rise to commercial agriculture or agroindustry that controls the lion's share of the productive process, for both the domestic market and increasingly geared to external markets. At present, the modernisation of Latin American agriculture has dramatic effects in terms of tenure, since there is a high concentration of property and agricultural production, whose main effects have been to displace small producers and peasants, leading to impoverishment, migration and social exclusion.

[...] Nowadays, the forms of land tenure in the region are highly varied and complex. Nonetheless, within this heterogeneous reality, the bipolarity persists in which the latifundium has been replaced by the capitalist enterprise that gears its production almost exclusively to the export market, which no longer maintains economic relations with the minifundista peasants, who produce for their own subsistence and for the local and regional markets. **(Latin American and the Caribbean (LAC) Report, p. 16)**

In Brazil, it is estimated that the soybean crop employs one million persons directly and that the soybean industrial complex employs some five million people. In the 1980s soybean production shifted from the south and southeastern regions, with small and medium producers (average 30 hectares) to the region of Mato Grosso and Goiás, including the cerrado region, with an average farm size of 1,000 hectares. A single company, Andre Maggi, has 150,000 hectares and produces one million tons of soybean per year. The consequence of this concentration in farm size has led to an increase in rural unemployment and food insecurity, spurring migration to the cities. The soybean market is characterised by a high degree of integration, as large corporations control the production, processing, and marketing, in both exporting and importing countries. **(Latin America and the Caribbean (LAC) Report, p. 44)**

In contrast, in East and Southeast Asia, which witnessed a doubling of the total population between 1960 and 2000 and hosts about 80% of farms worldwide, the average farm size has decreased.

Depending on the economic system and government policies, these averages can mask a growing split between larger operations and ever smaller farm plots for a large majority of farmers, many of whom are unable to reliably sustain food security for their families, struggling with debts from fertiliser, pesticide and seed credits and absolute poverty.

For a while, the Green Revolution contributed to increased agricultural production. Since the main objective was to generate more food, little attention was directed to how the benefits would be distributed equitably. The Green Revolution was intimately tied to the purchase of seeds, chemical fertilisers, pesticides and intensive irrigation—all external inputs. Its effect included the high dependency it created on external inputs and the debt that farm families incurred. Alternative knowledge was neglected. The approach seemed to assume that farmers were ignorant; it devalued local and indigenous knowledge. The introduction of pesticides and chemical fertilisers diminished land productivity, creating a need for more and more inputs to reap the same yield, adding an extra financial burden on the farmer. [...]

The Green Revolution was not neutral. The real wages during 1970/71 to 1973/74 in Uttar Pradesh, when the Green Revolution was making a big impact on yields, showed that wages decreased 18% because large landowners brought in more machinery and migrants to compete with local labour and the landless. In many areas, the Green Revolution failed to raise incomes of the rural poor appreciably or contribute substantially to their effective purchasing power. Also, larger-scale farmers had greater access to subsidies for irrigation and credit from the government. **(East and South Asia and the Pacific (ESAP) Report, p. 47)**

In Central and West Asia and North Africa impacts of socialist and capitalist attempts to industrialise agriculture were probably as mixed as the structure of this predominantly semi-arid region, where water scarcity and management is the major challenge in most countries. Many countries of the region are highly dependent on food imports, not least because of neglect of self-sufficiency over the past decades.

Changes in farm structures in most Central and West Asia and North Africa (CWANA) countries have been characterised by two major trends: a movement toward the concentration of farmland within a minority of private and public farmers and a movement toward the fractioning of farmland, mostly through inheritance and demographic growth, which constrains consolidation and intensification of family farms. **(Central and West Asia and North Africa (CWANA) Report, p. 29)**

Where the Green Revolution had a major impact, as in the rest of Asia, its impact was mixed and did not secure the livelihoods of small-scale farmers.

In Algeria and the former Soviet Union republics, the transition to a market economy has not yet been accomplished and land regime is still uncertain as the former state-owned farms have completely disappeared and conditions for gaining access to land are not clear. Many countries such as Jordan, Morocco and Tunisia have adopted a capital-intensive model of agricultural development at the expense of small-scale farming systems. This model is capitalistic and export oriented and based on private property rights of water and land. [...]

The Green Revolution generated tremendous increases in yields, particularly in large agricultural irrigated plains where cropping intensity was high because of efficient water management. But even in the regions where the Green Revolution occurred, small scale farmers could not invest to develop their production systems and to progress. Although the Green Revolution can be extended in terms of yield and production to other areas where natural resources are available . . . it will not alleviate poverty neither provide food for hundreds of millions of small-scale farmers.

(Central and West Asia and North Africa (CWANA) Report, p. 21)

Finally in sub-Saharan Africa, where 90% of food production is still derived from small farms, the Green Revolution did not substantially affect agricultural production. Instead, there has been decreasing interest in market-driven investment combined with reduced rates of public international investment in agricultural development.

Subsistence farming dominates the farming system in sub-Saharan Africa. There is little application of technology, particularly with food crops, leading to low agricultural productivity. Cash crops tend to be better developed than food crops. Farm sizes tend to be small and decline over time. **(Sub-Saharan Africa (SSA) Report, p. 8)**

However global markets and terms of trade as well as interventions of the World Bank and the International Monetary Fund had a major deteriorating effect on an already desperate situation of rural development in many sub-Saharan countries. Increasing dependency on food imports from international markets, due to lack of private and public investment in rural development and neo-liberal concepts of market-oriented food security measures, combined with decreasing prices for cash-crops such as cotton, cocoa or coffee, have resulted in no improvement and even decreasing food security in the region, which suffers from the highest levels of hunger worldwide.

Recent international interests in Africa's potential for biofuel production and foreign investments to acquire large areas of agricultural land to secure future access to arable land for domestic purposes are not promising to improve the situation of rural livelihoods in the region.

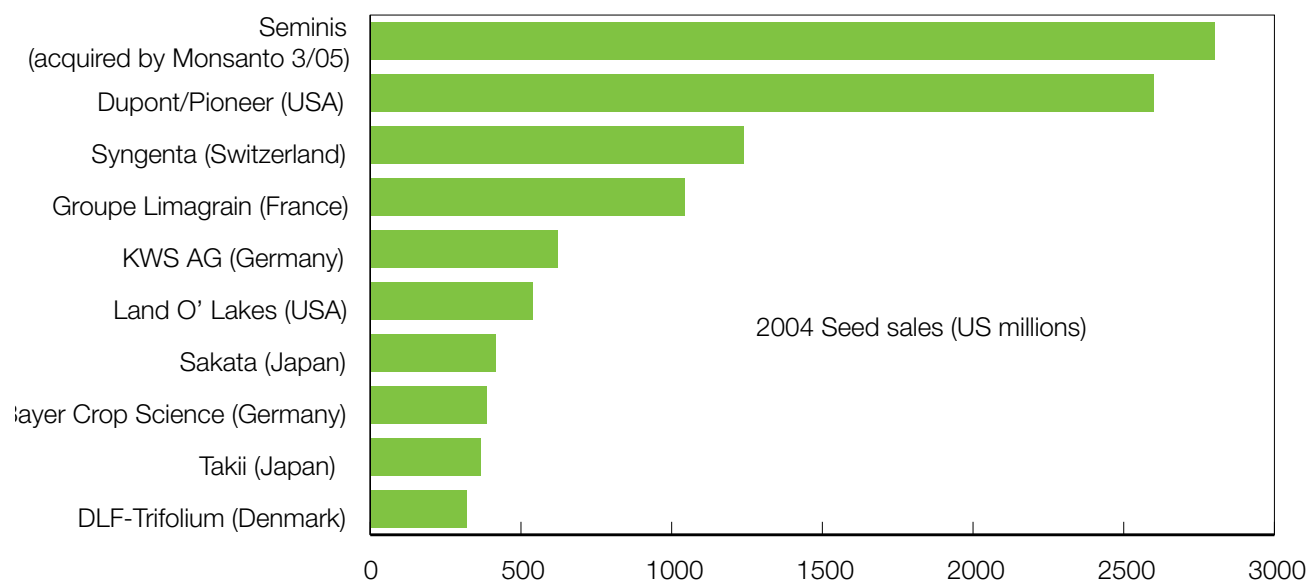
The region that has suffered most from declining terms of trade is sub-Saharan Africa. Since the 1970s, the deterioration of agriculture terms of trade in that region has led to a substantial reduction in the purchasing power of commodity exports. In addition to declining terms of trade, fluctuations and trends in prices negatively affected African agriculture. The declining and fluctuating export prices and increasing import prices compound socioeconomic difficulties in the region, as well as agricultural patterns. Short-term outlooks such as those from the World Bank project this situation to persist. **(Global Report, p. 267)**

In all regions and under all different circumstances industrialisation of agriculture had especially negative impacts on gender equality and the role of women in agriculture. Traditional discrimination of women with respect to property rights, land ownership, access to education and other democratic rights, resulted in exacerbated discrimination under new market conditions that do not reward their pivotal role and contribution to livelihoods in the informal sector.

As agriculture and food systems evolve over the next decades, gender issues and concerns are highly likely to continue to be central to AKST development, at least in the developing countries where women have played a significant role in traditional agricultural production. Over the years improvements in agricultural technologies have seldom been targeted to women as recipients of improved technologies. Yet there are more women working in agriculture than men, e.g., women in rural Africa produce, process and store up to 80% of foodstuffs, while in South and Southeast Asia they undertake 60% of cultivation work and other food production. **(Global Report, p. 293)**

In many developing countries, as well as in small-scale farm households of industrialised countries, women also form the backbone of predominantly male migration and seasonal search for off-farm jobs, leaving them with an even higher proportion of the unpaid labour to sustain the family. As technologies typically implemented by industrial farming practices are usually the domain of male rather than female control and 'expertise', they tend to additionally undermine their social status. However, these detrimental implications of industrialisation coincide with an increasing dependency of the global food system on female labour.

Table 19 The world's top 10 seed companies 2004



Source: ETC group – Communiqué, issue 90. September/October 2005.

Feminisation does not represent an equalisation of opportunities, but rather a further marginalisation of small-scale farms, since many female heads of household are younger and less educated than male heads of household, have less land, less capital and less access to credit. Fewer than 10% of women farmers in India, Nepal and Thailand own land and credit schemes in five African countries award women less than 10% of the credit awarded to male small-scale farmers. (Global Report, p. 46)

Drivers of industrial and chemical-intensive farming

The agrochemical complex

The last 60 years have witnessed a rapid increase in the concentration of commercial control by a handful of companies over the sale of planting seed for the world's major traded crops – by 1999, seven companies controlled a high percentage of global seed sales and the concentration has since increased through takeovers and company mergers. The budgets of the leading six agrochemical companies in 2001-2002 combined equalled \$ 3.2 billion US dollars – compared to a total CGIAR budget in 2003 of \$ 330 million, an order of magnitude less. (Global Report, p. 86)

Two of the stakeholders represented within the IAASTD until close to the end of the process were the world's largest agrochemical company, Syngenta, and CropLife International, a global federation representing the plant science industry (pesticides and genetically modified organisms). Monsanto participated in the initial Steering Committee. In a last minute move Syngenta and CropLife withdrew from the process. Syngenta's CEO at the time and president of CropLife, Michael Pragnell wrote to Bob Watson: "In our view the chapter draft has been heavily influenced by groups that are antagonistic to the private sector. This is resulting in a depreciation of the widely accepted contribution of agribusiness to agricultural productivity and therefore human welfare as well as systematic denial of the benefits of modern plant protection technology and the application of biotechnology to agriculture."

"Sadly, social science seems to have taken the place of scientific analysis," wrote Deborah Keith of Syngenta, who had participated as an author, in *New Scientist* in April 2008,⁶ providing two important hints on the structural problems of agrochemical companies with the findings of the IAASTD: "Syngenta spends \$100 million and takes over a decade to bring just one product to market ... it is only if companies like Syngenta protect their intellectual property that they can invest in products to benefit all. Innovation is only created through investment, and investment must be rewarded."

These are indeed key issues for a company. Investing large amounts in just one product forces a company to seek return on this investment by selling it on a very large, ideally global, scale and to seek protection from competitors. This standard practice of industrial production creates problems when applied to agriculture. Economies of scale and an exclusive focus on market-derived, financial returns on investment are counterproductive for goals such as food security and sovereignty, sustainable resource management, ecology and diversity. The IAASTD describes the corporate approach as the 'agricultural treadmill'.

The dominant policy model for promoting innovation is called the linear model, or the transfer of technology model. Also known as 'technology supply push', this approach relies on the agricultural treadmill i.e., market-propelled waves of technological change that squeeze farm-gate prices, stimulate farmers to capture economies of scale, deliver high internal rates of return to investments in agricultural research, but also encourage externalisation of significant social and environmental costs.

While the technology push model provided the basis for the positive impacts of the Green Revolution in favourable areas and under defined conditions that typically included high subsidies on fertilisers and pesticides, it has not served nearly as well as resource-poor areas that are highly diverse, rain fed, and risk prone, and that currently hold most of the world's poor.

(...)

Value added per agricultural worker in 2003 (constant 2000 US dollars) in developed market economies was 23,081 with a growth over 1992-2003 of 4.4%. For sub-Saharan Africa the figures are 327 and 1.4%, respectively. As long as the global treadmill is operating, even with all OECD subsidies removed, efforts to uplift rural poverty will remain severely handicapped and it will continue to be difficult to enlist the vast arable lands in developing countries that are now underperforming and degrading for purposes of global food security. In these circumstances, to continue with a technology-supply push conception of innovation seems inappropriate. The rural poor are not on the global treadmill; instead the global treadmill prevents them from development. (Global Report, p. 481)

6 Keith, D., Comment: Why I had to walk out of farming talks, issue 2650 of *New Scientist* magazine, 05 April 2008, page 17-18 www.newscientist.com/article/mg19826505.600-comment-why-i-had-to-walk-out-of-farming-talks.html

Apart from the contribution of irrigation, per hectare productivity increase of major staple crops was achieved by a combination of increased use of synthetic fertiliser, combined with breeding for high-yielding varieties, capable of converting increasing quantities of fertiliser, and the use of pesticides, which allowed for large scale, highly mechanised monocultures. Productivity has come at the expense of natural resources, natural and agricultural diversity, public goods and commons, social equity and human health.

The treadmill that has led to the emergence of industrial agriculture over the past 50 years, with its high but also deadly efficiency, was mainly driven by agrochemical input companies, which have taken over the better part of nationally and internationally operating seed companies during the past 25 years and now include genetic engineering as a key strategy for their future development plans. For an individual chemical company, no matter how dominant on the market, escaping this agricultural treadmill is extremely difficult and would actually require re-inventing its entire, highly successful business model. Understanding and subscribing to the need to convert agricultural practices to sustainable services for the public good and all its implications will not necessarily create a valid business. This is especially the case where the development of 'human capital' and commons, knowledgeable adaptation of methods rather than a simple switch of products, are the most important drivers of change. In addition, creating markets where there is no purchasing power is not the strength of individual companies.

These structural problems, rather than a lack of good will or ethical commitment, are probably the bottom line of a conflict that could not be resolved within the context of the IAASTD, despite good efforts from all sides. Public-private partnerships are strongly recommended as a means of the future. However, there are no bold recommendations to overcome these contradictions.

It is not clear whether the centralised and public AST [agricultural science and technology] policies of the last century can be replaced by modern decentralised public/private partnerships (such as private investment on R&D, standardisation initiatives, third-party certification and farmer organisation credit and saving programmes) targeting the reduction of poverty and increased sustainability. (Global Report, p. 215)

Global trade and subsidies

Global trade in agricultural products and its continued liberalisation are regularly hailed by political summits and international institutions as means to alleviate poverty, create new opportunities especially for developing countries and to guarantee the best possible distribution of food and agricultural products at the cheapest costs by making the best use of comparative advantages in different regions of the world. The IAASTD takes a close look at these political assumptions and also scrutinises underlying scientific models, usually dubbed as 'neo-liberal', as well as other scientific approaches to analyse the impacts of global trade on the past and future sustainability of agricultural production.

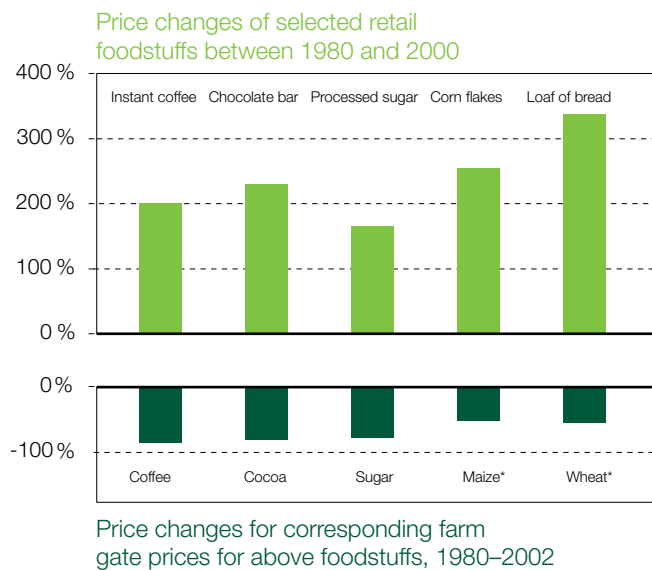
During the initial discussions on the design and terms of reference for the assessment a broad consensus had been reached to refrain from directly judging sensitive issues within the ambit of the World Trade Organisation. Government representatives were concerned not to jeopardise the independence of the assessment, and their leeway for common sense and scientific agreement, under the pressure of strong and diverging national 'bargaining' interests within the ongoing negotiations of the WTOs Doha Round. However, all members of the Bureau and authors agreed that trade issues are obviously key drivers of agriculture and development.

Under these special conditions the results produced by the scientists, well in advance of the global financial and economic crisis that has since sharply exposed risks and failures of our global economy and its present rules, were still perceived as 'too political' by some industry and government representatives.

IAASTD projections of the global food system indicate a tightening of world food markets, with increasing market concentration in a few hands and rapid growth of global retail chains in all developing countries, natural and physical resource scarcity, and adverse implications for food security. Real world prices of most cereals and meats are projected to increase in the coming decades, dramatically reversing past trends. Millions of small-scale producers and landless labour in developing countries and underdeveloped markets, already weakened by changes in global and regional trade, with poor market infrastructure, inadequate bargaining capacity and lack of skills to comply with new market demands, will face reduced access to food and livelihoods.

The food security challenge is likely to worsen if markets and market-driven agricultural production systems continue to grow in a 'business as usual' mode. (Synthesis Report, p. 22)

Figure 20 Percentage price changes of key commodities



* 1980s to average 2000–05.

Source: IAASTD Synthesis Report, pages 68/69

While the IAASTD acknowledges the importance and great potential of trade in alleviating hunger and poverty, improving food security and offering new opportunities for livelihoods, it points to an impressive list of national as well as international market failures in actually pursuing these goals.

Among these failures are:

- An enormous and increasing inequity of market access and benefits with a systematic exploitation of poor countries and the rural poor;
- The establishment of 'world market prices', which neither reflect real costs of production nor the externalities involved (e.g., environmental degradation, biodiversity loss, greenhouse gas emissions and detrimental socio-economic effects);

Agriculture generates large environmental externalities, many of which derive from failure of markets to value environmental and social harm and provide incentives for sustainability. **(Synthesis Report, p. 10)**

- A focus of investment and public support in developing countries on profitable exports rather than local and national market development;

Advice to developing countries has tended to focus on promoting opportunities for increased exports to international markets (traditional and non-traditional crops) rather than enhancing competitiveness of import substitutes or market opportunities in domestic and regional markets. **(Global Report, p. 453)**

- Collapse and serious impediment of regional and national food markets and systems as a result of global market pressure;

Some developing countries with large export sectors have achieved aggregate gains in GDP, although their small-scale farm sectors have not necessarily benefited and in many cases have lost out. The poorest developing countries are net losers under most trade liberalisation scenarios. **(Global Report, p. 442)**

- Destructive and costly subsidies and dumping of high input agricultural products of industrialised countries, such as the European Union and the United States;

Agricultural trade policies and subsidies in N[orth] A[merica] and E[urope] tend to undermine the fulfillment of development goals in other parts of the world. **(North America and Europe (NAE) Report, p. 175)**

- Concentration of market power in the hands of a small number of transnational companies with a tendency of increased vertical integration of market chains;

Agricultural trade is increasingly organised in global chains, dominated by a few large transnational buyers (trading companies, agri-food processors and companies involved in production of commodities). In these globalised chains primary producers often capture only a fraction of the international price of a trade commodity, so the poverty reduction and rural development effects of integration in global supply chains have been far less than optimal. **(Synthesis Report, p. 66)**

Figure 21 Market concentration offers fewer opportunities for small scale farmers



Source: IAASTD/Ketill Berger, UNEP/GRID-Arendal

Opening national agricultural markets to international competition before basic national institutions and infrastructure are in place can undermine the agricultural sector, with potential long-term negative effects for poverty alleviation, food security and the environment. **(Global Report, p. 442)**

The IAASTD therefore warns about premature opening of local markets to international trade regimes. Among the recommendations made by the assessment are the elimination or substantial reduction of subsidies and protectionism in industrialised countries, including escalating tariffs on imports depending on the level of value added.

Elimination of escalating tariffs in industrialised countries would help encourage value-added agroprocessing to help create off-farm rural jobs and boost rural livelihoods. **(Synthesis Report, p. 68)**

The beneficial effects of alternative trade channels such as fair trade and certified organics are acknowledged and presented as a blueprint for future expansion not only on an international level but also in national markets.

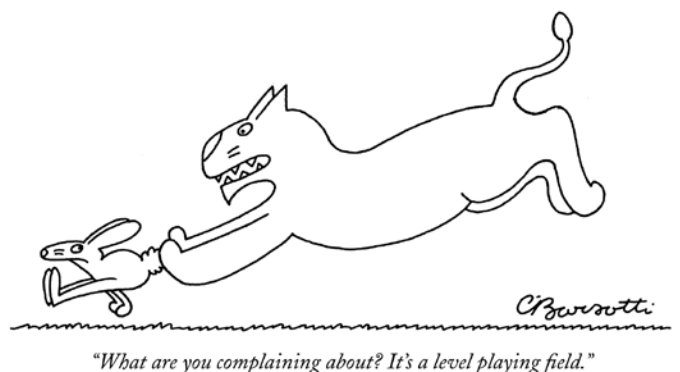
As a means of developing pro-poor procurement, initiatives such as Fair Trade and environmentally-linked production systems, such as organic and eco-friendly production, were introduced as alternatives to the mainstream commodity markets. While these models offer small-scale producers better terms of trade, the market share for these trading systems has been slow to grow and still only occupies a small percentage of global trade. Nevertheless, the principles were proven and a new generation of business models needs to be designed that can provide windows for the less endowed producers to enter mainstream markets through trading platforms that promote greater stability of demand. **(Global Report, p. 460)**

In order to ensure future internalisation of environmental costs presently not reflected in world market prices, the IAASTD points to several different policy options that could be employed simultaneously:

- Environmental taxes on agricultural inputs, such as fertilisers and pesticides;
- Food mile taxes to internalise social and environmental externalities;
- Payments for agro-environmental services.

Ecosystem services remain largely unpriced by the market. These services include climate regulation, water provision, waste treatment capacity, nutrient management, watershed functions and others. Payments for environmental services (PES) reward the ecosystem services provided by sustainable agriculture practices. PES is a policy approach that recognises the multifunctionality of agriculture and creates mechanisms to value and pay for these benefits. **(Global Report, p. 462)**

Such payments, which have already been introduced in various industrial and developing nations for specific purposes, will be especially needed on a global level in order to mitigate greenhouse gas emissions and to finance climate adaptation.



“What are you complaining about? It’s a level playing field.”

Bioenergy and biofuels

When humanity learned to master fire, biomass became its principal source of energy. Burning wood and fibre (i.e., biomass) for cooking and heat has a long history of success and failure. In some developing countries the majority of the rural population, especially the poor, depends on wood for cooking and heating. This can have substantial health impacts and collecting firewood can occupy substantial time and energy that could be better used for productive activities and education. In addition, although firewood is harvested sustainably in many parts of the world, in some areas it is not and the unsustainable use of forests, as well as agricultural residues, can create serious environmental problems.

Living conditions and health of the poor can be considerably improved when households have the opportunity to upgrade from inefficient, polluting and often hazardous traditional forms to modern forms of energy. Through their importance for the delivery of basic human needs such as potable water, food and lighting, these modern energy services are among the primary preconditions for advancements in social and economic development. (Global Report, p. 424)

Modernisation of bioenergy production and use to improve living conditions, efficiency and to avoid health problems from combustion, as well as substitution of wood with other renewable sources of energy (solar, gasification, wind), are therefore important challenges in many regions of the world. Effective and low-cost solutions are available, but sometimes require initial investments beyond the capacity of the rural poor as well as robust technologies, maintenance and competence.

Supplying energy to urban areas and industrialised countries may offer short-term economic gains for developing countries in the region, but with high costs for the environment and for the capacity of countries to produce food that is available, accessible and affordable to poor people. (East and South Asia and the Pacific (ESAP) Report, p. 164)

However, the recent boom of converting agricultural products into so-called biofuels or agrofuels threatens to create a diversity of serious environmental as well as social problems and poses additional threats to food security and food sovereignty. Food price increases, competition for land and water, expansion of monocultures at the expense of agricultural smallholders and accelerated biodiversity loss are among the concerns associated with a continued expansion of biofuel production, which is strongly supported through regulatory and subsidy measures by major economies, such as the US and the EU, as well as Brazil, Malaysia and Indonesia.

Table 2 Land area requirements for biofuels production

Percentage of total 2005 global crude oil consumption to be replaced by bioenergy	Energy yield			
	1st generation biofuels		Next generation biofuels	
	40 GJ/ha	60 GJ/ha	250 GJ/ha	700 GJ/ha
5%~1500 million barrels/year	230 million ha	153 million ha	37 million ha	13 million ha
10%~3010 million barrels/year	460 million ha	307 million ha	74 million ha	26 million ha
20%~6020 million barrels/year	921 million ha	614 million ha	147 million ha	53 million ha

Note: Conversion factors: 1GJ=0.948 million BTU; 1 barrel of oil ~ 5.8 million BTU
Source: Avato, 2006.

Current trends indicate that a large-scale expansion of production of first generation biofuels for transport will create huge demands on agricultural land and water - causing potentially large negative social and environmental effects, e.g., rising food prices, deforestation, depletion of water resources (see Chapter 4) that may outweigh positive effects. (Global Report, p. 422)

The IAASTD also states that the potential of biofuels to reduce greenhouse gas emissions compared to fossil fuels is highly controversial, ranging from small advantages to substantial disadvantages, depending on the assumptions made with regard to land use changes and energy inputs. Overall, the further expansion of biofuel production is not supported as a viable option of climate mitigation or poverty alleviation.

In fact, the majority of policies in OECD countries create incentives to maximise production of first generation biofuels, irrespective of quality and quantity of externalities. Consequently, many biofuels are produced with intensive use of energy inputs, leading to low energy balances and GHG emission reductions while contributing to environmental problems. (Global Report, p. 463)

Whether so-called second generation biofuels, based on conversion of wood and fibre instead of cereals and other food crops, would offer substantially better prospects is still to be proven.

There are also eco-ethical considerations; putting more ecologically fragile and necessary lands into production of biofuels; whether oil palm production in Southeast Asia at the expense of jungles, or soybean production at the expense of rangeland or rain forest. It may not be morally justifiable to purchase oils for biofuels from areas where the environment is being negatively exploited. **(North America and Europe (NAE) Report, p. 219)**

The IAASTD does not offer a final judgment on the medium to long-term prospects of biofuel production and rather points to the diversity of uncertainties. However, the evidence presented clearly speaks against short-term expansion of present first generation biofuels and warns against any hype with respect to the potential of second and third generation technologies within the next two decades. At the same time it points to substantial general risks involved in large-scale production of fuels from agriculture.

Small-scale biofuels and bio-oils could offer livelihood opportunities, especially in remote regions and countries where high transport costs impede agricultural trade and energy imports. There is also considerable potential for expanding the use of digesters (e.g., from livestock manure), gasifiers and direct combustion devices to generate electricity, especially in off-grid areas and in cogeneration mode on site of biomass wastes generating industries (e.g., rice, sugar and paper mills). **(Global Report, p. 379)**

05



© GREENPEACE / GUSTAVO GRAF

image For thousands of years, maize (corn) has been an essential food for the people of Mexico; it also plays an integral part in their culture and religion. (Mexico: 2006)

Part V

Tomorrow's knowledge and technologies

Most of the knowledge and technologies required for sustainable agriculture have already been developed. The problem is they have not been implemented, nor well adapted and scaled-up to the new challenges ahead. Innovation and long-term viability of the enormous diversity of agri-food systems is rather a matter of smart application and best use of a mixture of traditional and local knowledge with leading edge research and technologies from all realms of science. Making information available where it is needed requires massive investment, inclusion and commitment of all actors involved. What is needed most is a new and revived culture of sharing and collaboration of farmers, scientists, businesses and politicians to this end. A knowledge-based society that converts the public commons, science and technology into private property is certainly not the way forward, even less a global system that redefines the basic information of life, genetic properties and whole organisms as 'intellectual property'.

Agroecology – a diversity of solutions

Agroecology is the science of integrating agricultural production in its global, regional and local ecological, cultural and social context. It is also an emerging and spreading concept of integrating local, traditional and indigenous knowledge with formal science, including participatory development and sharing of knowledge as well as different ways of perception and knowing.

Small-scale diversified farming is responsible for the lion's share of agriculture globally. While productivity increases may be achieved faster in high input, large scale, specialised farming systems, greatest scope for improving livelihood and equity exist in small-scale, diversified production systems in developing countries. (Global Report, p. 379)

Because the ecology of diverse agricultural environments (agroecosystems) as well as cultural history and socio-economic circumstances vary enormously around the world, agroecology is a highly diversified concept. While this interdisciplinary diversity is the key to agroecology's enormous successes, it is also one of the reasons why the approach is still perceived as an alternative niche discipline by many policy and grant makers, mainstream scientific institutions and large parts of the private sector.

Some of its principles certainly apply to most of agriculture worldwide. However, most of its practical application and proposed solutions are not 'one size fits all' concepts. They are rather carefully tailored and adapted compositions of methods and concepts suited best for a specific situation in time, open to continuous improvement

and in search of a local optimum, rather than single purpose maximum results. Hence agroecology is highly knowledge-intensive while high-tech typically accounts for but a small portion of its recipes.

Agroecological methods include new and traditional methods of soil and water conservation and 'green water' harvesting and moisture conservation. They entail inter-cropping and polyculture systems and agroforestry, the use of additional and the re-use of 'forgotten' plants as well as a high diversity of locally adapted crop varieties and available wild species. Based upon the ingenuity and traditional local knowledge of generations of farmers, agroecological systems usually employ complex systems of synergy between plants, microbes and animals to improve soil fertility, reduce weather-related risks, exploit specific advantages of a given ecosystem as well as addressing its specific disadvantages and risks. They entail adapted concepts of crop-rotation and interdependencies of plants for pest control, as well as recycling and integrated use of different organic materials for shelter, clothing, energy and other purposes.

Most agroecological knowledge and experience lies with family farmers and communities and is not yet part of the globally available agricultural information and knowledge system. As most agroecological solutions appear to be highly site specific, little investment has been made so far in systematically taking stock of this knowledge and making it available to other farmers. Farmer-to-farmer networks of exchange of information and seeds are still marginal compared to other forms of institutional research and extension efforts. However, the enormous potential of agroecological practices and experience to mitigate and adapt to climate change has recently increased interest in these practices beyond their local and regional environments.

It is this continuing indigenous capacity for place-based innovation that has been almost entirely responsible for the initial bringing together of the science, knowledge and technology arrangements for what have become over time certified systems of agroecological farming (...) Systems such as these are knowledge-intensive, tend to use less or no externally supplied synthetic inputs and seek to generate healthy soils and crops through sustainable management of agroecological cycles within the farm or by exchange among neighboring farms. (Global Report, p. 67)

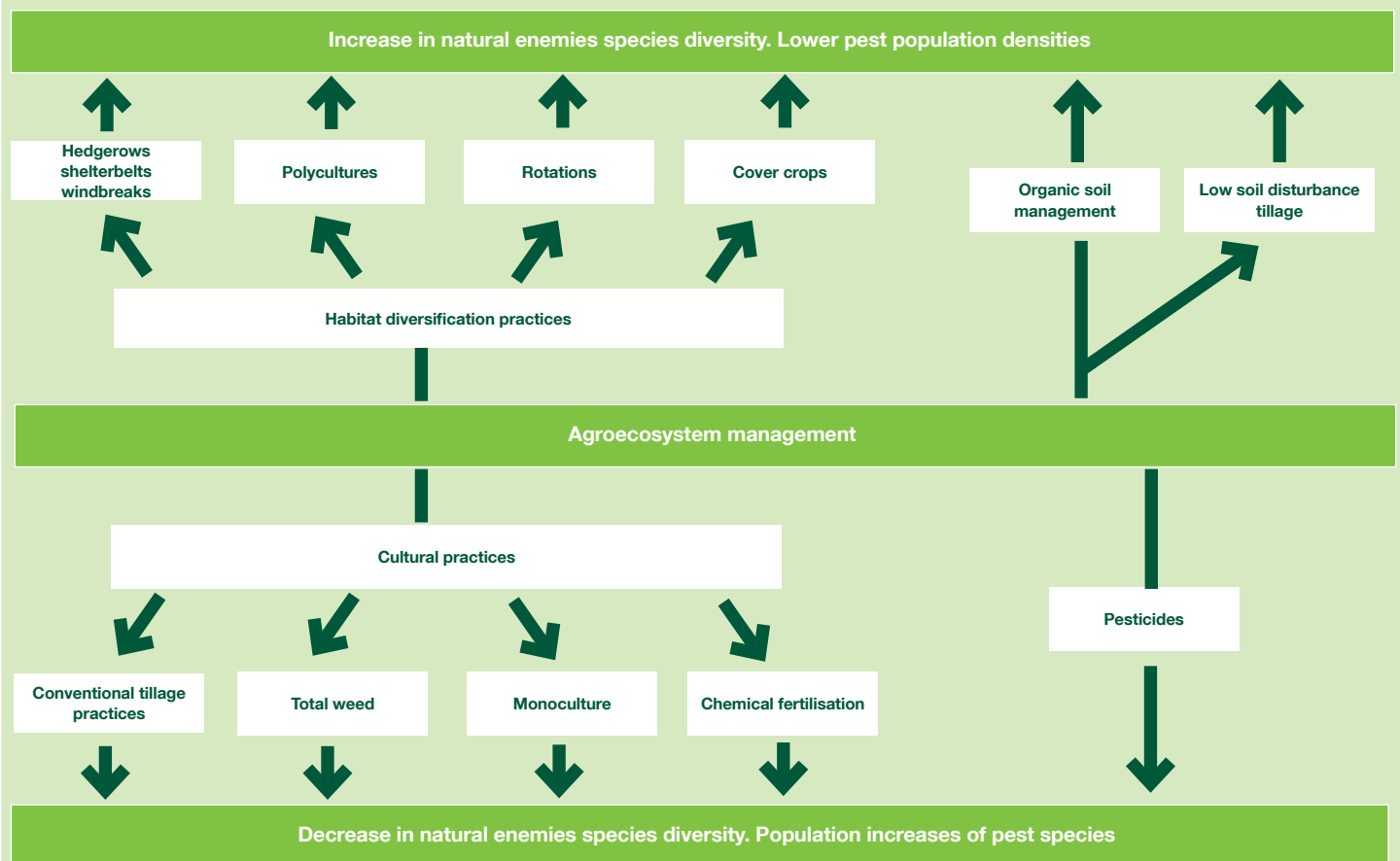
Agroecology's fundamental challenge to major players in the agricultural business is likely the fact that it usually works with minimal external inputs such as synthetic fertiliser, pesticides, machinery or patented seed. Its application and use therefore does not create global markets for agricultural inputs, even where it

creates sufficient surplus to provide farmers with financial resources for investment. Equally, the typical output of agroecological farming systems does not nurture global commodity and cash crop markets, while it does offer even global market opportunities, e.g., for high value specialties. Being embedded in local community and market structures actually is part of the integrated concept of agroecology, which recognises the needs and the health of humans involved, both as producers and consumers, as integral components of the overall ecological setting of a given agroecosystem.

The IAASTD emphasises that agroecological farming methods are as productive as conventional and industrial farming methods at lower ecological costs and fossil fuel-based inputs, with better chances to adapt to changing environmental and climate conditions, higher resilience and better performance with respect to delivering enough and wholesome food where actually needed.

Recent comprehensive assessments conclude that although these systems have limitations, better use of local resources in small scale agriculture can improve productivity and generate worthwhile innovations and agroecological/organic farming can achieve high production efficiencies on a per area basis and high energy use efficiencies and that on both these criteria they may outperform conventional industrial farming. Despite having lower labour efficiencies than (highly mechanised) industrial farming and experiencing variable economic efficiency, latest calculations indicate a capability of producing enough food on a per capita basis to provide between 2,640 to 4,380 kilocalories per person per day (depending on the model used) to the current world population. Their higher labour demand compared to conventional farming can be considered an advantage where few alternative employment opportunities exist. **(Global Report, p. 67)**

Figure 22 Agroecosystem management



Source: Altieri and Nicholls, 1999

A global study at the University of Essex by Jules Pretty and others,⁷ which attempts to quantify the beneficial impacts and potential of agroecological farming methods based on standardised criteria, is repeatedly referred to in different parts of the report.

A specific lesson-learning exercise covering 286 resource-conserving agricultural interventions in 57 poor countries offers an illustration of the potential of implementing more sustainable approaches to agriculture with existing strategies and technologies. In a study covering 3% of the cultivated land in developing countries (37 million hectares), increased productivity occurred on 12.6 million farms, with an average increase in crop yield of 79%. Under these interventions, all crops showed gains in water use efficiency, especially in rain-fed crops and 77% of projects with pesticide data showed a 71% decline in pesticide use. Carbon sequestration amounted to 0.35 tonnes C ha⁻¹ y⁻¹. There are grounds for cautious optimism for meeting future food needs with poor farm households benefiting the most from the adoption of resource-conserving interventions. (**Global Report, p. 225**)

Key advantages of agroecology:

- Higher quantitative and qualitative yields in small-scale farming systems, resulting in improved health and wellbeing as well as farm income
- Reduced emission of greenhouse gases and fossil fuel dependency
- Reduced use of toxic substances
- Improved and integrated natural resource management and biodiversity
- Improved resilience to extreme weather conditions and overall climate adaptation potential
- Increased competence, innovation and cooperation of small and poor farmers
- Improved livelihood opportunities for rural poor, including landless labour
- Improved understanding and innovation of the scientific community of complex agroecological interactions and agricultural multifunctionality
- Conservation and use of traditional, indigenous and local knowledge and value systems and respect for regional and community based social, cultural and spiritual identity

Key measures to promote agroecology:

- Shift international and national funding priorities towards agroecological research and development
- Revise national programmes and institutional arrangements towards agroecological extension, farmer schools, community and NGO support of local and participatory research, training and collaboration
- Revise university, farm school and other educational curricula to promote agroecology
- Revise national agricultural support programmes, tariffs and subsidies to promote agroecological approaches and economies
- Educate decision-makers about the advantages of agroecological approaches
- Promote international agroecological networks, exchange of information and experience

The case for organic agriculture

Organic agriculture is a fast-growing sector of agriculture, based upon a common set of basic rules and standards codified by the International Federation of Organic Agriculture Movements (IFOAM), as well as in various national laws and the international Codex Alimentarius. IFOAM's definition is: 'Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.'⁸

These principles are under constant revision and are continuously refined and adapted to better knowledge and scientific progress, but also to changing market conditions. The continuous review process, taking place at international as well as national levels, provides for a valuable discussion on sustainability standards.

7 Pretty, J.N., Noble, A.D., Bossio, D., Dixon, J., Hine, R. E., Penning de Vries, F. W. T. and Morison, J. I. L. 2006. Resource-conserving agriculture increases yields in developing countries. <http://pubs.acs.org/doi/full/10.1021/es051670d> Preceding this latest study in 2001 Pretty, et al. published an extensive list of on 208 case studies from 52 countries case studies, in Reducing Food Poverty with Sustainable Agriculture: A Summary of New Evidence, commissioned by the UK Department for International Development, Bread for the World, and Greenpeace (Germany). <http://www.essex.ac.uk/ces/esu/occasionalpapers/SAFE%20FINAL%20-%20Pages1-22.pdf> These case studies, complemented by additional submissions are available online at www.farmingsolutions.org

8 IFOAM, Definition of organic agriculture, http://www.ifoam.org/growing_organic/definitions/doa/index.html

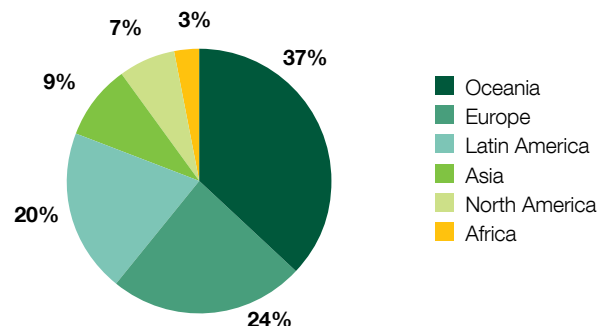
Organic agriculture can contribute to socially, economically and ecologically sustainable development, firstly, because organic practices use local resources (local seed varieties, dung, etc.) and secondly, because the market for organic products has high potential and offers opportunities for increasing farmers' income and improving their livelihood. It also contributes to in situ conservation and sustainable use of genetic resources. (Global Report, p. 23)

Certified organic agriculture is but a small portion of agricultural practices following the organic principles (health, ecology, fairness, care) that also need to be adapted to different regional agroecosystems as well as socio-economic conditions. The organic market is a fast growing business in industrialised as well as in developing countries. IFOAM reports 32.2 million hectares of land under organic cultivation and an additional 30.2 million hectares of wild collection areas and 0.4 million hectares of organic aquaculture managed by 1.2 million organic producers worldwide. Despite tripling the area under organic cultivation since 1999 this still constitutes a small niche within the global context. However, as costly certification is only useful for traded products at larger scale and many of the organic principles are applied by traditional and other agroecological farmers, it only forms the tip of a more sizeable iceberg.

Large areas, particularly in developing countries and some former Soviet States, are organic by default (i.e., non-certified), as farmers cannot afford to purchase fertilisers and pesticides. The extent of such non-market organic agriculture is difficult to quantify, but >33% of West African agricultural production comes from non-certified organic systems. In Cuba which has made substantial investments in research and extension, organic systems produce 65% of the rice, 46% of fresh vegetables, 38% of non-citrus fruit, 13% of roots, tubers and plantains and 6% of the eggs. (Global Report, p. 182)

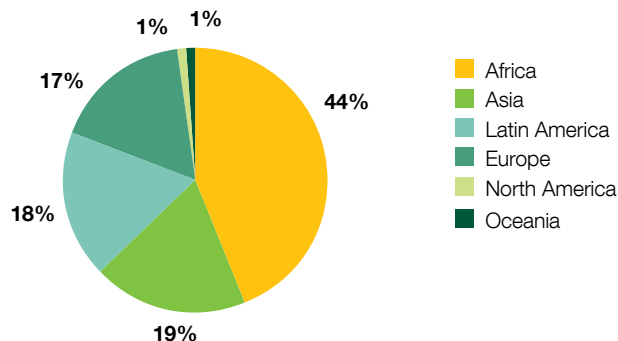
From a global perspective, the IAASTD categorises certified organic agriculture as a special subset of low-input agroecological methods. The specific advantage of organic agriculture, it states, is its ability to connect producers and consumers, even over longer distances, in a beneficial way, offering higher returns to one side and a guarantee of both personal nutritional quality and general environmental benefits, in most cases as well social quality of the product to the other side. Meeting the highly sophisticated standards and bearing the costs of organic certification are needed for export, but may not be necessary where products are consumed locally. Moreover the worldwide community of organic movements along the food chain provides opportunities for mutual support, including knowledge sharing, market development and fair trade relations, with an additional and exceptional potential of change.

Figure 23 Land under organic management by geographical region



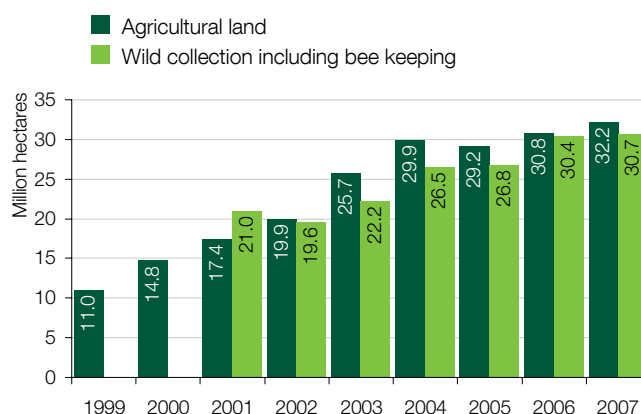
Source: FiBL and IFOAM 2009

Figure 24 Organic producers by region 2007



Source: FiBL and IFOAM 2009

Figure 25 Development of organic agricultural land and wild collection areas 1999 to 2007



Source: FiBL and IFOAM 2009

The IAASTD refers to the beneficial impacts of organic agriculture and fully acknowledges its enormous future potential that has not been developed adequately due to comparatively low research and development investments in this area. It points to studies which claim that the productivity of organic agriculture has been lower, especially under industrialised farming conditions, as well as evidence that organic can be as productive under these circumstances and provide even higher productivity in agricultural systems of small-scale farming. The assessment underlines the strong benefits of organic production for soil fertility, biodiversity, reduction of toxic inputs, water management, provision of healthier and more diverse food, improved livelihood opportunities and market access for small farmers and social equity. However, the IAASTD reports mixed evidence with respect to other sustainability aspects, e.g., manure management, productivity restraints from limited nutrient supply and even energy efficiency depending on the farming systems.

FAO warned that comparing yields between organic and conventional systems were meaningful only over time because high yields in conventional farming are often based on 'exploitative systems that degrade land, water, biodiversity and ecological services on which food production depends'. Conversion to organics from high-yielding conventional systems often results in a drop in gross yield of the marketable commodity; the degree of drop might vary considerably. Conversion from low-input, often traditional systems could raise productivity by optimising the use of local resources. Additionally, conversion to organics in medium-potential areas in the tropics could show good performance. **(East and South Asia and the Pacific (ESAP) Report, p. 36)**

The assessment also cautions that where organic is governed by large supply chains similar to those of conventional agriculture, small-scale production tends to be excluded from the market; specialisation on a few monocultured products can negate many of organic agriculture's initial multi-cropping and holistic advantages.

In summary, the IAASTD refers to organic agriculture as a stepping stone for sustainable agriculture of the future and puts it in the context of the overall challenge to develop agroecological farming methods for which it plays a central and promoting role, especially as it also provides specific marketing opportunities and comprises a global community of farmers and consumers. Investment of substantially higher shares of public as well as private research could enormously improve the present state and help to further evolve and mature organic practices in different agroecosystems.

Evidence is increasing that the transition to more ecological production practices does not compromise food security. Where external inputs have been high, yield reductions may occur during and after transition to organic farming, but organic agriculture may substantially increase yields in low-input areas. In traditional rain-fed systems, widespread in CWANA, organic agriculture has been demonstrated to outperform conventional agricultural systems under environmental stress conditions. Organic production additionally contributes to conserving biodiversity and natural resources, it may increase income or reduce costs, it produces safe and varied food, and it is sustainable in the long term. Therefore, organic agriculture should be an integral part of any agricultural policy aiming for food security and improved livelihoods. Organic farmers usually grow a variety of crops and rear livestock; this increases resilience of organic systems and may reduce production as well as market risks. **(Central and West Asia and North Africa (CWANA) Report, p. 130)**

Projected increases in certified organic agriculture raise additional sets of opportunities for AKST to contribute to maintaining productivity and soil nutrient levels while controlling costs and improving labour efficiencies. Policy options for reforming institutional environments, policies and programmes to be more conducive to sustainable agricultural methods include:

- Investing in the development of organic certification in developing countries.
- Reforming tax systems to shift the conditions under which certified organic farming compete with energy intensive agricultural systems, involving a shift from taxing wages towards taxing pollution and consumption of resources.
- Increasing awareness of organic certification to domestic consumers in developing countries;
- Supporting development of methods for organic certification compliant pest (and weed) and soil nutrient management, particularly non-proprietary, methods for the public good, such as biocontrol using natural enemies, nonchemical, and cultural methods of pest management.
- Supporting AKST to further energy efficiency in organic agriculture;
- Developing certified organic seeds that are better adapted to low-input farming landscapes.
- Investing in low external input technologies aimed at soil fertility improvement. **(Global Report, p. 446)**

Research and development priorities

Probably the most important overall recommendation of the IAASTD regarding priorities for future agricultural knowledge, science and technology (AKST) is confined in the “K”: Science and technology without knowledge will hardly improve living conditions nor address the key challenges ahead of us. Knowledge in the IAASTD context refers to the practical availability of scientific information and technology to those who have to use it. It also entails the broader context of science and technology: the fundamental knowledge about the diverse environments and interconnectedness of all the factors and drivers of agriculture and food production, which is held and communicated in diverse, frequently local and traditional forms that should not be seen as inferior to ‘formal science’.

The IAASTD is a multidisciplinary and multi-stakeholder enterprise requiring the use and integration of information, tools and models from different knowledge paradigms including local and traditional knowledge. **(Global Report, introduction, p. ix)**

A first priority emerging from this broad and integrated approach is the repeated demand to improve access to knowledge for farmers, small-holders, especially women, young adults and marginalised groups of rural society, as well as relevant institutions and decision-makers. Investment in access to knowledge, including relevant science and technologies, by public institutions as well as private enterprises is the most important single step for long term improvement of livelihoods, reduction of hunger and poverty as well as adequate handling of environmental challenges.

A second and closely related priority that the IAASTD spells out at various occasions is the need for science, research and technology to better serve the needs of the end users by including them in the production and implementation of scientific knowledge and technology and by learning from their experience and broader knowledge background.

The Transfer of Technology (ToT) model has been the most dominant model used in operational arrangements and in policy. However, the ToT model has not been the most effective in meeting a broader range of development goals that address the multiple functions and roles of farm enterprises and diverse agroecosystems. In this model, science and technology are mobilised under the control of experts in the definition of problems and the design of solutions, problem setting and solving. **(Global Report, p. 58)**

Old fashioned top-down concepts of ‘educating’ farmers how to improve their yields and performance in a competitive, growth-oriented market context, which may be prevalent in industrialised countries and regions but rarely in rural communities of developing countries, have frequently failed to deliver. They also have the potential of depreciating and destroying valuable knowledge as well as farming practices that had been more or less well adapted to various local environments and cultural needs. The IAASTD instead strongly advocates new, participatory approaches to improve technologies as well as the knowledge of all the stakeholders involved and to allow for the inclusion of all relevant questions to be answered.

The formal AKST system is not well equipped to promote the transition toward sustainability. Current ways of organising technology generation and diffusion will be increasingly inadequate to address emerging environmental challenges, the multifunctionality of agriculture, the loss of biodiversity, and climate change. Focusing AKST systems and actors on sustainability requires a new approach and worldview to guide the development of knowledge, science and technology as well as the policies and institutional changes to enable their sustainability. It also requires a new approach in the knowledge base; the following are important options:

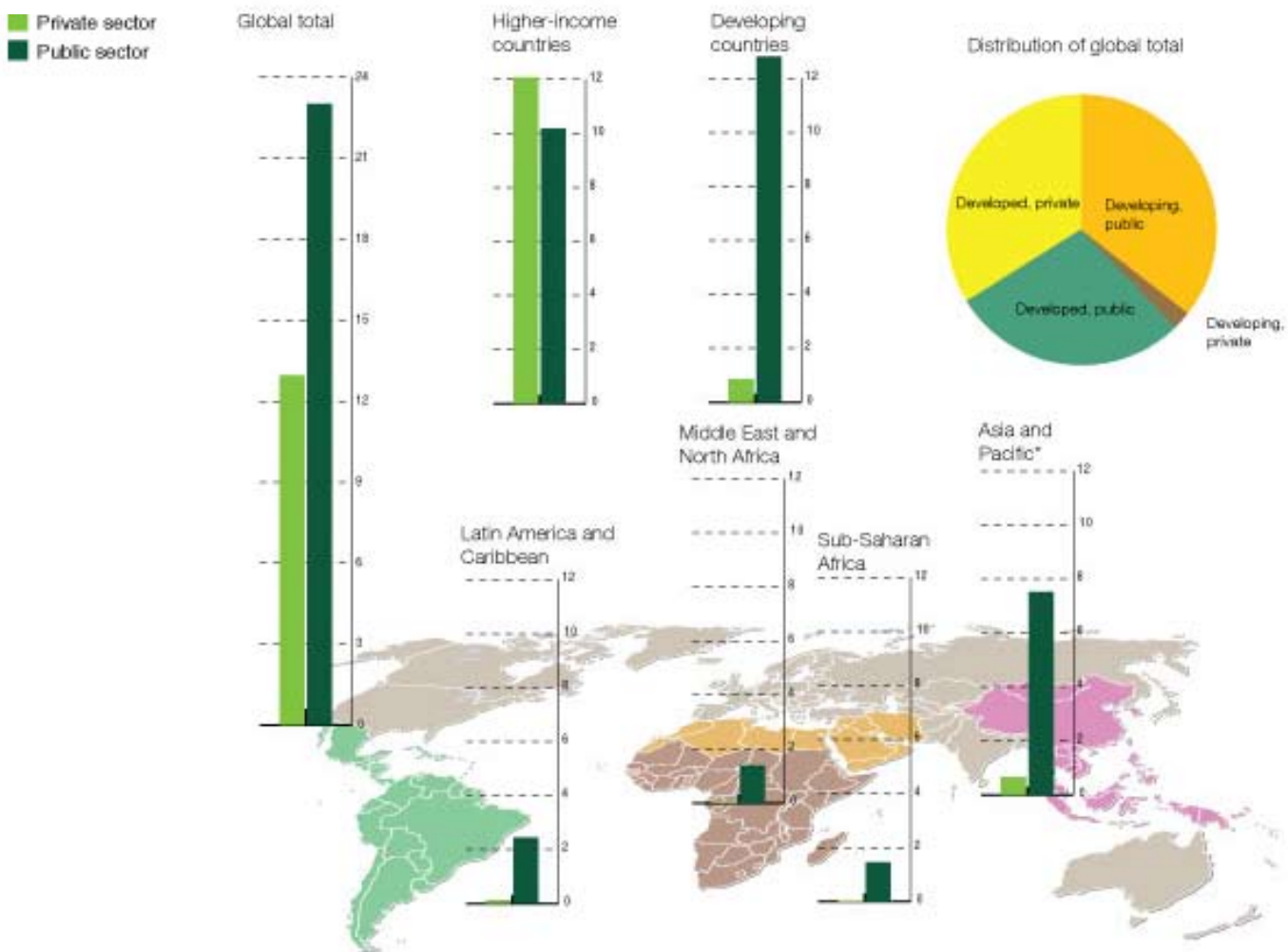
- The revalorisation of traditional and local knowledge and their interaction with formal science;
- Interdisciplinary (social, biophysical, political and legal), holistic and system based approaches to knowledge production and sharing. **(Synthesis Report, p. 30)**

In addition to these constraints of agricultural science and technology, which had already emerged during the ‘Green Revolution’, a more recent shift in investment in agricultural research has further aggravated its blindness towards key challenges of global development. In industrialised countries public funding for agricultural research has continuously declined over the past decades while private R&D investment has taken its place. Meanwhile public R&D has substantially increased in very few developing countries while national public investments and international donor investments have substantially decreased in the majority of least developed countries. In addition, the IAASTD notes that major shares of public spending in industrialised countries are strongly influenced by complementing private sector investments in university research and its interests and modes of action, including patent protection.

As a result, the mainstream of advanced agricultural research today is driven by private economic interests, which rarely take into account the specific needs of smallholder farmers, especially women, of marginalised regions and crops or concerns about ecological and social sustainability, but rather focuses on economic productivity of large-scale farm holdings with the capacity to invest in inputs and new products and serving global and national markets.

The AKST apparatus tends to focus on mainstream, input-intensive, irrigated monocropping systems—mainly cereals, livestock and other trade-oriented commodities, to the relative neglect of arid/dryland agriculture, mountain ecosystems, and other non-mainstream production systems [...] Resources are allocated to production systems that can show the highest economic returns to crop/commodity productivity. The capacity of AKST to address the challenges of poverty, livelihoods, health and nutrition, and environmental quality is conditioned by its capacity to address its own internal constraints and challenges. (Synthesis Report, p. 25)

Figure 26 Public and private agricultural R&D spending, selected regions, 2000 billion international dollars (year 2000)



* Asia-Pacific excluding Australia, Japan, and New Zealand.

Source: Pardey et al., 2006b based on Agricultural Science and Technology Indicators (ASTI) data at www.asti.cgiar.org and various other data sources.

The IAASTD points to a large body of scientific research and development and use of diverse forms of knowledge to overcome these constraints. Participatory, farm-based innovation has delivered impressive results with respect to improving livelihoods and local food security, as well as economic and environmental resilience of local and regional agricultural and food systems. Participatory plant breeding and resource management are highlighted as typical examples of such new approaches, as well as the integration and eventual adaptation of traditional and local knowledge to meet new challenges. Agroforestry, agroecological approaches, intercropping and integration of aquaculture and animal husbandry in cropping systems, diversification with a view to securing micro-nutrient food security, use of wild and 'forgotten' species, low technology means of water-harvesting and soil-conservation as well as organic means to improving soil fertility are other examples of locally adapted small-scale improvements that should receive increased attention and investments. In many cases underutilised methods of farmer-to-farmer and south-to-south technology transfer appear to provide better results than top-down technology transfer and unleash higher levels of adoption, common ownership and adaptive creativity.

The IAASTD also highlights the need to provide a sound scientific basis for the valuation, including monetary approaches, of agricultural services of key strategic public interest that are presently not rewarded by market economies, such as reduced greenhouse gas emissions, biodiversity conservation, natural resource management and improved health and social returns, including employment. Investment in research and development to improve and generate such public goods was a high priority for public investment in the IAASTD recommendations, given the present lack of incentives for the private sector to investing in these areas.

Finally, the IAASTD strongly advocates the improvement of interdisciplinary and holistic approaches to research and teaching. While the past decades provided an exponential growth of data and information in many disciplines and yielded vast new areas of exiting specialist knowledge, it appears that the level of overview and integration of this knowledge has rather decreased and the general level of 'know-why' among scientists has suffered from their increased levels of specialised 'know-how'.

University agricultural faculties progressively became divided into highly specialised departments. This split created 'knowledge silos' that reflected the increasing specialisation of scientific disciplines that reduced agriculture as an integrated practice into smaller and smaller fractions that largely excluded the human manager. (Global Report, p. 70)

This development is described as the result of a so-called 'paradigm of positive realism', which defines modern science as a neutral, universal, and value-free explanatory system providing objective truth independent of the human observer. A newly emerging paradigm of 'constructivism' rather puts the production of knowledge back into an evolutionary context of human interaction with its culture and environment. Such an approach also challenges scientists with evaluating their own work in the context of its social and environmental impact and to connect their own findings with those of other disciplines as well as other forms of knowledge and experience. In other words: cooperation and sharing of relevant scientific and non-scientific resources, questions and values are an indispensable source of the kind of innovation and mobilisation of all the knowledge available and required to meet the enormous social and environmental challenges ahead at the divergent local, regional and global levels where they can actually be addressed and resolved.

Patents and control vs. participatory and shared knowledge

So-called intellectual property rights (IPR), rewarding human ingenuity and inventions with monopoly control over those inventions, play an increasingly important role in the way agricultural knowledge, science and technology is produced, exchanged and implemented. The IAASTD acknowledges the contributions of different IPR systems in stimulating investment in research and providing incentives for distribution of products on the market. At the same time it raises fundamental questions about the trade-off between these positive and various detrimental effects that IPR systems have on knowledge generation and distribution, equity and sustainability goals.

Genetic resource management over the past 150 years has been marked by an institutional narrowing [...] This narrowing is illustrated in history by four major trends: (1) a movement from public to private ownership of germplasm; (2) unprecedented concentration of agrochemical, seed corporations, and commodity traders; (3) tensions between civil society, seed corporations, breeders and farmers in the drafting of IPR; (4) stagnation in funding for common goods germplasm. These trends have reduced options for using germplasm to respond to the uncertainties of the future. They have also increased asymmetries in access to germplasm and benefit sharing and increases vulnerabilities of the poor. [...] New ownership and IPR regimes have restricted movement and made development of non-commercial (public) good constructs more expensive. These changes have limited those actors that do not have legal, commercial and financial power. (Global Report, pp. 87-88)

There are three broad areas of concern about IPRs that the IAASTD mentions at various occasions. First, private control over knowledge is impeding access and further use of such knowledge by farmers and their experts, especially in developing countries where the costs and formal requirements of IPRs are hard to meet, notably when the inventions do not or only marginally result in market return but are used for public good.

In developing countries especially, instruments such as patents may drive up costs, restrict experimentation by the individual farmer or public researcher while also potentially undermining local practices that enhance food security and economic sustainability. In this regard, there is particular concern about present IPR instruments eventually inhibiting seed-saving, exchange, sale and access to proprietary materials necessary for the independent research community to conduct analyses and long term experimentation on impacts. **(Executive Summary of the Synthesis Report, p. 8)**

Second, IPRs increase the dependency of small farmers as well as local companies and institutions on powerful companies holding patents on their seed or other inputs, particularly given the global trend towards increasing market concentration for agricultural inputs in the hand of a small number of multinational companies. In this context IPRs not only allow transnational companies to reap a higher or unfair proportion of the value added, but to actually control the types and the path of technology applied, including their ability to withhold or undermine practices that are not in their economic interests.

Today in many industrialised countries an increasing percentage of the funding for university science comes from private commercial sources. It tends to be concentrated in areas of commercial interest or in advanced sciences such as satellite imaging, nanotechnologies and genomics rather than in applications deeply informed by knowledge of farming practice and ecological contexts. [...] Hence a condition of funding is that the source of funds often determines who is assigned first patent rights on faculty research results. In some cases the right to publication and the uninhibited exchange of information among scholars are also restricted. The assumption under these arrangements that scientific knowledge is a private good changes radically the relationships within the scientific community and between that community and its diverse partners. **(Global Report, p. 72)**

Third, IPR systems shape interactions, interests and investments in the scientific community in a way that puts economic benefits above long term sustainability and public interest. This is not only true for the increasing number of researchers in private companies, but has also altered the priorities of public research institutions seeking additional revenues from public private partnerships. This shift has already substantially altered the way that knowledge and information is being shared within the scientific community. The requirement to secure patent claims in advance of sharing new findings not only constrains the freedom and speed of scientific exchange. Patents can also discourage research in areas where future applications of its results appear to be blocked by broad patent claims on key methods or genetic information.

Particularly in advanced research, so-called thickets of rights lead to the tragedy of the anti-commons leading to underinvestment and underutilisation of technologies (Heller and Eisenberg, 1998). Property rights on research tools, processes and products create very complex situations for researchers and their institutions, potentially leading to underutilisation of technologies. **(Global Report, p. 478)**

According to the IAASTD, there are no substantiated data to prove that IPR benefits developing countries' or public research institutions' economies while evidence is strong that it distracts human and financial resources from addressing the needs of the poor as well as the environmental and social commons.

There are already commercial seed companies that spend far more on legal services than on research. This preponderance of legal over research expense in fighting through the patent thicket may be a 'warning' to public research institutions that emulating commercial plant breeding practices to produce public goods may be a less an optimal production pathway. **(Global Report, p. 478)**

Finally the IAASTD dwells on the unresolved issue of IPRs in different knowledge systems. Traditional and indigenous knowledge frequently does not satisfy western standards of publication and disclosure, nor do indigenous and local farmer communities even have concepts of private ownership of knowledge and information or plant and animal genetic resources. Unfair exploitation and biopiracy of their knowledge is a major concern, which may also prevent appropriate exchange among farmer communities, e.g., to adapt to climate change or improve local breeds. The IAASTD points out that those conflicts between private vs. public ownership have a negative bearing on in situ cultivation of agricultural biodiversity as well as farmer and community-based practices of participatory breeding.

Options for resolving at least parts of these problems include strengthening the capacity of those countries, institutions and most of all farmers who do not benefit from IP, in order to defend their interests at legal as well as institutional levels, including within international negotiations, e.g., within the TRIPs negotiations at the WTO, bilateral trade and institutional cooperation agreements. Compulsory licensing legislation (as exists in India and other Asian countries) for agricultural and food security relevant patents and varieties, as already broadly implemented for life-saving drugs, could be another approach, as could be broader research and farmers' exemptions on one side and the requirement for narrower patent claims and disclosure of the origin of patented germplasm on the other side. 'Open source' approaches within the scientific community and among scientific institutions are mentioned as still weak but promising alternatives to private patenting as is the systematic and preventive publishing of research results, which can – at least in theory – pre-empt future claims of novelty required for patenting.

Biotechnology and genetic engineering

Finding science-based common ground on the contentious issue of using genetic engineering in agriculture has been one of the explicit hopes of the World Bank and other initiators of the IAASTD. The scientists have not pleased the political ambitions of friends or foes of genetically modified organisms (GMOs). An early agreement among the Bureau and the authors had been not to look at potential solutions and technologies first to then subsequently assess pros and cons of their application. Rather the assessment was to start from key problems identified to then assess the available options and components of resolving them. It makes a huge difference whether one asks, "Here is the solution – what problems can we solve with it?" or if the question is, "Here is the problem, what are the available solutions?"

New evidence of high insecticide use by Chinese growers of GE insecticidal crops (Bt cotton) has demonstrated that farmers do not necessarily reduce their insecticide use even when using a technology designed for that purpose. This illustrates the frequently documented gap between the reality of how a technology is used (taken up in a given social context) and its 'in the box' design. (**Global Report, p. 95**)

In addition the assessment was to be evidence-based, rather than compiling the visions and aspirations of the scientists and stakeholders involved. This problem-oriented and evidence-based approach proved to put much less emphasis on this very specific technology of plant breeding than many other scientific and political assessments on the future of agriculture.

Box 1: A short history of patenting

Patent protection of human inventions has started in the 19th century as a contract between inventors and society, first codified internationally in 1881 (Paris Convention). In return for disclosing the details of the invention in a way that would allow its reproduction by skilled persons, the inventor was granted exclusive rights over the commercial application of the invention, including licensing, for a limited time.

While industrial patents have long played an important role also in agriculture, plants and animals had been excluded from this concept of intellectual property rights until very recently. In 1961 a special convention for the protection of plant breeders rights (UPOV) established an international system of exclusive rights over the commercialisation of new varieties for its breeder but did not prevent others from using the germplasm to develop new varieties, nor prevent farmers from replanting seeds. In 1980 the US Supreme Court in a landmark case decided that a genetically engineered microorganism was to be regarded as a 'composition of matter' created by human ingenuity and thus patentable. During the following years, patent protection of individual DNA sequences as well as higher organisms, including plants and animals, and also including not only human inventions but also discoveries were included in the concept; in 1991 UPOV was amended with the objectives of respecting such patents as well as allowing breeders to demand additional fees from farmers for replanting protected varieties.

In 1994 the World Trade Organisation established an Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), which obliges member states to legally protect intellectual property rights. Its application to plants and animals however is still contested. In 1992 the Convention on Biological Diversity established a concept of 'access and benefit sharing' for biodiversity, which theoretically provides for ways that countries of origin of commercially exploited life forms could reap some of the benefits from such commercialisation. However, the Parties to the Convention have so far failed to agree to the rules of a regime to implement this concept.

While patent rights are originally assigned to the individual inventor they are usually owned by the company or public institution he or she works for. In addition to using the legal concepts of intellectual property rights companies withhold knowledge and information they have generated or appropriated through private confidentiality regimes, some of which are also publicly protected as "Confidential Business Information", e.g., in applications for approval of the release of genetically engineered organisms into the environment and other product safety assessments.

Crops derived from GE technologies have faced a myriad of challenges stemming from technical, political, environmental, intellectual-property, biosafety, and trade-related controversies, none of which are likely to disappear in the near future. Advocates cite potential yield increases, sustainability through reductions in pesticide applications, use in no-till agriculture, wider crop adaptability, and improved nutrition. Critics cite environmental risks and the widening social, technological and economic disparities as significant drawbacks. Concerns include gene flow beyond the crop, reduction in crop diversity, increases in herbicide use, herbicide resistance (increased weediness), loss of farmer's sovereignty over seed, ethical concerns on origin of transgenes, lack of access to IPR held by the private sector, and loss of markets owing to moratoriums on GMOs, among others. **(Global Report, p. 95)**

The IAASTD points out the pivotal contribution of biotechnology at large in solving major challenges, including improved plant breeding, processing technologies, climate adaptation and plant and animal health. But it takes a rather cautious position on the safety, productivity and sustainability of GMOs.

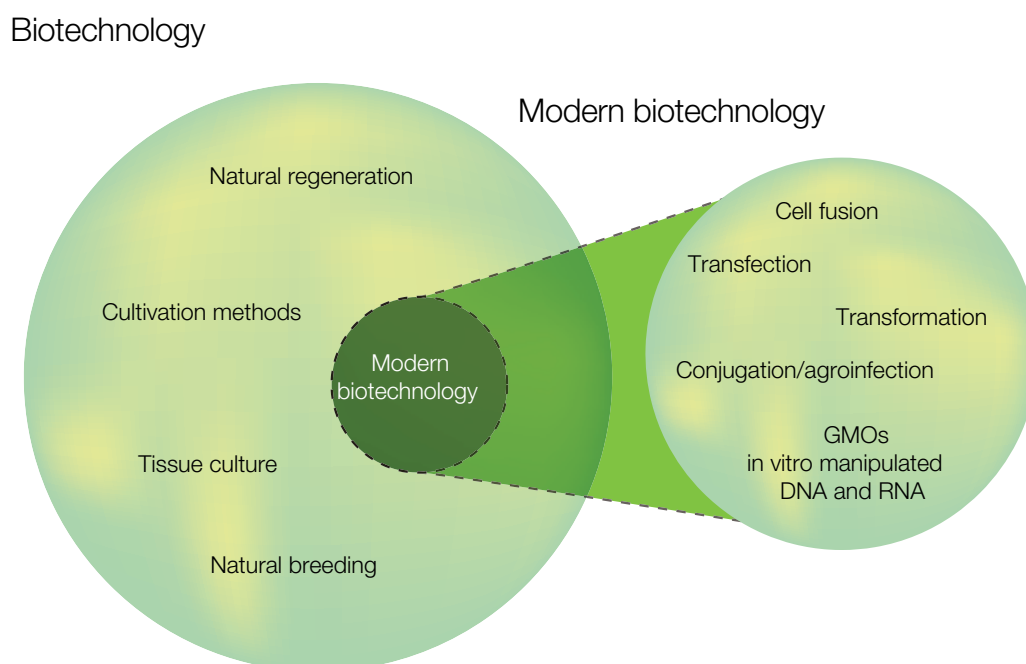
The pool of evidence of the sustainability and productivity of GMOs in different settings is relatively anecdotal, and the findings from different contexts are variable [Global Chapter 3, 6], allowing proponents and critics to hold entrenched positions about their present and potential value. **(Synthesis Report, p. 40)**

The present level of adoption of GE crops is critically put in perspective. Ninety percent of GE crops are planted in only four countries worldwide and comprise only two major traits: herbicide resistance ('Roundup Ready' and 'Liberty Link') and insecticidal properties (Bt technology), accounting for a total of less than 7% of the agricultural area.

Studies on GMOs have also shown the potential for decreased insecticide use, while others show increasing herbicide use. It is unclear whether detected benefits will extend to most agroecosystems or be sustained in the long term as resistances develop to herbicides and insecticides. **(Synthesis Report, p. 42)**

The Synthesis Report of the assessment also spells out some conflicting views among the authors regarding socio-economic aspects of genetic engineering that could not be settled.

Figure 27 Biotechnology and modern biotechnology defined



Source: Synthesis report, page 41.

Two framing perspectives on how best to put modern biotechnology to work for achieving sustainability and development goals are contrasted in the IAASTD. The first perspective [e.g., see Global Chapter 5] argues that modern biotechnology is overregulated and this limits the pace and full extent of its benefits. According to the argument, regulation of biotechnology may slow down the distribution of products to the poor [Global Chapter 5]. The second perspective says that the largely private control of modern biotechnology [Global Chapter 5] is creating both perverse incentive systems, and is also eroding the public capacity to generate and adopt AKST that serves the public good [e.g., see Global Chapters 2, 7]. (Synthesis Report, p. 43)

However, the authors point to a range of specific problems associated with some applications of biotechnology that need to be addressed regardless of these different perspectives.

Among these problems, intellectual property rights range especially high. Exclusive property rights and claims on certain methods as well as on individual genetic traits of organisms or such organisms as a whole can severely delay and prevent research and development, especially in the area of plant and animal breeding. It may also restrict or prevent access of farmers to plant genetic resources, impede effective forms of participatory breeding and threaten in situ conservation and adaptation of seed and animals to specific environmental conditions as well as cultural and social needs.

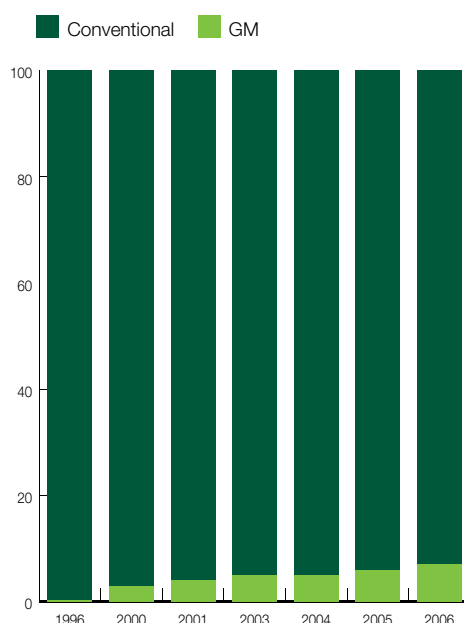
It will be important to maintain a situation where innovation incentives achieved through IPR instruments and the need for local farmers and researchers to develop locally adapted varieties are mutually supportive. Patent systems, breeders' exemptions and farmers' privilege provisions may need further consideration here. (Synthesis Report, p. 44)

A systematic redirection of AKST will include a rigorous rethinking of biotechnology, and especially modern biotechnology, in the decades to come. Effective long-term environmental and health monitoring and surveillance programmes, and training and education of farmers are essential to identify emerging and comparative impacts on the environment and human health, and to take timely counter measures. No regional long-term environmental and health monitoring programmes exist to date in the countries with the most concentrated GM crop production [Global Chapter 3]. Hence, long-term data on environmental implications of GM crop production are at best deductive or simply missing and speculative. (Synthesis Report, p. 45)

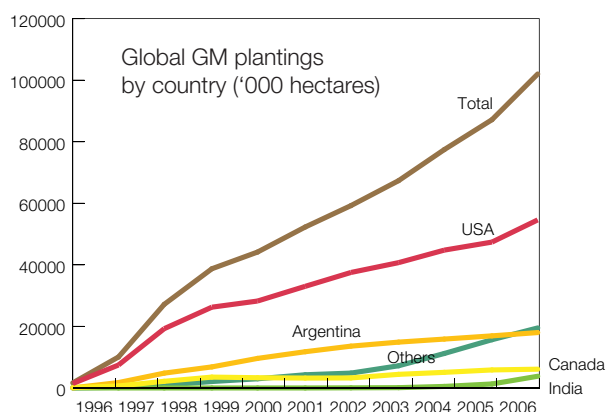
The report also points to the need for more and longer term safety research and capacity building, especially in developing countries, and advocates better involvement of farmers and the public at large in decisions about the application of controversial technologies.

Figure 28 Agricultural land (1996–2006) under GM and conventional crops

GM share of total (per cent)



Growth in GM agriculture



Source: James, C. and Wenzel, G. (2006) *Appl. Microbiol. Biotechnol.* volume 70, p. 642–650

06



© GREENPEACE / ATHIT PERAWONGMETHA

image Organic rice field in Thailand

Part VI

The way forward

There are no 'one size fits all' and silver bullet solutions in the generational challenge to make agriculture a driver of change for good. There are thousands of small steps and there is an enormous diversity of solutions. The IAASTD provides decision-makers at all levels with a wealth of positive policy options. We believe that there are also some simple steps to take in the right direction.

Not to be policy prescriptive but to offer options to decision-makers was the mantra of the IAASTD. Not an easy task, nor actually fully followed by authors. However, the IAASTD does not offer a simple set of recommendations or priority list how to achieve its clear message that global agriculture must undergo a 'fundamental shift' in order to sustain livelihoods, ecosystems and eradicate hunger and poverty of an increasing human population over the coming decades.

As we present here a selection of some of the options offered especially to governments, we believe that this is best done in the IAASTD's own language, which we draw exclusively from those Executive Summaries for Decision-Makers and of the Synthesis Report, voted and agreed upon in a meticulous line-by-line approval procedure by the representatives of 58 governments for the global SDM and the respective subsets of governments for the sub-regional SDMs, which also highlight different regional priorities.

It should be emphasised that many more options were put forward on policies, governance, science and research, education, socio-economy, culture, environment, resource management, and trade at micro and macro levels. Together they form a most valuable asset of political and practical steps towards a transition from our present destructive agricultural practices towards a more equitable, eco-efficient and sustainable agri-food system, able to fulfill the vision that no child goes to bed hungry any more.

I. Prioritising the resource needs and knowledge of the world's small-scale ecological farmers

Important options for enhancing rural livelihoods include increasing access by small-scale farmers to land and economic resources and to remunerative local urban and export markets; and increasing local value added and value captured by small-scale farmers and rural labourers. A powerful tool for meeting development and sustainability goals resides in empowering farmers to innovatively manage soils, water, biological resources, pests, disease vectors, genetic diversity, and conserve nature natural resources in a culturally appropriate manner. **(Executive Summary of the Synthesis Report, p. 5)**

Key options include equitable access to and use of natural resources (particularly land and water), systems of incentives and rewards for multifunctionality, including ecosystem services, and responding to the vulnerability of farming and farm worker communities. **(Executive Summary of the Synthesis Report, p. 6)**

Other proven policy approaches include expanding access to microfinance, financing value chains and local markets, streamlining food chains, supporting fair trade and organic agriculture as diversification and value addition strategies, and encouraging large-scale sustainable trading initiatives by the private sector. **(Global Summary for Decision Makers, p. 22)**

Society benefits when women are engaged in decision making, and when they have access to AKST and resources such as land, water and agricultural inputs and seeds. Health services, childcare and education support women's participation in agriculture. Preferential targeting of AKST and additional public support are needed to prepare resource poor women to become effective market participants. **(Global Summary for Decision Makers, p. 23)**

A number of other changes will strengthen women's contributions to agricultural production and sustainability. These include support for public services and investment in rural areas in order to improve women's living and working conditions; giving priority to technological development policies targeting rural and farm women's needs and recognising their knowledge, skills and experience in the production of food and the conservation of biodiversity; and assessing the negative effects and risks of farming practices and technology, including pesticides on women's health, and taking measures to reduce use and exposure. **(Global Summary for Decision Makers, p. 11)**

II. Supporting ecological farming systems with public research and investment monies

An increase and strengthening of AKST towards agroecological sciences will contribute to addressing environmental issues while maintaining and increasing productivity. **(Global Summary for Decision Makers, p. 6)**

More and better targeted AKST investments, explicitly taking into account the multifunctionality of agriculture, by both public and private sectors can help advance development and sustainability goals. **(Global Summary for Decision Makers, p. 7)**

More government funding and better targeted government investments in AKST in developing countries can contribute in a major way to meeting development and sustainability goals. This increase would involve more investment by the public sector in order to deliver a wide range of global public goods. This increased funding is justified given (1) the potential for high economic ROR [rates of return] in technologies that are applied by farmers in the field; and (2) evidence that AKST investments can help reduce poverty. Public investments must be targeted using evidence other than simply overall ROR to include social, environmental, health and cultural aspects, positive and negative, and the distribution of costs and benefits among different groups. [...] Funding is also needed for processes that ensure that resource-poor farmers, natural resource managers and other intended beneficiaries of the research participate in research decision-making. **(Global Summary for Decision Makers, p. 26-7)**

Investment opportunities in AKST that could improve sustainability and reduce negative environmental effects include resource conservation technologies, improved techniques for organic and low-input systems; a wide range of breeding techniques for temperature and pest tolerance; research on the relationship of agricultural ecosystem services and human well-being; economic and non-economic valuations of ecosystem services; increasing water use efficiency and reducing water pollution; biocontrols of current and emerging pests and pathogens; biological substitutes for agrochemicals; and reducing the dependency of the agricultural sector on fossil fuels. **(Executive Summary of the Synthesis Report, p. 6)**

Achieving development and sustainability goals would entail increased funds and more diverse funding mechanisms for agricultural research and development and associated knowledge systems, such as: public investments in global, regional, national and local public goods; food security and safety, climate change and sustainability. **(Executive Summary of the Synthesis Report, p. 7)**

Promote interaction between traditional, agroecological, and conventional knowledge and expertise. To this end, it would be appropriate to develop an intercultural participatory agenda that preserves and enhances the value of local knowledge, supplements it with scientific knowledge where relevant, and contributes to greater sustainability of productive systems, more efficient use of natural resources, and higher land yields, while maintaining, promoting, and enhancing the cultural and biological heritage of local communities. The current AKST system must be bolstered in order to make its agenda more holistic, complex, and diverse, which will address the problems faced by traditional and conventional systems, so that they will both evolve toward a more agroecological model **(Figure LAC-SDM-5)**. **[See figure 29] (Summary for Decision Makers of the Latin America and Caribbean (LAC) Report, p. 8)**

Increasing the performance of agriculture requires an improvement in productivity on the 80% of SSA farms that are smaller than two hectares. Earlier paradigms that typically attempted to fit farmers into the existing linear topdown structures of research-development-extension worked relatively well for major cash crops, but there has been less success on small-scale diversified farms [Chapter 5]. Options for AKST include integrated and participatory approaches that can increase the likelihood that appropriate technologies for production are developed and adopted by small-scale farmers. Alternative approaches include moving farmer engagement closer to priority setting and funding decisions, increasing collaboration with social scientists, and increasing participatory and interdisciplinary work in the core research institutions. There is evidence from East Africa that innovative approaches to AKST development such as farmer research groups are more successful in reaching women farmers than traditional extension activities. By understanding farmers' contexts and priorities, grounding new technologies in an understanding of farmers' motivations and constraints, and explicitly including groups that are often socially excluded such as women and minorities, AKST is more likely to be relevant and adopted. **(Summary for Decision Makers of the Sub-Saharan Africa (SSA) Report, p. 6)**

III. Supporting the multiple ecological functions of agriculture through policies that value and protect ecosystem services

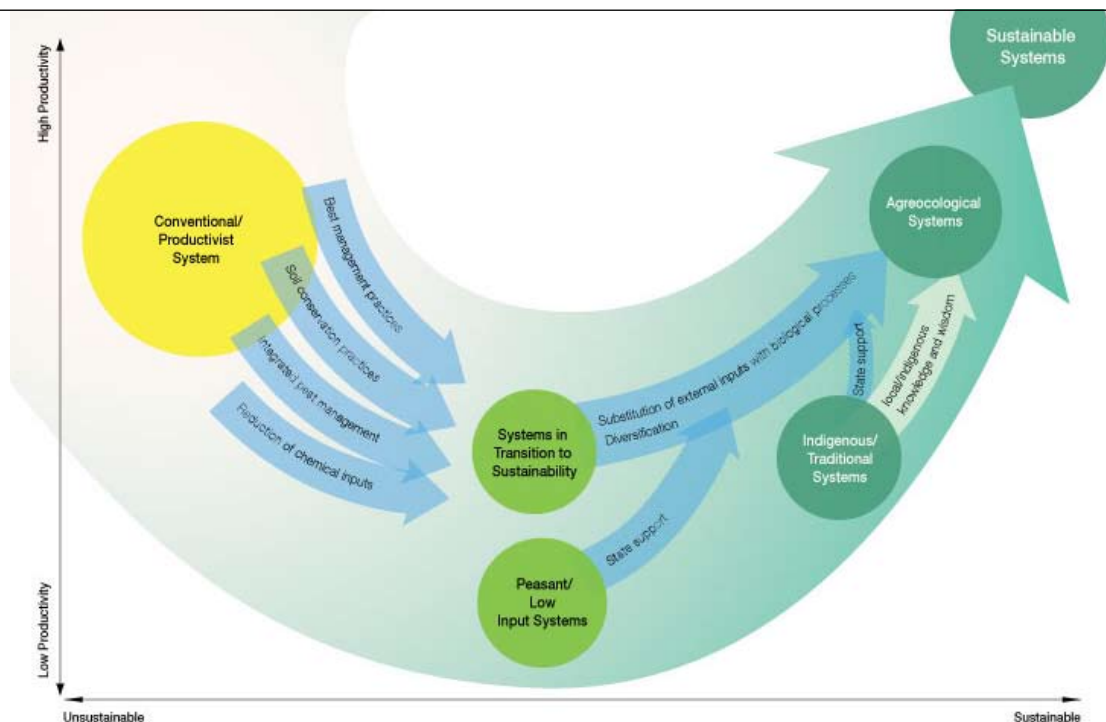
Policies that promote sustainable agricultural practices (e.g., using market and other types of incentives to reward environmental services) stimulate more technology innovation, such as agroecological approaches and organic farming to alleviate poverty and improve food security. (Global Summary for Decision Makers, p. 24)

Policy options include ending subsidies that encourage unsustainable practices and using market and other mechanisms to regulate and generate rewards for agro/environmental services, for better natural resource management and enhanced environmental quality. Examples include incentives to promote integrated pest management (IPM) and environmentally resilient germplasm management, payments to farmers and local communities for ecosystem services, facilitating and providing incentives for alternative markets such as green products, certification for sustainable forest and fisheries practices and organic agriculture and the strengthening of local markets. (Executive Summary of the Synthesis Report, p. 6)

AKST innovations that address sustainability and development goals would be more effective with fundamental changes in price signals, for example, internalisation of environmental externalities and payment or reward for environmental services. (Global Summary for Decision Makers, p. 23)

Market and trade policies to facilitate the contribution of AKST to reducing the environmental footprint of agriculture include removing resource use-distorting subsidies; taxing externalities; better definitions of property rights; and developing rewards and markets for agroenvironmental services, including the extension of carbon financing, to provide incentives for sustainable agriculture. (Executive Summary of the Synthesis Report, p. 10)

Figure 29 Transition to sustainable systems.



Source: IAASTD Latin America and the Caribbean (LAC) Summary for Decision Makers, page 9

Payment or reward for performance-based ecological services (PES) recognises the importance of the multiple functions of agriculture and creates mechanisms to value and pay for the benefits of resource-conserving ecosystem services provided by sustainable agricultural practices, such as low-input and low-emission production, conservation tillage, watershed management, agroforestry practices, carbon sequestration, biological control and pollination, and conservation of agricultural biodiversity. Other policy approaches that are already in use in various countries, which would reduce the negative footprint of agriculture include taxes on carbon, agrochemical use and water pollution. Such taxes provide incentives to reach internationally or nationally agreed use-reduction targets and support resource conserving and low-emission technologies. They provide incentives for multifunctionality in using agricultural land, broadening revenue options for land managers and allowing carbon-impact food labeling. Another option includes prohibiting particularly damaging practices in highly vulnerable areas (e.g., deforestation in tropical forest margins, use of toxic chemicals in watershed headways and near streams). To meet development goals, incentive and regulatory systems can be designed to ensure stable revenues for small-scale farmers and local communities, such as product certification for geographical origin and organic agriculture. **(Global Summary for Decision Makers, p. 24)**

IV. Addressing climate change through the agriculture sector with support for ecological farming

AKST can play a proactive role in responding to the challenge of climate change and in mitigating and adapting to climate-related production risks. ... AKST can be harnessed to mitigate greenhouse gas (GHG) emissions from agriculture, to increase carbon sinks and biodiversity (e.g., tree planting and conservation tillage), and to enhance adaptation of agricultural systems to biotic and abiotic results of climate change. **(Global Summary for Decision Makers, p. 24)**

New technologies could reduce the reliance of agriculture and the food chain on fossil fuels for agrochemicals, machinery, transport and distribution. Existing AKST could also help reduce fossil fuel dependency, given changes in institutional arrangements and incentives. Emerging research on energy efficiency and alternative energy sources for agriculture will have multiple benefits for sustainability. There is considerable potential for expanding the use of digesters (e.g., from livestock manure), gasifiers and direct combustion devices to generate electricity. More research and development is needed to reduce costs and improve operational reliability. **(Global Summary for Decision Makers, p. 21)**

Reducing agricultural emission of greenhouse gases within NAE will require changes in farming systems, land use and practices throughout the agri-food system, such as increasing energy efficiency and carbon sequestration, changing livestock feeds and reducing fertiliser overuse. **(Summary for Decision Makers of the North America and Europe (NAE) Report, p. 8)**

To address expected climate change challenges and impacts, a major role for AKST is needed to increase adaptive capacity and enhance resilience through purposeful biodiversity management. Options include irrigation management, water harvesting and conservation technologies, diversification of agriculture systems, the protection of agrobiodiversity and screening germplasm for tolerance to climate change. These measures would need to be supported by appropriate policy options, integrated spatial planning, and early warning and communication infrastructure that support the generation and dissemination of adaptation knowledge, technologies and practices. **(Global Summary for Decision Makers, p. 24)**

V. Recognising the inter-related principles of food sovereignty and the right to food

Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. **(Executive Summary of the Synthesis Report, p. 5)**

Policy options for addressing food security include developing high-value and underutilised crops in rain fed areas; increasing the full range of agricultural exports and imports, including organic and fair trade products; reducing transaction costs for small-scale producers; strengthening local markets; food safety nets; promoting agro-insurance; and improving food safety and quality. **(Executive Summary of the Synthesis Report, p. 5)**

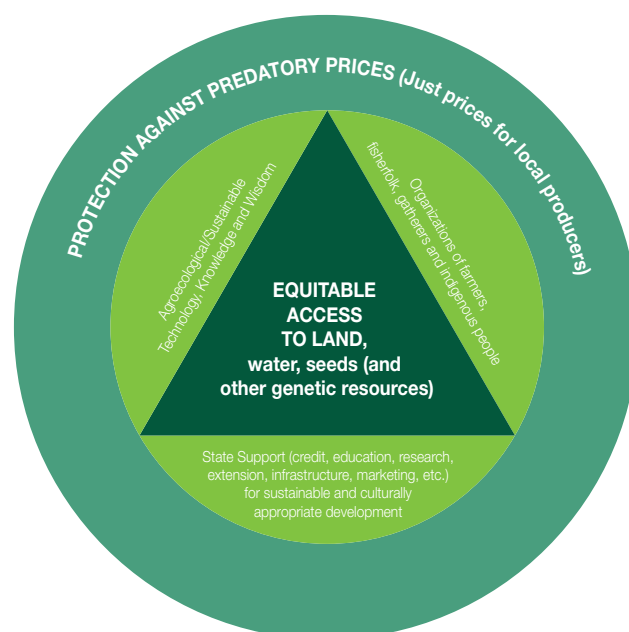
Food sovereignty is defined as the right of peoples and sovereign states to democratically determine their own agricultural and food policies. **(Global Summary for Decision Makers, p. 15)**

In order to meet the development and sustainability goals, AKST Public Support Policies must transcend models based on the assumption that the market alone can address the issues of economic and cultural poverty, hunger, and inequality. For example, Figure LAC-SDM-6 [see figure 30] presents a set of public policy options pertaining to food sovereignty. In order to implement public policies, it is necessary to achieve broad political and social consensus that will establish a legitimate strategic framework that can be sustainably applied in the short, medium, and long term. **(Summary for Decision Makers of the Latin America and Caribbean (LAC) Report, p. 10)**

There is growing concern that opening national agricultural markets to international competition before basic institutions and infrastructure are in place can undermine the agricultural sector, with long-term negative effects for poverty, food security and the environment. **(Executive Summary of the Synthesis Report, p. 10)**

Some developing countries with large export sectors have achieved aggregate gains in GDP, although their small-scale farm sectors have not necessarily benefited and in many cases have lost out. The small-scale farm sector in the poorest developing countries is a net loser under most trade liberalisation scenarios that address this question. These distributional impacts call for differentiation in policy frameworks as embraced by the Doha work plan (special and differential treatment and non-reciprocal access). **(Global Summary for Decision Makers, p. 7)**

Figure 30 Public policy options that contribute to food sovereignty



Source: IAASTD Latin America and the Caribbean (LAC) Summary for Decision Makers, page 11.

Developing countries are vulnerable to rapid fluctuations in world food prices and their agricultural and food systems are unlikely to be resilient to environmental, political and economic shocks. Policy options to enable these countries to respond to crises and achieve food security and sovereignty include greater democratic control (local, national, regional) and public sector involvement in agricultural policy, specifically through empowering farmer organisations, national governments and regional trading blocs.

Other policy options include improving

- (1) security of tenure and access to land, germplasm and other resources;
- (2) diversification with locally important crop species;
- (3) access to resources (e.g., credit, nutrients);
- (4) supporting rural livelihoods by transparent price formation and functioning markets with the objectives of improving small farm profitability and helping ensure that farm-gate prices are above marginal costs of local production; and
- (5) strengthen social safety nets. These options imply a fundamental transformation of AKST and economy wide approach to agricultural policy. **(Global Summary for Decision Makers, p. 22)**

Trade policy reform to provide a fairer global trading system can make a positive contribution to sustainability and development goals. Special and differential treatment accorded through trade negotiations can enhance the ability of developing countries to pursue food security and development goals while minimising trade-related dislocations. Preserving national policy flexibility allows developing countries to balance the needs of poor consumers (urban and rural landless) and rural small-scale farmers. Increasing the value captured by small-scale farmers in global, regional and local markets chains is fundamental to meeting development and sustainability goals. **(Executive Summary of the Synthesis Report, p. 10)**

In addition to trade in conventional (grain, tea, coffee) and new (fruits, vegetables) agricultural commodities, there is considerable scope for developing organic and fair trade markets where social, sustainable and ethical objectives can overlap. For a number of agricultural exports, market instruments that shift some risk to marketers and financiers can be of use in addressing problems of fluctuations and secular declines in price. It also is possible to diversify output, move up the value chain through processing activities and develop alternative crop uses without compromising food security. **(Summary for Decision Makers of the East and Central Asia and the Pacific (ESAP) Report, p. 9)**

Conclusions

While humankind has never before produced as much food, feed and other agricultural produce on this planet, the number of people going to bed hungry at night has also never been as high as today, nor has been the number of obese persons, often living right next to those undernourished. The waste of prepared food alone probably represent more calories than are missing by the world's hungry. Food production is one of the most important contributors to climate change and at the same time the industry most acutely threatened by its consequences. In addition, biodiversity, fresh water supply and forest areas world wide are under all under unprecedented stress. Expansion of agricultural land and intensification of production through increased inputs of energy, chemicals – mostly toxic, and irrigation have been prime drivers of this situation.

All this is the consequence of a paradigm of agricultural and food policies, research and development over the past 50 years that more production and higher labour productivity was the key to fight hunger and to keep pace with an ever growing world population. We have come to realise that this strategy is no longer a valid path. Industrialisation of agriculture with its monocultural approach, neglect of the ecological and social multifunctionality of agriculture, and commodification of food on a global level will not only fail to guarantee the survival of 9 billion people on this planet, expected for 2050. It is about to destroy the basis of our food supply and threatens the web of live upon which we all depend.

“If we do persist with business as usual, the world’s people cannot be fed over the next half-century. It will mean more environmental degradation, and the gap between the haves and have-nots will expand. We have an opportunity now to marshal our intellectual resources to avoid that sort of future. Otherwise we face a world nobody would want to inhabit.”

Professor Robert T. Watson, Director of the IAASTD

So what is the new paradigm to replace the productivist industrial agricultural approach? Tempting as it may be to speak of agroecological, energy-efficient small holder based food-sovereignty as such a new paradigm, it is important to acknowledge that the IAASTD does not provide such general conclusions and clearly abstains from offering any ideological solutions.

If there is one key message that the IAASTD repeats over and over again it is this: There are no silver bullet solutions and recipes to overcome the present multiple crises – financial, food, climate, energy – and to address the challenges of agriculture and food production. Instead, there are myriads of steps to be taken and to be pragmatically combined according to the large diversity of agroecological, social and cultural environments.

Simple steps in the right direction

We believe that there are some principles to extract from the report, which may not always apply, but still point to the way forward in most cases.

1. Food First. Agriculture should provide all residents of a region first and foremost with the necessary means to feed themselves a healthy diet. Other uses of agricultural land must never impede and should always be compatible with and adapted to this basic function of the land. Access to food or the means of its production are a fundamental human right for which every government in the world should be held accountable also at an international level.

2. Smallholders are the key to sustainable food security. As hunger is still a predominantly rural menace and as roughly 40% of the world's population depend on rural livelihoods and produce most of the food humanity consumes, efforts to eradicate hunger and to direct agriculture towards sustainability must focus on improving the situation and practices of small farmers and serving their needs, and depends upon ensuring their secure access to and control over land, water, seeds, markets, capital, and basic human rights.

3. Women make the difference. Women provide the larger part of agricultural labour, food processing, household health and nutrition services. Their continued lack of access to land tenancy, education and information as well as other fundamental human rights is the single most important obstacle to progress in many societies, especially in rural areas. Investment in general empowerment of women and gender mainstreaming at all levels is therefore the most efficient means to unleash enormous capacities for economic and social progress around the world.

4. Replace monocultures with diversity. Implementation of industrial concepts of economies of scale into agriculture has not only miserably failed to fulfil the goals of feeding the world in a sustainable way, it is also among the greatest risks of an uncertain future of climate change, oil peak and global environmental threats. Both wild and domesticated diversity of plants and animals, as well as the cultural and traditional diversity of agricultural practices and solutions is probably the single most important insurance against future large scale failures. Building resilient and adaptive agri-food systems upon the power of diversity and the ingenuity of the millions of farmers familiar with this diversity, therefore appears not only the safest way forward, but also the most promising path of innovation.

5. Design agricultural policies that support and enhance the multiple ecological functions of agriculture. Redirect research and investment funding towards ecological farming systems. Shift public financial support away from subsidies that promote unsustainable inputs, input-intensive industrial agriculture and export-oriented farming models towards rewarding environmental sustainability and ensuring the food and livelihood security of small-scale, subsistence and family farmers.

6. Escape the pesticide treadmill! Half a century of trying to control plants and microorganisms by means of toxic chemicals has resulted in poisoned rivers and air, contaminated soils, serious and globally dispersed proliferation of acute and chronic toxins in all biotic systems. While some of the long term impacts of pesticides are only starting to show, farming experience clearly proves that the chemical war against pests will never be won. Threatening pest levels are basically the result of lost biological checks and balances in severely disturbed ecosystems. Replacing toxic pest management strategies with biological and agroecological ones, based upon improved as well as traditional understanding of biological processes and interactions is therefore one of the most formidable challenges of modern agriculture.

7. Minimise fossil fuel dependency. Agricultural production systems must become independent of fossil fuel inputs over the coming decades. This is certainly a huge challenge for many present systems. Improved efficiency and productivity will require additional machinery (e.g., minimal mechanisation, irrigation, preservation and storage technologies) in some cases. However, as a general rule reducing fossil-fuel-based external inputs is not only an imperative from the overall global warming perspective, but also a much needed insurance against price shocks and shortage of supply.

8. Grow and produce food as close to those who eat it as possible. There are various good reasons for this approach:

- Food sovereignty: Independence from external factors beyond the control of local communities decreases risks and improves the ability to adapt environmental, social and cultural impacts of food production and consumption.
- Quality control: There is no better system than knowing those who produce your food.
- Food miles: The shorter the distance, the lower the input of fossil fuels for transport, but usually also for processing, packaging, loss due to waste and other factors.

9. Reduce and optimise meat production and consumption.

As meat production beyond the bearing capacity of pasture grassland is one of the most profound challenges to sustainability of agricultural production, there is an urgent need to substantially reduce over-consumption of meat, eggs and milk in industrialised countries and cities, which would also have immediate beneficial health effects in these countries. In addition, smarter and more effective means of meat production, including new sources of feed, e.g., from organic waste, improved diets for ruminants to reduce methane emissions, and the best choice of animal sources of protein adapted to different local conditions are needed.

10. Reduce waste of food and other agricultural products at every step of production, processing and distribution.

Starting with minimising post harvest losses at farm and storage facilities, to reducing losses in production and processing, waste of food in supermarkets and on catering and household level has an enormous potential to improve eco-efficiency and availability of food worldwide.

11. Rethink and improve how bioenergy is produced and utilised.

Large-scale cultivation of biofuels for a global commodity market is likely to create environmental, social and economic problems. Moreover, it is not compatible with the first commandment of agriculture with the present state of technology and under current environmental and socio-economic circumstances. Improvements of food and fibre use for household and community energy needs, however, are a key area for innovation for large parts of rural population in developing countries.

12. More trees! This firstly implies to stop deforestation, especially of old growth forests, which is not only agriculture's most important contribution to global warming but also to loss of biodiversity, water cycle disturbances and soil degradation. Secondly, integration of existing forests and planting of new trees in agroforestry systems is a powerful means to improve climate mitigation and resilience, biodiversity and watershed protection.

13. Adapt global trade to the major challenges ahead. As the 20th century post-colonial world order is presently undergoing fundamental shifts, global terms of trade offer one of the few conceivably effective means to designing a more equitable and world. In order to be effective, offering farmers and the rural poor strong incentives and financial means to neither abandon nor overexploit their land is not only a matter of human rights, peace keeping and social justice, but also the prerequisite to keep the rise of temperature within a manageable range.

14. Share the knowledge needed for survival! Making the scientific as well as local and traditional knowledge available that is needed to adapt our agri-food system to the requirements of environmental and social sustainability is in many cases not well achieved by trading or stockpiling such knowledge as private property. The simple reason is that those most in need of such knowledge do not have the means to buy it. In addition, efforts to withhold knowledge with the purpose of financial return or economic control prove to undermine the freedom and speed of exchange and thereby retard scientific progress and application of knowledge. Finally, systems of proprietary knowledge generation and exchange tend to artificially focus scientists and technicians on product-based solutions having the novelty required for patenting. Such a focus is narrowing the range of considered solutions and frequently even leads to active undermining and prevention of better, yet non-proprietary methods and approaches.

15. Continue global multi-stakeholder exchange of knowledge and views. Establishing a permanent intergovernmental body of experts, similar to the IAASTD, to assess and monitor all aspects of multifunctional agriculture, food production and consumption, based on a multi-stakeholder governing body would be an important contribution to enhancing our global capacity of change not only on the grassroots-level, but also at the level of UN institutions and international governance and national governments.

The reports

The IAASTD reports are available in English, executive summaries also in Chinese, Russian, French, Arabic and Spanish at www.agassessment.org

Further background can also be found at www.agassessment-watch.org

- Global Report
- Summary for Decision Makers of the Global Report
- Synthesis Report
- Executive Summary of the Synthesis Report

Sub-Regional Reports

- Central and West Asia and North Africa (CWANA) Report
- Summary for Decision Makers of the Central and West Asia and North Africa (CWANA) Report
- East and South Asia and the Pacific (ESAP) Report
- Summary for Decision Makers of East and South Asia and the Pacific (ESAP) Report
- Latin America and the Caribbean (LAC) Report
- Summary for Decision Makers of the Latin America and the Caribbean (LAC) Report
- North America and Europe (NAE) Report
- Summary for Decision Makers of the North America and Europe (NAE) Report
- Sub-Saharan Africa (SSA) Report
- Summary for Decision Makers of the Sub-Saharan Africa (SSA) Report

Statement by governments

All countries present at the final intergovernmental plenary session held in Johannesburg, South Africa in April 2008 welcome the work of the IAASTD and the uniqueness of this independent multi-stakeholder and multidisciplinary process, and the scale of the challenge of covering a broad range of complex issues. The Governments present recognise that the Global and sub-Global Reports are the conclusions of studies by a wide range of scientific authors, experts and development specialists and while presenting an overall consensus on the importance of agricultural knowledge, science and technology for development they also provide a diversity of views on some issues. All countries see these Reports as a valuable and important contribution to our understanding on agricultural knowledge, science and technology for development recognising the need to further deepen our understanding of the challenges ahead. This Assessment is a constructive initiative and important contribution that all governments need to take forward to ensure that agricultural knowledge, science and technology fulfills its potential to meet the development and sustainability goals of the reduction of hunger and poverty, the improvement of rural livelihoods and human health, and facilitating equitable, socially, environmentally and economically sustainable development. In accordance with the above statement, the following governments accept the Global Report.

Armenia, Azerbaijan, Bahrain, Bangladesh, Belize, Benin, Bhutan, Botswana, Brazil, Cameroon, China (People's Republic of), Costa Rica, Cuba, Democratic Republic of the Congo, Dominican Republic, El Salvador, Ethiopia, Finland, France, Gambia, Ghana, Honduras, India, Iran, Ireland, Kenya, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Libyan Arab Jamahiriya, Maldives, Republic of Moldova, Mozambique, Namibia, Nigeria, Pakistan, Panama, Paraguay, Philippines, Poland, Republic of Palau, Romania, Saudi Arabia, Senegal, Solomon Islands, Swaziland, Sweden, Switzerland, United Republic of Tanzania, Timor-Leste, Togo, Tunisia, Turkey, Uganda, United Kingdom of Great Britain, Uruguay, Viet Nam, Zambia (58 countries)

While approving the above statement the following governments did not fully approve the Global Report and their reservations are entered in Annex G.

Australia, Canada, and United States of America (3 countries)

GREENPEACE

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

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