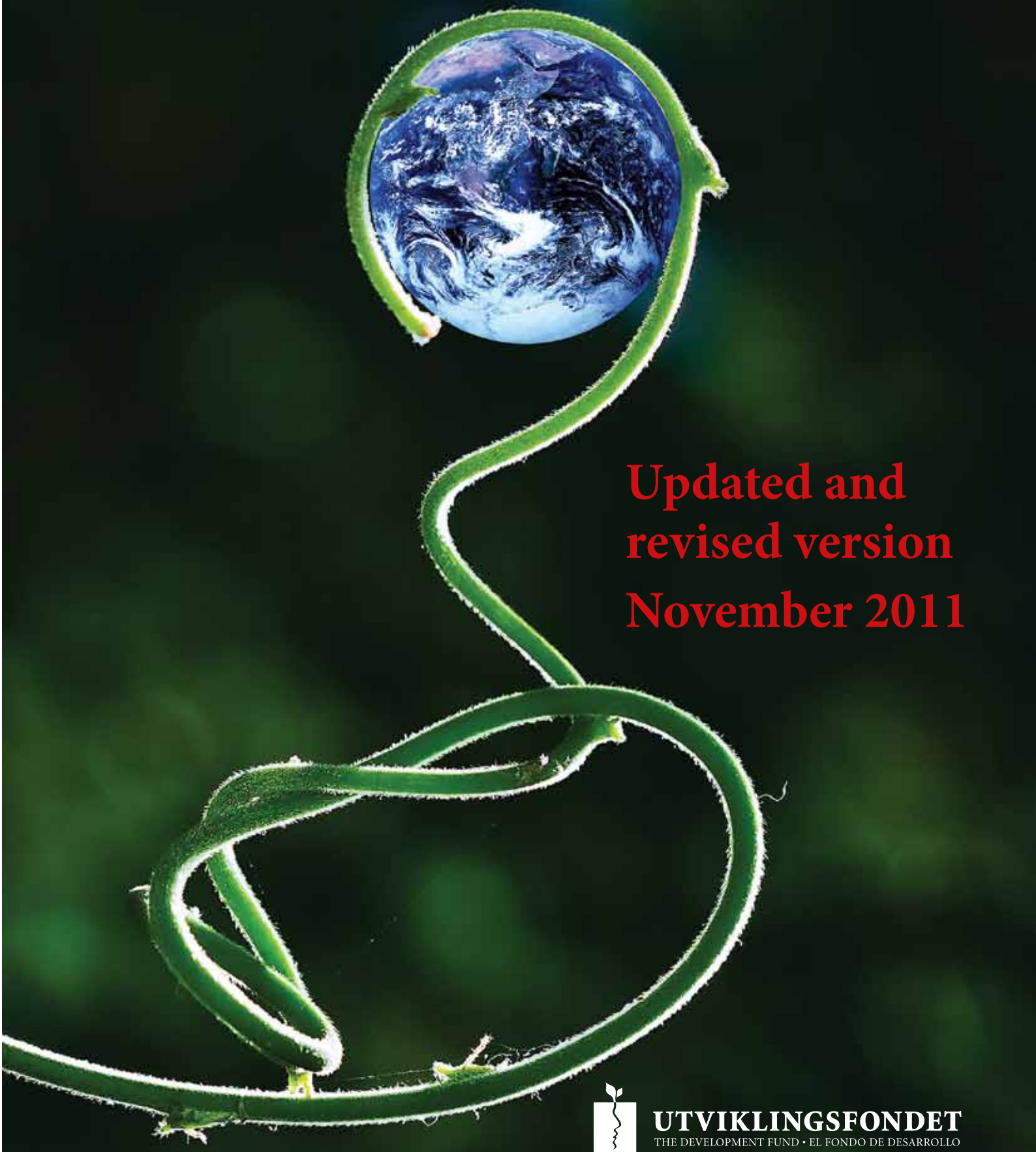
A Viable Food Future



Updated and revised version November 2011

UTVIKLINGSFONDET
THE DEVELOPMENT FUND • EL FONDO DE DESARROLLO

A Viable Food Future

PART I

Updated and revised version, November 2011

What kind of food production can

drastically reduce poverty,

reduce climate change and cool the planet,

restore biodiversity, soil fertility and water resources,

improve livelihoods and provide employment for billions of people,

produce enough, good, and nutritious food for 9 billion people or more … ?

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Part I

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Canada: USC-Canada; India: Forum for Biotechnology & Food Security, and Navdanya; Italy: Terra Nuova; Spain: Veterinarios sin Fronteras; USA: Food First, Oakland Institute; UK: Practical Action; and International organisations: ETC-group, Friends of the Earth, GRAIN, More and Better, La Via Campesina and the International Commission on the Future of Food and Agriculture.

Additional references: See Part II of the report

Part I of the report can be ordered in printed form from The Development Fund.
Both part I and II can be downloaded for free from www.utviklingsfondet.no/viablefuture

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The Development Fund is an independent Norwegian non-governmental organisation (NGO). We support environment and development projects through our local partners in Asia, Africa and Latin America. We believe that the fight against poverty must be based on sustainable management of natural resources in local communities.

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Contents

A Viable Food Future, Part I, introduces the concepts of ecological agriculture in the third millennium. Part II looks more in-depth into some of the issues introduced in Part I, giving additional information on on-going initiatives, existing knowledge and paths ahead. It also contains a reference list and recommended literature on the main themes.

Key messages

WE CANNOT CONTINUE TO IGNORE THAT …

The food, fuel and economic crises are connected and related to an unprecedented ecological crisis of the earth

- We cannot continue the overexploitation and destruction of natural resources.
- Our ecological footprint now overshoots the earth's biocapacity by more than 40 percent.

Hunger is not acceptable

- Almost 1 billion people suffer from hunger, yet enough food to eradicate hunger is produced in the world.
- Food production must increase in the coming years. Small-scale ecological food producers can feed a population of 9 billion people or more.

Unsustainable practices of food production[1] are no longer an option

- Industrial food systems pollute soils, water and air, and contribute to climate change.
- Industrial food systems impoverish millions of small-scale food producers, creating increasingly bigger waves of poverty, hunger and migration.

The present food system destroys people's health

- Unhealthy foods and diets cause obesity, heart disease and type 2 diabetes, affecting 2 billion people and serious pandemics are likely to occur in the near future.
- The use of pesticides, insecticides, herbicides, fungicides and antimicrobials can have enormous consequences on the health of humans and other living organisms.

We are at a crossroads and have the opportunity to embrace a different direction

- Food systems that produce enough and healthy food, create vibrant communities and fair economies, reduce climate change and sustain the planet are possible.
- We need to shift our thinking and actions towards favouring agricultural[2] practices that maintain and enhance ecosystem services and natural resources, while producing sufficient and nutritious food.

There is an existing wealth that has gone unnoticed, unsupported, even marginalised and ignored.

- More resilient and sustainable models of food production exist. They have evolved and adapted for millennia in traditional forms of agriculture and are more relevant than ever as viable tools in alleviating hunger and unemployment worldwide. They can be combined with latest science on sustainable forms of production.
- Field research has demonstrated that at least double digit increases in production can be obtained in developing countries without using chemical inputs like synthetic fertilizer and pesticides.

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[1] In this report "food production" includes harvesting and gathering if nothing else is specified or clear from the content.

[2] In this report "agriculture" includes cropping, livestock husbandry, pastoralism, fisheries, forestry and other natural uses for food production, gathering and harvesting in urban and rural areas – if nothing else is specified of clear from the content.

It is possible to produce enough food while applying agroecological principles

- The high productivity of small farms in terms of output per unit of area has been demonstrated, and sustainability-enhancing practices provide evidence of the potential to increase production and, at the same time, preserve the environment and cooling the planet.
- State of the art research on soil biology and the beneficial effects of soils rich in micro-organisms, presents a significant and still untapped potential for resilient production systems.

Shifting towards resilience and sustainability implies also a shift towards democratic access and management of resources

- There are 3 billion small-scale food producers worldwide (including their families) and they are the ones producing 70 percent of the world's food.
- Policies supporting small-scale producers and transferring decision-making power to them on the use and management of resources have a big potential to help create vibrant communities endowed not only with food but also vivid economies, well-being and the possibility to plan for a long-term future.

A shift in support and regulations is necessary for viable food production

- Stricter regulations of industrial agriculture are needed to shift away from damaging production systems. The real external costs (environmental and social) must be internalised in the cost of production.
- Small-scale ecological food production must be actively supported and promoted. The orientation of policies, support and research must be more innovative and creative in the search for approaches that blend traditional millennia-tested knowledge and state-of-the art contemporary knowledge adapted to the changing conditions.

Process and acknowledgement

Following the success of the initial version of this report, requests were made to produce an updated version with the latest available world figures.This is the updated version of Part I which was first published in September 2010. Part II of the report is published separately. Both are built on contributions from many people – the knowledge and experiences of small-scale food producers, activists in social movements and NGOs, politicians, technicians, writers and scientists as well as representatives of international institutions and organisations.

The report is the result of many people's work. Angela Hilmi has written the draft of the main parts of the report, both Part I and Part II. Marta G. Rivera Ferre has written the chapter on livestock and pastoralism (in Part II), and KG Kumar has written the chapter on fisheries (in Part II). Jonathan Ensor has contributed to sections on climate issues and also edited some of the case studies. Anuradha Mittal, Mia Henriksen and Farris Ahmed have edited case studies on good practices and projects (in Part II).

The first draft was reviewed by an Advisory Committee and discussed during a two-day meeting in Norway whereby rich contributions were provided. The following persons took part in the advisory meeting: Angela Hilmi, Bell Batta Torheim, Dena Hoff, Devinder Sharma, Eric Holt-Gimenez, Faris Ahmed, Jonathan Ensor, Marta G. Rivera Ferre, Neth Dano, Nnimmo Bassey, Nora McKeon, Olav Randen and the editor. Their comments and suggestions were very valuable and important in formulating the final version of the report. Many, many thanks to all of them.

In addition I would like to thank a few others who have given important inspiration and contributions to this report in different ways: Isabelle Delforge, Olivier de Schutter, Pat Mooney, Patrick Mulvany, Vandana Shiva, Paul Nicholson, José Maria Alvarez- Coque, Jules Pretty, Robert Wallace, Jan Slingenbergh, Jean-Marc Faures, William Settle, Jelle Bruinsma, Dionisio Ortiz Miranda, José Esquinas Alcázar, Mathis Wackernagel, Anni McLeod, Mukesh Srivastava, Peter Kenmore, Marc Dufumier, Pierre Gerber, Marcel Mazoyer, Jacques Weber, and all those who have had the patience and kindness to provide ideas and references of the latest available data and information in selected scientific fields with relation to the ambitious challenges being dealt with in the report. A special thanks to colleagues in the Development Fund, especially Sigurd Jorde. Many thanks also to designer Tor Otto Tollefsen for the layout and to editor Nancy Hart who has improved language and corrected errors.

The organisations listed on page four have directly contributed to the drafting of the report. It is, however, important to underline that none of them has approved the report or signed on to any of the statements or recommendations in the report because there has not been any such process for approval.

My role as editor has mainly been to organize the work and writing of the text, help structure the report and work on the political conclusions and recommendations. I have taken the final decisions on the editing and approved the text, researched and checked inputs to ensure that this publication gives the readers an honest appraisal of the situation the world faces – providing the facts that prove the potential of small-scale ecological farming to produce enough food for the world's population, mitigate climate change, preserve and restore natural resources and drastically reduce poverty.

Aksel Nærstad, editor

I. INTRODUCTION

The aim of this report is to provide scientifically based facts, arguments and ideas for what is needed to meet some of the most important challenges in the world today. This report is about food and agriculture, it sees food as more than calories that fill people's stomachs, and it sees agriculture as more than producing and harvesting food.

Our way of life, our well-being, our culture and interactions with the people we love and care for are intimately linked to how and where food is produced, what is produced, how we buy it, how we prepare it and how we eat it. The future of humanity depends on how food is – and will be – produced and provided.

As actors or observers, we witness with both our minds and hearts, the domino of unfolding crises. In a relatively short time, we have had the whole range of possible alerts to the health of our planet.

The food crisis in 2007–2009 increased the number of people suffering from hunger by 150 million, reaching, for the first time in human history 1 billion people with between 20 and 30 thousand people dying of hunger related causes every day. As this is written, in August 2010, grain prices are again increasing dramatically, Russia has stopped all grain exports to secure enough food for its own population, floods and droughts are threatening food production in many parts of the world. All of this could add up to a new food crisis, with a dramatic increase in the number of people suffering from hunger.

- *The climate crisis* together with other environmental crises such as loss of biodiversity and soil fertility, the overuse of water and the extinction of fish stocks, already are having devastating effects on people and the environment.
- *The fuel crisis in 2008* led to steep price increases, serving as a dramatic reminder that the oil age will come to an end within a few decades and a warning of how this will affect the economy and food production, if green alternatives are not developed in time.
- *The financial crisis of 2008 and the economic crisis of 2009–2010* pushed hundreds of millions of people into unemployment, led to dramatic reductions in social welfare in many countries, while billions of dollars in government funds were used to support banks and financial institutions.
- *The poverty crisis* continues to affect about half the world's population who are living in poverty, and more than one out of five persons living in extreme poverty.

THIS REPORT GIVES CONTEXT TO THE CURRENT SITUATION

Hunger. Almost 1 billion people are permanently undernourished, 75% of them are food producers and their families.

Obesity. 400 million people are suffering of obesity, and 1.2 billion more are overweight. This is a fast-growing health problem not only in the industrialized countries, but also in developing countries.

Malnutrition. In addition to undernourishment and obesity, other forms of malnutrition cause the death and serious health problems of millions of people.

Climate change. Food production and livelihoods are threatened by changing climates, and at the same time, agriculture is also a main contributor to climate change.

Environmental threats. Agricultural diversity, soil and water are critical for future food production and food security, but these resources are being drastically depleted and polluted.

Poverty. Almost half the world's population – 3 billion people – live in poverty, and almost 1.4 billion people live in extreme poverty. The majority of the poor live in rural areas and are linked to agriculture and other kind of food production.

As crises increase in number and depth, they effect increasingly bigger segments of the world population and show the limitation of our structural policies and practices. Individuals and entire communities – real people – are directly suffering while the choreography of the international community attempts to reassure and patch up with urgent fixes.

This report recognises that these are not short-lived crises. They are symptoms of un-sustainable modern economy, industry and food production practices.

It is now clear that humanity is at a crossroads and that it is urgent to rethink the shape of our very existence on earth. Healthy food systems are at the hart of a viable future for humankind.

Food production at a crossroads

Agriculture at a Crossroads – the *International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD)*, the most comprehensive study ever made of agricultural science and technology, reached a prophetic conclusion: *"Business as usual is no longer an option."* The IAASTD co-chair, Hans Herren, suggest to reformulate our questions as follows:

"How do we rethink our global food systems so that they can feed people, create healthy communities and economies and sustain the planet?"[3]

IAASTD was initiated by the World Bank and the Food and Agriculture Organization of the United Nations (FAO). About 400 scientists, experts and development specialists worked on it for four years. In 2008, 58 governments approved the Executive Summary of the Synthesis Report.

When the Global Footprint Network published *Ecological Wealth of Nations* in April 2010, it reached a similar conclusion in its calculation of the earth's biocapacity, or

[3] Hans Herren, co-chair IAASTAD "Supporting a True Agricultural Revolution" 12 May 2010, Ottawa Canada

DEFINING OUR TERMS

This report draws upon a broad set of references to underpin its content, and as is often the case, we have found that experts use different terms to refer to the same issues. Thus, it is important to define the terms we are using.

Sustainable agriculture, ecological agriculture, agro-ecology are used intermittently according to the context but all refer to agriculture that centres on food production that makes the best use of nature's goods and services while not damaging these resources. Further, these terms reflect:

- the application of ecology to the design and management of sustainable agroecosystems,
- a whole-systems approach to agriculture and food systems development based on traditional knowledge, alternative agriculture, and local food system experiences,
- linking ecology, culture, economics, and society to sustain agricultural production, healthy environments, and viable food and farming communities.

Industrial agriculture is based on maximising large-scale production and productivity of individual commodities and products through mechanisation and motorization, the development of agrochemicals to fertilize crops and control weeds and pests, and the use of high-yield varieties of crops.

Traditional agriculture refers to forms of farming, resulting from the co-evolution of local, social and environmental systems. It exhibits a high level of ecological rationale expressed through the intensive use of local knowledge and natural resources, including the management of agrobiodiversity in the form of diversified agricultural systems

Small-scale food producers are those men and women who produce and harvest field and tree crops as well as livestock, fish and other aquatic organisms. They include smallholder peasants, family crop and livestock farmers, herders and pastoralists, artisanal fisherfolk, landless farmers and farm workers, gardeners, forest dwellers, indigenous peoples, hunters and gatherers, and any other small-scale users of natural resources for food production.

the level at which society uses nature's assets. It compared humanity's ecological footprint, meaning the demand that consumption puts on the biosphere, with the earth's biocapacity, meaning the biosphere's ability to meet this demand, resulting in a kind of bank statement for the planet. The figures are staggering. According to its estimates, our ecological footprint now overshoots the earth's biocapacity by more than 40 percent, a foreboding reality. This "overshooting" is only possible for a limited time. We only have one planet. We can eat into our ecological "savings" temporarily but it cannot go on forever. There just are not enough resources in our fisheries, forests, fields or atmosphere to continue on the same course of depletion.

Of course, there is a choice: follow the same course in the direction of collapse, or take a new course, one that works with nature, not against it, in an effort to secure human well-being for both current and future generations.

What kind of food production?

As the social and environmental externalities of industrialized agriculture are being videly documented, it is increasingly realized that this agricultural model which seemed so promising will not be able to reduce hunger and poverty. In reality, industrial food production is highly damaging to human health, pollutes the soil, the water and the air, contributes to climate change, kills fauna and flora, and reduces biological diversity and the fertility of soils. In addition, there is a serious concern in the scientific community about this model being the crucible of potentially devastating pandemics. Industrial agriculture also has pushed millions of peasants into poverty and migration, and become the root of conflicts and unrest, while the economic system has failed to provide food for those who cannot afford to buy it or who lack access to resources to be able to produce food.

Yet, it is possible to take a more sustainable path to development, possibly to reverse the present trend that focuses on industrial agriculture and, instead, preserve and rebuild the rich fabric of dynamic communities and societies coevolving in nature-rich and culture-diverse territories.

Around us, in the villages, in the cities, in the urban neighbourhoods, within the communities in the countryside there is a wealth of knowledge, natural and human resources which are *de facto* those that are feeding most of the people in the world today. These resources could be managed differently, coupling traditional and contemporary knowledge, with new practices still to be invented, with a step-by-step transition towards more viable ways of using them. Instead of constantly ignoring existing initiatives, marginalising them, ghettoing them and letting magnificent knowledge-rich, labour-intensive agriculture systems go extinct, policies and public and private research and investments could be reoriented to take advantage of this existing wealth.

Hunger can be eradicated

Close to 1 billion people are suffering from hunger – the highest number in human history. Hunger is not a fatality. It is possible to end hunger and halt the agrarian crisis. Let this be the last era of peak hunger, and let the countryside be a better place to live. Time has come to unleash a potential loaded with benefits, benefits for the environment, for the climate, for the local communities, merging proven cutting-edge knowledge of ecological and traditional agricultures that have survived for millennia with state-of-the-art science oriented towards the well-being of the world communities. With solidarity and hope, with young generations taking over, making succession and success possible.

The report

Although some of the background for this report may seem grim, the main message in it is very positive and optimistic. Above all, the report focuses on agriculture. Pastoralism, gathering and fisheries are included, but are not looked upon in depth. This Part I is accompanied by a more extended Part II which gives additional information on on-going initiatives, existing knowledge and paths ahead, with more detailed descriptions of selected fields including chapters on fisheries, livestock and pastoralism.

The report does not attempt to deal with all policies and actions needed to change the dominant course of development in food and agriculture into a social, environmental and economic sustainable course. Instead, it focuses on which models of production should be supported and promoted, and which should not.

In 2009, social movements, NGOs and individuals from all over the world together developed the working document *Policies and actions to eradicate hunger and poverty* (see references). It proposes comprehensive policies for facing hunger and poverty issues. It is meant to stimulate discussions among decision makers, professionals working with food, agriculture, environment and development, activists and individuals, and lead development changes in a direction of a viable future for humankind.

DEFINING HUNGER

Undernutrition[1] is the result of prolonged low levels of food intake and/or low absorption of food consumed. Generally applied to energy (or protein and energy) deficiency, but it may also relate to vitamin and mineral deficiencies.

Undernourishment or Chronic Hunger is the status of persons, whose food intake regularly provides less than their minimum energy requirements. The average minimum energy requirement per person is about 1800 kcal per day. The exact requirement is determined by a person's age, body size, activity level and physiological conditions such as illness, infection, pregnancy and lactation.

Malnutrition is a broad term for a range of conditions that hinder good health, caused by inadequate or unbalanced food intake or from poor absorption of food consumed. It refers to both undernutrition (food deprivation) and overnutrition (excessive food intake in relation to energy requirements).

Chronic hunger. People who are chronically hungry are undernourished. They don't eat enough to get the energy they need to lead active lives. Their undernourishment makes it hard to study, work or otherwise perform physical activities. Undernourishment is particularly harmful for women and children. Undernourished children do not grow as quickly as healthy children. Mentally, they may develop more slowly. Constant hunger weakens the immune system and makes them more vulnerable to diseases and infections. Mothers living with constant hunger often give birth to underweight and weak babies, and are themselves facing increased risk of death.

Every day, millions of people around the world eat only the bare minimum of food to keep themselves alive. Every night, they go to bed not certain whether there will be enough food to eat tomorrow. This uncertainty about where the next meal will come from is called 'food insecurity'.

FAO defines **food insecurity** as: "A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life."

1 http://www.fao.org/hunger/en/

II. THE MULTIFUNCTIONALITY OF AGRICULTURE

Embedded in the complexity of nature, agriculture follows the rhythm of seasons. While some value agriculture as a way to transform inputs into commodities, solely a profit-making activity, others see it as a way of life, a visible result of the co-evolution of humanity and the natural world that has created untold diversity and underpinned the establishment of human cultures over the millennia.

The multifunctionality of agriculture was pointed out in the IAASTD report:

"Agriculture is multifunctional. It provides food, feed, fibre, fuel and other goods. It also has a major influence on other essential ecosystem services such as water supply and carbon sequestration or release. Agriculture plays an important social role, providing employment and a way of life. Both agriculture and its products are a medium of cultural transmission and cultural practices worldwide. Agriculturally based communities provide a foundation for local economies and are an important means for countries to secure their territories" (IAASTD Global Report. 2008).

This multifunctionality was also well reflected by the United States Department of Agriculture (USDA) in 1998. When, faced with the problems of industrial agriculture, it launched a call to act and recognise the public value of small farms (see box).

The value of small farms

In 1997, the United States Department of Agriculture (USDA) established a National Commission on Small Farms to examine the status and needs of small farmers in the USA. A Time to Act, its final report issued in 1998, recognized the importance and strengths of small farms. Although written specifically for the USA context, the thoughts are universal.

Some of the public values generated by small farms include:

Diversity: Small farms embody a diversity of ownership, cropping systems, of landscapes, biological organisation, culture and traditions. ...

Environmental benefits: ... Responsible management of the natural resources of soil, water, and wildlife encompassed by these operations [by small-scale farmers – editors note] produces significant environmental benefits for society to enjoy. Therefore, investment in the viability of these operations will yield dividends in the stewardship of Nation's natural resources.

Self-empowerment and community responsibility: Decentralized land ownership produces more equitable economic opportunity for people in rural communities, as well as greater social capital. ...

Places for families: Farms, particularly family farms, can be nurturing places for children to grow and acquire the values of responsibility and hard work. The skills of farming are passed from one generation to another under family ownership structures. ...

Personal connection to food: ... Through farmers markets, Community Supported Agriculture, and direct marketing strategies of small farmers, people are beginning to connect with the people growing therir food. Consumers are developing meaningful, direct relationships with the farmers and a connection with food as a product of a farmer's cooperation with nature.

Economic foundations: In some states and regions of the USA, dispersed farm operations are key to economic vitality. ..." (USDA, 1998).

Who are the small farmers?

Almost 90 % of all farms in the world are less than 2 ha.[4] However, country censuses do not systematically report on very small holdings or on small farmers because there has never been a universally agreed definition of small farmers. To illustrate the scale of variation, the average size of holding in Bangladesh (FAO survey 2005) is 0.3 ha while in Australia it is 3243 ha. Countries adopt varying criteria for coverage and classification of agricultural holdings. The FAO definition in 2010[5] was the following: the economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production purposes, regardless to title, legal form or size. The holiding could comprise more than one parcel located in one or more villages and the single management may be exercised by one household or jointly by two or more households or by a juridical person including authorized companies or public institutions.

For deciding the threshold level for holdings and for categorizing the farmers based on the scale of their operations, usually the main underlying criterion is "economic contribution", which is defined on the base of one or more of the following factors:

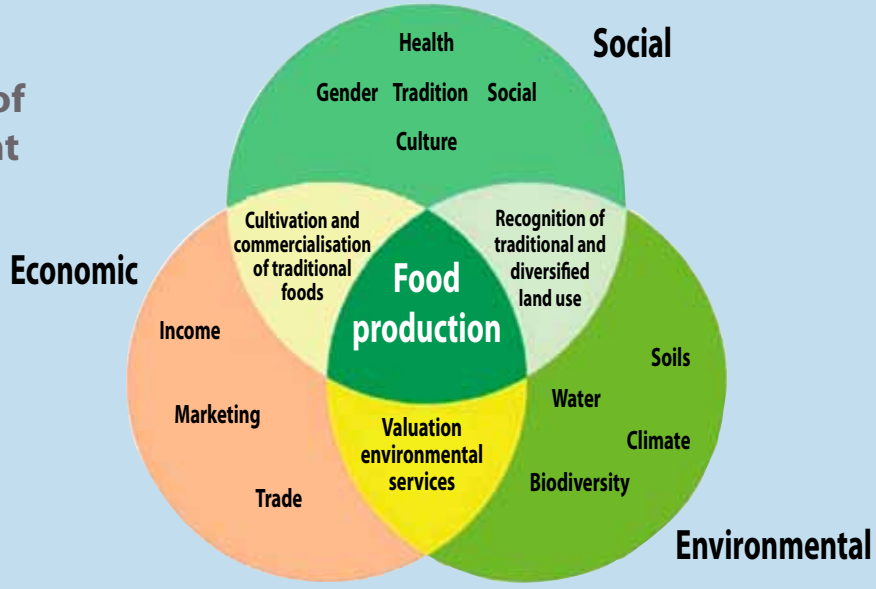
land size, herd size, marketable surplus/volume of sales or income earning potential of the holding. In the case of European countries, categorisation criterion is based on income generating potential. Standard Gross Margins (SGMs) are a way of classifying farms according to the type of enterprise on the farm, and their relative contribution to overall profit. The SGM provides a measure of a holding's business size, irrespective of its area and intensity of production.

In view of the complexity and diversity of definitions, a number of organizations use the term "small farms" for those farms under 2 ha.

[4] IAASTD Global Report, page 8.

[5] cited in Characterisation of small farmers in Asia and the Pacific, Asia and Pacific Commission on Agricultural Statistics 23rd Session April 2010.

The inescapable interconnectedness of agriculture´s different roles and functions



Source: IAASTD: Global Summary for Decision Makers. www.agassessment.org/

BIODIVERSITY PRODUCTIVITY: A CASE STUDY FROM UTTARANCHAL, INDIA

The state of Uttaranchal in the Himalayas has a long heritage of subsistence economy with agriculture as the core component involving over 80 percent of its population. A majority of the farmers are marginal and possess less than 1ha of agricultural land.

The study *A new Paradigm for Food Security and Food Safety*. *Biodiversity based organic farming*, carried out by the Indian organisation *Navdanya* found that the traditional mixed farming systems had high levels of biodiversity that invariably resulted in higher economic returns and more long-term sustainability. It also found that family farmers in this area regularly achieved higher and more dependable production from their land than large farms practicing monoculture in similar environments.

The total yield per hectare for farms with diverse cropping systems, in this case four different crops, was about 6 percent higher than for those with only one crop. In addition, the market price of the crops from the diverse farms was double that of the monocropped produce, mainly because smallholders tend to grow traditional crops that have more value to local consumers than the modern varieties grown in the monocropping schemes. In addition, the monocropping farms had higher production costs because the crops required chemical fertilizer and pesticides. In total, the net income of the farms with diverse cropping systems was 135 percent higher than for the farms with only one crop.

More information can be found at www.navdanya.org

Women play a major role

Rural women across the developing world play a major role in productive activities that are critical to the livelihoods of their households and societies. This includes crop production and livestock care, providing the food, water and fuel their families need, and serving as custodians of community foods, crops and beliefs, inherited from across the generations and kept vivid in local traditions and customs. They are the crucial transmitters of traditional knowledge to the new generations. Women farmers are particularly aware of the usefulness of plant genetic diversity as, in many parts of the world, they are the ones with primary responsibility for the production of subsistence crops that are essential to household food security. Women are often a reservoir of traditional knowledge of cultivation, maintenance and use of traditional varieties.

In the poorest and most marginal areas, characterized by extensive male migration, agriculture has become increasingly feminized (IFAD, 2003). The proportion of women-headed households continues to grow, reaching almost one-third in some developing countries.

Yet, women own less than 2 percent of all land and receive only 5 percent of extension services worldwide. It is estimated that women in Africa receive less than 10 percent of all credit going to small farmers and a mere 1 percent of the total credit going to the agricultural sector.

Agencies worldwide and on the ground recognize that when support is provided to a woman, the whole family and, in turn, the whole community benefits. Female agricultural scientists tend to focus on indigenous crops. They breed new varieties of vegetables resistant to drought and disease. They also mentor other women to learn better farming techniques and to become scientists themselves.

III. IS IT POSSIBLE TO FEED 9 BILLION PEOPLE?

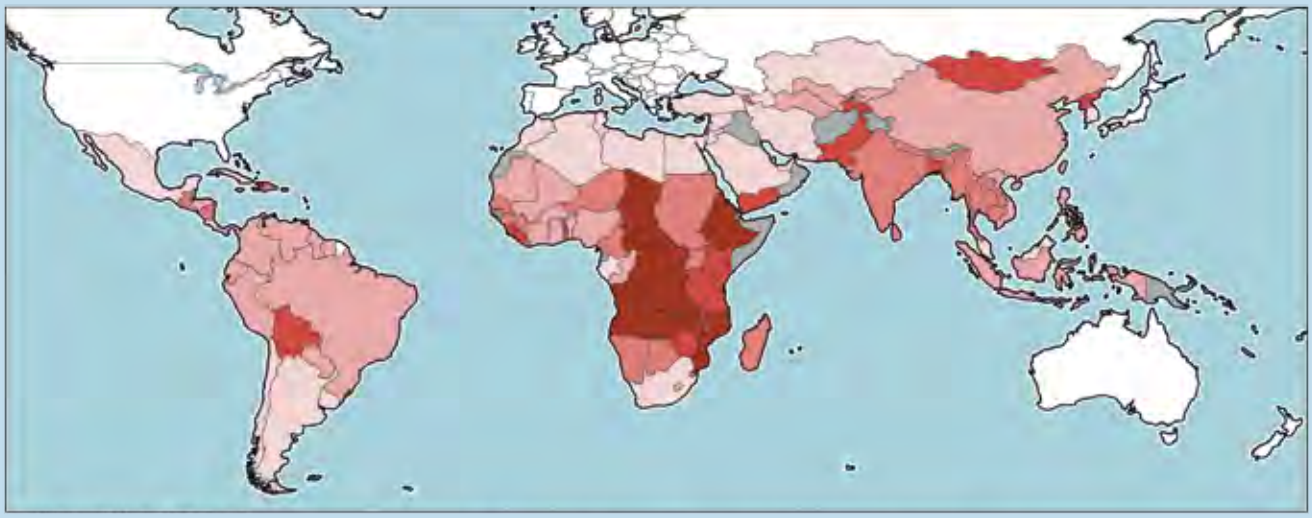
Hunger is one of the world's most burning issues. Although the numbers exist that quantify hunger, it is critical to recognize that understanding of hunger starts with individuals, not data. Hunger means women and men too weak to work, and children who will never develop full mental capacities because their mothers were malnourished and did not pass on proper nutrition. Hunger means parents see their children suffer and die. Hunger: the silent killer.

Those individual stories multiply and data does illustrate the unbelievable dimension of hunger. Every day, 16,000 children die of malnutrition and hunger-related diseases.[6] According to FAO figures, almost one billion people are undernourished, amongst the highest figures in human history. During its meeting in 2010, the Committee on World Food Security (CFS) asked FAO to review its methodology for estimating undernourishment in order to provide more timely updates and incorporate all relevant information, including analysis of the large number of household surveys that have become available in recent years. Therefore, no updated estimates for the number of undernourished people in 2010 are reported by FAO, nor has an estimate been made for 2011. However, because of increased food prices and the economic crisis in 2011, it is forseen that the number of hungry people will have increased again in 2011.

6 World Food Programme. Hunger Stats www.wfp.org/hunger/stats

FAO Hunger Map 2010

Prevalence of undernourishment in developing countries



Source: FAOSTAT 2010 (www.fao.org/hunger)

Note: The map shows the prevalence of undernourishment in the total population of developing countries as of 2005-7 – the most recent period for which complete data are available. Undernourishment exists when caloric intake is below the minimum dietary energy requirement (MDER). The MDER is the amount of energy needed for light activity and a minimum acceptable weight for attained height, and it varies by country and from year to year depending on the gender and age structure of the population.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

Prevalence of undernourishment in developing countries (2005-07)

- Very high (undernourishment 35% and above)
- High (undernourishment 25-34%)
- Moderately high (undernourishment 15-24%)
- Moderately low (undernourishment 5-14%)
- Very low (undernourishment below 5%)
- Missing or insufficient data

www.fao.org

To the almost 1 billion undernourished we must add the fact that, each year, our planet's population increases by about 74 million people. From 7 billion in 2011, population will reach 8.3 billion in 2030 and, by 2050, the number will be 9,1 billion, according to the UN Population Division.[7]

The Right to Food is a basic human right, but with the reality of the looming population growth, can this right be fulfilled for all? Is it possible to produce enough to feed everyone?

"Feeding people" does not refer to the passive action of handing out food. Eradicating hunger is about much more than making sure food is available and accessible to all. Eradicating hunger begins with preserving and creating viable communities where people have control over their own lives and livelihoods. Then it is about producing food – producing enough food and producing the right food.

There is enough food today

Adding up the numbers of today's global food production tells a positive story – that there is more than enough food produced to provide every person on the planet with an adequate diet. The edible crop harvest in the world is more than 4600 kcal per every person per day.[8] However a lot of the food gets lost after harvesting, in use as fodder and in waste (see box). Available food per person increased almost 18.6 percent between the mid-1960s and 2007, to 2796 kcal[9] per day per person (latest figures available as of October 2011), which meets the needs of an average adult man.

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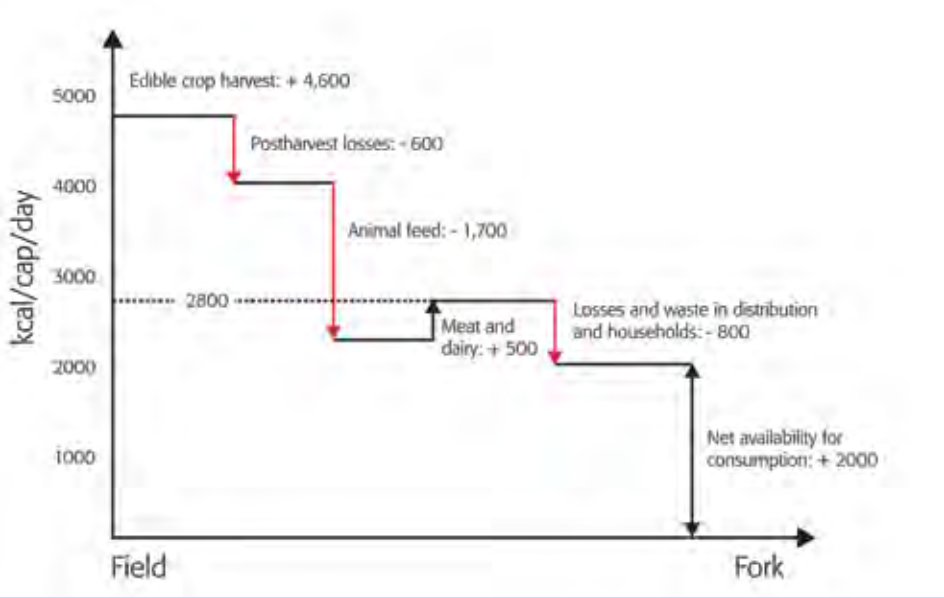
7 United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospect: The 2008 Revision. Population database. http://esa.un.org/unpp/p2k0data.asp

8 Lundqvist, J., C. de Fraiture and D. Molden. Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief. SIWI, 2008.

9 World Health Organization (WHO) and FAO data, www.who.int/nutrition/topics/3_foodconsumption/en/index.html ; http://faostat.fao.org/Portals/_Faostat/documents/pdf/world.pdf; http://faostat/DesktopDefault.aspx?PageID=368&lang=en#ancor ; http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368#ancor 24/10/2011

From Field to Fork



Source: Lundqvist, J., C. de Fraiture and D. Molden. Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief. SIWI, 2008.

Yet, there is no automatic relation between increased availability of food and reduction of hunger (see box). Between 2007–2009, the number of people suffering from hunger increased about 150 million – a dramatic increase not linked to any decrease in food production, but rather to a steep increase in world food prices, mainly caused by increased oil prices, speculation and competition between food and fuel crops.

It is well known that food is neither produced nor distributed equally around the world. Yet, calories available per person in developing countries average only about 15 percent lower than world average and 20 percent lower than in industrialised countries, so food availability and distribution do not explain the hunger situation.

How much must food production increase?
The declaration of the World Summit on Food Security held at FAO in November 2009, stated that:

"To feed a world population expected to surpass 9 billion in 2050, it is estimated that agricultural output will have to increase by 70 percent between now and then."[10]

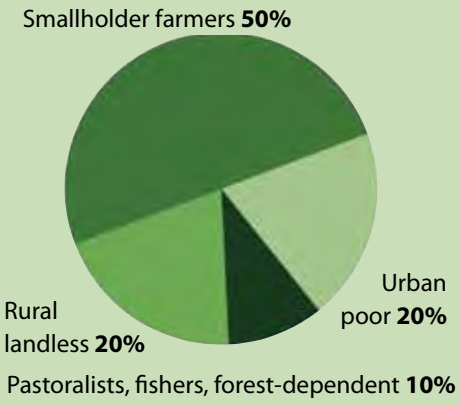
This 70 percent figure is now the most common figure used when it comes to estimating how much food production must increase in the next 40 years. However, others, such as the Norwegian government, estimate the need to "double food production" by 2050 to meet population demands (Norwegian Government budget proposal, 2010).

These calculations are based on projections on current trends in consumption and population growth, expected to increase by about 32 percent from now to 2050. However, the projections mainly consider the increased intake of calories, including increased meat consumption, while there are several other factors that need to be considered.

What we eat matters. It is both correct and incorrect to state that enough food is produced today to feed everyone in the world. It depends on what we eat. For instance, meat consumption in the USA is about 120 kg per year per person, world average is 43 kg, and in India, it is 5 kg. A lot of the meat production in the USA is dependent on grain which is fed to the animals. Thus, USA grain consumption is 800 kg per person per year, while in India, it is 200 kg. This means that current grain production provides enough for 2.5 billion people with a USA diet, but 10 billion people with an Indian diet (FAOSTAT, November 2008).

Food losses and food waste.[11] Studies on global food losses in high/medium income countries and low income countries requested by FAO and carried out in 2010-2011 suggest that one-third of food produced for human consumption is lost, which amounts to about 1.3 billion tons per year. Much more food is wasted int he industrialized world. Estimates are per capita food waste in Europe and North-America of 95-115 kg /year and in Sub-Saharan Africa and South/Southeast Asia 6-11 kg/year. In developing countries more than 40% of the food losses occur at post harvest and processing levels, while in industrialized countries, more than 40% of the food losses occur at retail and consumer levels. Food waste at consumer level in industrialized countries (222 million ton) is almost as high as the total net food production in sub-Saharan Africa (230 million ton).

Who the hungry are



Source: Hunger Task Force

10 FAO. 2009. Declaration of the World Summit on Food Security
11 Global Food Losses and Food Waste, SIK, FAO 2011

Food waste. Industrialized countries waste enormous amounts of food. Tristam Stuart, author of the book Waste, calculated that the hunger of 1.5 billion people could be alleviated by eradicating the food wasted by British consumers and American retailers, food services and households.[12] In its publication Who will feed us?, ETCgroup found that in the USA, waste rose from 28 percent of the total food supply in 1974 to 40 percent in 2009 – an average per capita waste of 1400 kcal a day,[13] which is more than half of the calories needed for an adult person per day.

How much more food will be needed to meet the needs of a population that will be 32 percent larger by 2050 depends on the factors above. If industrialised countries reduce their meat consumption, if post-harvest losses can be reduced, then there will not be a need for the 70–100 percent increase in food production that has been estimated. With more sustainable food production systems and consumption habits, a 20–50 percent increase could be sufficient.

From food exporters to food importers

The majority of the 50 least developed countries and the majority of all developing countries were net food exporters until the 1980s when they became net food importers. There are clear political reasons for this. Developing countries were forced by the World Bank, the International Monetary Fund (IMF), other finance institutions and rich countries to open up for import of highly subsidised food from rich countries, mainly USA and EU, and to produce cash crops, such as coffee, tea and flowers, for export. Known as structural adjustment programmes (SAPs), they also required cutting down government spending in areas such as extension services for farmers, ending price guaranties for farmers and consumers, and closing public food storage facilities, as well as cutting down on public expenses for education and health care.

There is a need for many developing countries to produce more food to end hunger. They have natural and human capacities to do so, yet political and economic structures, poverty, and rules such as the WTO Agreement on Agriculture make it difficult. It is also often not a matter of national priority. The Zero Hunger Project, initiated by Brazil's President Luiz Inàzio Lula da Silva in 2003 which is credited with contributing to a 27 percent reduction in poverty in the country, is a good example of what dedicated leaders can achieve.

12 www.guardian.co.uk/environment/2009/sep/08/food-waste

13 ETC-group: Who will feed us? with reference to Economist, "Environment: A Hill of Beans", November 28 2009.

MORE FOOD – MORE HUNGER

Introduction of high-yielding varieties of crops in Asia in the 1960s and 1970s was credited with averting mass famine and untold deaths from hunger. Known as the "Green Revolution", it did increase production greatly but, as is now known, increasing production does not always equal reducing hunger.

The total food available per person in the world increased by 11% between 1970 and 1990. In the same period, the number of people suffering from hunger dropped 16 percent, from 942 million to 786 million. However, at that time, China with its enormous population, was experiencing great economic growth which had a dramatic effect on the hunger statistics. If China was not included in the analysis, then the number of hungry in the rest of the world would have increased by 11% – from 536 million to 597 million.

In that same time period, Latin America's per capita food supplies rose almost 8%while the number of hungry increased by 19%. South Asia had 9% more food per person by 1990, but also 9% more hungry people.

Source: Lappé et al., 1998.

AGRO-ECOLOGY AND PEASANT MOVEMENT IN WEST AFRICA

Small food producers are the dedicated and most often anonymous guardians of biodiversity and eco-systems and the gifted creators of many agro-ecological practices. For decades both their knowledge and their needs have been ignored by dominant agricultural policies and programmes. It is when these thousands and thousands of small producers group together into organizations capable of defending their interests that real possibilities of advancing the agro-ecological agenda emerge, for they represent the majority of the population of most developing countries, particularly in Africa.

Today's peasant movement in West Africa was born in the early '90s in reaction to structural adjustment and the withdrawal of state support for agriculture. From the establishment of the Senegalese National Council for Cooperation of Rural People (CNCR) in 1993 to the formation of a regional network of 10 West African national peasant platforms (ROPPA) in 2000, the construction of the movement has been rapid and its political impact significant, succeeding in enshrining family farming and food sovereignty in agricultural policies at national and regional levels. From the outset the movement has been attentive to ensuring that West African peasant farming is not only family-based and multifunctional, but also sustainable. Participatory research has been conducted to identify and exchange traditional agro-ecological practices such as earth dams in Burkina Faso (zai) or compost piles in Senegal (sentaare). Cooperation has been built up between peasant-led and official research in areas like seed development and multiplication. In 1997, an FAO project supported the Senegalese national platform's efforts to develop its own agroecology-based agricultural strategy. A decade later studies demonstrate that 95% of Senegal's farms are family-based. They produce most of the food consumed in the country, employ 50% of the population and contribute to the sustainable management of natural resources even under the pressure of climate change.

Hungry food producers

Half of the almost 1 billion people suffering from hunger are small-scale farmers and their families. If they could increase their own production to provide enough healthy food for themselves, it would be the most successful reduction of hunger in human history.

There are many reasons why so many small-scale farmers cannot feed themselves, and any attempt to simplify the explanation would do a disservice to the situation. The same is true with identifying ways to change the situation. A whole range of policies and actions must be put in place, many of which are spelled out in the working-document *Policies and actions to eradicate hunger and malnutrition* (see reference list). Improving farmers' access to and control over resources, such as land, seeds, water and credit, is the most important. Improvement of storage facilities, infrastructure and local markets are also among the most important goals as well as access to information that will help smallholders improve their own production with ecological methods.

Small-scale ecological agriculture can feed the world

Small-scale food producers produce at least 70 percent of the food consumed in the world today and have a huge potential for increasing this production even more. Large-scale studies show potential production increases from 79 to 132 percent, while small-scale studies have shown the potential for a fivefold increase in production (see box and chapter 5).

The UN Special Rapporteur on the Right to Food, Olivier De Schutter, presented his report on agroecology and small scale farming[14] to the Human Rights Council in March 2011[15] which was presented by the press under the title: *"Eco-Farming Can Double Food Production in 10 Years, says new UN report."*[16] The report emphasizes the fact that: *"To feed 9 billion people in 2050, we urgently need to adopt the most efficient farming*

14 De Schutter, Olivier. 2010. Report submitted by the Special Rapporteur on the right to food to the Human Rights Council Sixteenth session Agenda item 3 (http://www2.ohchr.org/english/issues/food/docs/A-HRC-16-49.pdf)

15 http://www.srfood.org/images/stories/pdf/press_releases/20110308_agroecology-report-pr_en.pdf

16 http://www.srfood.org/images/stories/pdf/press_releases/20110308_agroecology-report-pr_en.pdf

RESULTS: INCREASED PRODUCTION WITH ECOLOGICAL FARMING

The following lists some of the results of studies conducted around the world on the impact of introducing ecological farming in smallholder systems.

Illustrative scientific research conducted in 57 countries found resource-conserving agriculture could increase the average crop yield by 79 percent (Pretty *et al.,* 2006).

The average crop yield increases were 116 percent increase for all African projects and 128 percent increase for the projects in East Africa (UNEP-UNCTAD, 2008).

Overall, the world average organic yields are calculated to be 132 percent more than current food production levels. (Organic Agriculture and Food Security, FAO. 2007).

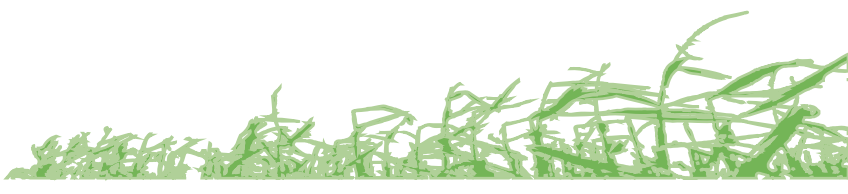
Crop yields more than doubled on average (increasing 2.13-fold) over a period of 3-10 years for 10.39 million farmers and their families and improvements on approximately 12.75 million hectares in 20 African countries (Foresight, 2011).

Maize yields increased between 20 and 50% in Brazil by using green manure (Parrot *et al.,* 2002).

Farmers in Nepal increased yields 175 percent by using agro-ecological management practices (Parrot *et al.,* 2002).

In Tigray, Ethiopia, composted plots had yields three to five times higher than those treated only with chemicals (Parrot *et al.,* 2002).

Farmers throughout the developing world have consistently high yield ratios when they incorporated intensive agro-ecological techniques, such as crop rotation, cover cropping, agroforestry, addition of organic fertilizers or more efficient water management (Badgley *et al.,* 2007).



techniques available," and *"Today's scientific evidence demonstrates that agroecological methods outperform the use of chemical fertilizers in boosting food production where the hungry live -- especially in unfavorable environments."*

In the report, the UN Special Rapporteur makes reference to scientific research that shows the high productivity of agroecological and other forms of ecological agriculture. A good example is the research commissioned by the Foresight Global Food and Farming Futures project of the UK Government[17] which reviewed 40 projects in 20 African countries where sustainable intensification was developed between 2000 and 2010."By early 2010, these projects had documented benefits for 10.39 million farmers and their families and improvements on approximately 12.75 million hectares. Crop yields more than doubled on average (increasing 2.13-fold) over a period of 3-10 years…"[18]

Hans Herren, co-chair of IAASTD, states very clearly there should be no doubt about the capacity for ecological farmers to feed the world:

"The evidence in support of low input, ecological or "conservation" agriculture is undeniable, from the IAASTD, to the Union of Concerned Scientists to a recent UNCTAD report that states 'organic agriculture can be more conducive to food security in Africa than most conventional productive systems, and is more likely to be sustainable in the long term.' And evidence that sustainable, ecologically based agriculture can provide the nutrition and income to the billion plus poor and hungry of today, and the 2 billion newcomers by 2050, is now well proven."[19]

17 Foresight, The Future of Food and Farming (2011). Final Project Report. The Government Office for Science, London.
18 De Schutter. 2010. Op.cit.
19 Hans Herren, op.cit.

THE CASE OF AUSTRALIA

One good example of growing concern about the negative impact on the environment of industrialized agricultural practices and transition towards greater sustainability is well reflected in the efforts of Australian farmers, illustrated by the following figures[1]:

- Farmers occupy and manage 61% of Australia's landmass, as such, they are at the frontline in delivering environmental outcomes on behalf of the broader community[2].
- Australian farmers spent $3 billion on Natural Resource Management (NRM) over 2006-07, managing or preventing weed, pest, land and soil, native vegetation or water-related issues on their properties. More than $2.3 billion was spent on weed and pest management, while land and soil-related activities accounted for $649 million of total expenditure.[3]
- Farmers have led Australian primary industries in reducing greenhouse gas emissions by a massive 40% between 1990 and 2006. This is Australia's leading greenhouse gas reduction contribution.[4]
- Natural Resource Management is a fundamental activity on Australian farms. In fact, 94.3% of Australian farms actively undertake Natural Resource Management.[5]
- 52% of farmers undertake activities to protect native vegetation, 45% wetland protection and 49% river or creek bank protection.[6]
- Farmers improving their Natural Resource Management practices reported doing so to increase productivity (88.6%), farm sustainability (88.4%) and better environmental protection (74.5%).[7]

1 http://www.nff.org.au/farm-facts.html
2 Australian Government Department of Agriculture, Fisheries and Forestry, At a Glance, 2010.
3 Australian Bureau of Statistics, Natural Resource Management on Australian Farms 2006-07
4 Australian Government Department of Climate Change, National Inventory By Economic Sector 2006
5 Australian Bureau of Statistics, Natural Resource Management on Australian Farms 2006-07
6 Australian Bureau of Statistics, Year Book Australia, 2009-10
7 Australian Bureau of Statistics, Natural Resource Management on Australian Farms 2006-07

This premise is usually overlooked in discussions on how to end hunger and feed future generations, even though it has been tirelessly repeated by the small-scale farmers themselves, as well as many NGOs and scientists. The fact that increased support to ecological agriculture can substantially increase food production has to be the principal strategy of any move from unsustainable industrial agriculture to a viable, multifaceted small-scale agriculture that can feed future populations. (See box for further documentation)

Can industrial agriculture also feed us?

Large-scale industrial agriculture produces only around 30 percent of the food consumed globally, while small-scale food producers produce at least 70 percent (ETC-group. Who will feed us?). Expansion of industrial food production on a scale necessary for meeting the current demand of the majority of the world's population, not to mention the extra 2.2 billion who will join the ranks by 2050, will cause enormous environmental problems. This is explained in the next chapter.

Industrial agriculture can be transformed

Confronted with the increased deterioration of natural and social environments, more and more producers are now reorienting their production systems towards achieving greater sustainability. Large plantations in countries such as Chile, Argentina and Brazil are now being rethought with a different paradigm based on circular systems with reduced input and energy consumption rather than focusing solely on linear approaches and on increasing throughput. Though the diversity of crops and the integration animal-crop may be less obvious than it is on small plots of land, the same overall principles apply.

In countries like Australia, New Zealand, United States and the United Kingdom, interest has grown to transition towards more holistic systems such as permaculture and agroecological systems. Permaculture is an approach to designing human settlements and agricultural systems that is modeled on the relationships found in nature and it is being applied at a large scale. It is based on the ecology of how things interrelate rather than on the strictly biological concerns that form the foundation of modern agriculture. Permaculture aims to create stable, productive systems that provide for human needs; it's a system of design where each element supports and feeds other elements, ultimately aiming at systems that are virtually self-sustaining and into which humans fit as an integral part. Mollison has described permaculture as *"a philosophy of working with, rather than against nature; of protracted and thoughtful observation rather than protracted and thoughtless labor; and of looking at plants and animals in all their functions, rather than treating any area as a single project system."*

OVERARCHING PATTERNS OF INDUSTRIAL AGRICULTURE

The following lists some of the identifying factors and results of industrial agriculture.

- Exclusive focus on maximising production and productivity of individual commodities and products
- Monocultural agricultural practices dependent on chemical fertilisers and pesticides, and fossil fuel inputs
- 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 livelihoods
- Loss of community and farmer control over land use

Source: Greenpeace, 2009.

IV. UNSUSTAINABLE PRACTICES IN AGRICULTURE

There is ample historical evidence of humans overexploiting nature (Diamond, 2004). With the advent of agriculture approximately 10,000 years ago, new areas of land and forests were cleared and landscapes transformed. Yet during those millennia, the world's small farmers improved soil fertility and biodiversity and used the natural resources in their local areas in a sustainable way. Now, within the last few decades, this has shifted – not because of the behaviour of the majority of farmers, but because of the way industrial agriculture has initiated unsustainable or damaging practices such as increasing use of chemical pesticides and fertilizers, rapidly undermining the global capacity for future food production.

In the course of the second half of the twentieth century, industrial agriculture expanded in developed countries and in some limited sectors of developing countries. Industrial agriculture increased food yields greatly but, at the same time, it undermined the global capacity for future food production

Industrial countries. In many countries, farmers benefited from support policies for agricultural development and from high real agricultural prices, enabling maximum opportunities for investment. The quality of life also improved for many farmers who replaced hard manual labour with mechanised farming. But confronted with harsh competition, the least-equipped farmers in the world's industrial countries saw their incomes collapse in the second half of the twentieth century, and less than 10 percent of the farms succeeded in going through every stage of what was called the contemporary agricultural revolution. Labour productivity could reach 2000 tons of cereals per worker per year resulting in overproduction and in a dramatic drop in real agricultural prices (Mazoyer, 2006). World prices were divided by two, three and even four in the course of a few decades. Consequently, during this time, more than 90 percent of the farms were impoverished by the lowering prices to the extent that, one after the other, they disappeared, providing a labour force for expanding industry and services. In little more than half a century, the difference in labour productivity between the least equipped agricultures in the world, practiced exclusively with manual implements (hoe, spade, digging stick, machete, harvest knife, sickle) and the most equipped increased dramatically: the gap widened from 1 to 10 in the interwar period, to 1 to 2000 at the end of the twentieth century.

Global level. Hit by lower prices, food dumping and the lack of protective measures, farmers' incomes collapsed and, in the past decades, hundreds of millions of small and

EXAMPLES OF BIODIVERSITY LOSS

The State of the World's Plant Genetic Resources for Food and Agriculture (FAO. 1997) gives examples of the loss of diversity which occurred in the last century.

- Of the 7098 apple varieties documented in the USA at the beginning of twentieth century, 96% have been lost.
- In Mexico, only 20% of the maize varieties reported in 1930 are now known.
- In China, in 1949, nearly 10,000 wheat varieties were used in production, but by the 1970s, only about 1000 remained in use.
- Some estimate that 75 percent of all agricultural biodiversity was lost during the last 50 years of the twentieth century, up to 90 percent for the most common species (ETC-group, GRAIN and ITDG. 2002).

Global distribution of risks associated with main agricultural production systems.

Source: FAO 2011. The State of the World´s Land and Water Resources for Food and Agriculture (SOLAW). http://www.fao.org/docrep/meeting/022/mb213e.pdf

medium farms plunged into crisis and were eliminated, adding to the growing rural exodus, unemployment, and rural and urban poverty.

Developing countries. The situation in industrialised countries is very different from the situation small-scale farmers meet in many developing countries. There are no, or very few, expanding industry and service sectors in most developing countries. It is not possible for most peasants to find other employment when they are pushed out of food production. They are pushed into more severe poverty and urban slums.

Depletion of ecosystems and natural resources

Depletion of ecosystems and natural resources is a serious threat for future food production. The United Nations Environmental Programme (UNEP) says that world food production could be reduced by up to 25 percent by 2050 as a result of negative environmental impacts, with increased hunger and poverty in many regions (UNEP, 2010). Loss of biodiversity, deforestation, reduction in soil fertility and overuse of water are undermining the potential of producing enough nutritious food for future generations, foretelling the possibility of unimaginable catastrophes in the coming years. There are several reasons for this unsustainable development, but industrial agriculture plays a major role.

Biodiversity

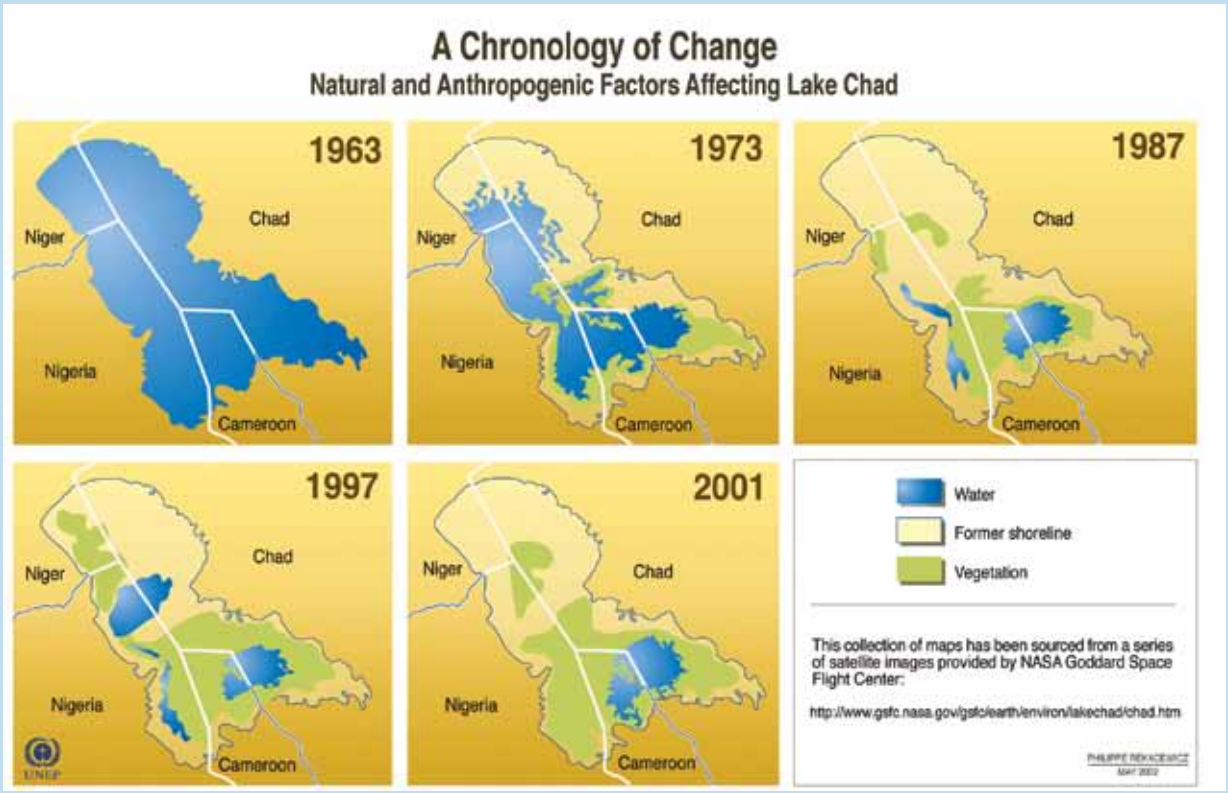
Over the years, the intensification of agriculture, especially industrial agriculture, has meant substitution of traditional crop varieties with high-yielding uniform commercial varieties for. This has led to a loss of plant genetic diversity and, at the same time, loss of genetic options for coping with and adapting to changing environments. Peasants have domesticated at least 5000 plant species, but the industrial food chain uses only 3 percent of them (Small and Catling, 2008). Globally, over 4000 assessed plant and animal species are threatened by agricultural intensification (IUCN. 2008).

Deforestation

Deforestation is a main contributor to climate change, responsible for about 17 percent of total greenhouse gas emissions (Norad) and substantial loss of biodiversity. It also increases the poverty of indigenous peoples living in and depending on the forest.

WATER USE IN AGRICULTURE

- Globally, rainfed agriculture is practised on 80% of cultivated land and supplies more than 60% of the world's food.
- Agriculture is by far the biggest user of water, amounting to almost 70% of all withdrawals, reaching up to 95% in developing countries (FAO. 2007d).
- The use of water, primarily in industrial agriculture, exceeds supply rates in many cases and is therefore unsustainable. An estimated 15–35 percent of irrigation withdrawals exceed the supply rate (WHO, 2005).
- There is serious concern about the groundwater level in many countries. For example, in the North China plain where more than half of China's wheat and a third of its maize are produced, the groundwater level is rapidly sinking due to over consumption. The level of the groundwater basin is forcing well drillers to go deeper to search for water, which is not renewable (Brown, 2009).
- Excessive water pumping has made the groundwater levels in China, India, Iran, Mexico, the Middle East, North Africa, Saudi-Arabia and the USA critically low (Worldwatch Institute, 2004).
- A number of the world's major rivers, including the Amu-Darla, Colorado, Ganges, Indus, Rio Grande and the Yellow river, are now dry during parts of the year.
- Lakes, especially the Aral Sea in Central Asia and Lake Chad in North Africa, have almost completely dried out.



Source (map): GRID-Arendal UNEP Collaborating Centre.

Expansion of agriculture is the most important cause of deforestation, especially in areas cleared for livestock, soya and agrofuel crops. In the humid tropics, expansion of the different forms of agriculture and animal husbandry is responsible for nearly 85 percent of deforestation (Lanly, 2004). According to the key findings of FAO's most comprehensive forest review to date, around 13 million ha of forests were converted to other uses or lost through natural causes each year between 2000 and 2010 as compared to around 16 million ha per year during the 1990s (FAO. 2010a). This forest loss compares to losing an area the size of Greece each year for ten years.

Land and soil degradation

Land degradation can take a number of forms, including nutrient depletion, soil erosion, salinisation, agrochemical pollution, vegetative degradation from overgrazing and the cutting of forests for farmland.

According to International Soil Reference and Information Centre (ISRIC), 46.4 percent of soil is experiencing an important decrease in productivity, and another 15.1 percent of soil no longer can be used for farming as its biological functions have been seriously depleted and it would take large investments to restore them. About 9.3 million ha of soil (0.5 percent) is irreparably damaged and no longer has any biological function.[20]

In Africa, 128 million ha – 26 percent of its degraded soils – are classified as strongly or extremely degraded, meaning that the terrain would require major investments and engineering works for reclamation, while another 5 million ha are irreclaimable. Overgrazing is the most important cause of soil degradation in Africa, accounting for 49 percent of the area, followed by agricultural activities (24 percent), deforestation (14 percent) and over-exploitation of vegetative cover (13 percent) (WHO and UNEP. 2010).

A document[21] based on the full report of the "The State of the World's Land and Water Resources for Food and Agriculture (SOLAW)[22] was presented at the FAO Conference (37th Session, June-July 2011) and contains a a map of the global distribution of risks associated with main agricultural systems. It also highlights the need to focus on those production systems where scarcity of land and water resources are further constrained by unsustainable agricultural practices and presents a table with a broad typology of the land and water systems requiring priority attention.

Water use

Water, a key factor in agriculture, is affected by both climate change (GECHS and The Development Fund–Norway, 2008) and overuse, which threaten future food production in many parts of the world. Climate change makes the weather less predictable and more variable – rain might come early or late, it might be much more or less than normal, and extremes such as droughts and floods come more frequently.

Overuse of water is a rapidly increasing problem. In many countries,

LOSS OF DIVERSITY

Only about 150 plant species are grown commercially around the world. Of these, global crop production concentrates on just 12 of them, namely maize, rice, wheat, soybeans, potatoes, sweet potatoes, bananas and plantains, sorghum, cassava, millet, sunflowers and canola. Some estimate that 75 percent of the biodiversity in agriculture was lost during the last 50 years of the twentieth century, and up to 90 percent of the most common species (ETC-group, GRAIN and ITDG. 2002).

This loss of diversity is also happening in domesticated animal breeds used for food and agriculture. According to FAO. there are 6536 local breeds, of which1080 are transboundary breeds for food and agriculture. Of all the known species, 9 percent already have become extinct, 20 percent are at risk and 35 percent not at risk, while the status of the other 36 percent is unknown (FAO. 2007c).

The Stern Report states that around 15–40% of species will face extinction if there is a 2°C increase in average global temperatures (Stern Review, 2006).

20 Information from www.goodplanet.info/eng/Pollution/Soils/Soil-degradation/(theme)/1662

21 http://www.fao.org/bodies/conf/c2011/en/

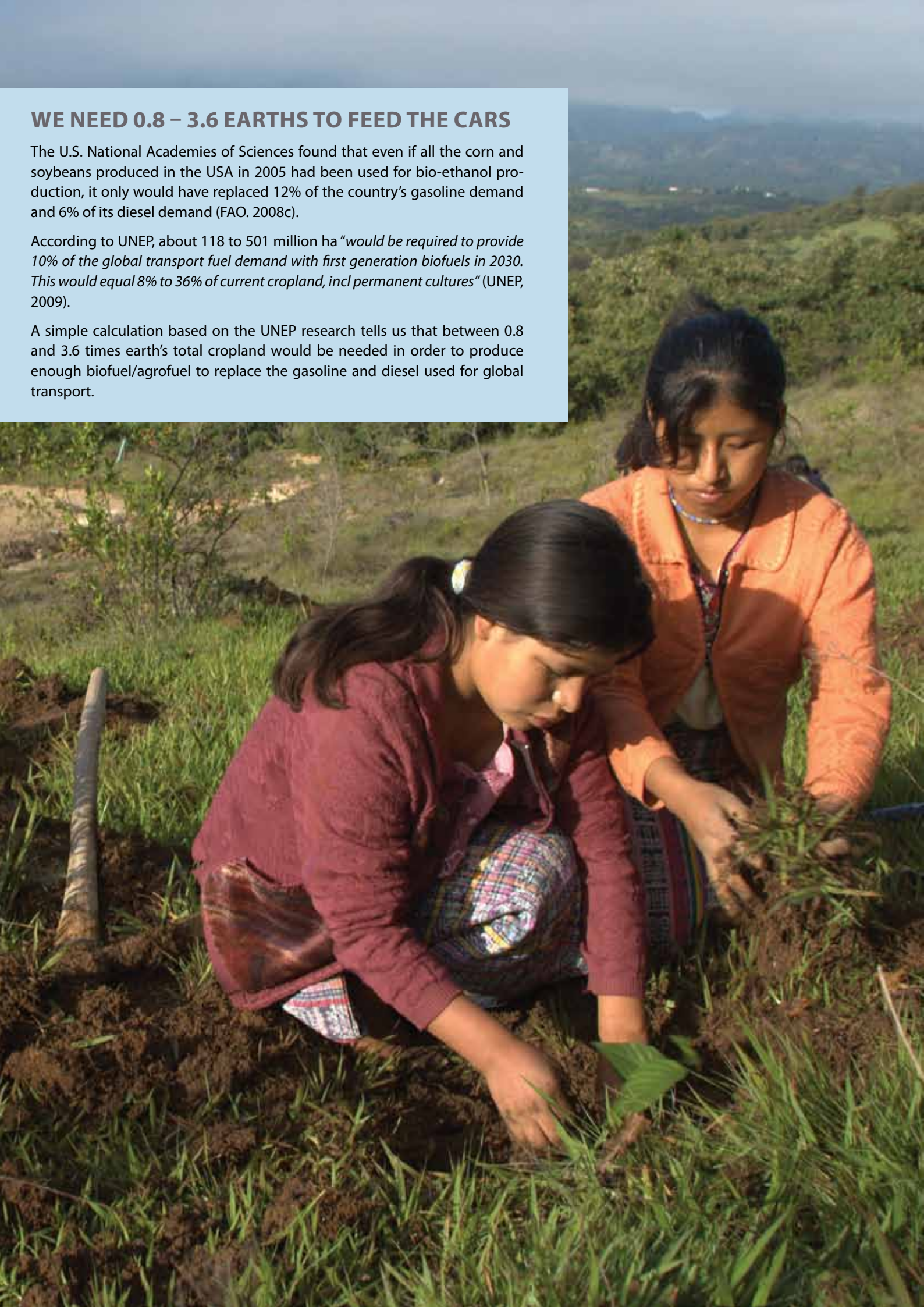
22 the full report will be released end Nov 2011 and available at: http://www.fao.org/nr/solaw/solaw-home/en/

WE NEED 0.8 – 3.6 EARTHS TO FEED THE CARS

The U.S. National Academies of Sciences found that even if all the corn and soybeans produced in the USA in 2005 had been used for bio-ethanol production, it only would have replaced 12% of the country's gasoline demand and 6% of its diesel demand (FAO. 2008c).

According to UNEP, about 118 to 501 million ha "*would be required to provide 10% of the global transport fuel demand with first generation biofuels in 2030. This would equal 8% to 36% of current cropland, incl permanent cultures"* (UNEP, 2009).

A simple calculation based on the UNEP research tells us that between 0.8 and 3.6 times earth's total cropland would be needed in order to produce enough biofuel/agrofuel to replace the gasoline and diesel used for global transport.



more water is extracted from rivers, lakes and groundwater sources than the inflow. This situation cannot go on forever (see box).

Fish stocks

Achim Steiner, Director of UNEP, has warned that commercial fishing might become history within 50 years. "*This is no science-fiction scenario. This can happen within the lifetime of a child born today.*"[23]

Stocks of the top ten species are fully exploited or overexploited. Overall, 80 percent of the world's fish stocks for which assessment information is available are reported as fully exploited or overexploited, requiring effective and precautionary management (FAO. 2009d). Only about 20 percent of stocks were moderately exploited or underexploited with perhaps a possibility of producing more (FAO. 2009d). A widely reported, though controversial, study by Worm, et al., predicts that if present trends continue, most fish stock will collapse by the middle of the century. (Worm et al., 2006).

Energy use

For thousands of years, agriculture has produced food and fodder by relying only on renewable resources. Now, the introduction of industrial methods has turned agriculture into an energy consuming system dependent on fossil energy. One of the huge challenges for agriculture is to reduce the use of fossil fuel and other non-renewable resources.

The new industrial farming has replaced thought-intensive technologies in use for so many millennia with fossil fuel energy-intensive technology. There are different calculations of the energy used in different food systems. Some estimate that it takes industrial food systems an average of 10–15 calories to produce and distribute one calorie of food (GRAIN, Seedling, July 2007). An ETC-group study, citing Pimentel (2009) reports that "*the total energy in the food system in the OECD states is approximately 4 kcal invested to supply 1 kcal of food, while in the global South, the ratio is approx. 1 kcal invested to supply 1 kcal of food.*"[24] Grain-fed beef requires 35 calories for every calorie of beef produced – an effective reversal of what had been the reason to develop agriculture in the first place.

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23 *Aftenposten* (Norwegian newspaper) 23.05.2010

24 Quoted from ETC-group (2009): Who will feed us. Original source: Pimental, David: "Energy Inputs in Food Crop Production in Developing and Developed Nations," Energies 2(1) 2009, pp1-24 http://www.mdpi.com/1996-1073/2/1

COLLAPSE OF FISHERIES?

- Most of the stocks of the top ten species, which together account for about 30% of world marine capture fisheries production in terms of quantity, are fully exploited or overexploited.
- Overall, 80% of the world fish stocks for which assessment information is available are reported as fully exploited or overexploited, requiring effective and precautionary management (FAO 2009d).
- In 2007, about 28% of stocks were either overexploited (19%), depleted (8 %) or recovering from depletion (1%), and thus yielded less than their maximum potential owing to excess fishing pressure (FAO 2009d).
- A further 52% of stocks were fully exploited and, therefore, produced catches that were at or close to their maximum sustainable limits with no possibilities for increasing catches (FAO 2009d).
- Only about 20% of stocks were moderately exploited or underexploited with perhaps a possibility of producing more (FAO 2009d).
- Commercial fisheries might have become history by 50 years from now (Worm *et al.* 2006).

Climate change

Industrial agriculture consumes large amounts of fossil fuel, with a direct greenhouse effect, mainly because of mechanisation and massive use of inputs, in particular fertilizers (the production of synthetic nitrogen is a high consumer of fossil energy). To this we need to add the large amounts of fossil fuel used in the corporate chain of which industrial agriculture is a part. This includes transport of goods to the farms (seeds, chemical inputs, implements), and then from the farm to distant markets (grain transported for further processing for animal food, for biofuel or for human food, and transport of processed goods to wholesale distribution channels. On average the food we have in our plate has travelled 6,400 km. In the case of sustainable small-scale production, there is practically no use of fossil fuel when the food is processed and consumed locally. On the other hand, small farms have a great potential for carbon sequestration.

Industrial agriculture and the global food system contribute substantially to climate change, totally about 40% of the greenhouse gas emissions. The negative impact on climate directly from agricultural production is about 13% of total greenhouse gas emissions. The production and use of chemical fertilizer are the main sources for this. Deforestation because of expansion of agricultural land, mainly for production of fodder for the expanding meat industry and for biofuel, counts for another 15-18%. Processing, packing and transport of food contributes another 10-12% . These(GRAIN, 2009) negative impact can be avoided with a different production model and localized food systems (see box on page 51).

Unhealthy food

The health implications of industrial agriculture have been widely documented (Gauker, 2009). It is now known that the chemicals commonly used in industrial agriculture (pesticides, insecticides, herbicides, fungicides and antimicrobials) cause endocrine disruptions and cancer in humans. The excessive use of antibiotics in livestock contributes to antibiotic resistance among humans. Synthetic growth hormones have been a major concern for decades as they alter normal human hormone levels and functions.

In addition to the chemicals used to grow food, industrial meals have invaded the planet. Processing foods can add months and even years to the shelf life of products, allowing for global food trade. Humans have an inherited preference for energy-dense food, as natural selection has predisposed us to the taste of sugar and fat. It is the increased energy density of processed foods that is causing the Type II diabetes and obesity now affecting 400 million people worldwide and an additional 1.2 billion who are overweight. Overall 2.7 million deaths annually are attributable to low fruit and vegetable intake, which is the cause of 19 percent of gastro-intestinal cancer, 31 percent of ischemic heart disease and 11 percent of strokes (WHO, 2003).

Pandemics

The account of the evolution and expansion of highly pathogenic avian influenza (HPAI), commonly called bird flu, chillingly demonstrated how strains of animal disease can develop on smallholdings can spread to industrial settings which are ideal populations for supporting virulent pathogens. Industrial agriculture's use of genetic monocultures of domestic animals removes whatever immune firebreaks would have been available to slow down transmission, and the larger population sizes and densities facilitate greater rates of transmission. At the same time, the crowded conditions depress immune response. High throughput, a part of any

industrial production, provides a continually renewed supply of susceptibles, the fuel for the evolution of virulence. (Wallace, 2009).

Industrial animal agriculture may bode disaster in terms of landscape destruction but also and above all because of pandemic risk. It is currently estimated that a severe pandemic would cost around 3 trillion USD, because of societal disruption, much worse than a combination of 10 severe earthquakes, tsunamis, cyclones or the melting of the North Pole taken together. Yet, relatively little is done about it. (Jan Slingenbergh, personal communication 2010).

Biotechnology

A 2009 Union of Concerned Scientists evaluation reported by Gurian-Sherman on the overall effect of genetic engineering on crop yields demonstrated that there were no significant increases in yields. In addition, although it was thought that genetic engineering would reduce pesticide use by creating plants resistant to insects and other pests, a 2000 study by the United States Department of Agriculture revealed that there was no overall reduction in pesticide use with genetically engineered crops.

Meanwhile, biological and genetic pollution are very real facts. Researchers found that release of only a few genetically engineered fish into a native population could make species extinct, and that pollen from GM corn engineered to produce its own insecticide could be fatal to beneficial insects. Research also show that GM-plants might be dominant to indigenous species and therefore a direct threat to diversity. A major fear was that if a pest- or herbicide-resistant strain were to spread from crops to weeds, a "superweed" could result that would be nearly impossible to stop.

In fact, this may have just proven to be the case in the southern USA where more than 100,000 acres in the state of Georgia have been seriously affected by a new super-weed, called pigweed. More than 10,000 acres have had to be abandoned and Georgia faces the threat turning into an unmanageable wasteland. According to University of Georgia researcher Stanley Culpepper, these superweeds emerged after farmers had undertaken intensive cultivation of Monsanto's GM soybean and cotton. This weed has also appeared in other states such as South Carolina, North Carolina, Arkansas, Tennessee, Kentucky and Missouri.

Synthetic biology[25]

Synthetic biology, the construction of novel life-forms using synthetic DNA made from off-the-shelf chemicals, is no longer science fiction. This extreme genetic engineering is now a reality. In May 2010, the journal Science announced that the J. Craig Venter Institute and Synthetic Genomics, Inc. had made the world's first self-reproducing organism whose entire genome[26] was built from scratch by a machine. According to the journal, this organism could be a boon to second-generation agro-fuels making it – theoretically – possible to feed people and cars simultaneously. The article further suggests that 'Synthia', as the new organism is called by ETC -group, or synthetic biology, could help clean up the environment, save us from climate change, and address the food crisis.

25 This section build on ETCgroup. 2010. Synthia is Alive … and Breeding. Panacea or Pandora's Box? and a book in press by Pat Mooney, BANG.

26 Genome: All of the genetic information, the entire genetic complement, all of the hereditary material possessed by an organism.

Pat Mooney, the director of ETC -group who has followed biotechnology issues closely for decades, says that *"It is much more likely to cause a whole new set of problems governments and society are ill-prepared to address."*

Building artificial life and the implications of the largely unknown field of synthetic biology raise many ethical questions. But there still remains no proper national or international oversight of new high-risk technologies that carry vast implications for humanity and the natural world. ETC group and other organisations have demanded a formal, open and inclusive oversight of synthetic biology, and have called for a global halt on research pending the development of global regulations.

Geo-engineering [27]

A wide range of geo-engineering proposals have been put forward, large-scale schemes that intend to intervene in the earth's oceans, soils and atmosphere with the aim of combating climate change. Large-scale experiments have taken place for several years. Examples of geo-engineering include blasting sulphate particles into the upper atmosphere to reflect the sun's rays, dumping iron particles in the oceans to nurture CO2-absorbing plankton, firing silver iodide into clouds to produce rain, genetically engineering crops to have reflective leaves, spraying seawater into clouds to make clouds whiter, dumping large quantities of plant matter into the ocean or turning it into charcoal for burying in soils.

The issue of large-scale geo-engineering experimentation and their potential impacts is not technical, but instead about rights, responsibilities and the future of the planet. These experiments can lead to irreversible processes with dramatic negative consequences for humanity and the environment. The precautionary principle must therefore be followed. It is vital that governments and the public receive information and knowledge about geo-engineering and that wide public debates take place. To avoid possible catastrophes, governments and international institutions must immediately

27 This section builds on Agriculture and Climate Change – Real Problems, False solutions.2009 and Swedish Society for Nature Conservation.2009. Retooling the Planet?

CORPORATE CONCENTRATION AND CONVERGENCE

A TALE OF TWO REALITIES

The Corporate Economy	The Local Economy
The top 10 seed companies control 67% of the global proprietary seed market and 82% of the world's commercial seed sales are proprietary.	Three-quarters of the world's farmers either grow locally-bred varieties or save their own seed. At least 1.4 billion people depend upon farmer-saved seed.
80% of agribusiness research is devoted to shipping, storage and market-maximization technologies.	100% of farmer-based research is devoted to environmental sustainability, productivity and nutrition.
The top 100 grocery retail enterprises account for 35% of global grocery retail sales.	85% of global food production is consumed close to where it is grown – much of it outside the formal market system.
The top 10 pharmaceutical companies control 55% of global drug sales.	Approximately 70% of the world's population is cared for by community health specialists using local medicines.

Source: ETC-group, 2008.

put a ban on such experiments and take actions to make sure the ban is efficient and respected.[28]

The Green Revolution

Beginning in the 1960s, the Green Revolution, a variant of the contemporary agricultural revolution but without the large-scale motorization and mechanization, developed widely in the developing countries, particularly in Asia. It was essentially based on the selection of high-yielding varieties of rice, maize, wheat and soya that required a heavy utilization of synthetic fertilizers and pesticides and, in some areas, irrigation. Governments encouraged the adoption of these technologies by enacting policies of agricultural price supports, subsidies for inputs, preferential interest rates for borrowing, and investments in the infrastructures for irrigation, drainage and transport.

Global production of wheat, rice and maize, the main crops of the green revolution, more than doubled in 25 years –in 1986 the production was 229% of the production in 1961. There were several reasons for this steep increase and the figure did not account for the fact that mixed-cropping systems were abandoned and there was a parallel loss of yield for other crops. However, while there is no doubt that the Green Revolution did play an important role in increasing the yields for some of the major crops, the notion that it played an important role in reducing the number of hungry people, is not correct. While the social and environmental problems of the Green Revolution have been widely documented (Daño, 2007; Shiva, 1992), many governments, foundations and institutions now support the Alliance for a Green Revolution in Africa (AGRA), initiated and massively financed by the Bill & Melinda Gates Foundation and Rockefeller Foundation.

Unsustainable models of production that increase the dependency of on external inputs such as synthetic fertilizers, herbicides, and pesticides, and make small scale farmers dependent on increasingly tight enclosures, especially seeds, can lead to increased indebtedness and have tragic consequences. This has been the case in India where some 199,132 farmers have committed suicide since 1997 according to the National Crime Records Bureau (NCRB), 2009. Another 40% are trying to quit agriculture if given a choice (59th Round of National Sample Survey Organisation, Govt of India, 2005). These suicides have been directly attributed to the Green Revolution.

Hans Herren, co-chair IAASTAD, recently talked about this "New Green Revolution" and the experiences from Asia:

"*Most of the buzz these days is around a "Green Revolution" for Africa, using essentially the same thinking we saw for Asia three decades ago. The Green Revolution in Asia was premised on a single dimension: increasing agricultural yields through modern technology to boost food production and feed people. And it was indeed successful. Yet we now know that this partial success came at a great cost: Badly depleted soils and water supplies, lost crop diversity, poisoned ecosystems and farmers becoming indebted from the high costs of inputs increased inequity and accelerated rural-to urban migration. In addition, we weren't calculating the carbon footprint of high-input agriculture, but today we know that this industrial form of agriculture is responsible for up to 14 percent of the planet's greenhouse gas emissions—not counting the deforestation that adds another 18 percent*" (Herren, op.cit).

28 See more information in Agriculture and Climate Change – Real Problems, False solutions, Retooling the Planet? and the book in press BANG- What Next? Collusion, Convergence or Changes in Course? by Pat Mooney, Director of ETC-group.

Agrofuels[29]

Growing plants and trees to make agrofuels and replace the declining fossil fuel reserves was initially presented as an opportunity for farmers. However, the reality has become a generalized situation of human and natural resources exploitation and devastation. For example, production of agrofuel crops competes with production of food crops, and was one of the recognised causes of the 2007–2008 world food price crisis. Jean Ziegler, during his term as UN Special Rapporteur on the Right to Food, classified agrofuels as a "crime against humanity"[30]. Both he and his successor, Olivier de Schutter, have called for a five-year moratorium on the expansion of industrial production of biofuels[31].

It is impossible to produce agrofuel in quantities that could possibly replace fossil fuels or even replace substantial parts of the oil which is being consumed. In fact, it would require more agricultural land than exists on the entire planet to replace only the gasoline and diesel used for transport (see box on opposite page).

Scientist debate over the extent to which different kind of production and uses of agrofuels have positive or negative impacts on the climate. Considerable research now indicates that the impact of agrofuel use on greenhouse gas emission is at the best negligible, but more likely negative. For some of the agrofuel production methods, effects are clearly negative, such as production of palm oil on plantations in former rainforest areas.

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29 Agrofuels is here used as GRAIN (www.grain.org) and others have defined it: biofuels produced from crops *cultivated in industrial plantations.*

30 Jean Ziegler in United Nation, New York, October 2007 (http://news.bbc.co.uk/2/hi/americas/7065061.stm)

31 Biofuels are any kind of fuel made from living things, or from the waste they produce.

LAND GRABBING

Source: UNEP/GRID-Arendal

However, it also must be noted that small scale production of fuel from plants can play a positive role if the production is locally controlled and used by the small-scale farmers and communities. Then the production can take place on lands the communities do not need for food production and the straw and other residues from food production can be used in the fuel production process.

Land grabbing

There has been a fast increase in the leasing and buying of land in developing countries, especially in Africa, by multinational companies and foreign governments. Fertile land is being bought and leased by investors, often at "giveaway" prices set by governments together with investors and local chiefs. This "land grab"[32] was spurred by the events surrounding the food and financial crises of 2007–2008. Countries and governments do not trust that the global market can provide food as before, making food a lucrative object for speculation. There are no verified figures of the amount of such land sales or leasing. A report recently presented to the UN Committee on world Food Security[33] present estimates between 50 and 245 million ha have been sold or leased out in such big land deals the recent years - areas between the size of Spain and the combined size of Portugal, Spain, France, Italy, German and Poland.

This section on landgrabbing has been placed in the chapter on unsustainable agriculture for several reasons. As a result of landgrabbing, peasants and pastoralists are forced off the land they have used for generations, with increased poverty as a result. This is not socially sustainable, and the farming methods used by the foreign companies are usually environmentally unsustainable.

Howard G. Buffet describes the land grab in the foreword of the report "(Mis)investment in agriculture" (Daniel, *et al.,* 2010):

"There is no disguising what is happening right now, on our watch. It is estimated that 50 million hectares have already been leased to foreign entities with at least 20 African countries considering similar deals. Some of these leases (99 years at $1 per hectare) are unbelievable deals. But they are only available to a select few. Local farmers (people who struggle to feed their families…) are not eligible for the deals being promoted in countries where millions of people remain dependent on food aid."

32 More information : http://farmlandgrab.org/

33 HLPE, 2011. Land tenure and international investments in agriculture. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2011. http://www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE-Land-tenure-and-international-investments-in-agriculture-2011.pdf

SMALL-SCALE AGRICULTURE FOR THE FUTURE IN NORWAY

Vikabråten is a small-scale farm located 460 meters above sea level, approximately 200 km northwest of Oslo, Norway. Seemingly isolated, many conclude that "no one can live off such a farm today." Yet a farm such as Vikabråten could feed 4 cows, even 10, 15 or 20 cows. A farm that 10 years ago was seen as modern and robust, is today easily written off as without a future. However the farmer, Ole-Jacob Vikabråten, tells his story about the development of the farm and how his family can make a living on a small farm by keeping costs low and a diversified production:

"The small-scale farms do not disappear by themselves. They are being victims of an extermination campaign which involves reducing public support and dismantling investment schemes as well as consequent misinformation about the economical realities on small and big scale farms.

Consequently, we need an antidote in the form of information, underlining that the small-scale farmer will play a key role in transforming the world to a greener and a more just place to live."

V. ECOLOGICAL AGRICULTURE: KEY PATHS TO A VIABLE FUTURE

There are alternatives to the unsustainable agricultural system described above. All too often, alternative agricultural strategies, based on more traditional structures are seen as backward and insufficient in providing food for the world. We argue the opposite. New and innovative ecological strategies and improved traditional techniques can significantly increase agricultural output in ways that also uphold viable agricultural communities. In this chapter, we explore how a change from industrial towards ecological agriculture can provide a viable option to "business as usual".

Traditional agriculture, stemming from local cultures, has been feeding the world for millennia. Small farmers have nurtured, conserved and brought us the thousands of cultivated species that have enabled humans to adapt to a wide range of environments. At present, 3 billion peasants (including their families) depend on these traditional and ecological forms of agriculture, pastoralism and fisheries for their livelihoods. Yet, both the agricultural systems and the peasants themselves often have been marginalised and ignored.

Today the threat of climate change and collapsing ecosystems has led to the realization that the very existence of these traditional systems, a treasure of humankind, is at stake. Yet these systems hold the seeds that have the potential to protect the environment and feed the planet's increasing population – their intrinsic resilience is too precious a quality to be lost.

This report identifies the following key points in understanding how ecological agriculture can be a more viable alternative than industrial agriculture.

Ecological agriculture:

- is based on methods, techniques and strategies that preserve and improve the environment;can show higher yields per unit of agricultural land;
- strengthens farmers' positions in relation to market and society, thereby reducing poverty among small-scale farmers who comprise half of the global population;
- is better suited to feeding the world's hungry, 50 percent of whom are themselves small-scale farmers;
- has the potential to increase food production towards a level which can feed future generations.

What is poorly understood is that talking about ecological agriculture means talking about a myriad of highly diverse agricultural systems developed over millennia in greatly varied ecosystems, ranging from the most remote, isolated, inaccessible places of the planet to densely populated urban areas. They include the infinite diversity of state-of-the-art agricultures being invented and re-invented by farmers and organisations that are constantly innovating. Contrary to the common perception, ecological agriculture is the most advanced and sophisticated human endeavour, able to add the latest science to its wealth of traditional knowledge, adapting it to both time and space. When practiced in enabling environments, it makes efficient use of resources while reducing risks and pollutions.

Grasping the reality of ecological agriculture only requires engaging in conversations with small-scale producers or observing the uniqueness of agricultural landscapes. Think of the incomparable beauty and harmony of rice terraces cascading down the slopes in Asia with sophisticated irrigation systems, the mosaic of colourful patches in the Andes with water zigzagging between fields giving off warm steam at night that

protects diverse varieties of potatoes, the stunning green patches of desert oases that support infinite varieties of fruits and vegetables, the citrus terraces on the slopes of the Mediterranean, multilayered agroforestry gardens of Zanzibar where vanilla and pepper are intertwined with an extraordinary diversity of trees, vegetables and spices, green patchworks dotted by sheep and cows grazing on steep hills on small diverse farms in Norway with a mix of forests, crops and grazing lands – all are vivid testimonies to an anonymous patrimony of humankind across the generations and centuries.

Ecological agriculture is widely practised

Today, there is a tendency to believe that ecological and traditional agriculture is of the past, easing into extinction as it occupies a marginal sector of the population that will soon disappear. There is also a common perception that industrial agriculture feeds the world. The reality is stunningly the opposite. The UN official statistics provide a figure close to 1.5 billion smallholder farmers (including family members), but statisticians acknowledge that these figures are low and do not reflect the reality, because often small farmers and urban farmers are not identified in national censuses.

Ecological agriculture is based on science and lived experience

In the last decades throughout the developing world, countless examples have emerged of sustainable and diverse agricultural practices drawing from the past while also applying the latest knowledge within given resources. These two seemingly separate entities usually are pulled together and implemented at the local level through farmers' organisations, NGOs, and other agencies, demonstrating the feasibility of intensifying production, regenerating and preserving soils, and maintaining biodiversity, based on sustainable technologies and locally available knowledge and resources. It has now been demonstrated that double digit increases in yields can be obtained while reducing synthetic fertilizers, and that pest control can be substantially improved while drastically cutting the use of chemical inputs. Beyond yields *per se* and the amount of food that can be produced, these different forms of production touch upon a whole range of environmental and social benefits with both tangible and intangible benefits for local communities and ecosystems.

The largest and most illustrative scientific research on resource-conserving agriculture, undertaken by Pretty *et al.* (2006), encompassed 286 interventions in 57 poor countries covering 37 million ha which equalled 3 percent of total cultivated area in all developing countries. Looking at how these interventions increased productivity on 12.6 million farms while improving the supply of critical environmental services, they found that the average crop yield increase was 79 percent, and all crops showed water use efficiency gains, with the highest improvement in rainfed crops.

A UNEP–UNCTAD (2008) report extracted a summary review of the impacts of organic and near-organic projects on agricultural productivity in Africa and found that *"the average crop yield increase were 116 percent increase for all African projects and 128 percent increase for the projects in East Africa"*.

The preparatory documents to the International Conference on Organic Agriculture, organized by FAO in 2007, stated that *"Overall, the world average organic yields are calculated to be 132 percent more than current food production levels."*

ECOLOGICAL AGRICULTURE IN TIGRAY, ETHIOPIA

The Tigray Region of Ethiopia is highly degraded, which contributes to low agricultural production and, in turn, exacerbates rural poverty.

Since 1996, the Institute for Sustainable Development (ISD) in Tigray has encouraged farmers to move from chemical fertilizers to manure, which has turned out to be very positive in terms of crop production. Further, the project has demonstrated that ecological agricultural practices, such as composting, harvesting water and soil, and diversifying crops to mirror the diversity of soil conditions can bring benefits to poor farmers, particularly to female-headed households who are the most vulnerable.

The project, led by farmers, builds on the local technologies and knowledge of the farming communities. As a result, local communities have been empowered and now develop legally recognized bylaws to govern their land and other natural resource management activities. The Government of Ethiopia has adopted the approach used by the project as its main strategy for combating land degradation and for eradicating poverty. As a result, the project has expanded to more communities in the Tigray region and in the rest of the country.

Some of the positive effects of the Tigray project, as identified by farmers, development agents, local administrations and ISD staff, include:

- crop yields are as good as, and often better than, those obtained using chemical fertilizers;
- agrobiodiversity is maintained and improved;
- biomass and biodiversity increase in the areas protected from free grazing;
- many plant and animal species that had disappeared from the local ecosystems return;
- improved vegetation cover protects the soil from erosion and provides good bee forage, helping the farmers and their ecosystems become more resilient to climate change;
- soil develops increased moisture retention capacity;
- plants grown with compost are more resistant to pests and diseases than crops grown with chemical fertilizers;
- positive effects of compost can remain for up to four years so, in contrast to chemical fertilizers, farmers do not need to re-apply compost each year;
- farmers have been able to get out of debt because they do not need to buy chemical fertilizers.

By 2008, the Tigray Bureau of Agriculture and Rural Development (BoARD) found that soil erosion in the region had been reduced by over 60% since the project started in 1996.

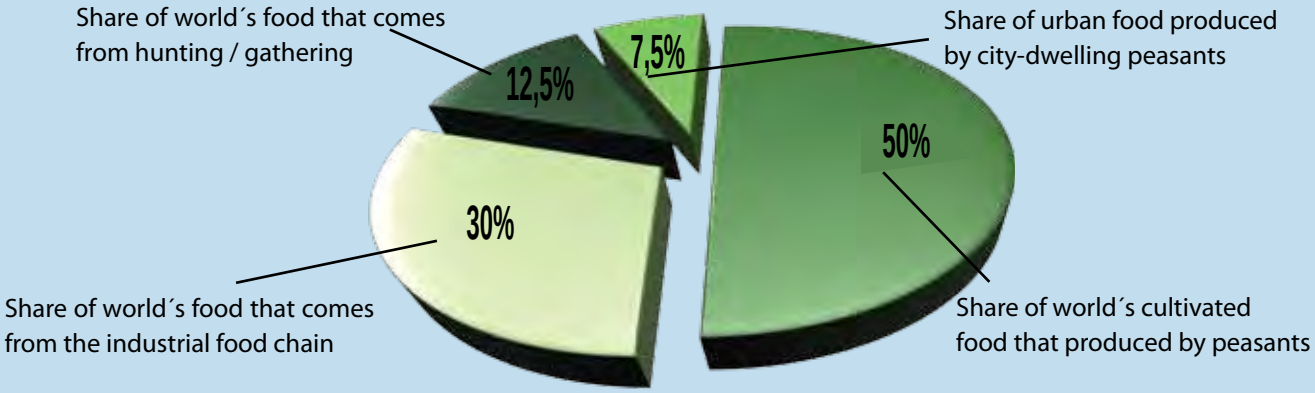
More information: FAO 2010b.

Badgley *et al.* (2007) published their research on organic agriculture and global food supply, reporting that:

"The most unexpected aspect of this study is the consistently high yield ratios from the developing world. These high yields are obtained when farmers incorporate intensive agroecological techniques, such as crop rotation, cover cropping, agroforestry, addition of organic fertilizers, or more efficient water management."

Several other case studies, including several mentioned in this document have shown spectacular result on the potential for increased food production with sustainable farming. *The Real Green Revolution*, Greenpeace (Parrot, *et al.*, 2002) provided examples of increasing maize yields between 20 and 50 percent by using green manures in Brazil) , of farmers in Nepal increasing yields 175 percent through agro-ecological

PEASANTS FEED AT LEAST 70 % OF THE WORLD´S POPULATION



Source: ETC-group. 2009

There are no exact figures on how much food is produced by different sources or which segment of the population get their food from which food systems. However, the figures in the graph are based on ten different scientific reports and there are many other sources which have similar figures.

The IAASTD Global Report also provides estimates, based on FAO census data, of 525 million farms worldwide of which 90% are small farms defined as having less than two hectares of land, which contribute substantially to global food production. It highlights that in Africa alone, 90% of agricultural production is derived from small farms.

FAO has estimated that about 15 % of the annual food intake for peasants and their families in rural areas in developing countries come from areas which are not cultivated[1], and that 75-90 % of all staple food is produced and consumed locally[2].

Food First[3] published in 2008 an article from M. Altieri with the following figures: "At present, small farms (2 hectares and less) produce the majority of staple crops for urban and rural inhabitants across the world - in Latin America 17 million peasant farms produce 51 percent of the maize, 77 percent of the beans, and 61 percent of the potatoes consumed domestically; 33 million small (mostly female-- run) farms in Africa, representing 80 percent of the farms, produce a 'significant amount of basic food crops with virtually no or little use of fertilizers and improved seed;' and in Asia most of the rice consumed is produced by more than 200 million small farmers".

Worldwatch Institute estimates that urban agriculture produce 15-20% of all food in the world.[4] Other institutes use similar figures, but the studies do not cover the whole world. FAO estimate that urban agriculture provides the food for about 700 million people.[5]

1 FAO. 2011. GEA4/2011. Working Document 4. Improving Food Sustems for Sustainable Diets in a Green Economy. FAO/OECD Expert Meeting in Greening the Economy with Agriculture, Paris, 5-7 September 2011. Draft: 12 August 2011.

2 FAO. 2011. GEA4/2011. Working Document 4. Improving Food Sustems for Sustainable Diets in a Green Economy. FAO/OECD Expert Meeting in Greening the Economy with Agriculture, Paris, 5-7 September 2011. Draft: 12 August 2011.

3 http://www.food¬first.org/en/node/2115

4 Worldwatch Institute. 2011. State of the World 2011

5 FAO Newsroom, 3. juni 2005: «Farming in Urban Areas Can Boost Food Security»

management practices, and of farmers in Tigray, Ethiopia, whose composted plots had yields three to five times higher than those treated only with chemicals.

IAASTD also reported that *"agroecosystems of even the poorest societies have the potential through ecological agriculture and IPM[34] to meet or significantly exceed yields produced by conventional methods[35], reduce the demand for land conversion for agriculture, restore ecosystem services (particularly water), reduce the use of and need for synthetic fertilizers derived from fossil fuels, and the use of harsh insecticides and herbicides"* (IAASTD, Synthesis Report).

Cutting-edge – yet low-risk technology

All sustainable forms of agriculture, which include traditional forms of agriculture and agro-ecology, make optimum use of available resources while reducing risks and social and environmental externalities. Agro-ecologists recognize that intercropping, agroforestry and other diversification methods mimic natural ecological processes, and that the sustainability of complex agro-ecosystems lies in the ecological models they follow. By designing farming systems that mimic nature, optimal use can be made of sunlight, soil nutrients and rainfall.

The great advantage of small farming systems is their high levels of agrobiodiversity arranged in the form of variety mixtures, polycultures, crop-livestock combinations or agroforestry patterns. Modelling new agro-ecosystems on such diversified designs can be extremely valuable to farmers whose systems are collapsing due to debt, pesticides, in terms of both the cost of the input and damage they can cause, or from the effects of changing climates. Such diverse systems buffer against natural or human-induced variations in production conditions.

There is much to learn from indigenous modes of production, as these systems have a strong ecological basis, maintain valuable genetic diversity, and lead to regeneration and preservation of biodiversity and natural resources. Traditional methods are particularly instructive because they provide a long-term perspective on successful agricultural management under conditions of climatic variability (Altieri, 2008).

85% of the world's food is grown and consumed within national borders or the same eco-regional zone where it was produced, even if not within the "100 mile diet" Most of this food is grown from peasant-bred seed without the industrial chain's synthetic fertilizers (ETC-group, 2009).

34 *[Intergrated Pest Management–editors note]*

35 *[here the meaning is using chemical fertilizer etc – editors note]*

AGRICULTURAL SUSTAINABILITY – DEFINITION

In Reaping the Benefit (The Royal Society, UK, 2009) the concept of sustainability is seen in the context of agricultural and food production as central to any future challenges (Pretty 2008). It incorporates four key principles:

Persistence: the capacity to continue to deliver desired outputs over long periods of time, across generations and, thus, conferring predictability.

Resilience: the capacity to absorb, utilise or even benefit from shocks and stresses, and still to persist without qualitative changes in structure.

Autarchy: the capacity to deliver desired outputs from inputs and production resources acquired from within key system boundaries.

Benevolence: the capacity to produce desired outputs such as food, fibre, fuel or oil, while sustaining the functioning of ecosystem services and not causing depletion of natural capital including minerals, biodiversity, soil or clean water.

According to these principles and measures, any system is unsustainable if it depends on non-renewable inputs, cannot consistently and predictably deliver desired outputs, can only achieve output goals by cultivating more land or causing adverse and irreversible environmental impacts that threaten critical ecological functions.

Source: Pretty 2008.

Ecological agriculture expands and builds on our choices

Ecological agriculture is based on diversity. This includes diversity of agrarian systems, the diversity of crops, animals, insects and other forms of biodiversity including wild relatives and wild species, and the diversity of ecosystems. It can draw from a pool of resources, including a wide diversity of seeds which not only offers broad choices of foods for consumption. It also provides opportunities to make innovative choices in efforts to manage risk and adversity. Adaptation is constant, following the fluctuations of climates, markets and social conditions. Ecological agriculture allows for expanded choices not only in space but also in time, as generations transmit bodies of knowledge to each other, as youth and elders work together, sharing information and ownership, planning and testing for the future. When practiced in an enabling environment, it is a form of agriculture that provides the most space and incentives for the next generation, offering them the choices for a viable future.

The only place where humans still co-evolve with a diversity of wild and cultivated plants is in and around the small farms where the choice of agricultural practices allows coexistence. Though we do not have exact figures, we know that peasants have domesticated at least 5000 plant species (Small and Catling, 2008). Knowledge about traditional varieties and wild relatives is in the hands and heads of small farmers around the world.

Field research in recent years has provided spectacular results on diversity. Jarvis et al., who studied the richness and evenness of traditional crops maintained by farming communities on five continents,[36] found that communities harbour a very rich number of varieties with almost ten times the diversity of individual farms. This means that the impressive diversity existing among small farms allows ongoing selection for farmers' preferred traits. The study also found that communities having smaller farm-field areas have more diversity than those with larger areas.

The country reports used for the draft Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (FAO. 2009b) indicated that the highest levels of crop genetic diversity occurred most commonly in areas where production was particularly difficult, such as in desert margins or at high altitudes where the environment was extremely variable and access to resources and markets was restricted.

36 Based on Simpson indices. The greater the Simpson value, the greater the evenness – i.e. when the frequency of varieties is more even, farmers are not devoting most of their land to one dominant variety. Instead high evenness means that the area planted to each variety is evenly distributed.

PEASANTS – COUNTING UP

According to official statistics, the world has some 1.5 billion smallholder farmers (including family members). However, the more realistic figure is probably double that number when full account is taken of the urban gardeners and livestock keepers, nomadic pastoralists, fishers and forest-keepers around the world. Urban gardeners often move back and forth between town and country and fishers often farm as well (ETC -group, 2009). Globally, the statistics look like this:

- 1.5 billion [peasants] on 380 million farms
- 800 million more growing urban gardens
- 410 million gathering the hidden harvest of forests and savannas
- 190 million pastoralists
- 100 million peasant fishers
- In addition, 370 million of these are also indigenous peoples.

"Together these peasants make up almost half the world's population and they grow at least 70% of the world's food. More than any other group, they feed the hungry. If we are to eat in 2050 we will need all of them and all of their diversity".

Source: ETC-group, 2009.

Ecological agriculture can build strong economies

There is a common perception that small farms are less productive and less efficient than big farms. It is surprising and alarming to realize how deeply these beliefs are rooted and the serious implications they can have in terms of designing wrong policies that can have devastating effects on local economies and communities.

Scientific research undertaken during the last three decades has demonstrated the inverse relationship between farm size and output (Rosset, 1999). This view is now widely shared by leading development economists, including those at the World Bank, with a wide acceptance that redistribution of land to small farmers would lead to greater overall productivity.

Large farms tend to plant only one crop because monocultures are the simplest to manage, while small farms are more likely to plant crop mixtures and fill the empty niche spaces with crops instead of weeds. They also tend to combine or rotate crops with livestock, using manure to replenish soil fertility. Such integrated systems produce far more per unit areas than monocultures produce.

Evaluating the relative productivity of small and large farms requires discarding "yield" as a measurement tool and using instead "total output". Yield only reflects the production per unit area of a single crop, while total output is the sum of everything a small farmer produces including grains, fruits, vegetables, fodder and animal products.

With regards to small farm efficiency, it has been demonstrated that small and medium farms make more efficient use of land. Large farms generally have higher labour productivity due to mechanization, so they might be considered more efficient in labour usage.

The definition of efficiency most widely accepted by economists is based on labour productivity but also includes "total factor productivity", which averages the use efficiency of all the different factors that go into production, such as land, labour, inputs and capital. Research by Rosset (1999) demonstrated that small and mid-sized farms have greater total factor productivity than large farms in most countries, with evidence that farms lose efficiency as their sizes increase.

A necessary precondition for small farms to nurture and strengthen the fabric of local economies is to have secure access to resources and means of production, with a say in the decision-making processes. Today's biggest limiting factor for small farmers is the lack of rights and access to production assets, especially water and land, and the lack of participation in local democratic processes. Recent history shows that the re-distribution of land to landless and land-poor rural families can be a very effective way to improve rural welfare. Rosset describes this with an example from Brazil:

"Estimates of the cost of creating a job in the commercial sector for example in Brazil range from 2 to 20 times more than the cost of establishing an unemployed head of household on farm land through agrarian reform. This provides a powerful argument that land reform to create a small farm economy is not only good for local economic development, but is also more effective social policy than allowing business-as-usual to keep driving the poor out of rural areas and into burgeoning cities. Sobhan (1993) argues that only land reform holds the potential to address chronic

CROP GENETIC DIVERSITY

Country reports that fed into the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture offered interesting insights into national genetic diversity. For example:

- Georgia has 525 indigenous grape varieties still being grown in the mountainous countryside and isolated villages;
- Romania has more than 200 local landraces of crops have been identified in the Western Carpathians area;

Nepal and Viet Nam have more than 50% of their traditional varieties grown by only a few households on relatively small areas.

Source: FAO. 2009b.

THE POWER OF INDIGENOUS KNOWLEDGE IN SRI LANKA

"I am Ranjith. I took up paddy farming just like my forefathers before me. Our paddy lands have always had a high level of salinity due to the proximity to the sea and harvests have been low. The sea water that gushed with the Tsunami of 2004 got deposited in the paddy fields in this area and further aggravated this condition. Due to the high level of salinity in the field, paddy seedlings started dying. After the third season it became almost impossible to plant paddy. The modern varieties of paddy which we were used to growing were unsuccessful in this high saline condition. We were on the verge of abandoning the only form of livelihood we knew."

With support of Practical Action and the National Federation for Conservation of Traditional Seeds and Agricultural Resources (NFCTSAR), Ranjith and other farmers started to grow ten local rice varieties which, according to indigenous knowledge, were suitable for growing in saline conditions. They used only organic fertilizer.

"In the case of certain saline resistant traditional rice varieties such as Rathdel, Dahanala, Madathawalu and Pachchaperumal the yields were high. Earlier when we grew modern paddy varieties, we got only 15 to 20 bushels (1 bushel = 36.4 litre) *from an acre. Now with these traditional indigenous varieties of paddy, yields can be as high as 60 to 70 bushels per acre. We were used to modern varieties and thought that these would bring forth a better yield. However after receiving training and observing the results, I am now convinced that growing traditional rice varieties is a good option for saline-affected paddy fields such as mine."*

More information: Practical Action (http://practicalaction.org/)

underemployment in most global South countries. Because small farms use more labour (and often less capital) to farm a given unit of area, a small farm model can absorb far more people into gainful activity and reverse the stream of out-migration from rural areas" (Rosset, 1999).

When practiced in an enabling environment, small-scale agriculture not only produces commodities, it also contributes to livelihoods, nurtures or maintains cultures, and provides ecological services. This indicates that the products of farming cannot be treated the same as other goods. The benefits of small farms extend beyond the economic sphere. By preserving biodiversity, open space and trees, and by reducing land degradation, small farms' garden landscapes provide valuable ecosystem services to the larger society.

Provide employment for billions of people

When we add up the number of smallholder farmers, urban gardeners, livestock keepers, nomadic pastoralists, fishers and forest-keepers around the world we reach the astronomic figure of 3 billion people (including family members),almost half the population of the planet today. Farming and the web of employment it creates in the rural communities and increasingly in urban agriculture is more extended and complex than we realize. They embody *diversity*, *stewardship* of natural resources, *equitability* through empowerment of communities with farmers relying on local business and services for their needs, they are *nurturing places* for families and children thereby expanding on family networks and institutions including education and health, they open *local market possibilities* that connect consumers with nature and with the people growing their food and they represent the *vitality* of local economies.

A common notion is that developing countries will or should follow the same development path as the industrialised countries. This foresees there will be the same reduction of numbers of farmers – from 40–80 percent of the population down to 1–3 percent, and that most of these farmers will get jobs in industry and services. However, there are not many such jobs in most developing countries, and the majority of farmers will end up in unemployment and deeper poverty if they have to leave their land. It also should be noted that if the production and consumption globally had been the same in the developing world as in the industrialised countries in recent decades, the environmental damage, including climate change, would have been so severe that it would have been impossible for billions of people to survive.

Urban peasant food production actually may be quite substantial, according to an *estimate cited by Canada's International Development Research Centre (IDRC), "25% of the entire global food output is grown in cities. Undertaken before the recent food crisis, it is likely that this figure significantly underestimates the current level of urban food production. History shows that urban agriculture production rises with food prices. Some years ago, UNDP estimated that at least 800 million urbanites produce some of their own food, including at least 200 million urban families that sell some of their produce in local markets. Again, these figures are probably much higher today. Almost 18% of the land in downtown Hanoi is used to grow food.30 In Quito, about 35% of urban land is used for agriculture and in the Argentinan city of Rosario, 80% of the land grows some food. In Abomey and Bohicon, two cities in Benin, half of the population in the peri-urban area is growing food as their primary activity*" (ETC-group, 2009).

Ecological agriculture is key to address climate change

In a comprehensive literature review of the options for lowering agricultural emissions at global and national levels, Wrights (2010) of the Overseas Development Institute concluded:

"While humanity is confronted with the almost overwhelming challenge of climate change and finite resources, there is no evidence suggesting that it is impossible to find a way to move forward. To the contrary, the growing body of analytical work examining scenarios at the global and regional level suggests it is not only technically feasible but also economically affordable, even profitable. The affordability of an ambitious response is even clearer when the costs of inaction are considered. These conclusions, however, only apply assuming a global transformation towards sustainability begins in the very near future and accelerates quickly."

PEASANTS

- breed and nurture 40 livestock species and almost 8000 breeds.
- breed 5000 domesticated crops and have donated more than 1.9 million plant varieties to the world's gene banks.
- fishers harvest and protect more than 15,000 freshwater species.
- and pastoralists maintain soil fertility is 18 times more valuable than the synthetic fertilizers provided by the seven largest corporations.

Source: ETC-group, 2009.

In agriculture, sustainability means a clear shift towards agro-ecological models of production that allow drastic reductions in the use of fossil fuel, present great mitigation potential through soil and plant sequestration, and have the flexibility and diversity required to allow adaptation to changing conditions.

It is important to note that the overall use of fossil fuel must be severely reduced. In agriculture, sequestration is often presented as the best solution to climate change, but in reality, it is not. Unless the use of fossil fuels is drastically reduced, CO_2 will continue to accumulate in the atmosphere, sooner or later provoking catastrophic climatic extreme events.

In practice, agriculture can contribute to cooling the planet in three ways: by reducing the use of fossil fuel through reducing fertilizer production and the use of fossil-fuel powered transport and machinery; by slowing the release of biotic carbon; and by increasing sequestration, particularly in soils.

Adaptation to climate change

There is consensus on the overall negative impact of climate change on agriculture. Studies indicate that South Asia and Southern Africa are the two "hunger hotspots" likely to face the most serious impacts from climate change. The crop with the single largest potential impact is maize in Southern Africa. Maize is the most important source of calories for the poor in this region and, with the effects of climate change, its yield could be reduced up to 30 percent by 2030. In South Asia, where roughly one-third of the world's malnourished live, several key crops – including wheat, rice, rapeseed, millet and maize – have more than a 75 percent chance of incurring losses from climate change (The Conservation of Global Crop Genetic Resources in the Face of Climate Change. 2007).

The uncertainty of future rainfall patterns, coupled with the likely increase in extreme rainfall or drought events and the emergence of unfamiliar pests and diseases, demands a form of agriculture that is resilient, and a system of food production that supports knowledge transfer and on-farm experimentation through building the adaptive capacity of farmers (Ensor and Berger, 2009; GECHS *et al.*, 2008).

Resilience to climate change in agricultural systems requires presence of overlapping elements:

- agro-ecosystem resilience – refers to the persistence and sustainability of yield from the land or sea in the face of a changing climate;

- livelihood resilience – achieved through livelihood strategy diversification, such as introducing fish into rice paddies or planting a wider variety of crop species;
- reduced dependence on external inputs; and
- decoupling of agricultural practice from volatility and changes in other markets, while retaining assets on-farm.

Many traits found in indigenous breeds will become increasingly important as climate change alters the environment and the pattern of pathogen spread between and within countries (Smallstock in Development, 2010). Their protection, along with the local knowledge that is critical to their management and breeding, is critical for the future.

Of course, small-scale farming can provide diversified diets including a wide range of pulses, beans, fruits, vegetables cereals and animal-derived products. In addition to being good for consumers' health, this diet also has its implications for climate change mitigation. A more vegetarian diet is responsible for fewer greenhouse gas emissions over a lifetime. Think about it: an average of 25 kcal fossil energy is used per kcal of meat produced, compared with 2.2 kcal for plant-based products (Pimentel and Pimentel, 2003). If developing countries were to consume as much meat as industrialised ones, we would need two-thirds more agricultural land than we have today (Jackson *et al.*, 2007).

A comparative analysis of energy inputs on long-term trials at the Rodale Institute found that organic farming systems used 63 percent of the energy required by conventional farms, largely because of saving the energy input that would have been required for synthetic nitrogen fertiliser (Pimentel *et al,* 2005). The majority of climate change mitigation activities are cornerstones of organic agricultural practice, meaning that organic production systems arguably serve as the best widespread examples of

THE GREATER PRODUCTIVITY OF SMALL FARMS

Rosset (1999) offers a variety of explanations for the greater productivity of small farms.

- **Multiple cropping:** while large farmers almost always use monocultures and one or, at the most, two cropping cycles per year, small farmers are more likely to intercrop on the same field, plant multiple times during the year, and integrate crops, livestock and even aquaculture, making much more intensive use of space and time.
- **Land use intensity:** larger farmers and land owners tend to leave much of their land idle, while small farmers tend to use their entire parcel.
- **Output composition:** large farms are oriented toward land-extensive enterprises, such as cattle grazing or extensive grain monocultures, while small farmers emphasize labour- and resource-intensive use of land. Large farms may produce crops with lower value than do smaller farms.
- **Irrigation:** small farmers may make more efficient use of irrigation.
- **Labour quality:** while small farms generally use family as labour – who would be personally committed to the success of the farm – large farms use relatively alienated hired labour.
- **Labour intensity:** small farms apply far more labour per unit area than do larger farms.
- **Input use:** small farms often use far more inputs per unit area than larger farms, though the mix on small farms favours non-purchased inputs, such as manure and compost, while large farms tend to use purchased inputs, such as agrochemicals.
- **Resource use:** large farms are generally less committed to management of other resources (such as forests and aquatic resources) which combine with the land to produce a greater quantity and better quality of production.

Source: Rosset, 1999.

low emissions agriculture to date. Organic systems also tend to be more resilient than industrial in terms of withstanding environmental shocks and stresses including droughts and flooding.

Various other assessments that have reviewed whether low emissions agriculture can feed 9 billion people have incorporated data from the certified and non-certified organic, agro-ecological and biodynamic farming movements, which are the best-defined bodies of intentionally sustainable, whole farm systems. Their results show an overwhelming concordance in the positive impact on climate change mitigation while ensuring sufficiently high levels of food production. As shown in this report, this dual potential and challenge of sustainable agriculture to mitigate climate change and feed the population by 2050 has become widely recognised.

Ecological agriculture: based on values of equity, justice and respect for the earth and its people

Ecological agriculture is community based and embedded in local cultures. The anthropologist Pablo B. Eyzaguirre, Bioversity International, describes the fundamental role of culture:

"To the anthropologist culture is the fundamental instrument and process by which humans adapt and evolve. It guides the development of institutions, decisions, social cohesion, rights and collective action. Culture contains and transmits bodies of knowledge.

As long as agriculture will be seen primarily as a technological process for using soil, water and biodiversity to produce good and commodities, we will continue to have hunger in the face of overproduction, malnutrition coupled with overnutrition and a growing population that is increasingly dependent upon an ever narrower portfolio of crops and livestock to meet its needs" (Eyzaguirre, 2006).

In ecological agriculture, local communities use culture and nature to meet their food and livelihood needs. Ecological agriculture is grounded in locally available resources and builds on past and present knowledge systems and practices. This temporal dimension also has a spiritual dimension that connects rural communities to the earth, whereby peasants become the stewards of nature, grounding evolution – the evolution of the human species – in a more extended dimension of time.

Even when they are forced to migrate to slums and urban neighbourhoods, small farmers transpose their knowledge to their knew environments as well as their seeds – planting and producing non-negligible amounts of food. For the population in many parts of the world, this intimate relation to the earth has been lost, together with the understanding of what is being eaten and where it comes from. As the consumers and producers have become farther apart, the bridges between them have become weak or nonexistent and the values of equity, justice and respect for the earth and for the people, deeply rooted in rural communities, have faded away.

VI. THE WAY FORWARD

Regulation and transformation of unsustainable large-scale industrialised agriculture, livestock raising and fisheries towards smaller-scale ecological production systems is urgently required if hunger is to be eradicated, an equitable food system established and the environment restored

Small-scale farmers should be recognized for their ability to feed the world, reduce climate change, preserve the natural wealth of agricultural and grazing lands, soil, biodiversity, water and aquatic resources that they use in production.

Local food production and small-scale agricultural industries in rural areas have the potential to provide decent jobs, which are of utmost importance especially for rural youth and women, and to revitalise agrarian, pastoral and fisheries-based economies, thereby preventing distress or involuntary migration to cities.

It is time to move in the direction of a viable food future.

Food sovereignty

Policy space for governments and people is needed to transform the currently dominant food system to a more viable and sustainable system. Food sovereignty will create that space and offers a way forward.

There is not one common definition of food sovereignty, but the different definitions do all go along the same lines. The IAASTD Synthesis Report has this short definition:

"Food sovereignty is defined as the right of peoples and sovereign states to democratically determine their own agricultural and food policies."

Since it was introduced internationally by the peasant movement *La Via Campesina* at the 1996 World Food Summit organised by FAO. food sovereignty has gained wide support from social movements, NGOs, institutions and some governments all over the world. Food sovereignty challenges the dominant model for food and agriculture and outlines an alternative model.

REDUCING EMISSION AND INCREASING SEQUESTRATION

It has been calculated that:

- by using agro-ecological practices to rebuild the organic matter in soils lost from industrial agriculture, sequestration equivalent to 20–35% of current greenhouse gas (GHG) emissions can be achieved;
- by decentralising livestock farming and integrating it with crop production, total GHG emissions can be reduced by 5–9%;
- by distributing food mainly through local markets instead of transnational food chains, total GHG emissions can be reduced by 10–12%;
- by stopping land clearing and deforestation for plantations, total GHG emissions can be reduced by 15–18%.

Brought together, these measures would lead to reduction and sequestration of one-half to three-fourths of current global GHG emissions.

This would also lead to decentralisation of production and distribution, effective support for agricultural practices based on agro-ecological processes, biodiversity and local knowledge, and profound agrarian reform.

Source: GRAIN, 2009.

DID YOU KNOW THAT … ?

The European Commission brought issues dealing with soil biodiversity into focus through the following list of questions in its report: *Soil biodiversity: functions, threats and tools for policy makers:*

Did you know that … ?

- One hectare of soil contains the equivalent in weight of one cow of bacteria, two sheep of protozoa, and four rabbits of soil fauna.
- There are typically one billion bacterial cells and about 10,000 different bacterial genomes in one gram of soil.
- Every year, soil organisms process an amount of organic matter equivalent in weight to 25 cars on a surface area as big as a soccer field.
- Only 1% of soil microorganism species are known.
- Some nematodes hunt for small animals by building various types of traps, such as rings, or produce adhesive substances to entrap and to colonise their prey.
- Some fungi are extremely big and can reach a length of several hundred metres.
- Some species of soil organisms can produce red blood to survive in low oxygen conditions.
- Termites have air conditioning in their nests.
- Bacterial population can double in 20 minutes.
- Soil bacteria can produce antibiotics.
- Bacteria can exchange genetic material.
- Soil microorganisms can be dispersed over kilometres.
- Fungal diversity has been conservatively estimated at 1.5 million species.
- Earthworms often form the major part of soil fauna biomass, representing up to 60% in some ecosystems.
- Several soil organisms can help plants to fight against aboveground pests and herbivores.
- The elimination of earthworm populations can reduce the water infiltration rate in soil by up to 93%.
- The improper management of soil biodiversity worldwide has been estimated to cause a loss of 1 trillion dollars per year.
- The use of pesticides causes a loss of more than 8 billion dollars per year.
- Soils can help fight climate change.

A project group established by the Norwegian Ministry of Foreign Affairs in 2006 to give advice on food security and hunger, with representatives from a wide range of organisations, institutions and companies concluded that, despite different opinions on food sovereignty, it has a lot of positive elements and that Norway should stimulate debates and research on the concept (NORAD, 2007).

One of the most common definitions of food sovereignty used by peasants' organisations and other social movements and NGOs is the one from Peoples Food Sovereignty Network (2002)

"Food Sovereignty is the right of peoples to define their own food and agriculture; to protect and regulate domestic agricultural production and trade in order to achieve sustainable development objectives; to determine the extent to which they want to be self reliant; to restrict the dumping of products in their markets; and to provide local fisheries-based communities the priority in managing the use of and the rights to aquatic resources. Food Sovereignty does not negate trade, but rather it promotes the formulation of trade policies and practices that serve the rights of peoples to food and to safe, healthy and ecologically" (Windfuhr and Johnsén. 2005).

More than 500 delegates from more than 80 countries took part in the Nyéléni 2007 Forum for Food Sovereignty[37] in Mali, where food sovereignty was developed further and concretized (Nyéléni Synthesis Report)

The civil society conferences held in parallel to the World Food Summits in 2002, 2008 and 2009 were all based on and promoted food sovereignty.

Wealth and the development of new indicators

Two decades ago, the need to reflect the human dimension in development approaches led to the creation of the UNDP Human Development Index. Today, a number of initiatives both from the public and private sectors are looking

37 www.nyeleni.org

BEYOND GROSS DOMESTIC PRODUCT (GDP)

"Economic indicators such as GDP were never designed to be comprehensive measures of well-being. Complementary indicators are needed that are as clear and appealing as GDP but more inclusive of other dimensions of progress – in particular environmental and social aspects. We need adequate indicators to address global challenges such as climate change, poverty, resource depletion and health.

In November 2007, the European Commission, European Parliament, Club of Rome, OECD and WWF hosted the high-level conference "Beyond GDP" with the objectives of clarifying which indices are most appropriate to measure progress, and how these can best be integrated into the decision-making process and taken up by public debate. The conference brought together over 650 policy makers, experts and civil society representatives to address these critical issues. Preceding the main conference, an expert workshop was held, wherein leading practitioners discussed the development and application of indicators of progress, true wealth, and well-being. (…)

On 20 August 2009, the European Commission released its Communication "GDP and beyond: Measuring progress in a changing world". The Communication—a direct outcome of the Beyond GDP conference—outlines an EU roadmap with five key actions to improve our indicators of progress in ways that meet citizens' concerns and make the most of new technical and political developments."

Quote from http://www.beyond-gdp.eu/

Regenerative agriculture: bridging traditional knowledge and modern science

New techniques are being increasingly used that bridge traditional knowledge and modern science. A good example is the success of regenerative agriculture whereby a combination of holistic management, grazing systems, site analysis and biological monitoring, including the use of GIS/GPS and biofertilizers as well as integrated polycultures is being increasingly adopted by most innovative farmers.

Holistic Management

Holistic Management is an animal and land management practice that mimics nature to benefit grazing stock and biodiversity at the same time. Graziers across the world have discovered that they can improve production of their herds while improving water & mineral cycles of environments under a holistic management regime.

Holistic Resource Management was pioneered by Allan Savory more than 40 years ago to offer land stewards a way to make grazing, land management and financial decisions that positively impact land health and productivity.This type of grazing management is now considered to be the single most beneficial technique for restoring both profits and biodiversity to independent grazing operations.

BioFertile Farms[1]

Over the last 20 years, pioneering scientists in Latin America have developed a range of 'farm-made' BioFertilizers to replace energy-intensive and expensive artificial fertilizers. These techniques have enabled farmers across Latin America access to the tools and knowledge needed to get themselves 'off the drip' of increasingly unaffordable artificial fertilizers. And now they bring this open-source knowledge to the world

Using a variety of simple processes, producers can make their own BioFertilizers in on their own farms. The biofertiliser movement has also revolutionised the use of Chromatography such that producers can use this analysis technique for a whole range of applications, allowing producers to test everything from their soils and produce to the various inputs they apply via a simple, effective, on-farm process.

Pasture Cropping[2]

Pasture cropping is a technique of sowing crops into living perennial (usually native) pastures and having these crops grow symbiotically with the existing pastures.

Colin Seis and Daryl Cluff initiated this idea about 15 years ago and since that time Colin Seis has spent much of his time perfecting this technique. Colin discovered that it is possible to grow many different types of winter and summer growing crops, without destroying the perennial pasture base, while sequestering large amounts of carbon. Over 1000 farmers across Australia practice pasture cropping in a whole range of climate zones.

Over the years there were more advances with the technique As a direct result of the ongoing work and the landholder education these same pasture cropping methods are now being used in such diverse places as Scandinavia, USA and south American countries.

Mob grazing[3]

Opposing the accepted view that grazing results in higher methane emissions, a New Zealand agronomist promoting the mob grazing concept has collected empirical evidence that shows the opposite: that grazing systems have up to 40% lower carbon footprint than intensive systems when all the external inputs and activities are evaluated (Philips T. Milk Production Carbon Footprint Summary. Pasture to Profit www.pasturetoprofit.co.uk).Mob grazing is being practised by the Carbon Farmers of America and of Australia (http://www.carbonfarmersofaustralia.com.au). Key to mob grazing and soil carbon capture is the presence of glomalin, a recently-discovered glycoprotein compound produced by mycorrhizal fungi as they supply water and nutrients from the soil to the plants in return for plant sugars. Glomalin contains 30–40% carbon (compared to 8% in humic acid), or 27% of the all soil carbon, and can survive in the soil for more than 40 years. Without a healthy population of arbuscular mycorrhiza in soils, glomalin cannot accumulate, and plants cannot thrive.

Water harvesting and soil conservation

The goal of the Jordan Valley Project was to demonstrate the potential for improving human and environmental conditions using low-cost, low-tech approaches on a 4 ha site under high salinity and drought conditions.This drought-stricken, desert land was greened within a year to create a productive food system and, in doing so, also became a carbon sink.

1 http://regenag.com/web/courses/biofertile-farms.html
2 http://regenag.com/web/courses/pasture-cropping.html

3 Mob grazing and water harvesting examples taken from the work of Julia Wright March 2010

at better ways to quantify the costs of using natural goods such as biodiversity and ecosystems services, in order to account for social and environmental externalities. A number of initiatives are developing series of indexes and indicators of production systems that will reflect their energy efficiency and their impacts on the environment and communities.

For the moment the negative costs of some agricultural practices on human health and the environment are still paid by societies. As an example, think of the cost to public health services of providing massive quantities of vaccines against pandemic risks, of having to treat victims of chemical contamination, food poisoning and nutrition-related diseases, or of the cost to societies of massive cullings of animals to thwart spread of disease, or of the cost of antipollution treatments of water streams, water tables, soil and air, to mention only a few, and only the short-term ones.

The time has come to establish accounting systems that better reflect the fact that nature is a finite resource and that we need to reverse the trend which today is to consider that nature's goods and services are free, and their use – or misuse – create the wealth of nations. It is time to pay for the use of resources or for the pollution of these resources, to reward those who conserve them, and to base the wealth of nations on the conservation and enhancement of natural resources and ecosystem services.

Mechanisms are still to be invented, defined and applied that could be suggested as a next step. But this same goal was emphasized in the Millennium Ecosystem Assessment and as shown in the "Beyond GDP Initiative". Too often we fail to understand that most of the world's conflicts, wars, mass poverty and migration stem from conflicts and lack of rights, especially common property rights over natural resources, and that today's financial, fuel and food crises are the symptoms of a profound ecological crisis of the earth.

The summer of 2009 saw the long-awaited release of the Stiglitz Report commissioned by President Nicolas Sarkozy of France. Produced by a team that included several Nobel Prize-winning economists, the report proposed new national indicators of progress, including an "Ecological Footprint". The Stiglitz Report was not an isolated phenomenon, but one of many signs of a broader awareness of ecological indicators. In 2009, Ecuador adopted the Ecological Footprint, becoming the first country to set a formal footprint target.

In July 2010 Oxford University and the Human Development Report Office of the United Nations Development Programme (UNDP) launched a new poverty measure that gives a "multidimensional" picture of people living in poverty. The Multidimensional Poverty Index (MPI) looks beyond income at a wider range of household-level deprivation, including whether a household has a decent toilet, clean drinking water within 30 minutes on foot, electricity, school-aged children enrolled in school and whether any member of a household is malnourished. The MPI will be used by UNDP in the 2010 Human Development Report.

New measurement and indicators of both poverty and well-being can become important tools in to create a viable future. At the same time, there is no doubt that there is enough knowledge to act now to eradicate hunger and poverty.

Support for small-scale farmers

Though great progress has been achieved in the analytical realm, and farmers have demonstrated in the field the great potential of traditional knowledge coupled with contemporary sustainable practices, much remains to be done to support small farmers and peasants and to follow-up on major initiatives such as the Millennium Ecosystem

Assessment and IAASTD. Shifting investment and financial support towards more sustainable management of the earth will need massive mobilization of communities and more accessible tools and instruments that better reflect the reality and enable polices to be adjusted accordingly.

Global governance of food and agriculture

The issue of who determines food and agriculture policies is central to ending hunger and making the transition to the model of food production advocated in this paper. Over the past decades, decision making regarding food systems has been characterized by severe restrictions on the policy space of southern governments at national and regional levels, and widespread inadequacy of political will to adopt policies benefiting the majority of their citizens.

At global level there has been fragmentation of international institutions dealing with food and agriculture and absence of an authoritative, democratic policy forum dedicated to ensuring the right to food and food sovereignty world-wide. By default, decisions regarding food systems have been taken by multilateral institutions dominated by industrialised countries such as the international finance institutions (IFIs) and the World

Adapting mechanization to the size and needs of farming systems the example of Egyptian agriculture along the Nile

In Egypt where agriculture is mostly concentrated in the Nile Valley, the mean size of the Nile Valley family farms is less than one ha. A field study undertaken by Roudart (Roudart 2001[1]) shows that the mean size of the plots is 0.5 ha, and that the irrigated areas often have a surface under 0.1 ha. Despite these very small sizes of land plots, the agriculture of the valley was producing enough to cover the energy needs of a population of close to 60 million human beings, an astounding record. Roudart has analyzed the evolution of the agrarian systems and demonstrated that the Egyptian agriculture of the Nile Valley is a model of modern and intensive agriculture, reaching productivity levels higher than those obtained in most developed countries.

The study was undertaken during different periods in time. The yields in 1995-1998 reached 5700 Kg of wheat per ha, 7400 Kg of maize per ha, 8400 Kg of rice per ha, the world highest mean yields. These yields are comparable and even higher than those of industrialized countries. During the same period the yields of the same crops in the US, France and Netherlands were lower. Regarding livestock, 70 percent of animal production is big cattle which represents 2.3 heads of cattle per ha, higher than the most efficient systems in the world such for example the 1.6 heads of cattle per ha reached in the Netherlands. Small farms are those with most cattle, and the most sophisticated animal-crop integrated systems.

Egypt is also very advanced in terms of motorization and has adapted mechanization to the size and needs of its farming systems. Most of the soil preparation work and water pumping and grain threshing is mechanized. This works well because of a very active renting system for the machinery which allows farmers, including small farmers, to have access to the equipment they need at the right time. The small size of plots is not an obstacle to mechanized water pumping as water is brought by gravity to the third level canals where it is usually pumped and brought to private canals running along the land parcels. This small size of plots is not either an obstacle for the different farming activities as mechanization facilitate some works during pick periods of the year (such as threshing and land preparation) thereby allowing for an additional planting season to begin. FAO data shows that there is one tractor per 26 ha in Egypt, which compares to one tractor per 48 ha in France, one for 11 ha in the Netherlands and one for 90 ha in the US.

The in-depth analysis of the evolution of this agrarian system and detailed field interviews have shown that decent living condition could be reached for a family with a plot of good land of a size between 0.5 to 0.8 ha, with the appropriate mechanization and animal-crop integrated systems.

1 Jouve, A.M., Abaab A., Anthopoulou, T., Arnalte, E., Bouderbala, N., Civici, A., Dogan, O.,El Twab, S., Elloumi, M., Estruch, V., Hajji, A., Napoleone, C., Roudart, L., Shali, Z. & Y.Tekelioglu. Terres Méditerranéennes- Le morcellement, richesse ou danger? Paris: Karthala, 2001.

Trade Organisation (WTO) operating under quite different mandates than the UN-institutions for food and agriculture, and by uncontrolled economic and financial actors.

While the 2007–2009 food crisis elicited a variety of reactions by the international community, some tended to perpetuate or exacerbate the mistakes of the past rather than opening up alternatives. The Committee on World Food Security (CFS) undertook a reform process in 2009 which is currently in application, and points in an innovative and promising direction. The framework document of the "new" CFS places global decision making on food security firmly within a UN system, setting up one-country-one-vote, endowing it with a mission of defending the right to food of the world's population with unprecedented participation by civil society and social movements.

It is important that governments defend CFS and support its evolution into an authoritative policy space able to:

- help change the dominant wisdom and strategies of agricultural development and food systems in the directions advocated in this report on a viable food future;
- introduce enforceable accountability on the part of governments, multilateral institutions and private sector actors;
- promote and build links between multi-stakeholder policy spaces at national, regional and global levels with meaningful participation by small-scale food producers' organisations and social movements.

However, reform of the CFS alone will serve no purpose unless it sets off a dynamic that can lead to redesigning the entire multilateral institutional architecture governing food systems and defending the public sphere from encroachment of private and special interests into global policy decision making.

Further reform of the UN system for food and agriculture is needed. A process should be started to evaluate and propose how the UN and other international institutions for food and agriculture could improve cooperation and coordination of their activities, possibly also merging some of them, namely FAO. World Food Programme (WFP), International Fund for Agricultural Development (IFAP) and Consultative Group on International Agricultural Research (CGIAR).

THE RIGHT TO ADEQUATE FOOD IS A BASIC HUMAN RIGHT AND GOVERNMENTS IS OBLIGED TO FULFILL IT.

Also other UN conventions and declarations are important for the issues this report is dealing with, especially:

- The Convention on the Elimination of All Forms of Discrimination against Women
- United Nations Declaration on the Rights of Indigenous Peoples
- United Nations Declaration on the Right to Development
- United Nations Convention on Biological Diversity
- United Nations Framework Convention on Climate Change
- United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa

Social movements are promoting two new UN declaration or conventions:

- on the Rights of Peasants and Small Farmers
- on the Right to Water

Governments, institutions and organisations should support the initiatives for these.

Some recommendations

Nothing is more important than to end hunger and severe poverty, stop climate change and stop the destruction of the natural resources that are so critical for the future of humanity. Drastic changes of policies and actions in many areas are needed, but long journeys always start with small steps. There are many actions that can be taken immediately to move in the direction of a viable food future.

The recommendations below only deal with the most pressing, immediate issues – namely some policies and actions directly linked to the production and harvesting of food. For more comprehensive policies, please see the working document *Policies and actions to eradicate hunger and malnutrition.* In addition, note that the recommendations below are explored and explained in greater detail in Part II of this report.

The report and the recommendations are based on the human right to adequate food which imposes a number of clear obligations on States (De Schutter, 2009). Governments must fulfil their human rights obligations, and respect and follow the UN conventions and declarations they have signed – not only in words, but in practice.

Start moving towards small-scale ecological food production

A shift in focus and policies of governments and international institutions is needed. Even if the importance of small-scale ecological food production is underlined in every Food Summit declaration, every report and every white paper, the reality is still that industrial agriculture is promoted and supported, and small-scale ecological food production is not.

Support and strengthen the organisations of small-scale food producers
Strong social movements are vital for making the changes needed in policies and practices, as well as for democratic and sustainable development of societies. It is therefore of utmost importance to support and help strengthen the organisations of small-scale food producers and food providers, and especially to strengthen the participation and role of women. It is also important to pay special attention to and support active participation of youth in these organisations.

Reorient incentives to small-scale farmers and regulation for agribusiness
The first priority in food production and consumption policies at all levels should be to support and protect food production for local markets and consumption in the communities themselves. Incentives in food production and provision must be redirected from supporting industrial agriculture and agribusiness to supporting ecological food production and small-scale farmers. Regulation and transformation of unsustainable large-scale industrialised agriculture, livestock rearing and fisheries activities towards smaller-scale ecological production systems is urgently required.

Reorient research and breeding agenda
Agricultural knowledge, science and technology (AKST) must be redirected and strengthened to support agro-ecological and other forms of ecological, low-external inputs, sustainable food production. It needs to be based on the needs of the small-scale food producers, and encourage active participation of farming communities in all stages of the research process.

Stop land grabbing
The buying, renting and leasing of land by multinational companies and foreign gov-

ernments for agricultural production must be stopped immediately. The land grabbing underway in developing countries pushes local people off of land they use and need for their survival, undermines local and national food security, and promotes unsustainable production models and practises.

Re-direct funding for climate change to support small-scale farmer solutions
A funding window must be established under the United Nations Framework Convention on Climate Change (UNFCCC) to support small-scale food production and provision as a means of reducing global greenhouse emissions. Food and agriculture sectors should be excluded from carbon offsetting schemes, flexibility mechanisms and the carbon market. Putting the world's food supplies at risk in such highly speculative and unreliable schemes is unacceptable.

Stop the extinction of fish stocks
Over exploitation of fish stocks and extinction of species threaten future food provision for a growing population, and must be stopped. Industrial fishing must be regulated more strongly and governments should prioritize artisanal fisheries.

Examples of empowering research that can bridge traditional knowledge and modern science

ORCA

The ORCA concept has been developed jointly by the Food and Agriculture Organization of the United Nations (Italy), Tufts University (USA) and the Research Institute of Organic Agriculture (Switzerland). The Organic Research Centres ALLIANCE consists of a number of partners sharing the same interests. The informal ORCA Research Centre for Climate Change for example, is already pooling the expertise of a dozen institutions worldwide. The proposed Organic Research Centres Alliance intends to internationally network and strengthen existing institutions with scientific credentials and empower them to become centers of excellence in transdisciplinary organic agriculture research. The objective is to ensure that environmental, economic, and social benefits accruing from organic research are shared worldwide. The ORCA concept is designed following a research paradigm that heavily draws on traditional knowledge, then adds scientific investigation and shares it widely. Research centres may be physical laboratories or "institutions without walls", formed through alliances between producers and scientists, as well as twinning between developing and developed countries' institutions.

ECOLOGICAL SCIENCE TO DEVELOP ECOAGRICULTURE [1]

An analysis of Ecoagriculture challenges and Critical Issues Requiring Scientific Research has been proposed by S. Scherr, Ecological science needed to develop ecoagriculture concepts, i.e., strategies to increase agricultural productivity and save the biodiversity of wild species and their ecosystem services would benefit farmers and farming communities seeking to protect, manage or restore biodiversity resources in their dynamically changing and fragmented agricultural landscapes, and provide missing additional ecological knowledge;

DEMOCRATIZING RESEARCH

IIED, following a series of conversations with farmers, pastoralists, indigenous peoples, policy-makers and representatives of social movements between 2005-2007 led the formulation of a major multi-country initiative to enable citizens to exercise their democratic imagination to decide on the kind of food and agricultural research they want. This international initiative has now become an action research project: Democratising the Governance of Food Systems. Citizens Rethinking Food and Agricultural Research for the Public Good. Rather than offer ready made solutions this 'Democratising Food and Agricultural Research' initiative supports a decentralized and bottom up process whereby farmers and other citizens can decide what type of agricultural research is needed to achieve the right to food and food sovereignty, and also organize to collectively push for change in policies and practice.

1 L.E. Jackson et al. / Agriculture, Ecosystems and Environment 121 (2007) 196–210 table 2 p. 204

Stop gambling with the future
Humankind cannot allow some governments, scientists or companies to gamble with the very existence of life on earth. Research and funding for genetically modified plants, trees, fish and animals in agriculture, livestock, fisheries and aquaculture must be redirected. The *de facto* moratorium, agreed by the Parties to the Convention on Biological Diversity, on the release and commercial sale of Genetic Use Restriction Technologies (GURTS), known as "terminator seeds", must be upheld. Real-world experiments and deployment of geo-engineering, such as ocean fertilization, restructuring of clouds and blocking of solar rays through stratospheric barriers must be stopped and forbidden. No products of synthetic biology should be released into the environment. Governments and multilateral institutions must immediately put in place regulatory bodies and control mechanisms to govern experiments on nanotechnologies and synthetic biology.

Support and implement food sovereignty
Governments, institutions and organisations should build their food and agricultural policy on food sovereignty and implement it. It is important to understand that problems related to food are not only about production systems, and that other global measures related to access to resources, trade or governance are needed. Food sovereignty proposes specific measures to target all these problems as a whole.

Longer term actions

Develop strategies and plans for solving the most important and pressing problems for humanity and the environment
Based on their political support for small-scale diversified and ecological food production and for food sovereignty, governments, institutions and organisations should develop strategies and concrete plans for how they are going to put this into practice. Such strategies and plans must be worked out in close collaboration with small-scale food producers and be based on their needs. Special attention must be paid to the special roles and needs of women and youth.

Preserve and increase agricultural biodiversity, restore soil fertility, retain the water and protect ecosystem health
Governments, institutions and organisations must support the conservation of endangered genetic diversity, primarily *in situ* but also *ex situ*. There is need for a global effort to improve and restore soil fertility and preserve water resources. A reward system for actions taken by small-scale farmers to ensure preservation of ecosystems must be developed and implemented. To prevent ecosystems destruction, stronger regulation and effective penalty systems must be developed that deal with such crimes where they occur.

Transform industrialised agriculture, livestock production and fisheries
Stricter and better regulation of industrial farming is needed to stop its negative environmental and social impact. Governments should also put in place programmes to guide and support farmers in transforming industrial types of agriculture to ecological production. Small-scale family farming, pastoralism and artisanal fisheries should again become the cornerstone of food production all over the world.

Cut the meat economy and change to healthier diet
Industrial meat production must be transformed and meat consumption reduced in the industrialized countries. Meat production should be an integrated part of a small-scale farming system, based on individual countries' own natural resources. Consumption patterns, especially in the industrial countries, have to change to less meat consumption and more fruit, vegetables, roots and cereals.

Ensure a decent income for all peasants and farmers
There is a strong need for developing food price mechanisms and support for farmers and other food producers which provide them an assured income, commensurate with a decent livelihood. Such systems must be based on the work and real needs of the food producers living under very different natural conditions.

Establish new international trade rules
International trade rules, in the WTO and under bilateral and regional trade agreements, must be changed to support rather than undermine local small-scale ecological food production for local and national markets. International trade rules for food should only deal with produce that crosses borders. Each country must have the right to decide its levels of self sufficiency, and its ways of protecting and supporting sustainable food production for local and national consumption. All direct and indirect subsidies on export production in the industrial countries must be banned.

Develop an index for well-being and sustainability
Governments, international institutions and civil society organisations should work together to develop new indexes which reflect the development of wellbeing for people, societies and nature. Setting the UNDP Human Development Index was a big step forward from only measuring progress and setbacks for societies in economic terms such as gross national income and gross national product. However, new indexes are needed to reflect the holistic situation for people, societies and nature.

Explore new innovative possibilities for supporting ecological food production
Innovative networks and methods are needed that will support and promote ecological food production. How can better links and cooperation be built between small-scale farmers and scientists? How can business people contribute? How can modern information and communication technology be used to share experiences and information among small-scale farmers? How ... ? We encourage all who reads this to brainstorm and put up ideas for discussion on new and innovative possibilities for supporting ecological food production.

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Se Part II of this report for more references

A Viable Food Future

What kind of food production can

drastically reduce poverty,

reduce climate change and cool the planet,

restore biodiversity, soil fertility and water resources,

improve livelihoods and provide employment for billions of people,

produce enough, good, and nutritious food for 9 billion people or more ... ?

Organisations that have contributed directly to this report:
Canada: USC; India: Forum for Biotechnology & Food Security, and Navdanya; Italy: Terra Nuova; Spain: Veterinarios sin Fronteras; USA: Food First, Oakland Institute; UK: Practical Action; and International organisations: ETC-group, Friends of the Earth, GRAIN, More and Better, La Via Campesina and The International Commission on the Future of Food and Agriculture.

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