AGRICULTURE, TRADE AND DEVELOPMENT

Toward greater coherence

An anthology on coexistence and development of agriculture
in developing and developed countries

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FOREWORD

Can agriculture in the developed and developing countries progress in parallel and in harmony with each other? The international agricultural debate in the EU and WTO points to conflicts of a political and commercial nature, although there are signs indicating some potential for agreement. Recent steep price increases for agricultural products can be expected to raise the possibility of consensus. This joint interest is particularly important today, as it appears that agricultural development is again set to be viewed – both in Sweden and internationally – as the engine in moving poor countries towards greater well-being.

In 2004, Inge Gerremo, Senior Advisor at the Swedish International Development Cooperation Agency (Sida), proposed that the Royal Swedish Academy of Agriculture and Forestry (KSLA) should consider dealing with the issue of agricultural development from the perspective of the rich and the poor world. As a result, a scheduled meeting in December 2004 discussed the topic *"Would agriculture pass a holistic audit – a contribution by KSLA to the global development policy adopted by the Swedish Parliament."* It was hoped that the discussion would underscore the strategic significance of the subject, not only for agriculture but also for social development as a whole in the developed and developing countries and that the academy would engage in a more detailed treatment of this in the future.

And, thus, a more detailed review was undertaken. As a result of the meeting in December 2004 and some other proposals, the idea emerged of conducting an analysis on the basis of a hypothesis with approximately the following content.

Agriculture will continue to be a key sector in Sweden and the developed world, but will probably produce other goods and services than is currently the case. Agriculture is a crucial starting point on the path to prosperity for many developing countries. Thus, it is necessary for them – just as we in Sweden once did – to develop agriculture from its subsistence level to a sector capable of selling to local markets, before moving on to the next stage of supplying cities nationwide with food, and then trading with neighboring countries, and eventually gaining the capacity to compete on the world market.

But this entails an adjustment of agriculture in the developed countries, from shifting its current focus on traditional staple goods to new products and services that consumers will increasingly demand in the future – such as highly processed and specialized foodstuffs, as well as raw materials for the energy, fiber and biochemical industries, plus services such as tourism, recreation, esthetic landscapes, housing, hunting, fishing and ecosystem services in the form of biological diversity, clean water and so forth.

KSLA requested a group of experts and writers to consider these issues. The idea was to write an anthology to serve as a knowledge platform in an effort to facilitate an insightful treatment of the question of

co-existence and the development of agriculture in the developed and developing countries alike.

Proceeding on the basis of Sweden's "Policy for Global Development", the purpose of this book is to highlight the linkage and conflicts of interest between the developed and developing countries in agriculture, trade and development, as well as the potential for coherence.

The book neither attempts to provide unequivocal answers nor does it outline definite development paths. Instead, it is aimed at presenting an important and complex area from the perspective of different expertise and experience. Nevertheless, the final chapter attempts to summarize certain conclusions from the various contributions and discusses possible ways forward.

The anthology is designed for a broad-based readership with an interest in agriculture in developed and developing countries, such as politicians, social movements, individual organizations, universities, government agencies, farmers, farming organizations and stakeholders. In conjunction with the ongoing generation shift among people holding various posts that involve a global approach to food supply, it is important that the issues raised by the book are discussed. Some of the chapters are also appropriate as course literature in various lines of study.

The project was planned and coordinated by a steering group consisting of Mats Denninger, Farmer and Aid Consultant, Inge Gerremo, Senior Advisor, Professor Per Wramner, Associate Professor Stefan de Vylder, and Bruno Nilsson, Academy Secretary General. Also, Annette Hellström, International Secretary and Lennart Hjalmarson, Managing Director, participated at the two meetings held with the entire author group during the progress of the project as representatives of three of the financing organizations.

The project was financed by Sida, the Swedish Cooperative Centre, the Vi Agroforestry Programme, the Swedish Federation of Farmers (LRF) and the Royal Swedish Academy of Agriculture and Forestry (KSLA). The steering group and KSLA wish to express their sincere gratitude for the financial resources placed at their disposal for the completion of the book project.

A huge thanks is, of course, also extended to all the authors, who kindly and enthusiastically provided their expertise and experience for the project – on top of all their other commitments – thereby making the anthology possible.

The book proved extremely popular, as confirmed by the sellout of the Swedish first edition. The question then arose as to whether this success could be repeated with an English version? The same steering group that handled the Swedish version – with the exception of Bruno Nilsson, who retired and was replaced by the Academy's current Secretary General, Åke Barklund – concluded that it would. We are grateful to the authors for reviewing their chapters and to Sida, which kindly financed the translation and publication.

Åke Barklund
Secretary General and Managing Director, Royal Swedish Academy of Agriculture and Forestry

IS THERE SUFFICIENT WATER TO ERADICATE HUNGER WORLDWIDE? – a misleading question

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Extract

The UN's Millennium Development Goal of halving widespread malnutrition in developing countries by 2015 is studied from the hydrological perspective, against the background of fears of rising water shortages. Since local agriculture is the key to growth, the challenges implied by self-sufficiency are studied on the basis of major hydroclimatic problems that must be resolved. Declining river flows in irrigation-dependent regions compel a renewed focus on the potential of rainfed agriculture, which appears substantial. However, the impact on the ecosystems – both terrestrial (land based) and aquatic (water based) – must be managed by balancing water for food production and water for the ecosystem within the catchment area. In a future perspective, a joint trade-off may prove to be attractive: combining the temperate zone's undisputed advantages in food production with the tropics' comparative advantage in the growing of energy crops (substantially larger energy efficiency).

A policy perspective of global food supply

During the next 50 years, mankind will face one of its greatest ever agricultural and environmental challenges. Despite the slowing growth rate, global population will continue to rise from the current 6.5 billion people to 9 billion by 2050.[1] The question is how food output can be secured for an additional 60–80 million people annually, in light of the current situation in which some 850 million go hungry each day. In addition, we are becoming increasingly aware that environmentally sustainable solutions for intensive agriculture are required that minimize negative environmental implications and support the generation of other ecosystem services, while also building resilience against future societal and environment-based shocks. Meanwhile, there is growing evidence that human-driven climate change has already aggravated the conditions for agriculture (primarily through declining precipitation) and threatens long-term agricultural productivity, notably in the poorest countries.[2]

Swedish agricultural policy and global agricultural development

There are a number of crucial links between European – and thus Swedish agricultural policy – and the global challenge to produce food for a

growing population. The difference between high agricultural productivity in industrial countries and current agriculture in developing countries – where grain harvests are generally at least five times lower than in developed countries, for example – is frequently used as an argument for boosting food exports in an effort to meet rapidly growing demand. In theory, and using the argument of comparative advantage, it sounds attractive to protect the agricultural sector in the North in order to sell cheap grain to poor countries in the South, where productivity is low and output insufficient. This appears particularly attractive in a situation in which the world, paradoxically, produces enough food at the global level to feed everybody.[3] Nevertheless, almost one in five people worldwide go hungry.

However, an integrated analysis highlights the difference between economic theory and *realpolitik* at the country level. All hungry people worldwide are also poor. The world's population is growing primarily in the developing countries. Today, more than 70 percent of the world's poor live in the countryside and depend essentially on agriculture for their food supply. As a result, agriculture plays a fundamental role in the economies of poor countries, with the sector frequently accounting for 20 to 40 percent of a country's gross domestic product (GDP). The World Bank concludes – just as it did 30 years ago – *that investment in local agriculture is the key to economic growth in the world's poor countries*.[4]

As in the case of Sweden up until 20 years ago, food security in most developing countries represents a high-priority national goal, adding to the significance of the agricultural sector nationwide. Poor people cannot afford to buy staple foods in a market, meaning there is little purchasing power in the South for food produced in the North. This is also reflected in the world food market. No more than 5–10 percent of world grain output is traded on the world market. Affluent countries in North Africa and the Middle East, for example, purchase most of it while countries in Sub-Saharan Africa import very little basic foodstuffs.

Declining watercourses require a shift in focus towards soil water

There are fears that the world is facing a growing freshwater crisis[5] and agricultural production is at the center of this potential calamity. No societal sector accounts for such a large extraction of freshwater from watercourses and groundwater sources as agriculture.[6] Declining water tables in India and China, for example, and serious streamflow reductions in river systems, including the Yellow River in China and tributaries feeding the Aral Sea, are primarily the result of water extraction for irrigation. The crisis centers on tropical regions where water shortages are common.

Estimates indicate that up to two billion people in more than 40 countries suffer from shortages of what is currently referred to as *blue water*, that is, liquid water flows. In other words, they do not have access to a blue water volume of at least 1,700 m^3 per person annually to meet the water needs of society, industry and irrigation.[7]

Of global precipitation over land of an average of some 110,000 km^3 annually, about 40,000 km^3

takes the form of runoff to rivers, groundwater and lakes. This blue water flow[8] is the source from which to cover society's water requirements for agricultural irrigation, drinking and sanitation, and industry. Agriculture's share of blue water extraction of some 4,000 km^3 annually accounts for 70 percent, while household water represents 8 percent, and industry 23 percent.[9] But overall extraction represents only 10 percent of total blue water flow. Since only stable year-round runoff is deemed possible for people to expropriate, the theoretical limit for blue water withdrawals is really much lower, probably about 12,500 km^3 annually.[10] Moreover, taking into account the requirements of shipping and the need to ensure a basic flow in rivers to maintain aquatic ecosystems,[11] the sustainable available threshold declines further, perhaps as low as about 7,500 km^3 annually.[12] Agricultural research points to additional requirements for unconsumed blue water flow to deal with the leaching of artificial fertilizers and salinization in irrigated agricultural land, which already today is a prerequisite for ensuring productivity in a substantial portion of tropical irrigated agriculture. This requirement can reduce the sustainable accessible supply by about an additional 2,000 km^3 annually, resulting in effective, sustainable blue water resources of only 5,500 km^3 annually. Forecasts estimate that the extraction of blue water for irrigation, cities and industry will rise by more than 1,000 km^3 annually up to 2025 (from about 4,200 km^3 per year in 1995 to some 5,300 km^3 per year by 2025).[13] Not surprisingly, this obvious blue water shortage is a matter of concern.

It is from this perspective that we should view the emerging strategic potential offered by the use of what is referred to as *green water* – the rainwater that naturally infiltrates the soil. Green water resources worldwide, amounting to an average of some 70,000 km^3 annually over land (or almost twice as large as the world's blue water flows), represent that portion of precipitation that infiltrates the soil, forms soil moisture and then evaporates back into the atmosphere. Green water resources are the basis for the production of all rainfed biomass worldwide – forests, grasslands, savannas, grazing land and agriculture.

Rainfed agriculture accounts for 80 percent of the world's agricultural land and produces some 60–70 percent of the world's food. From a future perspective, a key feature of green water flow is that, in the form of evaporation, it is made up of two components – non-productive evaporation and productive transpiration (water consumption by vegetation), when plants take up soil moisture during photosynthesis. As we will see later, this difference can be exploited.

From green to green-green-green revolution (a triple green revolution)

As noted, the use of blue water is about to peak, which means that irrigated agriculture has limited potential to contribute to meeting the future demand for food. Consequently, the analysis of the global challenge in respect of water, food supply and sustainable development must be widened to include soil moisture resources, meaning that it should be broadened from solely blue water to include green water. This is particularly important

in view of the fact that most food worldwide is produced using green water in rainfed agriculture. As a result, the overall challenge is transformed into the management of rain and not just water available in watercourses. Thus, the development of long-term resilient and environmentally sustainable system solutions for agriculture becomes crucial. *In other words, a paradigm shift in future agricultural strategies is required.*

The "green revolution" that was achieved using modern agricultural technology – blue water technology (irrigation systems and fossil-fueled pumps) and input materials – removed major regions of South Asia from the threat of a food crisis during the 1960s and '70s. Current conditions require nothing less than a new green revolution: a twofold increase in productivity over a period of one generation, notably in Sub-Saharan Africa (SSA), but also in parts of South, Southeast and East Asia. UN forecasts point in the opposite direction, with a reduction in productivity growth over the next 30 years (or about 1.3 percent annually) compared with the preceding 30 years (approximately 2.2 percent). In absolute terms, grain output, for example, must double from some 880 million tons in 1995 by an additional 850 million tons to slightly more than 1,700 million tons in 2025.

As noted by Conway,[14] this new green revolution must be "green – green", or "doubly green" since any new large-scale intensification of agriculture must be environmentally sustainable. Falkenmark and Rockström[15] believe that a new revolution must, de-facto, be a triple-green revolution, since it must inevitably proceed via considerable productivity gains in rainfed, green water-dependent agriculture worldwide: green for productivity gains, green for terrestrial-water focus and green for environmental sustainability.

Thus, a broad perspective must be adopted in tackling world food production, in which the socio-economic effects of agricultural investments in Sweden and in the South must be taken into account, as well as agriculture's ecological conditions and consequences. The freshwater problem is a crucial factor in determining the direction of future agricultural investments.

Focus on productivity growth

As noted by several observers[16] and now most lately by Millennium Ecosystem Assessment,[17] there is only minor scope for an environmentally sustainable expansion of agricultural land worldwide. Instead the focus must be on increasing harvest yields. In a global perspective, irrigated grain yields are higher than rainfed yields (with an average of about 3.5 tons/hectare compared with some 2.2 tons/hectare). The difference in yields between developed countries and developing countries remains substantial, with more than one ton per hectare for highly irrigated harvest yields (4.5 tons/hectare compared with 3.3 tons/hectare), and considerably more vis-à-vis rainfed yields (3.2 tons/hectare compared with 1.5 tons/hectare).

Now, does this difference indicate lower production potential in tropical countries (where most developing countries are located)? No, the lower average harvests are, of course, associated with higher risks of harvest failure due to

variations in precipitation (higher frequency of droughts, dryspells and flooding). But from a hydrological and agro-ecological perspective, grain crops among small farmers – even in savanna areas frequently hit by drought – can increase twofold or even fourfold (from the current 0.5–2 tons/hectare to 3–5 tons/hectare).[18] Commercial farmers in the savanna areas in Southern Africa frequently grow maize and get harvests of almost 8–10 tons/hectare. Harvest differences relate to complex socio-economic factors that lead to low investment in agriculture, and are both long-term (soil management) and short-term (use of fertilizers, plant species, labor, soil preparation).

However, one worrying aspect is that productivity growth in agriculture in large areas of the world since the early 1980s has begun to decline. There are indications that the green revolution in agriculture in certain parts of Asia is beginning to show signs of falling yields. In parts of China's northern plains, harvests are declining in pace with the fall in groundwater levels of more than one meter annually.[19] In the state of Gujarat, northwest India, where green revolution farming was introduced in the 1960–'70s, excess extraction of groundwater from coastal aquifers and rapid expansion of agricultural output in the 1970s, has led to saltwater infiltration and the collapse of production.[20]

Although many agree that most developing countries have the production capacity (in terms of water and land) to meet higher demand for food, the various signs of falling growth rates for harvests and the reversal of past agricultural progress are serious indications of the magnitude of the challenge. The UN forecasts harvest growth of up to 80 percent (for South and East Asia) in both irrigated and rainfed agriculture in the developing countries over the next 25 years,[21] with rice yields in developing countries rising from 3.5 to 4.5 tons/hectare, and other cereal crops from the current 3.2 to 4.7 tons/hectare.

Meanwhile, trading in foodstuffs is likely to rise in pace with growing demand for food, rapid urbanization, economic development and changes in diet. Even though the percentage of food exports from the North to the South may not rise (currently 5–10 percent of total output), in absolute terms they may be expected to double over the next 20 years, from about 110 million tons of grain annually to 245 million tons by 2025.[22]

How then should we describe the linkage between water and food production, especially in the context of the enormous hunger and poverty problems worldwide? The Millennium Goals – which all countries signed up for via the UN in the Millennium Declaration of 2000 – have as the first target the eradication of poverty and hunger worldwide (with a 50 percent reduction in poverty and hunger by 2015). Agricultural development and especially the management and supply of water represent essential components in this process. Here, we will translate the hunger goal into water flows in an effort to analyze the reasonability of attaining the goal in an environmentally sustainable manner (which is assumed in the Seventh Millennium Goal) and to provide an indication of the focus of investment requirements in agriculture now and in the future. This chapter is aimed at analyzing the water re-

quirement to produce the food needed to halve hunger by 2015, in line with the first stage of the Millennium Goal, and subsequently to eradicate hunger totally, in line with the Millennium Declaration's ultimate goal (a goal that we presume we will attain by 2030).

Hunger zone's hydroclimatic dilemma

The poor countries of the world are essentially in tropical regions. Poverty, population growth and highly agri-dependent economies are concentrated in these countries – notably in Sub-Saharan Africa (SSA) and parts of South, Southeast and East Asia. A significant portion of the world's population, almost 40 percent, live in arid, semi-arid or dry sub-humid tropical areas. These societies are located in the world's deserts, steppes and savannahs. Since sedentary agriculture (with settled farmers) is conducted on savannas (semi-arid and dry sub-humid zones) while agro-pastoral (both arable and livestock agriculture) and pastoral societies dominate in deserts and dry steppe areas (arid areas), *the savanna represents the world's greatest agricultural challenge in terms of handling extreme variability in precipitation and recurring water shortages*.[23] This relationship – between poverty and a problematic hydroclimate – has been highlighted for almost 20 years,[24] with, for example, the hunger belt in Sub-Saharan Africa during the great hunger catastrophe in the mid-1980s (1984–86) hitting precisely a semi-arid climate zone.[25]

Relationship between undernourishment and savanna climate

As part of the Millennium Goal efforts, the UN has drawn up data covering the most hunger-prone countries worldwide (Figure 1a). The expansion of the world's savannas and wetter steppes, where

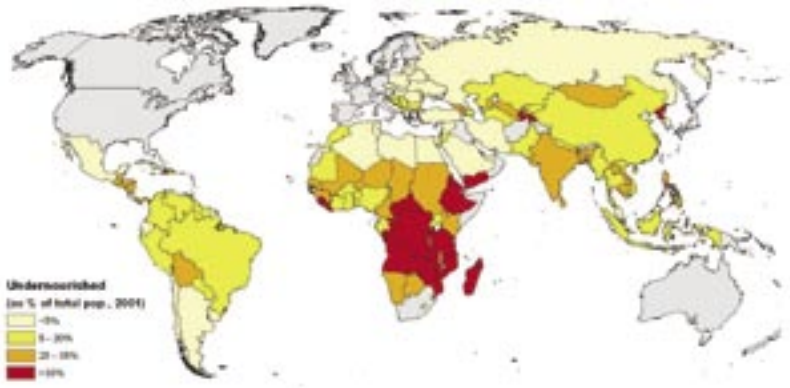

Figure 1a. Indicator for the UN's hunger goal: Level of undernourishment in developing countries (percentage 2001/2002). Source: UN Stat, 2005.

agriculture is pursued under semi-arid and dry sub-humid conditions, is shown in Figure 1b. What then are the characteristics of the hunger zone's climate? First, the steppes have a temper-ate and the savannas a tropical climate. The hotter savanna climate creates higher evaporation potential (greater risk of water shortage) and, thus, a greater challenge for food production. Even though we know that malnutrition is closely linked to poverty, and that poverty has complex roots, there seems to be a correlation between malnutrition in the world and the savanna landscape, notably in East Latin America, West, East and Southern Africa as well as large portions of South and Southeast Asia. Since hunger and poverty are greater in this tropical zone, we will focus primarily on the tropical semi-arid and dry sub-humid agrarian ecosystem. Accordingly, the possibility of mastering the savanna's water-related challenges is a crucial factor in our potential to meet the most fundamental Millennium Goal – the hunger goal.

Mastering dry periods – a core task

The savanna zone is characterized by distinct rain seasons (one or two per year), when growing takes place, followed by longer interminable dry seasons. Here, plant cultivation is water limited, as opposed to temperature limited in the temperate zone (such as in Sweden). The amount of rain on an annual or seasonal basis is seldom a scarcity factor – average rainfall ranges from 600 to 1,000 millimeters in the savanna, which is higher in the entire span from dry to wet savanna, compared with, say, arable land on the Eastern Central Coast of Sweden which receives an average of some 550 millimeters annually.[26]

Thus, there is sufficient rainfall to produce food (and rainfall is concentrated to the growing season). Instead, the challenge in the savanna is

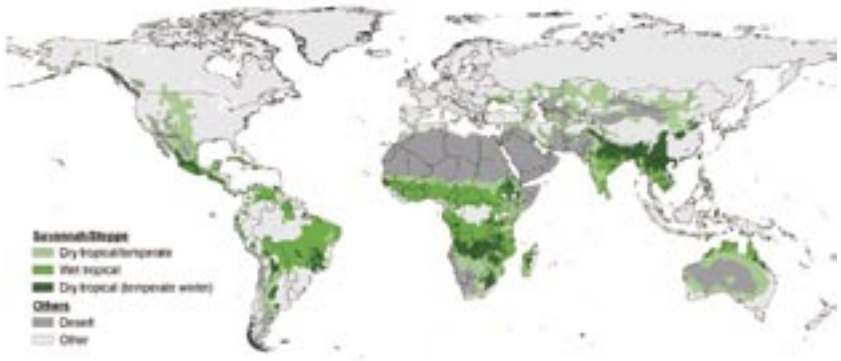

Figure 1b. Savanna and steppe regions worldwide, meaning areas with semi-arid and dry sub-humid climate – which present the greatest challenge in terms of hunger alleviation, but also considerable potential for higher agricultural productivity.

to manage (1) the extreme spatial and temporal variations in rainfall; and (2) the considerable potential evaporation (between 5 and 8 millimeters daily). Variations in rainfall result in a high frequency of meteorological drought and short dry periods during the growing season. Meteorological drought – when rain provides less than the minimum water requirement to ensure a harvest (about 300–400 mm) – affects savanna agriculture for an average of one or two years per decade.[27] Even more common, however, are short dry periods without rain during the growing season. Periods of at least 15 days without rain are essentially an annual recurring event, and the risk of agriculture being hit during sensitive growth stages (during blossoming, for instance) is extremely high, frequently 70 percent.[28] *Thus, the challenge is to attempt to minimize the risk of harvest losses amid dry periods during the growing season and to build up social safety nets in an effort to manage recurring meteorological droughts.*

A dilemma – and one that has a major impact on agricultural productivity – is the hydroclimate's impact on farmers' risk management. The substantial risk of losing investments in input goods and labor due to drought is a key explanatory factor underlying the extremely low harvests that farmers gain in poor savanna land, generally 0.5–2 tons/hectare for basic crops such as maize, millet and sorghum.[29] Paradoxically, plant nutri-

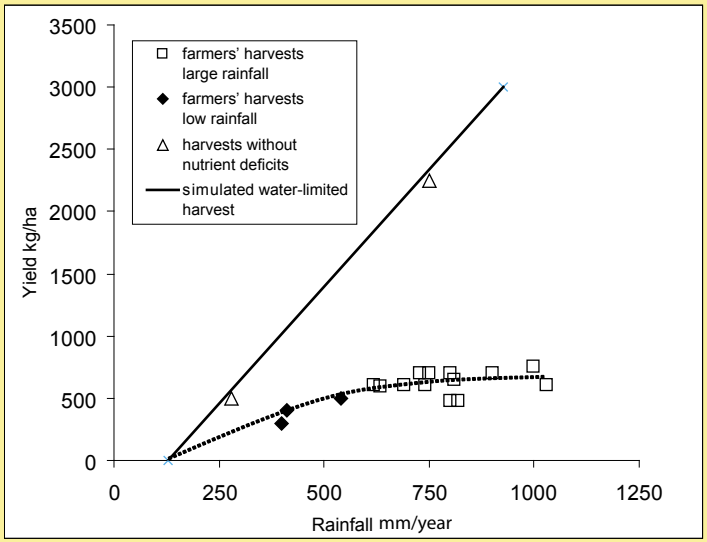

Figure 2. Sorghum harvests in Burkina Faso. Observed harvests amid different rain conditions for crops with and without additional fertilizer. Crops subject to nutrient deficiencies level out at harvest yields less than 1,000 kilos per hectare while the response to higher rainfall is very high among crops with adequate access to nutrients (based on Breman et al., 2001).

ents are often more limited than water in the frequently drought-hit savanna, since farmers – as part of their risk minimization strategy – are hesitant to invest in fertilizer. This results in low harvests irrespective of rainfall levels, since the lack of nutrients means there is no major growth response to substantial volumes of green water. This is illustrated by an example from Burkina Faso for sorghum (Figure 2).

Thus, water security represents a key investment in reducing the risk of harvest loss caused by unreliable rainfall; while nutrient scarcity, soil preparation, weed control and plant disease, as well as plant cultivation technology and crop selection are frequently crucial factors curtailing harvest yields, and must also be taken into account.

Water shortage in savanna agriculture

Despite sufficiently large rain volumes to produce harvests four to eight times larger than is currently the case, a considerable portion is lost in blue water formation.[30] Only the residual constitutes the green water resource (soil moisture), that is, the freshwater source for rainfed cultivation. Figure 3 shows the average annual distribution of rain among various flows in African savanna agriculture. The blue water flow from fields may amount to more than 50 percent of rainfall. From the farmer's perspective, up to 25 percent of the rain is "lost" in the form of surface runoff from fields (creating major land erosion problems), and up to 30 percent may constitute groundwater flows past the root zone, due frequently to a lack of water take-up capacity among plants suffering from nutrient deficiency. Of the remaining green water resource, at least half is lost – and often two thirds – in non-productive evaporation from the soil, ground and foliage surfaces. What remains is only 15 to 30 percent of the rain, which is conveyed to productive green water flow, in the form of transpiration, and contributes directly to food production.

This means that savanna agriculture frequently suffers from water shortage but not due to meteorological drought, but because of agriculture-related drought, meaning that vegetation suffers from a scarcity of green water in the root zone due to the lack of land management, fertilizers, labor input and so forth.

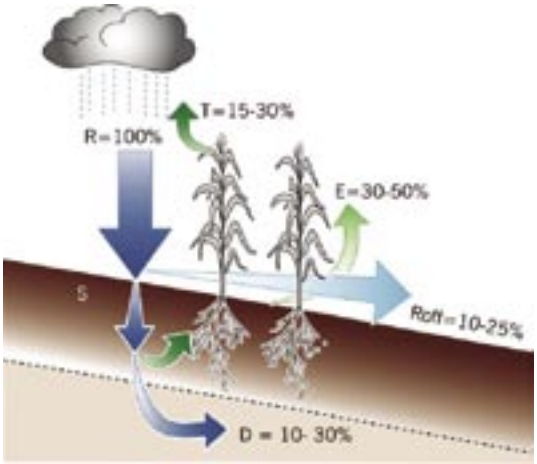

Figure 3. Water balance in African savanna agriculture. Partitioning of rain among green and blue water flows. (Rockström, 2003)

An understanding of this situation is crucial, since it entails that agricultural systems exposed to management-related water shortage offer improvement potential, while systems in which the hydroclimate is the factor underlying low productivity offer little or no potential for enhancement.

The Millennium Development Goal's water challenge

Seventy times more water than for households

Our biomass requirements explain why we need such large quantities of freshwater for our survival and well-being. The production of a ton of grain requires between 1,000–3,000 tons of freshwater in the form of green water flow* (evapotranspiration or total evaporation), which translates to some 1,000–3,000 m^3 of water per ton.[31] One approach to gaining a more detailed estimate of the required amount of water for our food supply is to analyze the water flow required to produce the various food products (carbohydrates, fats and proteins from grain, vegetables, fruit, meat and dairy products) included in the diets of various cultures worldwide. This type of analysis shows that an average of a half cubic meter of water is used to produce 1,000 kilocalories of vegetable food (0.5 m^3/1,000 kilocalories). In the case of meat production, the figure is much higher, which is due to low transformation efficiency in livestock rearing (notably for grain-fed meat production) and is estimated to amount to 4 m^3 of water per 1,000 kilocalories.[32] Thus, a balanced diet of 3,000 kilocalories per person/day, of which 20 percent is in the form of animal protein intake, requires 3.6 m^3 of freshwater, or 1,300 m^3 per person annually. This is what we regard as the water requirement for a desired diet. This constitutes more than 90 percent of a person's water requirement, *and illustrates why agriculture is by far the largest direct water-consuming sector worldwide.*

Nowadays, water-for-food consumption varies from 600 m^3 per person annually in the most malnourished countries in Africa to some 1,800 m^3 per person annually in Europe and North America. The question now is how much additional water is required to (1) halve the proportion of undernourished population by 2015 and (2) to eradicate hunger across the globe by 2030.

Shifting the focus from irrigation to crop water requirements

Before proceeding with this future-oriented analysis, however, we must first look at the current situation. Estimates show that agriculture worldwide consumes (via evapotranspiration/green water flow) about 6,800 km^3 of water annually, of which irrigated agriculture uses 1,800 km^3 annually and rainfed agriculture 5,000 km^3 annually.[33] In addition, large volumes of green water are used

* We differentiate between water resource and flow. Irrigated agriculture takes its water from the blue water resource, meaning the stored runoff in dams, aquifers and lakes. Rainfed agriculture takes its water from the green water resource, that is, soil moisture in the root zone. Both resources are formed by flows (infiltrated rain for the green resource and runoff for the blue resource) and both resources are transformed into a flow in conjunction with agricultural production, namely the green water flow (evaporation and transpiration, frequently defined as evapotranspiration) back into the atmosphere.

to maintain other ecosystem services, such as grazing land, biodiversity and timber production.

Figure 4 shows an estimate for the distribution of precipitation in the form of blue and green water in developing countries worldwide, and how water consumption is allocated between agriculture and basic ecosystem services in the natural ecosystem. The two key conclusions that may be drawn from Figure 4 are that (1) green water flows in agricultural production (crops, livestock, forests) represent the dominant water applications in agriculture (when normally the entire focus in respect of water and agriculture is usually on the irrigation sector), and (2) there is very little unused water in the physical landscape (the unutilized portion in the blue flow consists primarily of storm flows that people cannot use directly).

The consequence of this is that an understanding of water use in green water-dependent systems is crucial in assessing the potential to supply a growing world population.

In analyzing future water requirements to meet the Millennium Declaration's Hunger Goal, we have used 2002 as the reference year (since UN statistics on current agricultural output have been updated to that point). Total water consumption[34] in developing countries is currently estimated (2002) to total some 4,500 km^3 annually (Figure 5) (compared with the previously

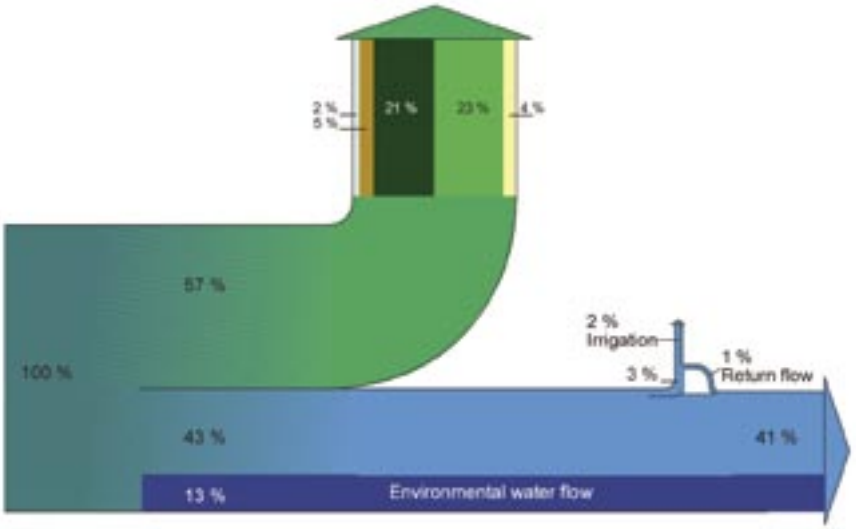

Figure 4. Partitioning of precipitation in developing countries (92 countries on the basis of the UN's categorization) into green and blue water flows. The proportion of precipitation used as green flow to maintain various terrestrial ecosystems (forests, savannas, rainfed agriculture) and blue flow for aquatic ecosystems and irrigated agriculture.

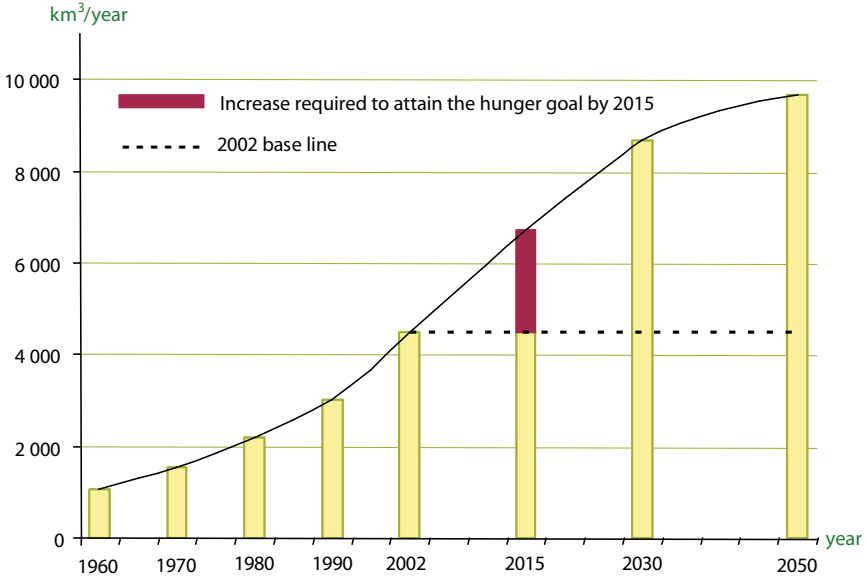

Figure 5. Water consumption (as the comsumptive flow of green water) for food production in developing countries worldwide. The increase between 2002 and 2015 represents the water requirement required to achieve the Millennium Development Goal for hunger (to halve the 1992 proportion of undernourished by 2015). For 2030 it is assumed that the Millennium Development Goal has been attained (eradication of hunger) and the increase between 2030 and 2050 is a reflection of population growth.

noted 6,800 km^3 annually for the entire world).[35] The production of sufficient food to attain the UN hunger goal of halving the portion of malnourished people by the year 2015 requires an additional 2,200 km^3 annually. This entails raising about 400 million people to an adequate diet of 3,000 kilocalories per person/day and supplying new population increments of 60–80 million people annually. This is more than current global water consumption for irrigation and, volume-wise, equals about half of the water storage capacity in dams worldwide.

Meeting the Millennium Development Goal completely (eradicating malnutrition) by 2030 requires additional water in agriculture, raising the total water requirement to 4,165 km^3 annually, which by the year 2050 advances to an overall additional water requirement of 5,160 km^3 annually. *This represents a formidable challenge for world agricultural growth. The world's poorest and most undernourished countries require at least a 100 percent increase in water consumption in agriculture already during the next decade to attain the hunger goal by 2015 (assuming that all required staple foods are produced within the country's borders).*

How much progress can be made in reducing losses?

How can such a large water requirement be met in underdeveloped regions? The water consumption

estimate is based on the assumption of continuing *unchanged water productivity* (m^3 of water/ton of output) in agriculture in the future. Consequently, the major question is the degree to which productivity can be raised, meaning that non-productive water losses are made productive.

Generally, a linear relationship is said to exist between water consumption and harvest. The slope of this linear relationship determines water productivity, that is, how much water is actually needed to produce a diet. However, a frequently overlooked factor is that a harvest yield increase from low levels (<2 tons/hectare)[36] already results in improved water productivity as a result of the productive portion of total evaporation (the productive green water flow) rising in relation to the non-productive portions (evaporation, runoff losses). The relationship between water productivity and enhanced harvest yields is thus dynamic (non-linear). This offers considerable potential to produce more food using relatively smaller amounts of consumptive water per new harvest unit.

On the basis of the empirical harvest/water relationship, based on field observations in tropical agriculture, as presented by Rockström,[37] we have been able to compute the effect of a more water-efficient diet, with food being produced in more productive agriculture and a reduction in water losses (plant growing only). Current water productivity averages 1,800 m^3 per ton, but can be reduced to 1,500 m^3 per ton by 2015, and cut to 1,300 m^3 per ton by 2030. In terms of water requirement, this effect means that the need for additional water is reduced by some 300 km^3 annually – which is already a significant decrease, corresponding to no fewer than four Egyptian Aswan dams.

As a result, the total water requirement for attaining the hunger goal is reduced from about 2,200 km^3 annually to some 1,950 km^3 annually. The decrease is based on an assumed productivity gain in tropical agriculture from the current average yield of some 2 tons/hectare to an average yield of 2.3 tons/hectare by 2015, a yield of 3 tons/hectare by 2030 and 4 tons/hectare by 2050.

The way forward to this goal requires improvements in the management of land, water and vegetation. We estimate that this is possible with current water and land management skills, cultivation technology and the impact on yields arising from improved fertilizer use, soil preparation and crop sequence. *A key factor will be to increase the proportion of rain available for the crop (by minimizing run-off and maximizing the soil's water retention capacity) and by increasing crop water-absorption capacity (by means of better crops and an improvement in plant nutrient status).*

How large a contribution can irrigation offer?

However, even after the consideration of productivity gains, the residual water requirement for agriculture in poor countries is staggeringly high: an extra 1,950 km^3 annually of consumptive water use by 2015. Let's go a step further and see how large a share of this higher water requirement can be covered through an expansion of irrigated agriculture? Forecasts in recent years have become more cautious as a result of greater awareness of (1) the static trend in dam capacity for large-scale irrigation facilities; (2) the high

social and ecological costs of large-scale water infrastructure; and (3) the social opposition and frequently dubious economic value of large-scale water investment for agriculture. Also, there is rapidly growing blue water stress in many of the world's river basins. Some 15 percent of river water across all continents is already over-exploited, further reducing hopes for irrigation as a panacea for future food production.

Even the most optimistic expansion projections for dam and irrigation capacity suggests a cautious growth rate.[38] During the Millennium Goal period up to 2015, we do not expect investments in new water reservoir infrastructure to permit more than an additional blue water extraction of 350 km^3 annually for irrigation. In other words, irrigation can only contribute about 15 percent of the 1,950 km^3 of annual additional water required to attain the milestone goal by 2015.

Subsequently, there remains 1,600 km^3 annually that must derive from rainfed agriculture – via additional productivity gains on current land and land expansion. The latter implies that agriculture is to use water currently consumed by vegetation. This will primarily involve expansion into tropical forests and savannas – a move that seems unavoidable and would, of course, have negative implications for other ecosystem services in these systems.

The potential of rainfed agriculture

Research points to favorable potential for attaining major productivity gains in rainfed agriculture. According to Pretty and Hine,[39] who evaluated more than 100 agricultural projects worldwide, there is at least the potential for a 100 percent increase in yields in rainfed agriculture, compared with 10 percent for irrigated agriculture. Analyses by Rockström and Falkenmark[40] point in the same direction: there are no hydrological obstacles to doubling or even quadrupling harvests on the savanna. The recently completed global evaluation of water use in agriculture, The Comprehensive Assessment of Management in Agriculture,[41] concludes that there is sufficient freshwater and expertise to raise productivity in a sustainable manner in rainfed agriculture in developing countries.

One key area is investment in integrated land and water management, especially fertilizer use, soil preparation and investment in water management, notably the capture of rainwater in various small water harvesting systems. The collection of surface runoff from small drainage areas (<100 hectares) in small dams (<1,000 m^3) permits protective irrigation of small-scale fields (<1 hectare, which dominate among smallholders in developing countries), offering major potential to raise staple food yields. For example, the results of trials in northern Burkina Faso indicate that protective irrigation, combined with organic and non-organic fertilizers, can more than double sorghum yields, (from the current 0.5–1 ton/hectare to more than 2 tons/hectare).[42]

Similarly, research in India indicates that protective irrigation during brief dry periods in rainfed agriculture can boost yields by up to 100 percent.[43] Plowing-free cultivation methods offer substantial potential to raise yields and water productivity in tropical agriculture by enhancing

the infiltration of rain into soil (using subsoiling technologies) and increasing the amount of organic material in the soil. These systems have contributed to higher harvests and improved soil and water productivity in countries in Latin America, Africa and South Asia.[44]

Thus, there is the know-how and methods for developing tropical rainfed agriculture to a level that contributes to higher food output and improved water productivity. The reasons that this approach did not succeed in the past are complex, but are largely linked to shortcomings in human and institutional capacities, a lack of political and operational focus, as well as difficulties involving poverty and investment capacity.

Environmental effects requiring attention

We have seen that an enlargement of global agriculture entails that more water is earmarked for agricultural production. Since water volume is constant, this can only be done at the cost of natural ecosystems. Thus, it is important to identify beforehand the problems that must be dealt with and the choices available. Agriculture is already the societal sector with the greatest impact on the environment, according to the UN's Millennium Ecosystem Assessment.

What is really involved?

The effects of the changes on land and water systems required by the hunger goal influence terrestrial and aquatic ecosystems alike. These living systems interact in an intricate web and are fundamental for human well-being. This is commonly popularized by reference to the cost-free tasks they perform and on which society is heavily dependent, meaning the ecosystem services they offer.[45] The ecosystem provides society with "ecological goods" such as timber, crops, fish, meat and "ecological services" such as pollination, climate regulation, and the degradation of certain pollutants. Crop pollination is probably the most visible service in plant cultivation.

We must safeguard these services to avoid undermining sustenance for future generations. Also, a landscape's configuration of ecosystem services (such as via biological diversity) contributes to building up ecological resilience, that is,

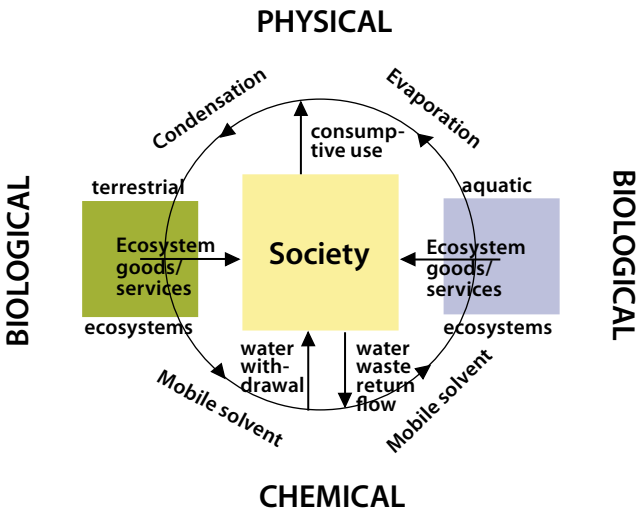

Figure 6. Water constitutes the biosphere's blood and its global circulation encompasses ecosystems and society alike (from Falkenmark 2003).

the ability of a system (such as wetlands or a city) to deal with disruptions (such as flooding or a stock market crash), avoid collapses and develop further.

A constructive approach to viewing the problem is to realize that water circulation between the ocean, atmosphere and continents functions as the blood circulation in the biosphere. Thus, water constitutes a common denominator for the two systems: the global ecosystem and the social system. The water cycle makes life possible in the biosphere, while water is simultaneously a vital component in our social system, in which a number of activities are more or less water dependent. Both terrestrial and aquatic ecosystems (the former are sustained in soil water, the latter in watercourses) and society and its activities are incorporated into this cycle. Man diverts liquid water (blue water) and consumes a portion, which then evaporates (green water), and returns the remainder with accompanying impurities (blue water) (Figure 6). Rainfed agriculture is pursued in the "terrestrial ecosystem" box and irrigated agriculture in the "society" box.

Social activities cause quality degradation via pollutants, salinization and so forth but also entail that part of the blue water disappears from the landscape through evaporation. The result rebounds on both systems with effects that threaten human security in the long term.

Terrestrial ecosystems (of which agriculture is a part) consume massive volumes of water in plant production. As shown in Figure 4, already today the larger portion (almost 90 percent) of the global green water resource is used in maintaining terrestrial ecosystem services. Forests, followed by grazing lands and agriculture, use the largest amount of green water.

Avoidable and unavoidable environmental impact

It is important to realize that environmental changes essentially fall into two categories: *avoidable* – such as erosion as a result of poor land management, or excess use of fertilizers, leading to the leaching of nutrient salt surpluses and, in turn, resulting in algae growth in watercourses and lakes; and *unavoidable* – such as substantial water consumption by crops, regardless of whether this involves green water from the soil or blue water via irrigation. The terrestrial systems determine how much rainwater remains for recharging groundwater and watercourses after vegetation requirements are met.

As regards unavoidable environmental impact, we must develop new methods that trade off the water requirements of nature and food production. This should be undertaken through a framework of consultation and coordination, with a balancing of the needs of various interest groups. But such trade-offs require that we know how far we can go in depleting water flows: in other words, what minimum requirements must we meet to avoid destroying aquatic ecosystems in downstream and coastal areas (*environmental flow*)?

Environmental effects of future food production

As regards green water flows, it is crucial to dif-

ferentiate between the water effects of raising water productivity in agriculture in relation to the water effects of raising agricultural production. The former focuses on unnecessary water losses and aims at the transformation of non-productive evaporation from moist soil to productive transpiration from denser vegetation (*vapor shift*). The latter entails that the crop consumes more water, meaning there is a smaller residual to form runoff to watercourses. The former action may be viewed as positive, since unavoidable evaporation is used to produce more vegetation, while the latter has negative effects as a result of having to induce more water into the evaporation process.

Water productivity gains (less water consumption per ton of crop output) may encompass various positive measures: reduction of direct evaporation from canals and water surfaces, thus raising runoff, saving pump energy, preventing salinization and water logging arising from poorly managed irrigation – an extensive problem in irrigated regions. Other ways are *vapor shift*, by stimulating a shift from evaporation from soil to transpiration from the crop by facilitating infiltration, covering soil using various types of *mulch*, thereby raising the soil's water retention capacity during dry periods, along with protective irrigation during dry periods to boost water uptake in roots. These measures always involve higher agricultural productivity, meaning a larger harvest. Thus, saving water through superior water productivity is a win-win situation, and one in which more food is produced per land unit.

However, negative environmental effects from *output increases* must be expected, although these are the result of yield gains (more crop tons for the same acreage). Higher agricultural productivity offers superior water productivity, but higher output always raises total water consumption.*

Small-scale water harvesting may also have negative effects on water supply, although this impacts on the ultimate destination of the accumulated water: If water is set to evaporate, there will hardly be any effect downstream; but, there will be an impact if the rainwater is moving towards a watercourse. Horizontal enlargement of acreage through cultivation of grasslands or forest area will, of course, rebound on terrestrial ecosystems in the form of reduced biodiversity, and so forth.

Quantification attempts

We have conducted the following estimates to provide an idea of how the effects can be expected to be distributed among aquatic ecosystems, terrestrial systems and measures with negligible environmental effects.

We must expect water to disappear from *aquatic systems* in two ways: 1) via the utilization of what are "losses" from the farmer's viewpoint in the form of leakage from irrigation facilities, etc.,

* A simple example illustrates this relationship. A farmer grows a hectare of crop with a productivity of 2 t/ha, which has a water productivity of 2,000 m^3/ton. This consumes 4,000 m^2 of water (2 t/ha x 2,000 m^2/ton). Thanks to soil and water improvements, the farmer raises the yield to 3 t/ha (productivity increase). Water productivity advances to 1,500 m^3/ton, that is, a saving of 500 m^3/ton. But, nevertheless, the system consumes more water, 4,500m^3 (3t/ha x 1,500 m^2/ton).

but which, in a broader perspective, are not losses, since the water actually returns to the groundwater and watercourses; 2) via expansion of irrigation and through protective irrigation following rain accumulation.

Effects on *terrestrial systems* can be expected to emerge as a result of expansion to new land. If the crop uses less water than natural vegetation, there may be effects on runoff and the local climate alike, resulting from changes in green water flows.

The only measures for which we can *hardly expect any significant environmental impact* involve transformation from pure evaporation to plant uptake and transpiration, meaning *vapor shift*.

One estimate indicates the *trade-offs* facing us in the future in connection with the task of attaining the 2015 milestone target for hunger alleviation in tropical countries (Figure 7). Of the total requirement of 2,200 km^3 annually of additional water consumption in agriculture up to the year 2015, as much as 650 km^3 annually could be saved via water productivity gains, with no or negligible effects on other social or ecological systems. An increase in harvest yields on existing agricultural land, despite water productivity gains, will lead to large absolute increases (probably less relative ones) in water consumption with effects on aquatic ecosystems (greater irrigation, protective irrigation, improved rainwater management to facilitate higher infiltration of the soil by rain, thereby preventing runoff), which we have estimated at about 1,000 km^3 annually. This leaves 600 km^3 annually that must, unavoidably, derive from the expansion of current agriculture (corresponding to a continuation of the current expansion rate for agricultural land in developing countries). The alternative to this expansion may be food imports, for example.

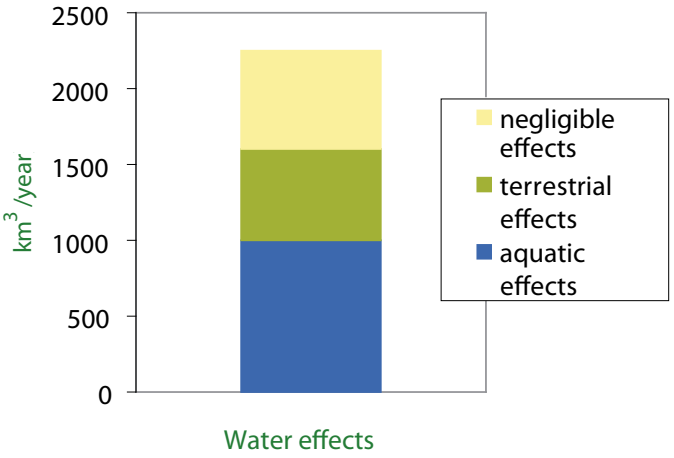

Figure 7. Scope of anticipated environmental effects, viewed from a hydrological perspective: three categories (aquatic, terrestrial, negligible).

Discussion and conclusions

Enormous challenge

Humanity is facing one of its greatest challenges as regards the production of sufficient food to eradicate hunger among a growing world population. Currently, food production is sufficient to make hunger merely a distribution problem. However, population growth up to the mid-century entails a 50 percent increase in world population.

Rising water shortages worldwide prompted this study, which analyzed how the Millennium Development Goal to eradicate hunger appears when viewed from the perspective of the developing countries' water resources. Investments in local agriculture are viewed as the key to economic growth in poor countries. The core challenge that has emerged is that most of the poorest countries are in the savanna climate zone, where water shortages have many facets and plant water security entails major challenges. It is evident that we cannot base any great hopes on a substantial expansion of irrigation systems, since the effects of the green revolution are currently visible in the form of more or less dried up watercourses across 15 percent of the particular land area.

Consequently, the focus must revert to rainfed agriculture. In this case, a key issue is whether it is possible to master droughts and dry spells and influence farmers' risk management. Rainfall is essentially sufficient for harvests that are 4 to 8 times higher than current yields if droughts and dry spells and nutrient deficiency can be managed and favorable productivity potential utilized.

Inevitable alterations of landscapes and water management will, however, give rise to biophysical changes in soil and water, with an impact on the natural ecosystem. Some of the effects are avoidable and will prove possible to minimize, while others are unavoidable and are due to the high water requirement of photosynthesis.

Biomass, trade and comparative advantage

Generally, the agricultural sector represents a crucial factor in the economies of developing countries, and most poor people live in rural areas. Investments in local agricultural development are a key factor in social development in these poor, largely agrarian economies.[46] From the Swedish viewpoint, trading in food with these countries is unlikely to have any significant role in the foreseeable future, despite the comparative advantages in terms of Sweden's water supply and agricultural productivity.

However, there is an increasingly attractive scenario for trading in biomass between Sweden and developing countries that could emerge, depending on how energy prices and climate progress in the decades ahead. Bio-energy, such as ethanol as fuel for the transport sector, may constitute a key cornerstone in such a policy. Tropical regions have an overwhelming comparative advantage in the production of crops for bio-energy, primarily sugar cane but also palm oil, with an energy efficiency widely exceeding temperate energy crops cultivated in Sweden. This is because of the unique plant physiology properties of these crops, which have adapted to the tropics.

The tropical advantage for energy crops does not equally apply to tropical food grains such as maize, sorghum and millet. Temperate regions currently produce grain harvests of wheat, rye, oats and barley, which widely exceed average yields in tropical countries, even in the case of the highest-yielding tropical grain, maize (averaging two to three time higher).

This offers tropical countries a remarkable advantage for the production of biofuel, which could be expected to provide scope for the joint

trading of energy and food between Sweden and developing countries.

Balancing water for food and ecosystems

Since rainfall must suffice to meet the water requirement of man and nature, rising food production must be balanced with the requirements of natural ecosystems. Of course, local considerations in particular regions will need to be taken into account in identifying acceptable trade-offs. Opposing interests must be balanced internally. Since intensified agricultural production could entail a reduction in blue water formation, this may lead to an additional reduction in flows to watercourses. *In other words, the margin for agricultural expansion is set by the minimum amount that must remain for aquatic ecosystems. If this margin cannot be satisfied, imports must be viewed as a solution.*

All activities prior to the water divide must be reconciled within the framework of local rainfall. The cooperation required between upstream and downstream interests, between green water-dependent plant production and blue water-dependent activities, between polluting activities and rainwater-dependent food supply, and between man and nature may be summed up in the term *hydrosolidarity*.[47]

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27. Glantz, 1994
28. Barron et al., 2003
29. Rockström, 2003
30. Rockström and Falkenmark, 2000
31. Falkenmark and Rockström, 2004; Pimentel and Houser, 1997
32. Falkenmark and Rockström, 2004
33. Rockström et al., 1999
34. The term water consumption is used here to mean consistent consumptive use of water, meaning the amount of evaporation and transpiration, or total green water flow, used to produce food (plant cultivation and livestock rearing)
35. SEI, 2005
36. The reason for this is that the water balance in low-yield agriculture results in large "losses" of water. In particular, this involves direct evaporation from soil in tropical environments.

As harvests are low, the surface foliage covering the soil is also low, resulting in high soil evaporation. When harvest yields rise, so also does the shadow effect on the soil, leading to drastic reductions of evaporation water, which may instead be used to meet the crop's water requirement. Evaporation losses can be reduced from more than 50 percent of rainfall in low-yield tropical agriculture (<2 tons/hectare) to less than 20 percent in high-yield cultivation. (>4 ton/hectare).
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BIODIVERSITY IN AGRICULTURE IS NO LUXURY

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Peter Einarsson, Organic Farmer and Consultant

The conservation of biodiversity in agriculture has become a primary goal of Swedish agricultural policy. Why? The political debate conveys the impression that biodiversity is a luxury, a treat that we in an affluent country can and should allow ourselves for historical, scientific, esthetic or ethical reasons. In other words, it is viewed as a cost, a burden that agriculture should be able to bear. Given this mindset, the key policy question naturally becomes: How much biodiversity can we really afford?

This paper takes a totally different approach. We argue that biodiversity is both a prerequisite and a key economic asset for agriculture – a production resource that creates enormous value already today and will become absolutely indispensable in the future. Thus, investing resources in biodiversity is not a form of luxury consumption; instead, it is a necessary investment to protect an asset that the world cannot do without.

Viewing biodiversity as a luxury or an academic interest is unfortunately not an inexplicable aberration, but a rather logical consequence of how agriculture is practiced today, particularly in affluent countries but increasingly also in poor economies. Using various industrially produced inputs, agricultural production has been able to liberate itself in many ways from its biological limitations. Today, we can grow crops on biologically dead soils, just like greenhouse production is intentionally conducted in sterile culture media. We can maintain far more livestock in a region than the number local fodder production permits, because animal feed is cheaper to buy on the world market anyway. We can forget about returning farmyard manure to the nutrient cycle – in business terms the most profitable alternative is to dump it in a pit, just as they do in North American feed lots.

However, these shortcuts past biological limitations, and various others, share a common prerequisite – cheap fossil energy. This prerequisite will soon cease to be available.[1] Oil and fossil gas resources are already in decline. Long before they are exhausted – within a few decades – shortages will lead to prices that make fossil-driven agriculture economically impossible. Coal is more plentiful, but even if it could be mined at an economically sustainable cost, the environmental implications are so daunting that coal is hardly a realistic alternative. Climate impact alone should be a sufficient deterrent.

This means that the only realistic future strategy for agriculture – as well as for society in general – is to proceed from the realization that the historical parenthesis of the fossil-energy society

is about to close. For agriculture, this entails a reversal to what has always applied, except for the past 50–100 years; namely, that it is our ability to use biodiversity in a productive and sustainable manner that sets the limits for what and how much agriculture can produce.

Concurrent with this change, we must both meet a continued population growth of 2–3 billion people (the vast majority in developing countries) and reduce agriculture's negative environmental impact in several respects – a necessity not least to avoid any further reduction in biodiversity.

Is this a catastrophe scenario? Is it impossible to feed 9 billion people without fossil energy-based shortcuts such as inorganic fertilizer, advanced mechanization and long-distance transport of animal feed and foodstuffs? Will we inevitably end up in hunger and hardship or in armed conflict over the control of key resources such as arable land, water and remaining oil deposits?

We see little reason for being so pessimistic. Although the difficulties of the adjustment ahead of us must not be underestimated, we do not believe they are primarily of a technical nature. There is an enormous unutilized potential to develop smarter and leaner agricultural production methods that mobilize and interact with natural biodiversity instead of ignoring it. This paper provides many examples of this.

The production potential of biodiversity has been poorly utilized largely because we have lacked sufficient incentives to develop it. From this perspective, the forthcoming oil crisis is a positive rather than a negative change. Throughout the brief history of fossil energy-dependent agriculture, there has never been a lack of dissenting voices or small-scale attempts to turn the tide. But the reasons for mainstreaming the alternatives have never been more compelling than today.

Neither should we forget that agriculture is in a far better position than most other industries to deal with the impending oil crisis. Agriculture controls the really key production resources – those required to harness solar energy and transform it into food and other biological products. The oil crisis is likely to revert the negative economic cycle that agriculture experienced almost universally during the first half of the 20th century. (Refer also to *The Biosociety* in this book.)

As regards environmental problems, many – maybe most – of agriculture's negative effects relate to fossil energy-driven shortcuts, which will now be less attractive and eventually impossible. In other words, it will be easier, not more difficult, to bring them under control.

Biodiversity in agriculture

Biodiversity is the variability among living organisms of all origins. It encompasses not just the diversity of species but also variation within species and among the ecosystems of which all living organisms are part. Worldwide to date, between 1.7 and 2 million species of plants, animals, fungi, and microorganisms have been identified, with estimates pointing to an ultimate total range of 5 to 30 million species.

The UN Convention on Biological Diversity[2] defines an ecosystem as "a dynamic complex of plant, animal and micro-organism communities

and their non-living environment interacting as a functional unit". All living creatures are part of ecosystems and all ecosystems depend on the creatures comprising them. The interaction of the various species in ecosystem processes ensures the continuation of life on Earth.

Examples of life-supporting processes are:

- Photosynthesis, which binds energy and carbon in plants and produces oxygen.
- Decomposition of organic material and recycling of nutrients to the soil.
- Regulation of temperature and water flows.
- Pollination of crops and fruits.
- Control of pests in agriculture.
- Degradation of toxic substances.

We humans sometimes forget that we, like all other creatures, depend entirely on the ecosystems in which we live, and from which we get our food and other necessities, and in which we deposit our waste. Since we are also part of human communities with their economic and social structures, our discussions and endeavors often focus on factors such as economic growth, profit margins, employment, communication and cultural offerings. We assume that nature exists as an inexhaustible pool of "resources" – energy and materials that we can extract and process and then, if we wish, transform into economic value. We forget or disregard the huge and incredibly rapid transformation of the Earth's ecosystems that has been and continues to be the result of much human progress, and the frighteningly rapid loss of biodiversity throughout the globe. As diversity disappears, ecosystem functions and their adaptive capacity – the very basis of life processes – are threatened.

It is estimated that the current species extinction rate is at least a hundred times and maybe more than a thousand times faster than the "natural" species loss that we would have had without any human impact. Today, 23 percent of all mammals are threatened by extinction.[3] In the case of birds, species threatened by extinction represent 12 percent, while the corresponding figure for coniferous trees is 25 percent. Many other groups of organisms are not so well known. Several factors underlie the disappearance of these life forms, such as the transformation of ecosystems, the introduction of exotic plant and animal species, hunting, illegal collecting and trade, as well as environmental pollutants and climate change. Intra-species variation is decreasing in a similar manner and for the same reasons. The decrease in diversity has been particularly dramatic in agriculture, where both plant and animal material has been radically standardized and homogenized during the 1900s. In extreme cases – such as maize and poultry – a handful of varieties and breeds owned by commercial corporations completely dominate production.

2004 marked the completion of the Millennium Ecosystem Assessment (MA), a global study of the world's ecosystems and biodiversity by more than 1,360 researchers from 95 countries.[4] The MA's goal was to create a scientific basis for the decisions and actions required to achieve sustainable utilization of the world's ecosystems. The main results from the MA were published in 2005, and unfortunately

we can only conclude that so far, governments worldwide have made no progress in reversing the negative trends. This is despite the fact that almost all the world's states[5] have signed the 1992 UN Convention on Biological Diversity and have thus pledged to conserve and sustainably use their biodiversity and share the benefits from the use of genetic resources in a fair and equitable manner. A decade after the Convention was ratified, world governments established the so-called 2010 target: to reduce significantly the loss of biodiversity worldwide by the year 2010. Subsequently, EU member states voluntarily adopted the more ambitious target of stopping the loss of biodiversity by 2010.[6] But despite all good intentions, biodiversity continues to disappear at an unchanged or increasing pace.

One of the primary reasons is the rapid expansion of agricultural land and the transformation from an agriculture based on natural cycles to industrial agriculture based on fossil energy. More land was transformed into arable and grazing land during the 30-year period of 1950–1980 than during the 150-year period of 1700–1850. Substantial areas, notably in tropical forests, continue to be transformed into farmland. About 15 million hectares of tropical forest disappear annually, with a large share becoming grazing or arable land. A substantial amount of the land farmed today suffers seriously from soil erosion, salinization, water-logging, soil compaction and nutrient loss. Globally, it is estimated that 10–20 percent of all agricultural land suffers from reduced output for these reasons, and in developing countries the share is 25 percent.[7] In the US, where soil erosion has decreased in recent decades, it is nevertheless estimated that about 6 tons of soil per hectare disappear for each ton of grain produced. Of the world's grazing land, it is estimated that as much as 70 percent is more or less damaged.

Fair and equitable sharing of benefits?

With the growing value of biodiversity, conflicts surrounding it have also increased. The Convention on Biological Diversity gives each member state sovereign control over all genetic resources within its borders. The idea behind this provision was to create a market to enable countries rich in genetic resources – mainly in the South – to sell their genes to biotechnology companies and research institutions in the North, in return for financial compensation and access to new technology. Many believed that hidden treasures in the form of valuable characteristics of plants and animals in the South could generate substantial revenue, and in turn contribute both to economic development and to the conservation of valuable natural areas in the South. Fifteen years after the Convention was signed, we can only conclude that these hopes have not materialized. Very few agreements with so-called bioprospecting companies have been concluded, and the agreements signed to date have not provided any significant revenue for local development or nature conservation. A recent study of bioprospecting agreements in the Pacific Rim region lists a total of only 22 finalized access agreements in those 41 countries over the period 1991–2004.[7b]

What has happened is that biotechnology

companies in the North are increasingly patenting living material, everything from individual gene sequences to complete plants. In a bid to protect themselves from this, many developing countries have tightened up legislation so that all handling of genetic diversity requires official permits. Caught in the middle are the local populations – smallholders, fishermen, and indigenous peoples – who historically have been the guardians and developers of biodiversity. The tug-of-war between governments and large companies means that local populations lose traditional rights and thereby both their livelihoods and their role as food conservationists. Within the framework of the Convention, negotiations are in progress on a set of rules to control access to genetic resources and the sharing of benefits from their use. Meanwhile, negotiations are being conducted within the World Trade Organization (WTO) covering intellectual property rights for life forms and within the World Intellectual Property Organization (WIPO) on genetic resources, traditional knowledge and folklore. In addition, world governments are trying to reach agreement on the practical implementation of the FAO's International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). In all these forums, discussions have largely begun to resemble purely commercial negotiations: How much should big corporations pay developing country governments for genetic patent rights? The numerous representatives of indigenous and local populations at these meetings have so far failed in gaining acceptance for a perspective that would instead offer them protection from intellectual property rights over local knowledge and local genetic resources, to allow knowledge and genetic material to continue to be used and developed at the local level as it has been throughout history.

Agriculture with biodiversity – and without it

In the beginning, humans were opportunistic omnivores on the savanna. We were rather mediocre hunters – neither particularly fast nor strong – so the main food had to be that which didn't run away or offer much resistance. Seeds, roots, insects, small animals – and occasionally the remains of larger prey left behind by more skilled hunters.

However, we were very inquisitive and inventive. As humans expanded into new biotopes, they displayed a remarkable ability to adapt their foraging patterns. There is an enormous span between the diet of the Kung people in southern Africa, of which 50 percent is mongongo nuts, and the traditional Inuit diet, based entirely on animals such as reindeer, seal, whale, fish and birds. The ability to use local biodiversity creatively in widely different environments was the key to the expansion of humankind across the globe.

Very soon, we also began to actively change our biological surroundings. Harvesting and hunting were supplemented with conscious management of natural biotopes to promote useful plants and animals. Tools were created to develop a desirable mix of plants in forests, and land was burned to stimulate grass growth and attract graz-

ing animals. From there, the step to farming and livestock rearing was neither long nor dramatic. The "Neolithic Revolution" was probably far less revolutionary than the term suggests. Hunters and gatherers did not suddenly stop hunting and gathering to instead become growers and animal herders. The sharp boundary between wild and domesticated diversity is a very recent notion that only became a reality in the most extreme forms of industrial agriculture during the 20th century.

On the contrary, the normal state has been a blend, or mosaic, of the wild and the domesticated, and far more of this mosaic continues to exist than what we realize. Just consider the average Swedish semi-natural pasture. It is grazed by domesticated livestock, fenced and looked after by people, but the vegetation is almost exclusively the natural flora of the site. Although management patterns have resulted in a selection, it has not been subjected to plant breeding, and has not been sown, fertilized, or "protected" by any pesticides. Or look at beekeeping, which nowadays is usually based on improved bee strains, but otherwise depends completely on the bee's natural foraging behavior and choice of plants. And, by the way, what is the most important product of

The Latin American freshwater snail *Pomacea canaliculata*, (Golden Apple Snail) was imported into several countries in Southeast Asia in the 1980s to replace domestically farmed varieties. The experiment was a total failure, but the snail quickly escaped into the wild throughout the region and is currently a major pest in rice farming. The photo shows the snail's characteristic pink egg agglomerations on the rice plants and the adult snails in the water around the rice plant stems. Control with chemical pesticides also kills fish and other desirable water organisms, and is frequently hazardous for people and water buffalo alike. Tapi, Kabankalan, Negros Occidental, the Philippines 1998. *Photo: Peter Einarsson* .

beekeeping – honey or pollination?

Especially in developing countries, and in particular for the very poorest people there, wild biodiversity remains a crucial component in the food supply.[8] In a recent study of the economy in a rural area in Zimbabwe, natural biological diversity contributed 35 percent of total household income.[8b] Across Asia, the rice paddy's green leafy weeds are a traditional source of vitamins and trace elements, and in some areas the custom is that the poor and landless who weed the rice paddies get to keep the weeds. Fish, shellfish, snails, insects and so forth are significant protein sources in many regions. Forests provide not only fuel, but also berries, fruit, nuts, vegetables and spices. In many areas of the tropics, people retain traditional knowledge about *famine foods* – wild foods that in crisis situations can bridge the gap to the next harvest or ceasefire. Nor is it more than a few generations since the lingonberry was the completely dominant source of vitamin C in Sweden in winter, and just a little longer since we periodically mixed bark in our bread.

Thus, the most characteristic feature of the historical relationship between humans and biodiversity is not domestication per se but rather the strong element of co-evolution. Whatever the mix between wild and domesticated diversity, cultural ecosystems have been shaped by the interaction of human will and natural preconditions. It has been a relationship of mutual dependence in which natural factors such as soil, climate, flora and fauna have been used and changed by human activities – but have also changed us and created our enormous diversity of local cultures.

Human dependence on biodiversity remained very direct for a long time. Nurturing local eco-

During the 1990s, farmers in many countries experimented with biological control methods. The photo shows Rodolfo Oray, one of those who developed the method of feeding the snails with leaves from taro *(Colocasia esculenta)*, a sweet potato-like root vegetable, They prefer taro to the less tasty rice leaf. The taro leave can be used to catch the snails, but Rodolfo sees no great problem in their presence as long as they do not eat the rice. Apart from being feed for the snails, the taro leaves also act as a fertilizer. Tapi, Kabankalan, Negros Occidental, Philippines 1998. *Photo: Peter Einarsson.*

systems was an absolute necessity, a simple question of survival. Without a functioning plant nutrient cycle and other ecosystem processes, there could be no vegetation and thus no food. This does not imply that all historical cultures pursued sound stewardship of nature, far from it. But imprudence was punished very directly and without mercy. Deforestation around the Mediterranean basin during the Roman Empire is a classic example that led to permanent climate change and drastically reduced biological production capacity.[9]

It was the introduction of fossil energy into agriculture that gave us the potential to liberate ourselves from biological limitations and circumvent our dependence on biodiversity. Mechanization and intercontinental transport commenced the process already in the 19th century, but it was the breakthrough of inorganic fertilizer in the mid-1900s that radically changed the character of agriculture. When debit and credit no longer needed to match on the plant nutrient balance sheet, agriculture too could be organized on the basis of the key principle of industry – specialization.

Prime flatland soil could now be used for grain and other annual crops each year – instead of at most two years out of three. Animal husbandry was concentrated instead in areas with inferior arable soil. There were no longer any limitations on how much livestock that could be kept, either on an individual holding or in total, as feedstuffs could always be purchased from other parts of the country or on the international market. This permitted an enormous expansion of animal production, notably pigs and poultry – animals that were previously a luxury, since they competed directly with people for a limited amount of cereal grains. They now became the cheapest kind of meat, as they were perfectly suited to the industrial production system. The radical restructuring that has swept over agriculture in the affluent world since the Second World War, and is now in full swing in the developing countries, is based essentially on fossil energy, the prerequisite for inorganic fertilizer, mechanization and cheap transport.

The most serious aspect of this development is that it has permitted us to be careless and yet go unpunished, in a manner impossible for earlier generations. In just a few decades, we have undone a large share of the local ecological adaptations developed over thousands of years of coevolution between humans and the rest of nature. Worst of all is the carelessness that degrades the soil itself, the most difficult resource to replace.

North America's extremely nutrient-rich arable soils were developed under the grasslands on which enormous buffalo herds grazed and sustained the Native American cultures right up to the end of the 19th century. These lands are now farmed using methods that have in many cases led to a 50-percent reduction in topsoil – the biologically highly active surface stratum in which all decomposer organisms live and manage nutrient circulation. Acceptable harvests are still possible, but what happens in 50 years time, when the topsoil is totally depleted and low-cost inorganic fertilizer is no longer available?

Conversion of rainforests in Brazil to agricultural production is an even faster way of making

productive land infertile.

Excessive irrigation – leading to salinization and water-logging – is the single largest cause of loss of arable land, and is very common throughout the tropics. Relatively speaking, soil problems in Sweden are minor, but nevertheless harvest losses due to soil compaction from heavy machinery alone are estimated to be 10–15 percent.[10]

Few continue to deny the negative effects of industrial agriculture, but many claim that industrialization was necessary to feed a growing world population. Suffice it to say that there have always been alternative paths; but since these were not chosen we will never know how well they would have served us. However, the primary purpose of industrialization was never to increase agricultural output, but to replace manpower with energy and thus make food cheaper – just as industrial products replaced craft products in so many other areas.

For an excellent example of the enormous development potential in a biodiversity-based production, we need only turn to Swedish agricultural history. Sweden's population explosion in the 19th century is fully comparable with that of many developing countries in the 20th century. From 1800 to 1950 the population tripled despite substantial emigration. It is frequently claimed that it was inorganic fertilizer that saved us from a real famine disaster. This claim lacks all factual basis. The use of inorganic fertilizer was insignificant until after the Second World War. By that time, the food crisis had long since been averted.

What permitted Swedish food output to essentially keep step with population growth was instead a technical innovation based entirely on a more intelligent use of existing biological resources.

For more than a thousand years, natural meadows were the engine of agricultural production. Meadows were natural grasslands that had been cut out of the forests but allowed to retain a sizeable number of bushes and trees. They represented three-quarters of farmland and supplied the winter fodder for livestock, in the form of hay and dried leaves. They also supplied the arable land with nutrients, since this was where the winter manure from the livestock was deposited – it was not returned to the meadows, which were not fertilized at all. Meadow cultivation was a sophisticated but fragile system. The care of the essentially wild meadow biotope had been developed to a level of precision that is best compared to a very well tended garden. But the basic problem was that the nutrient flow went only in one direction. The net extraction of plant nutrients could never exceed what the meadow plants themselves could replace.

That limit was exceeded when population growth began to gain pace around 1800. Excessive harvesting caused yields from meadows and arable land alike to plummet. Attempts to offset this by means of more intensive haymaking in meadows only made matters worse. The crisis forced a complete system shift, based on a recently imported technology, namely, the cultivation of legume plants such as clover, vetch, alfalfa and lupine. These had been grown in Asia for several thousand years, but only arrived

in Europe during the 18th century. The Asians knew that legumes provided good harvests even in poor soils and that they had a fertilizing effect on subsequent crops. Today we know that this is because of the symbiotic nitrogen-fixing bacteria that live on the legume roots.

When farmers began to grow grass and legumes on arable soil for winter fodder instead of harvesting hay from meadows, yields per hectare readily quadrupled – while cereal crop yields also increased, thanks to inclusion of legumes in the rotation. This resulted in most meadows being plowed up to create more arable land. At the end of the 19th century, the ratio between meadow and cropland was the reverse of what it had been at the start of the century – three quarters of farmland were now arable.

As a result, Swedish agriculture not only managed to cope with the acute food crisis, but to do so with essentially unchanged acreage and manpower requirements. It had also created a production system that – despite far greater intensity – could replace the nutrients removed from cropland over the long term. However, it could not match farming based on inorganic fertilizer, which after the Second World War was able to offer an unlimited nutrient supply without any need for crop rotation.

One result of the transition to industrial forms of production in agriculture was that many functions that had previously been available on every farm and controlled by farmers themselves were taken over by specialized companies. One of these functions was plant breeding. A hundred years ago it was the rule also in Europe that every farmer used his own seed from year to year. Seeds were exchanged among neighbors and villages, but there were no specialized seed companies. That picture changed rapidly during the early decades of the 20th century. Following the rediscovery of Mendel's genetic theory, science-based plant breeding surged and by the 1930s commercial seed had gained dominance in Europe.

The reason was obvious. Plant breeding companies offered varieties that sometimes yielded twice or more compared with the old local varieties, as well as being more resistant to various plant diseases. Farmers needed little persuasion to buy the new product, it spoke for itself.

But the coin had another side – or several really – which was not noted until much later. A large share of the old varieties disappeared almost overnight. Few farmers saw much value in saving the old seed, so most of it was eaten and disappeared forever. We will never know how much genetic variation was lost.

But the shift also meant an abrupt end to co-evolution – the continuous local adaptation of plant varieties to soil types, climate, farming methods, taste preferences, different uses and so forth, that had continued uninterrupted since the Stone Age. Instead we got a small and continually shrinking selection of standard varieties, many of them grown on millions of hectares. We can only speculate about the consequences of this, since we lack any baseline for comparison.

Finally, the great surge in yields was a one-off phenomenon – as well as a paradox. It was possible to achieve such spectacular results only because there existed such a vast range of farmer-

bred local varieties from which to start. The great leap forward was achieved by combining just a few of the very best. But since then, no genetic diversity is developed by individual farmers – commercial plant breeding products have eliminated the prerequisite for their own existence.

When the same development was repeated a few decades later in many developing countries – during what was known as the green revolution – there was more awareness of the consequences and a relatively large portion of the displaced plant material was collected and deposited in gene banks (that is, seed collections in freezers). The overall impact was also much less comprehensive. In many regions local varieties of many crops continue to be cultivated – frequently with comparable yields.

How to get back and ahead – some rules of thumb

How then can we find the necessary path back to an agriculture capable of sustaining itself solely on biodiversity and the sun's energy? What changes are needed? What can be salvaged from the pre-industrial tradition and what innovations are required because the world has changed?

We will not attempt to answer these questions by detailed technical speculations. This is because the changes ahead of us will primarily take the form of a mental challenge. Will we be able to reconsider profoundly enough all the modes of thinking we currently view as universal, although they only apply within the narrow framework of reference represented by the fossil-energy parenthesis?

Here are some proposals for new rules of thumb:

Broad-based knowledge. Industrial agriculture may well be high-tech, but it has depleted the knowledge of biodiversity among all except a few experts. Ethnobiologists testify to the highly sophisticated biological know-how that was and still is the rule in pre-industrial farming cultures.[12] We must revive this tradition. We need to revert to the inquisitiveness and inventiveness that created the vast diversity of agricultural ecosystems. We will need a level of innovation that is only achievable if the production of knowledge is liberated from its professionalization and again becomes everybody's concern. With modern science in our toolbox, we have a potential that our forefathers could only dream of, but without broad-based knowledge we cannot utilize it.

Local adaptation. Standardization and mass production have given us products like reliable, low-cost electronics, but that does not mean that these principles are equally valid for agriculture. Variation and local adaptation – rather than uniform, large scale processes – are what make agro-ecosystems sustainable and productive. The fact that plant breeding companies manage to sell exactly the same product for cultivation on millions of hectares is nothing to brag about, but rather proof of the fragility of the entire industry. From a biological point of view, there should ideally not exist two fields anywhere with genetically identical crops. Plant breeding today has completely failed to preserve diversity and has thereby invited plant pests to the permanent feast offered

by monocultures.

The fixation with a handful of crops is equally misdirected.[13] Bulk production of maize, wheat and rice was permitted to totally dominate the Green Revolution. Other crops were crowded out of arable land to the extent that the increased production of carbohydrates led instead to shortages of protein and vitamins – as in the case of Southeast Asia's rice growing system, which previously included a number of leaf vegetables, fruit trees, taro and other tubers, and notably fish, frogs and other protein sources. Similarly, the fixation with arable production has led to the neglect of other food sources. The largest share of the world's agricultural land is not arable but semi-natural pasture. It covers three times the area and is mostly mismanaged – over-grazed, under-grazed, or otherwise inappropriately used. The importance of wild biodiversity has already been noted. Urban agriculture is another underestimated resource that can contribute a large share of the nutrient supply for people worldwide.[14]

Local self-determination. Real local self-determination for those actually engaged in food production is a prerequisite for liberating local resourcefulness. It does not matter how skilled and innovative producers are if land, water or other necessary production resources are controlled by others. Without political democracy and economic freedom, the development potential of biodiversity cannot be used optimally. This is why many of the world's small farmer organizations refuse to speak about food security without simultaneously discussing self-determination. Food sovereignty or *soberanía alimentaria* – self-determination over the food supply – has become the rallying call.[15]

Respect nature. A commonplace that needs to be repeated is that acute threats to biodiversity must be averted. Seriously disrupted ecosystems are extremely difficult to restore. Lost genetic resources are gone forever. Occasionally, optimists pop up who talk about redundancy in ecosystems and claim that we can confidently eliminate large numbers of species without any risk. The truth is that nobody knows for sure. Our understanding of ecosystem function is limited, sometimes rudimentary. The optimists may be right, but if they are wrong they are irreparably wrong. Here, if anywhere, the Precautionary Principle applies. A number of studies indicate that a reduction in diversity leads to accelerating loss of ecosystem services – in other words, the opposite of redundancy in ecosystems.[16] We must proceed on the basis that everything is needed, even when we do not understand how or why. In addition – perhaps even more difficult to accept – we must learn to respect natural limits even when we have the technical potential to transcend them. Having a sharp saw does not make it a good idea to cut the branch on which you sit.

Long-term perspective. The time perception of industrial society has been a catastrophe for agriculture. In biological contexts 100 years is a short time. Among the few well-functioning indigenous societies still existing, we can observe a time perception that matches biological rhythms. Economically significant natural phenomena – forests, rivers, and important prey – are treated with religious reverence. The wise spirits of the

forefathers continue to inhabit the villages and are often consulted in the event of difficult decisions. Even in modern societies, farmers have long retained a multi-generation perspective in which land and forests are not managed merely for immediate returns but also to ensure a livelihood for children and grandchildren. Perhaps this tradition can still be salvaged. Today's extreme ideal – the quarterly report perspective of large corporations – already typifies agriculture in North America and other recently colonized regions. It creates a purely extractive economy that treats everything – including permanent production resources such as soil and groundwater – as consumable and interchangeable commodities.

Global solidarity. A current interpretation of global solidarity is that we Swedes should permit developing countries to produce an increasing share of our food. This is a smug and self-interested interpretation that produces the same result as any outsourcing of production: cheaper goods for us. Any serious interpretation of global solidarity inevitably involves changes in global production patterns. In agriculture, this applies particularly to meat production. There is neither enough land nor water to produce meat for another few billion people in the volumes and with the methods in which we currently indulge. This does not imply that we must all become vegetarians, but perhaps that the average Indian's diet rather than the average European's should provide the benchmark: less animal protein, more vegetables, and a large share of protein from lentils, peas and beans. It also implies that meat production must be designed on ecological principles: which animals fit where? How can each ecological niche be used optimally?

With a switch from fossil fuels to renewable energy, arable soil must also produce considerable amounts of energy, at least to meet agriculture's own needs. Here also global solidarity is essential. There are already many signs that the agrofuel appetite of the North threatens the food security of poor people in the South. In a recent report on the world economy, the International Monetary Fund noted that "The use of food as a source of fuel may have serious implications for the demand for food if the expansion of biofuels continues."[16b] Indeed, Jean Ziegler, a UN special rapporteur went so far as to call the biofuel trade "a crime against humanity."[16c]

Above all global solidarity means that all production resources must be used, including Sweden's, even though it may cost us a little more than buying from abroad. For instance, we have an excellent and largely unutilized ecological potential to produce meat from grass.

Pioneers

Fortunately, there is no shortage of good examples. Even though many as yet are small scale and not always fully accepted by mainstream institutions, a host of pioneers are already reverting from fossil energy-driven farming to an agriculture driven by the sun, knowledge, and biodiversity. It is genuinely encouraging to see so many people defying the law of least resistance and making the effort to develop forward-looking and sustainable methods, despite the continued availability

of simpler and cheaper but unsustainable shortcuts.

Organic farming deserves a general mention here, especially as it is frequently underrated or misunderstood. Organic farming is not based on an arbitrary refusal to use chemical inputs, but on principles closely related to those outlined above. The conversion to organic operation entails a conscious choice to base production on the resources available on the production site, and minimize dependence on purchased inputs. This of course provides an incentive to optimize the use of biodiversity, and in particular of ecosystem processes. It also requires considerably greater knowledge and personal involvement, since local adaptation makes it virtually impossible to apply off-the-shelf concepts from elsewhere without modification. Farmers, by the way, often note this as a highly positive feature of the transition – the greater the challenge, the more interesting the work.[17]

Organic production is currently expanding very rapidly, also in most developing countries, but there are some interesting North/South differences. While the expansion in developed countries is driven by a certified added value market, and frequently also by government support, many farms in developing countries find organic production profitable without any special incentives. Cost savings on inputs – which are always relatively more expensive in developing countries – are alone sufficient as a driving force. The links to a revival of traditional farming methods and

Many plant varieties have been developed for special purposes. Here puffed rice is being prepared using a traditional rice variety preserved in a seed bank (see photo above) run by Nayakrishi Andolon (New Farming Movement) in Bangladesh. Bushnupur-Nalshodha, Tangail 2004. *Photo: Peter Einarsson.*

to an on-farm seed supply based on traditional varieties are also much stronger – perhaps mainly because industrial methods have a shorter history in these regions and have not had time to bury all traditions quite as deeply. And, most importantly, recent research shows that the yield penalty usually associated with organic farming in developed countries does not apply in developing countries. On average, organic conversion is accompanied by higher yields in the developing world.[17b]

Mainstream agricultural research at universities, international organizations and private companies has been considerably slower than farmers themselves to move away from the industrial paradigm. This is hardly surprising, since agricultural universities developed very much as a part of the general enthusiasm for the shining promises of fossil energy-driven agriculture. But there has been substantial progress in recent years and it is no longer difficult to find positive examples from the research world as well. When the FAO in 2007 held an international conference on organic agriculture and food security, this was viewed by many as a sign of growing international awareness of the potential of organic agriculture.

The few examples that we have space for here are chosen to give a diverse sampling of development efforts that we find promising. Those wishing to explore for themselves can, for example, study the ILEIA archive, which offers an impressive wealth of data, primarily from developing countries.[18]

A social movement of ley seed blenders. In less than a decade, a substantial number of Swedish livestock farmers have reclaimed control of their ley seed mixtures from the seed industry. Multi-year leys on arable land – mixtures primarily of grass and clover – have been the mainstay of fodder production for dairy, beef and sheep farmers since the legume revolution in the 19th century. But since the breakthrough of inorganic fertilizers in the 1950s and the transition to more grain-based feed, both plant breeding and technical development of ley cropping have fallen behind. Seed companies have offered a few standard mixtures, and their lack of local adaptation has been compensated by higher nitrogen input.

Gunnar Danielsson – a sheep farmer from southern Sweden – has changed this picture a good deal. By means of independent research and field experiments, he initially developed ley seed mixtures for his own needs. Over time this led to extensive lecturing and to cooperation with a small seed company that currently markets a large range of ley seed for on-farm blending and supports a minor social movement of ley seed blenders. In turn, this has compelled all other seed companies to offer a broader and better selection of seed.[19]

The key benefit of on-farm blending is, of course, that farmers can tailor the ley crop to their own requirements, and not merely to local soil and climate. Plants can be selected that either give a high protein content or more energy, depending on the livestock involved and whether they need to grow rapidly, produce milk or be kept on a "low flame" for later finishing. Unpredictable weather conditions can be countered by means of mixtures that contain both drought-resilient plants and varieties that thrive in wet conditions,

Weed is a relative concept. Aquatic plants such as water lily varieties *(Nymphaea)* and especially the water hyacinth *(Eichhornia crassipes)* cause considerable overgrowth and choking of watercourses in many places worldwide. But in Bangladesh both plants are included as utility plants in the rice growing system. During the monsoon period, the prolific water lily and water hyacinth plants are permitted to take over the rice paddies. Ahead of planting, these are cut, composted and spread as fertilizer. The water lily is also edible. The root tubers, stems and seed are used in cooking. The photo shows a rice paddy with compost heaps dominated by a red water lily, probably *Nymphaea nouchali* (bilati shapla). Gadthala-Rupshi, Tangail, Bangladesh 2004. *Photo: Peter Einarsson.*

ensuring that something will continue to grow irrespective of weather conditions. To use the ley alternately for grazing and cutting, a farmer can deploy several varieties of each component species, with different maturity times and varying tolerance to cutting, grazing, or trampling.

The ley mixture can also be a component of the preventive animal health program. Herbs such as caraway, chicory and burnet are now common components in the diet of many Swedish cattle and sheep. Last but not least, many farmers are experimenting with legume varieties and species in an attempt to extend the productive lifespan of the ley beyond the traditional 3–4 years. Extending the reseeding interval by a few years would give both a cost saving and a positive environmental impact in the form of lower energy consumption and reduced nitrogen loss.

More rice from fewer plants. Farmers from a range of countries are reporting radically increased harvests by breaking most of the traditional rules of rice growing. The new cultivation method is referred to as SRI – System of Rice Intensification – and was first developed in the 1980s by a French missionary in Madagascar, Fr. Henri de Laulanié.[20] The main features are early transplanting of very small seedlings with very wide spacing, well-aerated soil with very little water in the paddies, and manual weeding. Labor input is slightly higher but water requirements are

halved and neither inorganic fertilizer nor chemical pesticides are required to attain harvests that repay the extra work several times over.

The biological explanation is that each rice plant – thanks to the extremely low seeding rates, with as little as one tenth of the normal amount – gains optimal conditions to develop its full potential. Sparse planting results in much stronger growth both of the root system and the canopy, further boosted by better aerated soil and a nutrient supplement from weeds that are allowed to decompose between the plants after weeding. The small number of plants is offset by very strong tillering (many stalks per plant).

Since the mid-1990s, SRI has spread to most rice-producing countries, with adaptations to local conditions. The method first encountered distrust among researchers, as it sounded "too good to be true". A number of academic studies are now in progress to document and analyze the results. Advocates emphasize that higher yield in itself is not the greatest benefit, but rather higher productivity in relation to land, water and labor inputs.

Natural bacteria against fungal infections. A Swedish research group led by Berndt Gerhardson at the Swedish University of Agricultural Sciences has developed the world's first biological alternative to chemical seed coating. The first product, Cedomon, is now marketed by a subsidiary of Lantmännen (Swedish Farmers' Supply and Crop Marketing Organization) for use with barley and oats. The follow up, Cerall, is used for wheat, rye and triticale. Cedomon and Cerall contain the bacterium *Pseudomonas chlororaphis*, a natural root zone bacterium that is entirely unmodified. It is active against a number of the most common seed-borne fungal diseases and the mode of action is primarily indirect. Although the bacterium secretes a fungus-inhibiting substance, the quantity is so small that it does not account for the effect. Instead, the most important factor is probably the purely physical competition for nutrients and space in the root zone, and that the *P. chlororaphis* infection stimulates a resistance reaction in the plant that helps block fungal pests.[21]

In other words, the product emulates the natural competition between microorganisms for the crucial space next to plant roots. In just a few years, the method has almost entirely replaced chemical seed disinfectant in Sweden and is now being launched on the European and world markets.

Wild diversity makes cattle ranch profitable. When Jim Reed took over his parents' ranch of 721 hectares in Texas, he was advised to sell it as fast as possible because of poor profitability in a tough business. Nevertheless, Jim and his wife decided to persist and searched the Internet for innovative management methods. Eventually they found a site dealing with Holistic Resource Management and signed up for a course.

Today, the ranch is a profitable operation combining beef production with hunting of white-tailed deer, wild boar, wild turkey and ducks. Management plans are drawn up in consultation with the Texas Park and Wildlife Department's wildlife biologists and focus on actively restoring and managing the ranch's various biotopes with rotational grazing as a primary feature.

Operations are meticulously planned to permit grazing animals to conduct most of the maintenance, through the targeted effects of grazing and trampling. Properly used, the latter breaks up crusted surfaces, enhancing infiltration and biological activity in the soil and facilitating the sprouting of herb and grass seeds. For example, cattle graze on weed areas early in the season because they find the young weed shoots tasty, while later on in the season the weeds are avoided. The rooting of the wild boar is much appreciated, as it provides free soil tillage for the grasses and herbs that have been gradually reintroduced to the ranch.

In January 2006, Jim Reed calculated that 25 percent of the ranch's income derived from beef cattle, 45 percent from white-tailed deer, 15 percent from wild boar, 10 percent from turkeys and ducks and 5 percent from financial investments. One of the long-term projects of the ranch is to recreate the natural deciduous biotopes that were heavily degraded during the 20th century.

Some of the positive changes observed over the seven years that the ranch has been managed according to the new method are that:

- the amount of organic material in the soil has increased,
- soil erosion has essentially been halted,
- water infiltration has improved,
- natural grass and herbaceous vegetation has increased in terms of species diversity, ground cover and biomass,
- several native species that had disappeared have spontaneously returned,
- a steadily rising number of wild mammals and birds, both in terms of species and population size.

Hunting, which is currently the ranch's major source of income, also provides the potential for Texans to experience their local countryside and learn about sustainable natural resource management. The ranch is an hour and a half by car from Dallas. Using focused marketing, the owners reach urban and rural dwellers, especially the young generation, who can add a unique experience of nature to their efforts on behalf of sustainable development.[22]

Locally adapted plant breeding in cooperation between farmers and researchers. MASIPAG is a Philippine organization that has established a large network of local farmer organizations and trial farms, where farmers in cooperation with researchers do their own plant breeding and variety trials.[23] The organization was set up after a national conference in 1985 at which farmers, academics, environmental activists, politicians and officials discussed the country's rice production and its problems and potential. The farmers experienced mounting problems with rapidly declining diversity and increasing dependence on a few commercial, high-yield varieties that required considerable annual investments in commercial fertilizer and pesticides, and which also displayed falling yields after three or four seasons. Many farmers became indebted and complained about depleted soils, health problems from pesticides and the loss of wild diversity, such as leaf vegetables, small animals, fish and so forth that were previously features of the varied farming system.

MASIPAG – a Philippine acronym for

Farmer-Scientist Partnership for Development – now has 456 local farmer organizations and 42 NGOs (individual organizations) as members, as well as 286 farmer-driven trial farms (as of 2004). Locally adapted plant breeding is the core activity, but the farms also offer training in organic farming and situation analysis. Thanks to the trial farms, farmers with very small resources can learn to conduct selection and innovative breeding activities. Without MASIPAG it would be practically impossible for many farmers to experiment, since a trial that leads to a smaller harvest would entail major problems for the family, even hunger. But the organization stresses that the role of the researchers is educational and advisory. Farmers make all selection decisions on the basis of the criteria they themselves set.

In addition, there is access – via local farmer organizations and MASIPAG's nationwide network – to all the rice varieties and the shared expertise accumulated over the past 20 years. By 2004, MASIPAG's genetic bank included 859 collected traditional rice varieties, 826 rice strains developed via its own operations and 50 traditional maize varieties. Since the traditional material is well tested and characterized by *in-situ* cultivation (in a field environment) it represents an active value that far exceeds that of varieties only accessible *ex-situ* (in gene banks). Characterization and breeding of local livestock and chicken breeds have also commenced.

By means of MASIPAG's work, thousands of farming families have created sustainable farms, with greater biodiversity, higher profitability and reduced vulnerability. Yields on farms with the locally bred, organically grown varieties are generally on a par with or higher than on farms using high-yield commercial seed varieties. The average rice harvest from a randomly selected number of farms in MASIPAG's network in 1998 was about 4.5 tons per hectare, well above the national average.[24] In addition to better economy, security and health, many farmers in the network emphasize that one of the major gains from MASIPAG is their newfound pride and the revival of the culture of sharing. Seed from the breeding program is offered to other farmers free of charge, subject to the sole condition that recipients in turn offer the seed variety free of charge to other interested farmers – something that appeared very strange to Rolf Jördens from UPOV (International Union for the Protection of New Varieties of Plants) when he participated as a panel member with representatives from MASIPAG at a conference in Stockholm in autumn 2000.[25]

Forest reserve provides clean water for dairy production. The hills outside the city of Turrialba in Costa Rica are the center of the country's dairy industry. In particular, a mozzarella-like white cheese is produced here and sold in the stores in the capital San José. A few hundred years ago the slopes were covered by forest, but today large areas have been turned into leys and grazing land for intensive dairy farming. The production of cheese is conducted in local multi-farm dairies that require an ample and stable supply of clean water. At the end of the 1990s, the community realized that a number of the area's natural wells and their crystal-clear drinking water were threatened by the expansion of grazing land into forest areas,

prompting the municipal council to attempt to resolve the problem. The solution was to set up a forest reserve in the runoff area, which is the basis for the water supply to the dairies. Due to the municipality's substantial dependence on dairy production (and the fact that some councilors were themselves dairy farmers), combined with some forward thinking, the new forest reserve gained enthusiastic support from local farmers, who now view the protected forest as a guarantee of their water supply and thus an invaluable asset. A buffer zone of 50–100 meters around the forest proper has been set aside for spontaneous reforestation of areas felled in recent decades. This rainforest-like mountain forest with patches of deciduous trees is also rich in biodiversity. It is home to the Resplendent Quetzal, one of the rare birds that attract numerous tourists to Costa Rica each year. In the longer term, it is likely that using the forest also as an ecotourism destination[26] could further strengthen the local economy.

Insect and weed control through inter-cropping. Some of the most troublesome pests in maize cultivation in East Africa are the various species of stem borers, whose larvae attack the maize stems, and the weed *Striga hermonthica*, which parasites on the roots of the maize plant and in serious cases can kill the plant completely. Combined, these threats can reduce harvests by more than half. Dr. Zeyaur Khan and his research team at the International Centre for Insect Physiology and Ecology (ICIPE) in Kenya have developed a method that can simultaneously control both problems simply by intercropping maize with two forage crops.[27]

The method is called "push-pull" since it is based on a combination of crops that respectively repel and attract the stem borer larvae. *Desmodium uncinatum*, a forage legume, provides the repellent effect. It is sown between the maize rows, but is so low-growing that it does not compete with the maize.

The perimeter around the maize field is sown with a type of high grass that the larvae find more attractive than the maize. In particular, ICIPE recommends *Pennisetum purpureum*, which produces a glue-like substance to trap the larvae. The strategy is based on the insight that the larvae's original host plants – before maize was introduced into East Africa a century ago – must have been various domestic grass varieties.

The impact on the Striga weed was an unexpected side-effect of the system. It is the Desmodium plants that repress Striga by providing a ground cover, combined with the secretion of a repellent substance from its roots.

The push-pull method does not require any special inputs other than know-how and seed for the intercropping plants. The attractor crop around the maize field requires a little extra space, but, as in the case of Desmodium, it doubles as a useful forage crop. Also, Desmodium is nitrogen fixing and contributes to nutrient supply for the maize, while also preserving soil moisture and counteracting soil erosion by providing a ground cover.

Resistance

The dismantling of fossil energy-driven agriculture will not take place without resistance. As in all major paradigm shifts, the keepers of the prevailing wisdom will show enormous inertia. The fact that it is mostly individual farmers and development assistance workers who represent innovative thinking is completely in line with Kuhn's classic analysis of the scientific community's inability to integrate divergent perspectives.[28]

However, we can assume that the changes, once they do emerge, will be rapid and drastic. That innovators still are relatively few and far between is no indication of the time horizon; paradigm shifts are revolutionary, not evolutionary.

Apart from the inevitable inertia, there are two other sources of resistance that may prove more bothersome. One is that the change will be more severe in affluent countries than in developing countries – simply because the former are so favored by current conditions. Global agriculture and food trade flows are organized primarily to satisfy the luxury consumption of the global upper class. It is the expensive habits of the rich world that consume the largest volumes of fossil energy and other non-renewable resources, and trading patterns still reflect colonial power relations. Spoiled European and North American consumers will not willingly forgo their privileges.

The second and perhaps even more significant source of resistance are the transnational corporations that have increasingly tightened their grip on the farming and food sectors in recent decades. Their expansion has been particularly noticeable in the sector most directly involved with biodiversity – plant breeding and seed production. During most of the 20th century the sector was dominated by public sector players, farmer-owned cooperatives and small, locally based private companies. Today, publicly financed plant breeding is in decline or has disappeared entirely in most countries, and private industry has undergone radical restructuring. A handful of transnational corporations, mainly from the chemical industry, now control a considerable share of world plant breeding. A scenario where farmers reclaim more control over their seeds, while applying smarter biological methods to reduce dependence on purchased inputs, is a direct threat to the financial interests of these corporations.

What is dangerous with the resistance from those who defend their established privileges is not primarily the risk that they could succeed in preventing necessary change – there simply isn't much choice in the long term. But they can obstruct and slow down the process, and every unnecessary delay means an irreplaceable loss of biodiversity. Lost species and crashed ecosystems can never be replaced; losing them reduces our options forever.

Politically, developing countries play a key role in this game. Traditionally, they have always glanced at the rich world, attempting to "catch up" – as implied in the ill-chosen term "developing country". Even today, many politicians in developing countries seem to assume that European and North American production patterns must be right, since we live amid such great abundance.

Meanwhile, however, a more independent mindset is beginning to emerge, and politicians and intellectuals in developing countries now more frequently question this uncritical imitation.

The fact is that developing countries in many ways are better prepared for a rapid change of direction. They are less enmeshed in unsustainable consumption patterns. They have a more substantial base of traditional farming skills and practical knowledge of biodiversity. And in contrast to the affluent world, they have a healthy skepticism regarding the intentions of transnational corporations. Thus, if developing countries manage to liberate themselves from their colonial sense of inferiority, they can do much to break the resistance from privileged groups and achieve more rapid global change.[29]

A glimpse of the future

Finally, we'd like to offer a glimpse into a future when agriculture is managed for the benefit of both wild and cultivated biodiversity.

Our farming correspondent climbs into her time machine, parked at the edge of a newly sown field at the Alsike Vicarage farm in the province of Uppland, Sweden, and sets her target time to May 2047.

Her journey into the future seems to take only a few moments, and on arrival she immediately notes that the large field has now been divided into a mosaic of smaller patches and strips where various crops are grown in a recurring pattern. Winter grain grows on some strips, while others look like recently established rapeseed plants, some have been newly sown, and a few still remain uncultivated after winter. Here and there are patches of flowers, most in early their stages. The surrounding landscape is a mosaic of arable fields, pasture and forest. Some livestock can be seen grazing among the trees.

A group of workers in blue overalls are enjoying a coffee break on a wooded hill near the field. They have apparently been collecting insects. One of them lifts up a glass jar buzzing with winged insects, and beside them there are butterfly nets.

– We've just done the routine check of the insect fauna, responds a young man to her question. We do this every week during the most intensive part of the growing season. Why? Well, how else would we know what crop protection measures to use?

The anti-pest measures he's talking about turn out to be various combinations of parasitic wasps, pheromones, and plant-based preparations, primarily to control insect larvae, flea beetles and blossom beetles. Pests are not a major problem, since push-pull techniques and intercropping to favor predators ensure that major outbreaks are rare.

An elderly woman has collected a handful of soil samples and placed them in small sealed plastic containers. She's now testing the samples one by one with a sensor, attached to a mobile terminal.

– I'm sending the data to our laboratory, she explains. This is simply to confirm that we have succeeded in inoculating the autumn crops. We get back a profile of the key species in the microflora.

– I am old enough to remember when we had to rely on chemical analyses. They gave a snapshot of the nutrient status, but we really had no way of predicting how the nutrient supply would develop during the season.

– Now when we can see how strong the mycorrhiza species are, it's not all that difficult to guess how they will develop. And we also get warnings if any aggressive fungi are emerging.

– The lab is in Kazakhstan, by the way, she adds with a smile. We have a few language problems occasionally, but we think they are unbeatable when it comes to the analysis.

A few of the others eagerly join the discussion, and add to the picture of what agriculture now looks like both in the Alsike area and worldwide. Chemical pesticides are not used at all in farming here, but there is still sporadic use in the US and some tropical countries. Apart from more stringent environmental laws, most farmers anyway feel that chemicals produce too many unanticipated effects on soil microorganisms. The synthetic oil available (primarily coal based) is much more costly than bio-energy; farmers produce all the energy they need to cover their own farm requirements.

Our reporter avidly studies the small four-wheeler parked by the edge of the field. The bodywork is coated with a silicone film that generates electricity for a battery with a storage capacity far exceeding that available in the early 2000s. The battery can also be charged using a gas turbine. The fuel is biogas produced from farmyard manure behind the barn. The combination of biogas, solar energy and wood is normally enough to cover annual fuel and heating needs. Equipment for burning grain or straw is also available if needed. Any surpluses are sold on the local market.

– Old fashioned inorganic fertilizer is no longer available, replies the elderly woman to the reporter's question. Making nitrogen fertilizer from ammonia became far too expensive when energy prices rose. You can buy various types of compost pellets, but we ourselves have livestock who need winter fodder anyway, so we have no problem with growing enough nitrogen-fixing crops.

– We actually grow a lot of Alsike clover. You do know that it was here alongside the road that Linnaeus first discovered it? We celebrated the 300th anniversary just a few years ago. Our guests included several big shots from the Royal Swedish Academy of Agriculture and Forestry and other places.

– You mustn't exaggerate the clover thing, Granny, interjects a young woman who has been silent until now. When I compute the nutrient balance, potassium and phosphorus are almost always the limiting factors. So what's really crucial is that we are able to buy the town's compost from the Knivsta recycling plant. It doesn't matter how careful we are with our own manure, we need to compensate for the plant nutrients we sell with the harvest. Otherwise, we'd always lose a few kilos of phosphorous and potassium each year, and that would cause problems in the long term.

– Well, that's pretty obvious nowadays. That and the mycorrhiza that can tease out the phosphorus from the soil.

Production at Alsike Vicarage proves to be

rather varied, largely because it is close to the cities of Stockholm and Uppsala, to which vegetables and eggs are delivered daily by train. The farm also has beef cattle, sheep and chickens. Crops include leys, protein fodder mixtures containing vetch, rapeseed, chicory and cereals, and some grain grown to maturity for chicken feed and human consumption, as well as spices, a range of Brassica vegetables, some potatoes and a good deal of root vegetables.

– We're kind of privileged to be able to do so many different things and employ so many on the farm, says the man with the butterfly net. If we were further from the city it could be difficult to run a profitable line of fresh produce.

– One of the best things compared with the past is that the seasons are an important sales factor again, notes Granny. When the Dutch had to stop their greenhouse growing of peppers in the winter, we were able to sell parsnips and red cabbage instead. You do know how much vitamin C there is in red cabbage?

Apart from agriculture, the farm also has horse stables, and welcomes school classes for ecology studies in the meadows, fen and mixed forests. Field studies are a key feature of schoolwork, since biodiversity is now viewed as a basic school subject and is required knowledge in many sectors. Given the major climate change in recent decades, considerable resources are invested in environmental monitoring and ecological restoration.

– Nevertheless, the changes here haven't really been that drastic since your time, says the butterfly catcher. Look at the US though, where the entire ecosystem in the Midwest was about to collapse 20 years ago, before the radical new agricultural policy was introduced that requires either crop rotation or grazing land. Imagine being grain farmers for three generations and then be forced to learn how to handle cattle!

– Yes, really, and don't forget those who made grazing land out of it all and started buffalo herds, replies the young woman.

– The changeover must have been easier for them in Uganda, who never lost their local market and managed to keep so much of their traditional seed varieties.

– How come you know so much about Uganda?, asks the reporter.

– We have a lot of contact with farms all over the world via the Internet. And several of us visited a Ugandan village a few years ago. Just yesterday I got advice from a farmer on how they develop their local bean varieties. They have an exciting trial and seed exchange system that we also plan to use here with some neighbors.

– You see, says Granny, nowadays almost all plant breeding is decentralized. Most of the varieties we use are unique to this area and we've been selecting them for many years. In the age you live in I'm sure it's still possible to patent varieties and stop farmers from using their own seeds, right? All that disappeared with the great reforms in the 2020s, when anti-monopoly laws were passed to protect all biodiversity.

– Wasn't it mainly farmers in developing countries who pushed for that decision at the UN?, asks the man with the butterfly net.

– Yes, that's right, and that also marked

the beginning of the end for those huge plant breeding corporations. Their gene-manipulated seed was unable to compete on the market without monopoly privileges, and when the power balance between the North and the South changed, governments in the North could no longer protect them as they had previously.

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HOW SWEDISH IS A SWEDISH COW?

How Swedish consumption and production of food is dependent on and affects ecosystems in Sweden and abroad

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Summary

How dependent are we on farmlands in other countries? *How Swedish is a Swedish cow?* refers to the level of dependency of Swedish animal production systems on agricultural ecosystems outside Sweden. In 1999, almost 80 percent of the areas needed to produce the manufactured feed that was purchased for Swedish animals were dependent on imports. But purchased feed is only a portion of what animals eat – cows, beef cattle, pigs and chickens also use meadows, pastures and homegrown feed mixtures. Thus, over one-quarter of the total farmlands necessary to raise Swedish animals lies outside national borders. So, Swedish animals are 75 percent Swedish. But that is more than the human population. More than one third of our consumption is dependent on farmlands in other countries. Swedes themselves are actually only two-thirds Swedish!

That Swedes are not self-sufficient in their food supply is not necessarily negative. However, to assure long-term sustainable food production and food safety, there is a need for decision makers, producers, retailers and consumers to recognize the consequences of our production and consumption choices on ecosystems nationally and globally. We are highly dependent on support from foreign ecosystems via imports. These imported farmlands are a part of our own production systems. However, present ways of measuring and analyzing production are outdated and misleading. Thus, national discussions of the Swedish food production system need to be expanded to include the production systems of imports – and the resulting environmental consequences of this production. While globally, the World Trade Organization (WTO) can encourage sustainable trade by allowing countries to differentiate trade partners based on environmental considerations. Presently, the WTO prohibits this. This is a problem since our present and future capacity for development is dependent upon functioning ecosystems in Sweden and abroad.

Introduction

Swedish food provisioning has become globalized[1]. More than one-third of Swedish food consumption originates from farmlands outside of Sweden[2], while 80 percent of the farmlands

needed for purchased animal feeds are outside Swedish borders. But much of this globalization is invisible. What we eat – where it comes from – how it is produced – is difficult, if not impossible, to see.

In Sweden, if you ask someone where their breakfast is from they would know the coffee is imported, but not that it was grown in Brazil, Columbia, Guatemala, Kenya or Vietnam – and roasted in Germany or Finland. Swedes love bananas. The majority of imports come from South America, particularly Ecuador and Peru, but the organic ones are from the Dominican Republic. According to official trade statistics, our orange juice comes from Norway! The oranges are from Brazil and Spain, but are pressed in Norway. If a child drinks a glass of chocolate milk, she probably does not know that cacao comes to Sweden from the Ivory Coast or Ghana. Your boiled egg is probably from Finland if you are a tourist eating in a hotel. Your toast is probably Swedish, but depending on the season, the fruit in your jam could be from Italy. Yoghurt is certainly Swedish, but if you added muesli you created an international treat with coconut from Indonesia, Swedish oats, raisins and almonds from the US, dates from Turkey and palm oil from Malaysia. It is not easy to see the origin of ingredients on domestically processed products. There is information about sugar, calories and fiber, but not where

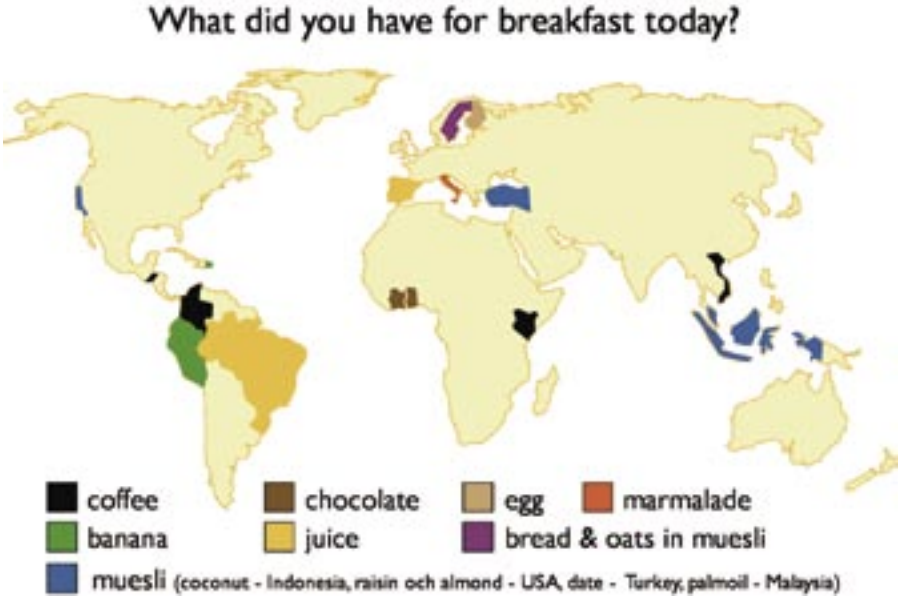

Figure 1. Where did your breakfast come from today? If you are Swedish your coffee may have come from Guatemala, Kenya or Vietnam. Oranges are grown in Brazil or Spain. If your egg wasn't organic it could be Finnish. Probably your toast was Swedish, but the fruit in your jam could be from Italy. Yoghurt is definitely Swedish, but the muesli you added made it a real international dish – with coconut from Indonesia, Swedish oats, raisins and almonds from the US, dates from Turkey and palm oil from Malaysia. (Illustration Robert Kautsky/azote.se)

ingredients are from and never how they are produced (unless it is certified organic [KRAV] or Fair Trade).

To import from others in not a problem – but how sustainable is our consumption if imports are not produced sustainably? Swedish agriculture has comparatively high environmental standards for domestic production, but these standards are not usually applied to imports. Thus, if we are dependent on external inputs, such as inputs for feed concentrates and fertilizers, then our production is partially based on other production systems. Do they hold the same environmental standards? If not, we risk undermining our own potential for future production and development.

Farmlands are the result of close interactions between humans and nature – but nature is the most basic factor of production. It is functioning ecosystems[3] that generate the food we need – so called "ecosystem services". Examples of these services are fertile soils, pollination and clean water.

The farm sector in Sweden today seems to take ecosystems into consideration, either voluntarily or by regulation. Why do we not have the same requirements for import partners? Partly, because many do not realize the degree of our interdependence through trade. Present trade statistics and institutions need to be revised to include the production systems of imported goods in domestic Swedish output. Further, present measures are not ecologically relevant as ecosystem subsidies are not recognized or made explicit and environmental costs are most often not included in prices. In fact, the present global market system is designed to block feedbacks as to changes in ecosystems and promote economic development at the expense of the ecosystem health.

Again, dependence on imports is not problematic if we acknowledge these links and sustainably manage resources both at home and abroad. (Certainly, discussions of energy use and emissions associated with transportation of imported goods are also relevant). However, this is not the case for several reasons. When consumers are too far removed from the consequences of production, they cannot see that they are undermining their own, their children's or their grandchildren's future food security. Also, traditional statistics do not give a measure of nature's life-support capacity – namely, the large areas of farmlands providing food to Swedish citizens that are not visible[4]. We give a measure of this support in hectares of living farmlands – not US dollars or tons of grain. All the data presented herein are farmlands needed for Swedish food consumption – no matter where on Earth they have originated. Through trade, Swedes now "buy farmlands" worldwide. This chapter hopes to widen the base of discussion in national and international agricultural debate beyond national borders and to do so from an ecosystem perspective.

How dependent are we on nature in other countries?

According to national statistics, Sweden has a high degree self-sufficiency in food provision[5], although our studies indicate that Sweden remains highly dependent on foreign ecosystems[6].

By the end of the 1990s, 14 percent of the lands needed for direct food consumption (fruit, vegetables, grains, that is, not for animal production) were Swedish. Another 14 percent were cultivated with crops for our indirect consumption of meat, milk and eggs and meadow and pasture areas comprised 37 percent of consumption areas. Almost 10 percent of domestic production was exported. Thus, more than one-third of food consumption relied on the support capacity of agricultural areas outside Sweden (see Figure 2).

What do we import? Coffee, chocolate and rice were the largest imports for human consumption. Together these three crops accounted for over one-fourth of import areas. However, the largest portion of imports was for inputs to animal feed (60 percent) – due to the increasing importance of manufactured feed in animal production.

The agricultural areas that support animal production are certainly the most difficult for people to perceive. We drink milk, and eat meat, eggs and cheese. But what do cows, pigs and chickens eat? Few in Sweden know that animal feed includes three main components: roughages (hay, silage, meadows and grazing); on-farm feed concentrates (potatoes, wheat, rye, barley, oats, and peas)[7]; purchased feed concentrates[8] (grains, oil seeds, and byproducts such as molasses from sugar beets)[9].

Half of the areas needed for Swedish animals are for roughage production (in the 1960s roughages comprised 60 percent) – refer to Figure 3. On-farm crops used 16 percent of total feed

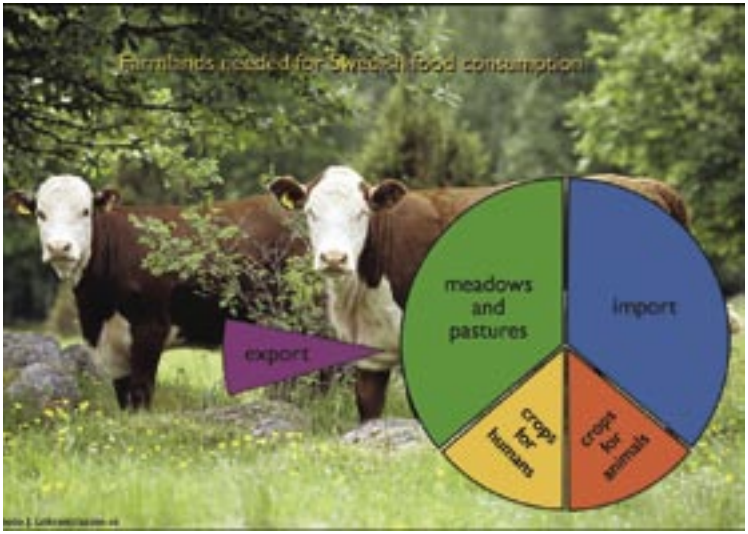

Figure 2. By the end of the 1990s, 14 percent of the lands we needed for our consumption of fruit, vegetables, grains etc., were Swedish, while an equal area was cultivated for our indirect consumption of meat, milk and eggs. Swedish meadow and pasture areas comprised 37 percent of consumption areas and almost 10 percent of domestic production was exported. More than one-third of food consumption relied on the support capacity of agricultural areas outside Sweden. (Illustration Robert Kautsky, Photo Jerker Lokrantz/azote.se)

Farmlands needed for Swedish animal production

Figure 3. Half of the farmlands required for Swedish animals is for roughage production (meadows and pastures). On-farm crops account for 16 percent fo total feed areas. Thus, the remaining third of the croplands needed by livestock are for purchased feed concentrates. Of these cropland areas, almost 80 percent are imported. Of the total 2.8 million hectares required for consumption by Swedish livestock, 750,000 hectares are located in other countrie s. How Swedish is a Swedish cow if 25 percent for the total farmlands required to raise her lie outside national borders? (Illustration Robert Kautsky/azote.se)

areas. Thus, the remaining third of the croplands needed by animals are purchased feeds (the level was one-fourth in the 1960s[10]). Of these cropland areas almost 80 percent were imported. Of the total 2.8 million hectares needed for animal products consumption – 750,000 hectares are located in other countries. How Swedish is a Swedish cow if 25 percent of the total farmlands necessary to raise her lie outside national borders?

Table 1 shows that approximately 20 percent of purchased feeds originate in South America in the form of soybeans from Brazil[11]. Another 20 percent of areas come from Southeast Asia in the form of palm oil seeds from Malaysia. The remainder of imported areas comes from within the EU.

Changes in consumption and production choices

Changes in patterns of Swedish consumption and production of animal products since the 1960s have resulted in greater import dependence. The major drivers of the need to import meat consist of (1) increased total consumption levels, (2) changes in consumption patterns, and (3) decreasing domestic production due to declining industry profitability[12].

With the exceptions of regular milk and butter, consumption of animal food products has increased since the 1960s. Over the last 40 years, total meat consumption increased over 40 percent. We eat the same amount of beef, but 50 percent more pork and five times as much chicken[13]. Swedes have also changed consumption preferences to favor particular cuts: pork tenderloin and chicken breast[14]. In 1999, the import and export tonnages of pork were almost equal, but while exports included all types of cuts, imports were only cuts of a higher quality, mainly tenderloin and filet[15]. There is a similar pattern for beef imports that are mainly roast beef, entrecote and filets. To supply increased demand and changed preferences for meat, trade flows increased markedly. Swedish imports of pork, beef, and poultry increased seven, six, and twenty-five times, respectively, since 1962[16]. Thus, total meat imports increased almost seven times from 16,000

FARMLANDS FOR INPUTS DEPLOYED IN SWEDISH LIVESTOCK PRODUCTION, 1999

Inputs for purchased feed concentrates	Total area, hectares	Total %-age	Of which import	Imports, hectares	Imported from
Soybean cake	186 411	20 %	100 %	186 411	Brazil, Norway, Germany, Netherlands
Palm kernal cake	155 874	16 %	100 %	155 874	Malaysia, Indonesia, Netherlands
Rapeseed and rapeseed cake	121 038	13 %	100 %	121 038	Denmark, UK, Germany
Peas	31 725	3 %	0 %	0	
Other protein inputs[1]	54 855	6 %	100 %	54 855	Indonesia
Vegetable byproducts[2]	167 724	18 %	95 %	159 338	Netherlands, Germany, UK, Denmark
Seed	191 483	20 %	20 %	38 297	Unspecified
Beet pulp and molasses pulp, etc.	38 244	4 %	87 %	33 272	Poland, Lithuania, Germany, Netherlands, Denmark
Miscellaneous	849	0 %	0 %	0	
TOTAL	948 202	100 %	79 %	749 085	

1 For example coconut, sunflower seed, cottonseed etc.
2 For example maize gluten, bran, starch products etc.

Table 1. Some 20 percent of farmlands used for purchased feed inputs are in Latin America, solely for soybeans grown in Brazil. An additional 22 percent of the farmlands required for the cultivation of palm kernel cake are located in Southeast Asia, primarily Malaysia. The EU accounts for most of the remaining farmlands.

to 109,000 tons. Sweden has gone from being a net trade exporter of meat products to a net importer[17]. Thus, Swedish meat consumption and production are both highly dependent on international trade – to be able to export less desirable cuts of meat as well as to import feed inputs.

At the same time as consumption changes took place, animal production systems became markedly less dependent on local land areas[18] through intensification of production, including importing more feed inputs[19]. The net result for local farm areas used for animal production is a decrease of 30 percent since 1962. The decrease in roughage production and increased use of manufactured feeds (mainly imported inputs high in energy and protein, such as grains and oil crops) was overwhelmingly driven by market forces, particularly relatively limited and expensive do-

Figure 4. To meet increased demand and changing preferences for meat, total Swedish meat imports have risen almost seven times since 1962, advancing from 16,000 to 109,000 tonnes. Swedish impor ts of pork, beef and poultry increased seven, six and twenty-five times, respectively, during the period. Sweden has moved from being a net trade exporter of meat products to being a net importer. However, livestock production has a dual dependence on the global market: first, to be able to export less desirable cuts of meat – thereby gaining a market for its output; and, secondly, to gain access to imported inputs for animal feeds. (Illustration Robert Kautsky/azote.se)

mestic protein sources[20]. Since inputs to feed at the farm level are responsible for approximately 70–75 percent of production costs[21], industry has focused on these costs. Focus has been on market prices, which do not include the significant ecological consequences and thus the costs borne by society both inside and outside Sweden. Producers, consumers, and the Swedish government do not seem to be fully aware of these externalities created by modern animal production, and are particularly unaware of those created in the production of feed inputs that have been moved outside Sweden's borders through trade.

Environmental effects of production intensification in Sweden

As Swedes ate relatively less lamb and beef (animals whose diets are roughage-based) and farmers increased the use of feed concentrates, the use of meadows and pastures decreased[22] while the use of crops for feed concentrates increased[23]. These changes resulted in a multitude of ecological consequences.

First, the shift away from roughages and replacement with feeds based on imported oilseeds and grains is a major driver of change in the Swedish agricultural landscape. Important effects related to the associated decrease of ley in

crop rotations and the reduction of pastures and meadows in production are:

1. reduction of biodiversity: declines in floral species richness and evenness[24] and reduction of faunal diversity[25];

2. loss of food sources in the Swedish agricultural landscape: clover is a key food for some species of bumblebees[26];

3. changes in the regional landscape mosaic: loss of structure and habitat[27];

4. reduced soil fertility: reduction in organic matter content and impaired soil structure[28].

Further, the shift away from locally grown roughages has led to a number of indirect, adverse environmental changes. For example, higher consumption of grains has resulted in an increasing use of pesticides since the mid-1990s (since they are primarily grown in cereal-dominated crop sequences)[29]. The replacement of roughages with imported oilseeds has also resulted in a major source of cadmium onto the farm today via imported animal feed inputs, such as beet fiber, soybean meals and vitamin-mineral mixtures[30]. Cadmium is assimilated by plants. The amount of cadmium in phosphate fertilizers applied on soybeans in Brazil was 4–10 times higher and on oil palm in Malaysia was approximately 16 times higher than level applied per hectare on rape seed in Sweden[31] . Since cadmium in feed is not fully absorbed by animals and thus partially excreted in animal wastes, feed inputs are an external source of cadmium to Swedish soils where it accumulates[32]. In one study of pigs in Sweden, protein inputs contributed 50 percent of the total cadmium in feed[33].

Thus, current practices of increasing amounts of imported feed inputs may in fact work contrary to some of the 15 national environmental quality goals of the Swedish Ministry of the Environment, particularly: #4: a non-toxic environment, #7: no eutrophication, and #13: a rich agricultural landscape.

Environmental effects abroad of producing feed inputs

The two largest feed inputs with respect to areas used were soybean and palm oil seed cakes (cakes are what remain after the oil is pressed out). Soybean cake is the single largest imported component in animal feed. The cultivation of soybeans in Brazil has increased dramatically during the last decades, and Brazil has been the major exporter of soybean cakes to Sweden for many years[34]. Much of present soybean cultivation is a major threat to the environment, and especially to biodiversity. Most soybean plantations are located in the *cerrado* (central Brazilian scrub savannas) and in native Amazonian grasslands, with dramatic effects on these areas, as the native vegetation is converted to farmlands[35]. This has both local and global ecological consequences, such as degradation and disappearance of ecosystems, ecosystem functions and reduction of the global genetic pool. The Brazilian *cerrado* is perceived to be the world's most diverse and speciose savanna[36]. Rising global demand for soybeans is also increasingly expanding cultivation into the tropical forest[37].

Loss of natural ecosystems as a direct or in-

direct consequence of cultivation of soybeans is obvious. Added to this are effects on soil fertility, such as compaction and erosion[38]. Furthermore, the environmental impacts of soybean cultivation extend beyond the direct effects of land conversion due to the massive infrastructure developments needed for transportation of harvest and inputs which then foster other kinds of exploitation, such as logging and ranching[39].

The largest fraction of palm kernel cakes imported to Sweden came from Malaysia and Indonesia where conversion of natural forests to oil palm plantations is, as in the case of Brazilian soybeans, a major threat to biodiversity and thus to the provision of ecosystem functions[40]. Some researchers argue that establishment of economically viable plantations may be a sustainable way to prevent the natural forest from further degradation[41]. However, for this to happen, law enforcement and the legal environment in producer countries must be heavily strengthened[42].

Implications for food safety

There is even reason for concerns about food safety in relation to increased import dependence after the multitude of food safety scares starting in the mid-1990s: food-borne diseases such as bovine spongiform encephalopathy (BSE), foot-and-mouth disease, Salmonella, Campylobacter, Listeria, Escherichia coli, and contaminants such as dioxins, and illegal antibiotics. Sweden has relatively high standards for animal production, both with respect to animal treatment (ethics) and food safety[43]. For example, bone and meat meal in ruminant feeds was banned in 1987, well ahead of the EU ban on all mammalian bone and meat meal in 1994 (see Box 1). Traditionally,

HIGH STANDARDS FOR SWEDISH ANIMAL PRODUCTION

- No growth hormones permitted in beef or milk production.
- Restrictive use of antibiotics and ban on use in feed since 1986.
- Consideration of animals' natural behaviour in management practices (for example, larger space requirements than EU directives.
- Ethical restrictions and consideration of animal health as foundations for breeding programs.
- Animal transport requirements above EU standards.
- Voluntary industry association agreement not to use GMO crops in feed.
- No use of cadavers in animal feeds since 1987, prior to EU ban in 1994.
- Ban on ruminant bone or meat meal in ruminant feeds in 1991, prior to EU ban on mammalian bone or meat meal in ruminant feeds in 1994.
- Mandatory Salmonella testing of feed inputs – not required in EU.

Sweden has been able to maintain a high level of control over product quality and animal production. However, this control does not necessarily extend to the production systems of imported inputs and has, in fact, become difficult to maintain with increased globalization. We argue that long food and feed production system chains that are not easily traceable and transparent pose potentially serious health risks. The tight interconnectedness of the systems of imported meat products and animal feed inputs facilitates the rapid spread of food or feed-borne contamination and allows what has been called "cascades of disaster"[44].

Unfortunately, there are already examples of such cascades in Sweden. In 2003, Salmonella-infected pork imported from Denmark was rapidly distributed and served at restaurants throughout southern Sweden before being detected[45]. That same year, there was also a serious feed-borne outbreak of Salmonella in pig feed in Sweden from imported protein inputs[46]. Epidemiological surveillance in several industrial countries during recent decades indicates that there is a considerable increase in the prevalence of food-borne diseases and those outbreaks are also more devastating[47].

A mismatch between global markets and sustainable management

Imports themselves are not the problem. The global market has the potential to facilitate sustainable production. It can provide opportunities to spread risks among different supply sources. It can also provide alternative production sites that are more sustainable, for example, Swedish hothouse tomato production generates more CO_2 emissions than do Spanish imports[48]. And, as this book hopes to discern, trade can provide food and livelihood opportunities where they may have been previously limited, not available or untenable. However, today there is a mismatch between how the global market works and sustainable management of resources partially because:

1. society does not sufficiently or appropriately recognize our level of dependence on ecosystem support[49];

2. we do not include imported ecosystem support in our national production systems;

3. we have an international framework (the WTO) that blocks links to ecosystems.

Today in Sweden, there is a resolute consumer, industry, and governmental belief in relatively high levels of self-sufficiency in meat production and that animals are raised on 'Swedish' feed. However, there is a large discrepancy between our results and those in the present national debate or in official statistics.

In some discussions, indirect, foreign production sources are ignored in discussions, for example, on the sustainability of Swedish meat production[50] and food safety[51]. We argue that animal production should be recognized as being closely tied to the origin of the animal's feed, not just determined by the country in which animals are raised or slaughtered, since feed areas are a portion of the production system. Trade has already expanded the Swedish production system, but our out-dated economic accounting systems do not allow us to see this.

In official publications the Swedish Department of Agriculture described manufactured feed in 1999 as well over 90 percent Swedish[52]. Yes, it was processed in Sweden – but with imported ingredients! Another example is that self-sufficiency figures for meat production in SJV annual reports measure net consumption, that is, the amount of domestic production minus the amount of consumption[53]. This simple figure misses the large portion of trade that takes place due to consumer preferences and price differences. For example, 20 percent of meat consumption in 1999 was imported. This is a very different figure than the published self-sufficiency figures for meat products during 1999 of 95 percent[54], and assertions by researchers that Sweden is self-sufficient in production of pork and chicken[55]. It is however, typical of the overall picture of food consumption in Sweden according to authorities, described as including "only a few imports"[56]. This picture is incomplete. Sweden may be capable of producing the total quantity of meat consumed domestically, but present measures do not capture consumer preferences for different cuts of meat. Import flows need to be included in calculations to reflect this. As Swedes changed their consumption patterns they not only increased their level of dependence on imports, but also increased exported amounts significantly. Exports of unwanted cuts of meat are an important industry as well. Thus, knowledge of export flows is also necessary to enable measurement and understanding of the level of interdependence of the system.

The poor transparency of import statistics is another serious obstacle for Swedish producers and consumers in understanding animal production. There are at least two examples where products cannot easily be traced and producers are not obvious. First, cured meats do not require country of origin labeling. Second, statistics only reveal the country of purchase, not the country of origin. For example, the Netherlands is reported as the largest exporter of soybean and palm kernel cakes, while Germany exports more palm kernel cakes to Sweden than Malaysia[57]. The Dutch do not cultivate soybeans nor the Germans palm kernels, but the level of detail of Swedish, EU and FAO import statistics does not permit further coupling of inputs to the production systems of original exporting countries thus thwarting scrutiny of production methods in these countries. Appropriate information about the chains of production and trade must be made explicit.

In light of recent events directly related to meat and animal feed inputs, an important determinant of the future of Swedish production rests on the industry's ability to assure quality control all along the global production chain. The hitherto successful strategy has been based on control of inputs and production, based on an understanding of the system and consequences. The increasing rate and extent of disease outbreaks[58] despite increasing efforts at institutional control (such as the EU Rapid Alert System for Food and Feed – RASFF: *http://europa.eu.int/comm/food/food/rapidalert/index_en.htm*) may indicate that full control of a system as large as global animal production is practically impossible[59].

Sweden has begun to recognize and inter-

nalize the social-ecological costs of production changes within its own borders, by supporting the concept of "multifunctional agriculture" to secure agriculturally related public goods (ecosystem services, such as biodiversity and nutrient cycling) while also working towards economic efficiency and maximization of social welfare. Specific policies have been to support extensification of ruminant production and organic farming with mixed systems. These actions maintain biodiverse grasslands and open landscapes and restore recycling of on-farm nutrients between livestock and crops while at the same time fulfilling economic and social goals. A step towards internalizing imported ecosystem support would be to include measures of external ecosystem support in the national environmental goals. To measure farmlands as we do in this chapter is one possible measure to quantify this dependence, as it is both ecologically based and has communicative power. The WTO has also taken steps in this direction with the creation of "green boxes" that allow agricultural supports to "multifunctional agriculture" where consideration is taken for other factors than free trade alone.

Trade in itself does not degrade ecosystems, but the present institutional framework does influence its impact on the environment negatively, particularly because environmental subsidies are seldom recognized or included in national policy or economic accounts. We have close links in the economic system, such as price and delivery information. Feed factories in Thailand or Sweden can press a button and purchase tons of soybeans from Brazil in the morning and from Canada after lunch. There is information on price and delivery times, but nothing about soil quality or water used in production – nothing about the ecological consequences of our production abroad. The present international market system was designed to trade goods and maximize economic efficiency. That it does. It is amazing that we can drink coffee year-round from Brazil, Vietnam and Kenya. But economic efficiency alone is not sustainable. For the market to function properly social and environmental costs must be included so that products have the "right price".

Trade has removed a nation's limits on production and consumption, but the ecological limitations – and, potentially, the damage – still remain in the ecosystems of exporting countries. Because we are dependent on ecosystems for our basic food security it is in our own self-interest to insure their continued functioning. In fact, ecosystem capacity should be the framework within which we operate. Yet, the institutional framework we follow today is that of the WTO. This organization has rules that prevent nations from prioritizing environmental considerations. Members are not allowed to require that products be produced in an environmentally friendly manner. Sweden cannot refuse to buy soybeans that were the result of deforestation. Rules do not allow discrimination based on Process and Production Methods (PPMs). A nation can only differentiate on the basis of the final product. PPMs are important because production methods play a definitive role in the alteration of ecosystems and their capacity to generate ecosystem services, such as food.

This chapter has presented several recommen-

dations to improve consideration of environmental consequences in Swedish food consumption and production choices: expansion of production system boundaries, increased transparency, use of indicators with ecological relevance, traceability to the country of origin, revision of self-sufficiency figures, and internalization of ecological costs. Also, we need international trade institutions that maintain nature's life-support capacity where countries are not only allowed, but encouraged to have minimum environmental production standards. If it is not possible to have dynamic links and transparency with such a large system as the present globalized food provision system, then perhaps the global system must be transformed into smaller more manageable entities.

Notes and references

1. Globalization in Sweden is characterized by such features as higher trade volumes, a larger number of trading partners and longer trading distances (Deutsch 2004)
2. Deutsch and Folke 2005
3. The combination of the living parts of a particular area (plants and animals) with the non-living components such as water, light, nutrients, and air. These parts functioning together make a unique system called an ecosystem.
4. Borgström 1965
5. Statistics Sweden, Agricultural Statistics Yearbook, 2002 (SCB-JÅ 2002)
6. Our consumption of agricultural products was calculated as: domestic production + imports – exports = consumption. Domestic production is computed as the number of crop hectares cultivated to meet direct human consumption and all pasture and grazing lands, as well as hectares carrying feed crops required for our consumption of animal products: beef, poultry, pork, milk, eggs and so on. Imported products are, for example, coffee and olive oil or soybean cakes. Processed products are converted to farmlands using a conversion factor – for instance, a liter of orange juice is converted to fruit and, in turn, to hectares of farmland. Finally, all hectares used in

the production of exported goods are deducted (Deutsch and Folke 2005)
7. On-farm feed consumption is estimated by quantifying domestic production and then deducting exports and human consumption (Deutsch and Folke 2005)
8. Feed concentrates are made of cereals, oil seeds and byproducts from, for instance, sugar production, along with meat, bone and fish meal (SJV 2000). Apart from peas and cereals, input goods for cultivation were almost exclusively imported. Although many of these raw materials are byproducts, meaning crops that provide two products (such as soybean oil for cooking and soybean cake for animal feed), the entire farmland is included as necessary for maintaining animal production. However, not double counted when calculating human consumption. Feed concentrate provides at least 50 percent of the energy content in the overall feed requirements for livestock (SCB-JÅ 1998. and G. Gustafson, Department of Animal Nutrition and Management, Centre for Sustainable Agriculture [CUL], Swedish University of Agricultural Sciences [SLU])
9. SJV 2000
10. Feed concentrate volumes rose 160 percent from 1962 to 1999 (820,252–2,108,500 tons) (SJ 1965, SJV 2000)
11. SCB 1965–1995
12. L-E Lundqvist, (The Federation of Swedish Farmers – LRF) pers. comm.
13. FAOSTAT 2003
14. FAOSTAT 2003
15. T. Agn, Swedish Meats; V. Maeriläinen, ICA; J. Köpper, COOP; A. Nilsson, LRF pers. comm.
16. FAOSTAT 2003
17. SJV 2001; SCB-JÅ 2002
18. L. Ohlander, Department of Crop Production Ecology, SLU, pers. comm.
19. A number of external inputs have increased in line with production changes, such as inorganic fertilizer. The separation of livestock and crop production systems has reduced the potential to recycle nutrients, leading in turn to a greater need to purchase inorganic fertilizer.
20. P. Einarsson, (The Swedish Ecological Farmers Association – Ekologiska Lantbrukarna), pers. comm.
21. K. Larsson, Swedish Farmers Supply and Crop Marketing Association (Lantmännen), pers. comm.
22. SCB-JÅ 1998
23. Deutsch and Folke 2005
24. Ingelög, Thor et al. 1991; Svensson 1992
25. Bernes 1994
26. Risberg 2004
27. Ihse 1995
28. Björklund, Limburg et al. 1999
29. SJV, Naturvårdsverket et al. 2002
30. Lindén, Olsson et al. 2003
31. Blix and Mattsson 1998; Mattsson, Cederberg et al. 2000
32. Lindén, Olsson et al. 2003
33. Olsson, Lindén et al. 1999
34. SCB 1965–1995
35. Fearnside 2001; Donald 2004; Ratter, Ribeiero et al. 1997
36. Klink, Moreira et al. 1993
37. Fearnside 2001
38. Barber, Orellana et al. 1996
39. Fearnside 2001
40. Donald 2004
41. Härdter, Chow et al. 1997
42. Costanza, Audley et al. 1995; Robertson and van Schaik 2001
43. Witte 1998
44. Levin 1999
45. DN 2003-08-06
46. SJV 2003
47. Käferstein 2003
48. Carlsson-Kanyama 1998
49. Costanza, Audley et al. 1995
50. K-I. Kumm, Department of Economics, SLU pers. comm.
51. LRF's homepage (in Swedish): www.lrf.se
52. SJV 2000
53. SCB-JÅ 2002
54. SCB-JÅ 2002
55. K-I. Kumm, Department of Economics, SLU pers. comm.
56. SJV's homepage (in Swedish): www.sjv.se
57. SCB-JÅ 1965-2002; FAOSTAT 2003
58. Käferstein 2003
59. Holling and Meffe 1996; Milestad, Sundkvist, Milestad, Jansson 2005.

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AFRICA'S FOOD CRISIS
– Does Asia's green revolution offer any lessons?

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Introduction

Sub-Saharan Africa's inability to feed its growing population seems to be a permanently insoluble problem. Well, at least this is the impression conveyed by frequent misery reports. However, this has not always been the case: at the time of independence, for example, most of Sub-Saharan Africa was self-sufficient in food. In less than 40 years, the region has moved from being a net food exporter to dependence on imports and external aid programs. This is usually attributed, in part, to difficult natural conditions, with unreliable rainfall and highly varying harvest yields. But, in particular, negative expectations are heightened by the numerous accounts of corruption and powerlessness in "soft" states, or simply by the unwillingness of kleptocratic and villainous despots – often allied with powerful fractional interests – to embrace development.

This contrasts sharply with the accounts of Asian "miracle" countries, which, within a few years, advanced from being poor agricultural countries to being capable of securing their food supply via domestic production. Thanks to successful "green revolutions", several Asian countries succeeded in rapidly raising acreage yields for key food crops, reversing a situation of widespread food shortages to one of nationwide self-sufficiency, and even going as far as exporting staple foods.

In Sub-Saharan Africa, however, the production of staple foods has not at all increased to a similar degree and productivity has risen only marginally, with a few exceptions. Hardly any African country is self-sufficient in staple foods. Meanwhile, it is occasionally claimed that Sub-Saharan Africa offers substantial agricultural potential.[1] If so, why has it not been utilized? Why has the green revolution had so little success in Africa when it so obviously succeeded in Asia? What is required to achieve a similar result in Sub-Saharan Africa – if at all possible?

Part of the picture is that many Asian countries in the 1960s – when some of their green revolutions commenced – were, paradoxically, described in the same despondent tones as those currently reserved for Africa. Food problems threatened and were acute in many cases. Meanwhile – and so reminiscent of accounts from today's Africa – the Asian governments of the day were fre-

quently portrayed as being similarly incapable or unwilling to develop. The expression "soft" states – meaning countries that lack the requisite social discipline to implement policies – was coined by the renowned Swedish development economist Gunnar Myrdal with these particular governments in mind.[2] Nonetheless, they demonstrated that they were fully capable of driving a development process. How did this happen? Is there more to learn from these cases?

A research team consisting of some 20 international researchers, including Swedish and African researchers, attempted to provide answers to these questions by means of a project (*Afrint* – African food crop intensification) conducted from 2002 to 2004.[3] Accordingly, we studied Africa's food crisis against the background of the Asian experience. The Asia leg of the project consisted of an historical and comparative study of agricultural development in seven Asian countries based on written sources and interviews with key people.[4] The African leg of the project focused on four countries in what we may refer to as the Sub-Saharan maize and cassava belt.[5] Here, two types of surveys were conducted: first, on the macro level by means of an analysis of secondary data and interviews with key people; and, second, on the micro level through interviews with more than 3,000 smallholders in 103 villages in the eight countries. At the micro level, data compilation centered on areas with comparatively high potential for productivity gains, meaning areas with favorable agro-ecological (soil and rainfall) and infrastructure conditions (however, in an effort to gain a more generally applicable impression, most high-potential areas were excluded). Despite this selectivity, these survey areas may be viewed as representative of the environments in which a majority of the sub-continent's population live, while also being sufficiently varied to provide information on crucial circumstances for smallholder activities and considerations in this direction.

The green revolution in a new light

Advocating a green revolution is nowadays frequently viewed as quite inapt. In many cases it is almost like waving a red rag to a bull – a symbol so incongruous that it should preferably be avoided. Usually, the green revolution is described as a rather restricted technology package (seed, fertilizer and irrigation) centered on two food grains, namely, rice and wheat. In addition, it is viewed as an event during a limited period in the 1960s and '70s in a few countries in Asia – a one-off intervention. While it is conceded that it (temporarily?) succeeded in raising productivity in Asian agriculture, it is viewed as having done so at tremendous social and environmental costs.

In any case the green revolution is regarded as particularly inappropriate for transfer to Africa. First, it is viewed as being excessively dependent on irrigation, for which Africa offers limited potential. Second, the agro-ecological conditions in Africa are far too varied to lend themselves to a "standard technological solution". Moreover, the green revolution is seen as being excessively centered on crops that are less significant in Sub-

Saharan Africa, where, instead, maize, millet and root vegetables are the key to feeding people.

We found that a good deal of this criticism was mistaken and poorly supported – and frequently seemed intentionally misleading.[6] Of course, the Asian green revolutions suffered from a number of teething problems, leading to ecologically negative results (a disproportionate or inappropriate use of fertilizers, excessive farming and/or poor handling of pesticides and so on). Many of these shortcomings have since been put right through education, pricing policy and continuing technological progress. Similarly, claims regarding negative social consequences have proved exaggerated. When Asia's green revolutions were launched, many feared that only estate owners and large farmers would be able to afford the investment in the new technology and that smallholders and leaseholders would become mere workers and lose their land. Although these worries were then well-founded, actual development has provided little support for them. On the contrary, the technology proved to be scale neutral, with smallholders frequently benefiting most from it. Well-informed writers on the subject emphasize increasingly that the green revolution was a powerful means of combating poverty and can also be so in the case of Africa.

Claims that the green revolution would not be suitable for Sub-Saharan Africa – or, alternatively, that Africa is not suitable for a green revolution – look increasingly like hasty conclusions. These assertions are based primarily on a static view of the green revolution, and often appear to focus one-sidedly on "Asian" crops such as rice and wheat. To be sure, this is where it once started, but since then the green revolution has progressed and has become increasingly Africa friendly.[7] Plant breeding does not only involve raising harvest yields per hectare, though the development of high-yield seed varieties remains a key feature. Alongside this, the green revolution has focused on a greater number of crops than the original two, and progress has been made in terms of increasing the number of food crops of significance for Africa (such as maize, millet, beans, cooking bananas, sweet potatoes and cassava). Meanwhile, considerable research has been carried out on creating new seed varieties that offer faster growth and/or greater drought tolerance and resistance to disease. Consequently, technology (or for that matter, nature) is nowadays less of an obstacle than it was just a few decades ago.

Nevertheless, equating the green revolution with technology is misleading. A number of factors determine whether it seems advantageous to use or copy (new) technology. Naturally, all forms of technology are important but only as a component among several in a more extensive reform package. In Asia, the role of the various states in implementing the green revolution was of decisive significance (refer below). There, the new technology was encompassed by political priorities that underscored the role of smallholders, along with agricultural research, advice, credit programs, pricing policy and import protection, etc. Our interpretation of the Asian green revolution is summarized in Figure 1:

- The Asian green revolution was state led in

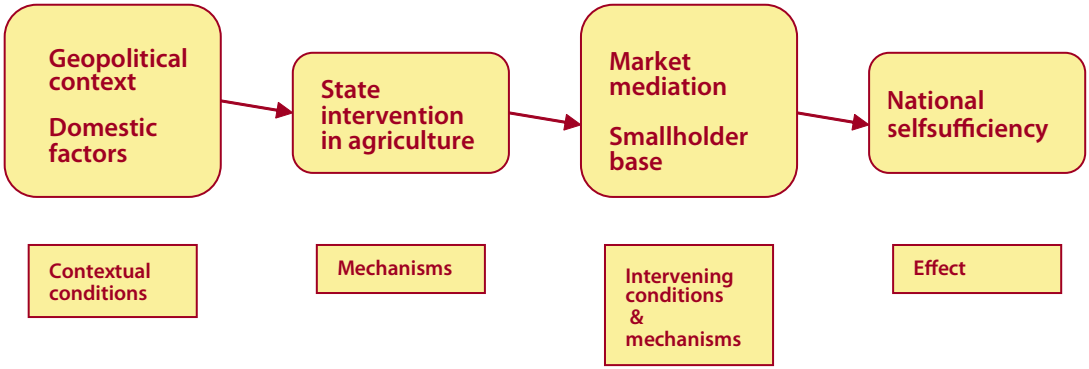

Figure 1. A causal model of Asian green revolutions.

the sense that the state was the initiator and the driving force behind the development of the agricultural product chain.

• The Asian green revolutions were initiated by governments with the aim of attaining national self-sufficiency in staple foods. This was warranted not only by direct food supply problems but also by uncertainty regarding the potential to cover requirements by means of imports.

• The Asian green revolutions were market mediated, meaning that the market and private players played a key role in various stages of the product chain, in respect of agricultural inputs, as well as trading and product processing. Thus, we are not dealing with socialist models, as pursued (less successfully) in countries such as China and Vietnam into the late 1970s or in North Korea up to the present day.

• Asia's green revolutions were smallholder based, that is, they were founded not on the basis of large estates or on large-scale mechanization. Asian rice farming continues to be dominated by small-scale family holdings.

• Finally, we underscore the importance of the geopolitical situation and the domestic political dimensions, which prompted many Asian governments of the day to invest seriously in the implementation of what was then a new agricultural policy, usually referred to as "the green revolution".

We would like to note that the model is not used as a normative concept but as a causal and explanatory model. As such, it may assist in understanding the Asian experience. We hope, however, that important lessons can be drawn in respect of Africa's potential to carry through a green revolution in the early 2000s.

The Asian experience

Even though the general pattern of change in Asian agriculture is complex and varied, it is

nevertheless possible to identify a sufficient set of common denominators to point to the special development path in the region. Beginning in Japan during the Meiji period (1868–1912) and subsequently repeated in the region in the 1960s and 1970s, Asian governments began to realize that agriculture, and notably food production, had to be stimulated instead of exploited if their countries were to remain independent. Moreover, the growth of agriculture began to be seen as the only realistic way to finance industrialization and modernization. Asian regimes decided to promote food production by means of extensive programs of credit granting, and subsidies, along with price policy, infrastructure investments (roads, irrigation and schools) as well as research and advice as part of efforts to develop and distribute high-yield seed varieties and new farming methods.

While these governments assumed a leading role in agricultural development – with administrated markets becoming the norm – by no means were they socialized and private merchants eliminated. On the contrary, in the Philippines in 1982, for example, private dealers handled 90 percent of the wholesale trade and 90 percent of the retail trade in rice. It is worth noting that it was profitable for smallholders to adopt the new technology, but also that the green revolution at the time was initiated in high-potential areas that could be expected to offer attractive investment returns. This permitted continuing investments in other areas at a later stage. Consequently, but also as a result of migration and the leveling out of inter-regional factors, regional inequalities were not as sizeable as forecast by early critics.

Almost simultaneously, but evidently independently of each other, governments in India, Indonesia and the Philippines made a complete reversal in their agricultural policies with the introduction of the green revolution program in the early 1960s. Almost without exception, these and other similar approaches broke not only with the established practice (which stressed the importance of keeping rice prices low for the urban population) but also with the prevailing orthodox development theory of the time.

A number of factors interacted to induce Asian regimes to assume the role of developing states. In a number of countries, population growth, combined with poverty and limited access to agricultural land, led to social unrest, food queues and food riots. The fact that the very survival of governments was threatened by growing political opposition explains, in part, the political policy reversals. In a bid to retain power, existing governments in Japan and India, for example, began to support domestic food production and improve conditions for smallholders, who became the backbone of the new agricultural development programs. In the Philippines, Ferdinand Marcos was elected president 1966 on a program aimed at raising domestic rice output. In other countries, such as Indonesia, military coups permitted new leaders to break with previous policies and focus on the same goals. In some cases, such as Taiwan and South Korea, reforms were pushed through that strengthened smallholders. This led the governments to win widespread support from the poor majority of the population.

External geopolitical factors played an equally

significant role. War and the threat of war with neighboring countries (India-Pakistan, India-China, China-Taiwan, and the Korean conflict) fuelled pressure on governments. Following independence in 1947, India was incapable of feeding its population without wheat imports from Pakistan – formerly a part of India prior to separation. Following hostilities between the two countries over control of Kashmir, the Indian food situation deteriorated and it became increasingly crucial to attain national self-sufficiency in food. In South Korea and Taiwan, the geopolitical conditions were decisive. Under the threat of an invasion from North Korea and China, respectively, the South Korean and Taiwan governments managed to secure far-reaching freedom of action that powerful fractional interests would otherwise have denied them.

In addition, all this occurred at the height of the Cold War. There were widespread fears, not least in the US, of contagion from the Chinese revolution (the domino theory), and the thinking was that an ample supply of food for the peasantry could offset this threat. The US government also made a policy reversal: From having previously focused on food exports – strongly influenced by domestic concerns regarding excess wheat production (for example, the PL 480 program) – Washington began to underscore the importance of exporting technology instead of wheat surpluses. Both directly and indirectly, via the Ford and Rockefeller foundations, for example, major programs were pursued at international plant research institutions – including CIMMYT in Mexico (wheat) and Los Banjos in Philippines (rice) – aimed at the development of new, high-yield seed varieties. Moreover, these were shared, free of charge, with countries that were interested (though not with China, of course). This approach was a major contribution to the rapid spread of the new technology. As noted, the result was a surge in output and productivity in Asian food grain cultivation, coupled with declining social unrest and national self-sufficiency in staple foodstuffs.

Also, at this time world grain prices were high, making food imports costly. Not only did this reinforce the significance of a policy aimed at national self-sufficiency in staple foods, it also made it economically prudent to introduce subsidies and pursue an active agricultural price policy. Thus, overall we see how a series of simultaneous and interacting factors – both external and internal – contributed, firstly, to Asian government policy reversals and, secondly, to the dedication with which the Asian green revolutions were pursued.

The African dilemma

It is frequently claimed that Sub-Saharan Africa's currently troublesome food situation is due to the green revolution (in the technology sense) never reaching the subcontinent. In part, this is viewed as being due to these technologies not being adapted to suit African conditions, and, in part, because African governments neglected agriculture. However, the problem of Africa's food production is not primarily one of technology (such as unsuitable crops) or nature (such as poor soil

and unreliable rainfall). Neither is it due to the alleged lack of interest among African governments in developing agriculture. On the contrary, numerous attempts have been made at state-led agricultural intensification. However, these have generally resulted in short-lived production increases rather than sustained productivity gains. Instead of posing the question: "Why has Africa not undertaken green revolutions?" we should ask: "Why have they not proved sustainable?"

To be sure, part of the answer is that before the 1980s, few suitable high-yield crops were available. But this does not suffice as a general explanation. The issue is primarily one of policy, but policy is not an autonomous variable. To understand the policy pursued (or not pursued), it is necessary to look at the circumstances that shaped the policy (or lack if it) and at the situation that political decision-makers faced.

Conditions in Africa in the 1960s were totally different than those prevailing in Asia. Sub-Saharan Africa is an enormous subcontinent and one that has long been viewed as "under populated". There was ample uncultivated land and the need for the intensification of agriculture (capital- and labor-intensive) was by no means as urgent as in Asia. Up to the mid-1970s and in certain cases to the 1980s, most countries included in the Afrint study were self-sufficient in food, while Sub-Saharan Africa was actually a net food exporter in the 1970s. Thus, there was no acute, permanent food crisis (although temporary supply problems did arise) and domestic pressure for change was weak.

Also, external pressure on governments was insignificant or non-existent. Dependence on food imports was not at all as great as in Asia. Moreover, ever since independence it had been axiomatic (not just within Africa but also among donors) that the (colonial) national borders were not to be revised, thereby further reducing external threats as effective mobilization factors. The vast distances and sparse population also meant that the expansion of infrastructure (road, rail and power networks) was relatively costly and not as extensive as in Asia. But this is not to suggest a complete lack of action, however.

A number of modernization programs were undertaken, but these consistently assumed the character of short-lived production gains. For the most part, these modernization efforts involved securing the urban population's food requirements by suppressing prices of staple foods. (Just as in Asia prior to the policy U-turn). Investments were made in state-controlled farms and large-scale irrigation projects, which tended to be hampered by bureaucratic inefficiency and poor profitability, as well as in large estates, which were frequently owned by government-allied "entrepreneurs", who grabbed most of the subsidies. The supply of food for smallholders and the rural population was not normally viewed as a problem.

The situation changed dramatically in the 1970s following a series of internal and external shocks. Population growth and drought (in the Sahel region, for instance) combined to make the food supply consistently precarious. Meanwhile, oil prices quadrupled in 1973, undermining most government budgets; followed by plummeting copper prices in 1974, which hit Zambia

very hard. These developments prompted many African governments to promote food production and assume a leading role in developing agriculture. Public sector expenditure in the agricultural sector was consistently substantial. As in Asia, the government provided credit and assumed responsibility for inputs (seed, inorganic fertilizer and so forth) and for trading in agricultural commodities via marketing boards. Plant research programs commenced and new, high-yield seed varieties were made available.

However, these moves did not always encompass smallholders, or at least not for any length of time. In Kenya, for example, subsidies for inorganic fertilizer ceased (presumably for cost reasons) when the modernization program was extended to encompass the majority of farmers. In Zimbabwe, seed and inorganic fertilizer, which were previously reserved for the white minority farmers, were extended to the black farming majority, resulting in a deluge of maize. Prices plunged, farmers were unable to repay their loans, government finances were undermined and the program was abandoned after just a few years.[8]

However, a series of reforms were conducted that are superficially reminiscent of the Asian programs. Unfortunately, African market reforms involved almost exclusively the government monopolization of trade in agricultural inputs and commodities. Price policy assumed the form of pan-territorial and pan-temporal pricing, which meant (at least in theory) that all farmers received as much (or as little) payment irrespective of where they were and the time of the year they had anything to sell. This resulted in relatively stable markets – much appreciated by the small farmers. However, it was costly for the state, particularly because of poor infrastructure and, thus, high transport costs. By contrast, the Asian reforms commenced in favored areas with substantial underlying populations and relatively favorable communications, which facilitated program costs. African efforts were far more costly and were economically unsustainable in the long term. As opposed to Asian reforms, margins between production costs and product prices were squeezed both for farmers and (public sector) intermediaries, reducing the incentive to produce for the "market".

Since governments consistently gave priority to low (urban) consumer prices instead of higher (rural) producer prices, this resulted in the preservation of the status quo rather than progress, and in areas in which conditions were worst, smallholders withdrew into subsistence farming.[9] Parallel with losses among government cooperatives and "marketing boards", the cost of subsidies increased and, ultimately, the situation also became untenable for the state authorities.

That this unsuccessful – at least economically – policy continued for such a protracted period is attributable in no small degree to the political weakness of African states. However, it is wrong to attribute the blame – as is commonly the case – to "rogue states" with kleptocratic tendencies. It hardly seems reasonable to presume that African politicians are more or less roguish than politicians elsewhere.

As noted, Asian states were in many cases weak and corrupt. However, the considerable

pressure for change to which they were exposed compelled them to act as vigorous developing states, permitting them to transcend and discipline fractional interests and pursue long-term, national development programs. This contributed to strengthening and legitimizing the Asian states. In many cases, it also allowed them to implement reform programs by means of heavy-handed "persuasion".

In Sub-Saharan Africa – where governments have substantially less control over their particular territories[10] and where corresponding pressure for change was absent, a much more cautious approach was adopted, as exemplified by numerous cases in which credit repayments ceased or were simply remitted. As opposed to Asia, African government authorities – in a bid to ensure short-term survival – allied themselves with fractional interests. Local strongmen, such as village, clan and tribal chiefs, were co-opted and given benefits, provided they remained loyal to the distant state apparatus. In brief, indirect governance became the norm also after independence. While the Asian green revolutions encompassed smallholders, African reforms generally excluded them and thus failed to revolutionize agriculture.

Moreover, during the Cold War, aid was frequently given to reliable governments as direct support for state finances – irrespective of whether or not these governments had any development aims. As a result, in many cases aid functioned as an artificial lifeline, making governments less dependent on national development. The state remained weak, distant and challenged, and development failed to emerge.

Changes in game rules

In the 1950s and '60s, it was almost taken for granted that the state should play a leading role in development programs. This is supported not only by academic publications dealing with the development of the "Third World". A similar role was played by governments in the development of the "welfare state" in the West. Since then, the view of the government's role has undergone a radical change. This is due partly to the experience noted above, but in particular it is because the Western welfare state and the apparatus managing it are increasingly questioned. Following the fall off in postwar growth, the role of the government in Western states has emerged as a problem rather than a solution, as manifested in the neo-liberal renaissance since the 1980s. From the mid-1980s to the mid-1990s, many African states were compelled to accept Structural Adjustment Programs (SAP) in an effort to reduce the direct involvement of the state authorities in economies and instead make way for private market players. SAP also marked the end of the previous price policy, plus the termination of subsidies for agricultural inputs. In middle of this period, the Cold War came to an end with the collapse of the Soviet Union in 1989. This also removed the need to provide aid, which has been halved since then.

This has undoubtedly raised the pressure on African governments to achieve something. It was expected, for example, that structural adjustment would lead to intensified agriculture and an acceleration of overall development. Results, however, have not lived up to expectations – notably in agriculture. Family farming is mainly small

scale, in terms of both acreage and output. Family members work in the fields, with women accounting for the greater share of the labor input, using basic hand implements. Both average output and yield per hectare for key crops (maize, rice, millet and cassava) are low, although there are variations in and among villages and regions. The *Afrint*-project found, for instance, that the mean yield per hectare is currently merely 1.3 tons for maize (median 1 ton per hectare) but also that productivity differences are considerable within the various villages. The top producers (just a few percent of smallholders) gain yields that are more than twice those of the poor majority (refer to Figure 2).

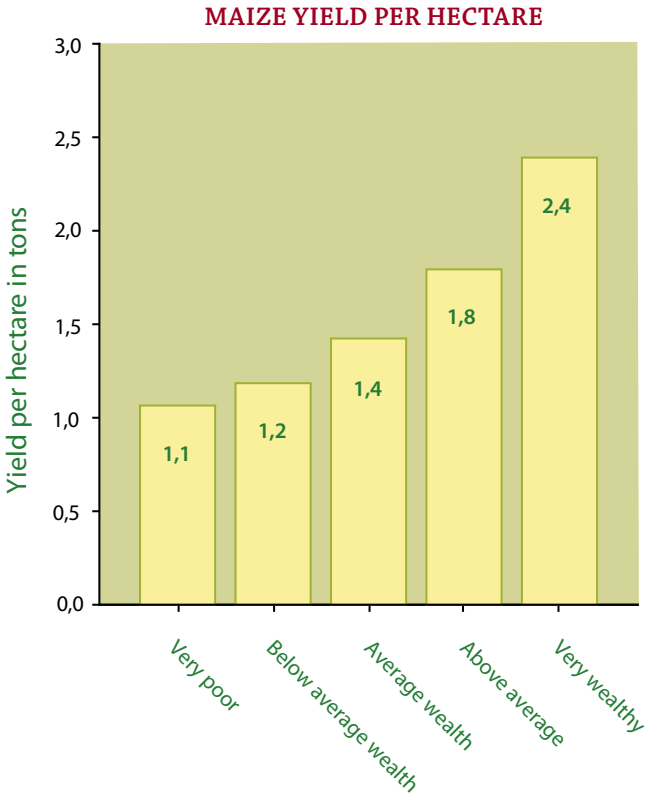

Figure 2. Maize yield per hectare, in tons, based on wealth category.

Frequently, high-yield smallholders also have access to larger acreage (note that the *Afrint*-study focused on smallholders and excluded large farmers). This difference is because only a small minority of smallholders can afford inorganic fertilizer . It is also this small, high-yield minority that can produce for the market while the large majority of smallholders – focusing mainly on self-sufficiency – are not actually self-sufficient in food from harvest to harvest, even during a good year.

In most cases the situation has deteriorated since the introduction of structural adjustment programs. The presumptions of the World Bank and donors – that there was a large group of willing and able market players waiting in the wings who would rapidly and readily fill the vacuum left by the retreating state – turned out to be nothing more than wishful thinking. In Sub-Saharan Africa, the markets – like infrastructure in general – are little developed and transaction costs are high.

Nevertheless, smallholders are generally positive to new technology. Even though hybrid seed is occasionally reused (which reduces harvests), the use of high-yield seed varieties is common, notably in the case of maize, with utilization actually higher in Sub-Saharan Africa today than it

was in South Asia in the '70s (*Afrint* data). This suggests that technology is not a great stumbling block, as often contended. On the other hand, few smallholders can currently afford to use inorganic fertilizer and, thus, the harvest potential offered by new seed varieties cannot be realized. Our interviews also pointed at problems that smallholders feel are the primary obstacles to higher food production, namely, high prices for inputs, notably inorganic fertilizer (African smallholders now pay the highest prices worldwide for inorganic fertilizers), and low prices for marketed products.

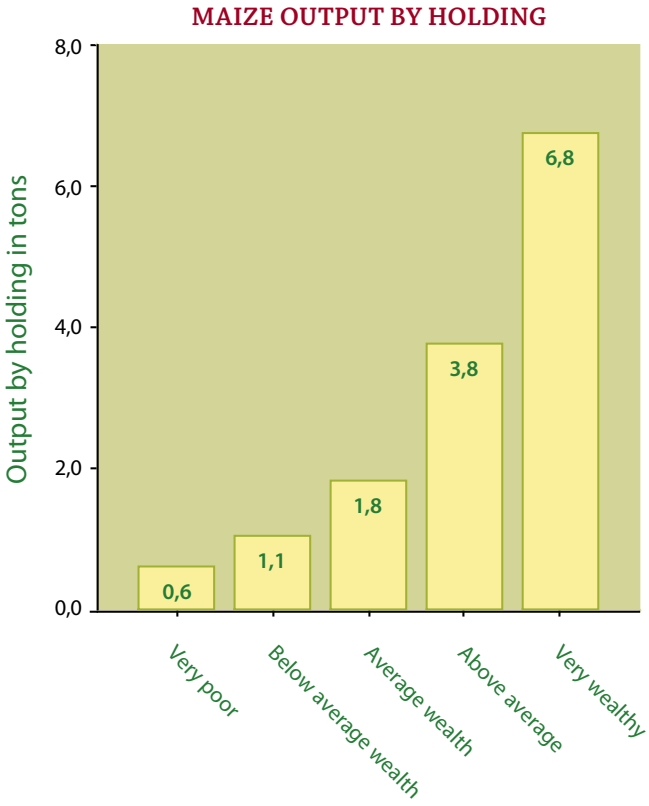

Figure 3. Maize output by holding, in tons, based on wealth category.

In our (relatively favored) survey areas, we found that only about 10 percent of households succeeded in producing a saleable surplus of food crops. More than half of the households interviewed were compelled to purchase staple foods in local markets. To afford this, they can get income from other sources, such as by selling cash crops (cotton, tobacco and coffee) or by wage labor. But since markets are undeveloped and local purchasing power is low, this potential is limited and is available mainly to the relatively favored minority of wealthy households. For the majority of smallholders, such income is small and insufficient to alter their exposed situation.

However, everything is not bleak. African agriculture has unutilized potential and the continent has the capacity to be self-sufficient in staple foods without major inputs. The already noted productivity booms, resulting in "maize floods", as well as local yield gaps, as noted above, provide evidence of this.

Time for an African green revolution?

The current situation in Sub-Saharan Africa is similar to that in Asia in the 1960s, with food shortages and social unrest as common features. A rising population has led to shrinking farm plots, with no uncultivated land available in

many locations. Thus, intensification (more output from less acreage) is necessary. Plant breeding has provided a range of high-yield, drought-tolerant and pest-resistant crops suitable for Africa's ecological conditions. Farmers are highly positive to new technologies. The reduction in aid, combined with problems in the wake of structural adaptation, has evidently compelled a number of African states to become more active. The Afrint study found, for instance, that some African states have infringed the SAP stipulations in a number of ways (by reintroducing import bans, flexible protective tariffs, subsidized inorganic fertilizer, and so forth) and that a number of governments now appear willing to play a role resembling that adopted by the Asian states in the past. These observations suggest that the time may now be ripe for an Africa green revolution.[11]

But a number of factors challenge this conclusion. The fact that passive governments are no longer propped up by means of "aid" is a positive development; however, a relatively larger reduction in agricultural aid vis-à-vis overall aid presents a problem. The shrinking economic resources of African states have resulted in a decline in agricultural research and a collapse in advisory services, among other negative effects. Meanwhile, the financing of plant research by the developed countries has also declined, and is increasingly being turned over to large, transnational companies who do not provide anything for free. While world market prices for grain were high in the 1960s and '70s – making it financially sound to subsidize domestic production – prices have since fallen back to their lowest level since the Second World War. This has made it more difficult to justify a price policy similar to that of Asia. However, these low world market prices are "artificial" and are caused by the developed countries' subsidizing their agriculture, leading to overproduction. Some of this excess output is dumped in poor countries, thereby further reducing the incentive for them to invest and develop their domestic markets.

Every man for himself! The Asian governments that conducted green revolutions did so from compulsion and an immediate survival interest rather than for generally progressive purposes. During the Cold War, the developed countries had no problem in propping up corrupt and reactionary regimes as long as it was in their interests. Development was not always the primary goal of aid policy. In Asia – with a few exceptions – the green revolution was supported, since it was viewed as a form of protection against the "Red Peril". Today – as rich countries sing the praises of the market and compel African governments to reduce their role in their economies – these same affluent governments are undermining market development and green revolutions in Africa. For these governments, power over food and the support of their own farmers and the food industry is obviously more important than nurturing poor, malnourished African smallholders. Today, the West lacks sufficient pressure for change to warrant a policy that promotes development in parts of the world other than its own.

However, despite the obstacles, the situation can be changed and, thus, we would like to close this report on a positive note. Our analysis has

shown that African governments can reverse the downward trend – but not without support from the international community. This requires political intervention at several levels, including the adjustment of international trade rules and changes in research and aid priorities. This is a challenge not just for African regimes but equally so for Western governments and aid agencies, whose emphasis on a holistic policy stance is sufficient reason to finally adopt a coherent approach to the food supply problem, as so frequently requested.

The international debate on poverty and food supply is now progressing rapidly. As recently as a year ago, it was acceptable to discuss poverty without any reference to agriculture and its role. Now suddenly it seems the simple truth has grown roots: Poverty in Sub-Saharan Africa is largely because the farmers who are expected to feed the continent do not have enough to feed themselves. International donors are now beginning to adjust their activities to this simple truth, even though Sida (Swedish International Development Cooperation Agency) was a bit slow off the mark.

A coalition of 25 donors, including the World Bank, FAO, IFAD, USAID, DFID and Sida[12] recently agreed a platform for agricultural and rural development required to achieve the Millennium Development Goal for hunger reduction. Points of agreement include:

- that poverty is primarily a rural phenomenon and that rural development is driven by agriculture,
- that it is profitable to invest in rural development, and
- that far greater resources are required if he goal of halving poverty be 2015 is to be met.

Similarly DFID[13] has issued a policy document that candidly states what everybody has avoided saying for years, namely, that we must invest in high potential areas if we are to kickstart dynamic agricultural growth that will ripple out to less favorable areas.

Meanwhile, the pendulum in the aid technology debate has done a full swing. We are now back to the 1970s and discussing budget support and sector programs. Consequently, the new mantra in the aid debate is to support the entire agricultural and rural sector in recipient countries. This is one of two points that should make us feel uneasy. We can only hope that the level of professionalism in aid organizations and skills among agricultural officials in recipient countries has increased sufficiently to avoid a repeat of the mistakes of the 1970s.

Finally, the other point of concern is that if the EU and US continue to subsidize their agriculture and dump their surpluses, the basic situation will not change. It will continue to be cheaper for African leaders to feed their populations in the major cities by buying maize from Kansas rather than from their own hinterland. So why not continuing doing so?

There is, however, a light in the darkness. As noted, food grain prices in the 1960s and '70s were rather volatile and occasionally very high. This encouraged leaders in Asia to replace grain imports with domestic output. This carrot has not been available to African leaders. Now, however,

the situation appears to be changing. Concerns about climate change with the resulting efforts to replace fossil fuel with bio-energy, coupled with China's emergence as a major grain buyer, appear to be driving up global prices. It may again be attractive to invest in utilizing the potential that actually exists in African agriculture. And it need not occur at the expense of food security. Given these conditions, it is possible to envisage African leaders working openly with donors.

And they can, indeed, if they are given the right incentive. *After all, they are no different from us!*

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INTERNATIONAL TRADE IN AGRICULTURAL COMMODITIES, ECONOMIC DEVELOPMENT AND EU AGRICULTURAL POLICY

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Introduction

Food is a basic prerequisite for mankind in more ways than one. Besides the obvious need to eat in order to survive, numerous people remain economically dependent on agriculture. Most of the world's poor live in rural areas and a majority of the most impoverished people are directly or indirectly dependent on the prices of staple goods that they themselves grow or buy. To date, population growth has not led to a shortage of foodstuffs at the global level. Production gains have more than offset the rising number of mouths to feed. However, the distribution of food is highly imbalanced. Almost one billion people are extremely poor and/or suffer from malnutrition. In pace with globalization, rising trade in foodstuffs may level out differences in natural production conditions, while also providing vital income for many of the world's poor. Unfortunately, over a protracted period, the international food trade has been characterized by very peculiar circumstances, with the West[1] – by means of tax-based subsidies – selling substantial surpluses at artificial prices and using high tariff barriers to protect its own markets from unrestricted competition from other countries. As a result, it has been difficult for farmers in the South to attain profitability in farming and gain success in exporting their products. This paper discusses food supply, and the relationship between food trading, EU agricultural policy and economic development, as well as commenting on the role of the World Trade Organization (WTO) in this context. Some of the issues are also discussed in the chapter paper *Toward a Brighter Future for Farmers?*

Economic development and the supply of food

Human capacity to find new solutions and improvements has led to enhanced production efficiency and increased output, among other gains. Nowadays, there are many societies in which large majorities of people never need personally devote time, energy or effort to produce food for the day. For the first time in human history, we have entire societies in which only a few percent of the population are directly involved in food production. The situation differs little in the case of other necessities, such as clothing and housing.

Throughout the industrial world, societies have changed from having previously been agrarian, with a majority of the population engaged in agriculture, to the current situation with complex structures within which, by historical standards, we consume unbelievable amounts of goods and

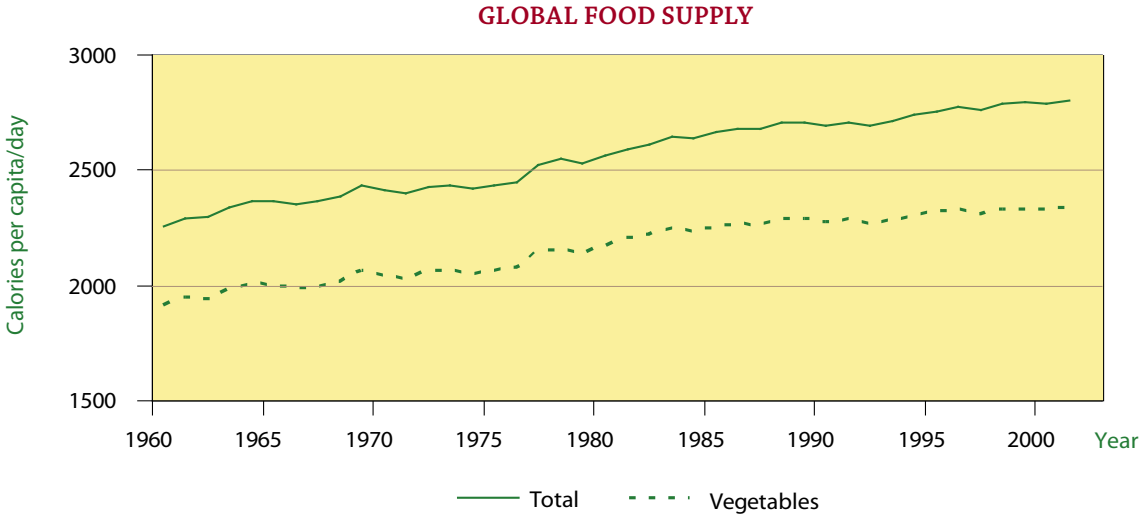

Figure 1. At the global level we can conclude that the supply of food is not a real problem, having increased steadily over the past 45 years.

services and within which living standards have surged over a relatively limited period. Today, we are witnessing similarly rapid development in major regions worldwide, notably Asia. International trade is a focal point for development through which production specialization offers also small countries opportunities for favorable growth.

Parallel with the high – and in many cases rising – levels of affluence, there is, however, another reality. A considerable share of the world's population lives under conditions totally unacceptable in the West. About one billion people suffer from extreme poverty, famine and malnutrition. Many lack the most essential necessity – food for the day.

Agricultural produce is needed not only to avoid starvation. Worldwide, a majority of the poor continue to live in rural areas and are totally dependent on agriculture. At the international level, there is a clear relationship between inferior economic progress and a high proportion of rural population. Poor farmers and villagers can get food by growing what they require or by getting an income that permits them to buy food. In many countries, improved income for rural dwellers is frequently synonymous with higher prices for agricultural produce and for their labor. Thus, the supply of food for the individual household is directly linked to food prices. If a society is to progress economically and raise the food supply,

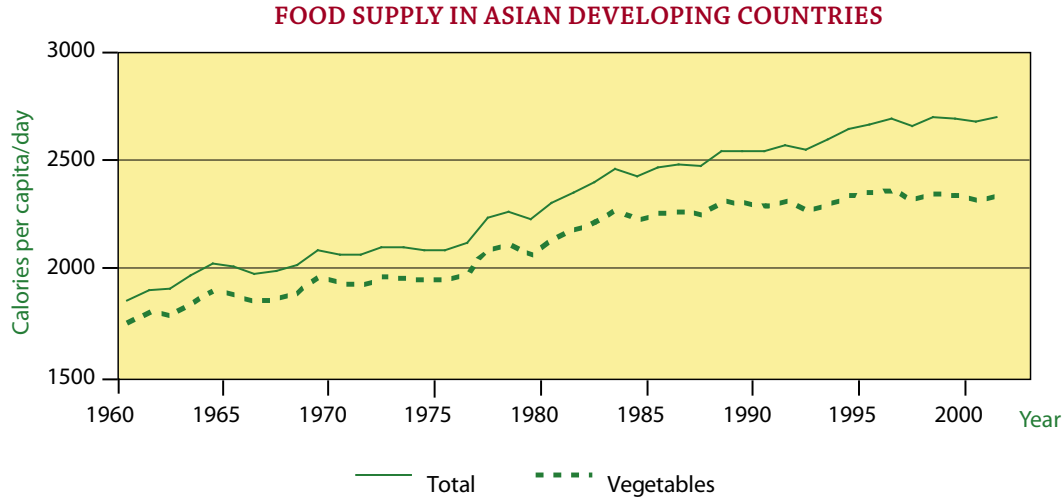

Figure 2. During the 1960s and '70s, the average food supply in Asia rose steadily, though rather slowly, before increasing sharply during the 1980s and '90s.

technological progress, specialization and productivity gains must also emerge in agriculture.

However, at the global level, we can see that the food supply presents no real problem, having risen sharply over the past 45 years. Gains in food output have actually outpaced population growth at the international level. The FAO[2] provides data on food supply and food trade from the 1960s to the present day. For most people, the daily food intake consists mainly of vegetables. The FAO's foodstuffs database shows that almost 85 percent of the daily average calorie intake for people derives from vegetables. During the period covered by FAO data, the share of vegetables declined from 85 percent till 83 percent.

Thus, the situation looks rather positive at the global level. On a per capita basis, calorie intake is rising steadily and, as yet, there is no indication that the world will encounter serious problems with the overall food supply. However, behind the generally positive picture from the FAO's aggregated data, there are vast variations in the food supply.

As could be expected, we in the industrial countries have long enjoyed access to a calorie volume far exceeding our average requirements. In contrast, a large majority of people have had an average food supply that is far closer to the daily requirement for a tolerable life.[3] Since the FAO's figures are average estimates covering large re-

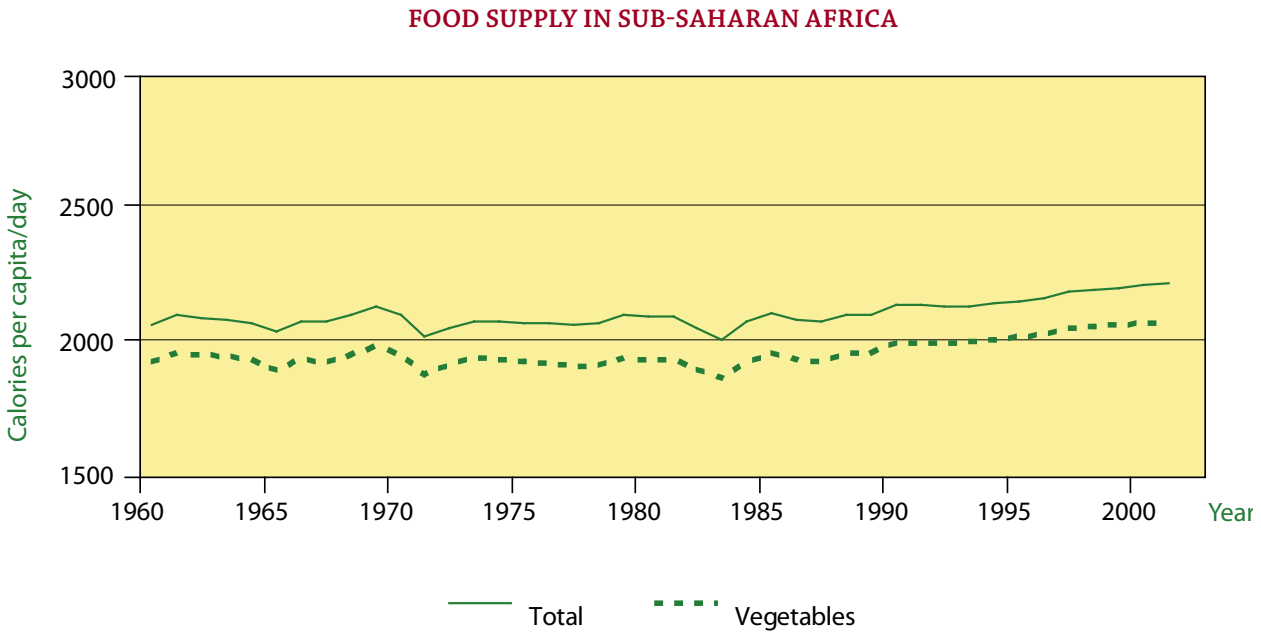

Figure 3. In the case of Sub-Saharan Africa, the lack of development and problems with the food supply emerge more distinctly. This area has seen almost no improvement in recent decades.

gions, many people did not receive sufficient food during the particular period.

The FAO data shows a number of distinct trends. For example, the proportion of vegetables consumed in the well-off developed countries is well below the average. Throughout the period, the share of vegetables consumed in the West ranged from 71 to 73 percent. It can also be noted that even though we have had more than we need, the food supply has consistently continued to rise.

A study of the data for developing countries in Asia reveals a radically different picture (Figure 2).

At the beginning of the data period, famine and poverty were widespread in many of these countries. During the 1960s and '70s, the average food supply climbed steadily, but rather slowly, before rising significantly during the 1980s and '90s. The primary underlying factor was that China managed to raise its food supply from some 2,000 calories per capita /day at the end of the 1970s to almost 3,000 calories per capita/day by the end of the century. Similar positive progress was also reported by other developing countries

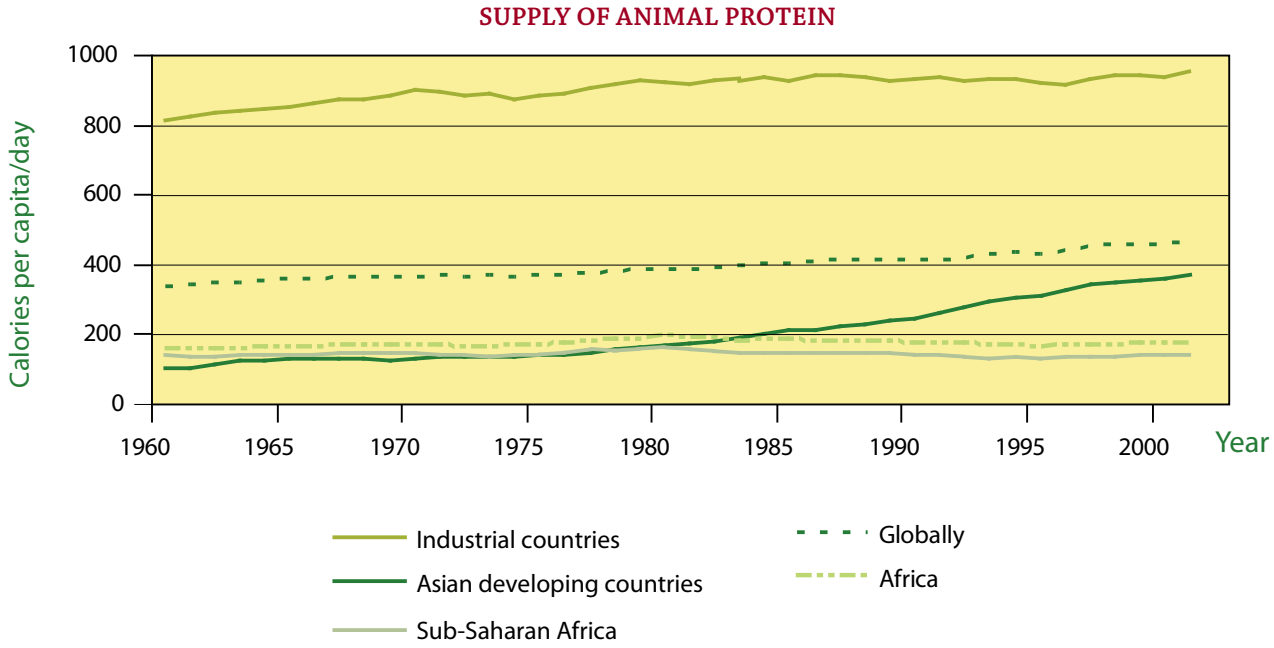

Figure 4. For people with ample access to food, any improvement in their financial situation is reflected in a rise in the share of meat and dairy products in their daily diet, among other effects. The enormous difference in living standards evident today is also mirrored by the fact that we in the West eat six or seven times more meat and dairy products than the average African. Positive development in Asian developing countries is marked by the population eating more than 3.5 times more meat and dairy products today compared with the early 1960s.

in Asia. In addition to the rising average food supply, there is also a distinct reduction in the proportion of vegetables, which declined during the period from a full 95 percent in 1961 to about 86 percent, in other words close to the average for the world population in 2002.

Progress in South America and Latin America was not quite as dramatic. Compared with Asia, most of the countries there had a substantially high average food supply at the beginning of the period and progress has since been positive but not quite as robust as in Asia. Overall, the supply of meat and dairy products has been substantially higher in South and Latin America. A comparison between Africa and Asia's developing countries shows even more distinct contrasts.

For Africa as a whole, it may be noted that the situation was slightly better than in Asian developing countries in 1961, but that development since then has failed to match that in Asia.

Instead, there is a very slight but steady increase in the food supply, with a number of periods of declining output during the 1960s, '70s and '80s. Neither did the share of vegetables decline during the period, ranging from 92 to 93 percent in all years.

However, there are also considerable differences within Africa. Sub-Saharan Africa shows a lack of development, with clear problems in the supply of food (Figure 3). This area has seen almost no improvement in recent decades. The lack of progress is also indicated by the fact that the share of vegetables consumed in Sub-Saharan Africa increased from 93 percent to 94 percent of the total average calorie intake between 1961 and 2002.

For people who have hardly sufficient food for the day, the change in food supply is probably an apt reflection of overall economic development. For those who can satisfy their appetite, an improvement in economic conditions is reflected in a rising share of meat and dairy products in the daily diet, for example. Accordingly, one way of summarizing the average development discussed above is to look at the supply of meat and dairy products.

Thus, food supply has risen in terms of average calorie intake per capita. There is sufficient food at the global level, but there is an inability to distribute the resources to ensure everybody can avoid famine and poverty. The vast difference in current living standards is also reflected by the fact that we in the West eat six or seven times as much meat and dairy products as the average African. The progress in Asia's developing countries is reflected notably by their consumption of more than 3.5 times as much meat and dairy products today as they did in the early 1960s.

Trade, liberalization and development

Economic development and affluence in the North is attributable largely to greater economic integration and growing international trade. The share of output sold internationally continually outpaces the growth in production. Efficiency gains are boosting output, but international trade is growing even faster.

In the case of agricultural commodities, distinguishable trends emerge from the globalization process in the past few decades. In absolute terms, the overall export volume of agricultural goods has risen, but as a proportion of total exports, agriculture has witnessed a declining share. In the early 1960s, it was more than 30 percent; by the beginning of the new millennium, agriculture accounted for only 10 percent of total goods exports.

For countries in the South, it is also noted that there is a definite decrease in the significance of agricultural commodities in the international trade of these countries. The share of agricultural commodities of both exports and imports has decreased but the fall is much larger in the case of exports. Another reflection of the same trend is that the South's share of global agricultural exports dropped from almost 40 percent in 1961 to less than 30 percent in 2003.[4] During the same period, the developing countries' share of total imports of agricultural commodities increased.

In other words, the past 40–45 years have seen a marked trend, with developing countries declining in significance as export countries while increasing their share of imports. This pattern is particularly evident in Sub-Saharan Africa.

A similar trend is noted when we look at agriculture's share of national exports. It is most evident for countries in Sub-Saharan Africa, meaning that agricultural exports have declined as a proportion of total exports. Nonetheless, agricultural commodities continue to account for some 20 percent of total exports from these countries, though the share was almost 70 percent in the early 1960s. As regards imports, the share has fallen marginally, but ranged from 20 percent to 15 percent throughout the period. In many cases, losses in the agricultural commodities trade have not been offset by gains in other trade.

In Latin America and the Caribbean, agricultural goods continue to account for a large share of exports, but have also experienced a decline. In 1961 agriculture accounted for about half of total exports, falling to about a quarter by 2003. In the case of Asian countries, superior economic growth has meant that agricultural commodities – which previously accounted for the dominant share of these countries' international trade – are now considerably less significant. In the case of both exports and imports, agricultural commodities currently account for less than one tenth of the total trade of these countries. A sharp rise in other output has gradually led to the declining significance of agriculture.

For the world's Least Developed Countries (LDCs), agricultural commodities' share of exports has fallen from 70 percent to less than 20 percent, while their share of imports has consistently been more than 20 percent, hardly changing during the period. Today, agricultural commodities account for about a quarter of total goods imports in the LDCs. Moreover, the LDCs' agricultural sectors are not particularly integrated into the world market, meaning that trade in agricultural commodities is unusually small in relation to output in the agricultural sector. During the past 40–45 years, LDCs have been marked by the fact that their international agricultural trade has not increased in relation to agricultural output. This contrasts with the South as a whole, for which agricultural trade as a proportion of output has more than doubled and is currently about 50 percent.

However, the countries that have most clearly increased their share of international trade in foodstuffs and agricultural commodities are largely the industrial countries. In particular, the statistics reveal the EU's higher agricultural exports. Trade between the various EU countries represents a substantial share of the aggregate international trade in agricultural goods but the EU noticeably increased its exports to other countries during the period 1980–2002. By contrast, the share that the developing countries sold to the industrial countries in general and to the EU in particular declined significantly during the period. However, EU exports have fallen considerably in recent years, notably as a result of reduced export subsidies and agricultural policy reforms.

Within the EU it is frequently pointed out that the Union is the largest importer of agri-

cultural commodities from the LDCs. However, the fact is that the share of EU agricultural imports deriving from Sub-Saharan Africa fell by half – from 8 percent to 4 percent – in the period 1980 to 2002. Similarly, the developing countries have experienced a change in trade flow patterns. Due to such factors as difficulties in selling to the West, the share of trade among developing countries has increased, while trade in agricultural commodities with the industrial countries has seen a relative decline.

How should we interpret these trends? According to conventional economic theory, all parties benefit from higher international trade, and economic growth goes hand in hand with productivity increases and economic specialization. Applying a liberal policy, we should – at least in theory – expect countries to specialize in production in which they enjoy comparative advantage, that is, in areas in which they have relatively low costs. How does this theoretical approach compare with the trend in recent decades in international trade in agricultural commodities?

Current international trade in agricultural commodities

Tariff barriers were very common in the agricultural sector after the Second World War, and over a protracted period agricultural commodities were exempted from negotiations as a result of an agreement between the US and EU to exclude agriculture from the GATT negotiations.[5] However, a sharp rise in the EU's subsidized exports in the 1980s, plus a number of other changes led to an American interest in including agricultural commodities in discussions on liberalization, reduced tariffs and more equitable rules for international trade. Consequently, during the Uruguay Round, agricultural commodities were put on the GATT and WTO agendas; thus, since 1994 there have been rules aimed at reducing trade-distorting policies in the agricultural sphere.

Accordingly, over a number of decades, international trade in agricultural commodities was completely out of step with conventional economic theory. The steep rise in EU exports and declining imports cannot be attributed to the EU's comparative advantage in the production of foodstuffs. Instead, the explanation lies in the special agricultural policy pursued by the EU.

The EU's Common Agricultural Policy (CAP) is very wide-ranging and highly complex. However, the fundamental idea is simple and is based on high tariff structures around the EU market. Behind this protective wall, the EU has generally had substantially higher prices than those prevailing on the world market. This price difference also meant that producers in the EU were generally not interested in selling on the world market. Rising output in the EU imposes downward pressure on EU prices. However, lower prices have not led to higher consumption – once people have ample access to food, they will not buy much more despite falling prices. Because the EU has made political pledges to farmers to guarantee relatively high prices, it has frequently bought up food surpluses arising in the Union. As a result of productivity increases in the EU, agriculture became a problem! One way of

"eliminating" any surplus is to dump it on the world market. Thus, the EU's previously rising exports had very little to do with comparative advantage.

However, recent years have seen the emergence of a number of trends for which trading in foodstuffs may again be explained by comparative advantage rather than being a residual item in national agricultural policy. For example, the growth in Chile's agricultural exports, and the export successes of Brazil and Argentina, as well as New Zealand's export-led production, appear to be examples of economically warranted changes in trade. We seem to be moving slowly toward an international food trade that will be driven increasingly by fundamental economic conditions and less so by national protectionism.

EU's agricultural policy and farmers in other countries

The world market in foodstuffs is rather small compared with total output, meaning that the vast majority of agricultural commodities are consumed in the country of origin. Thus, when the EU sharply raised its exports in the 1980s, this led to declining prices for many agricultural commodities outside the EU. By conveying tax-financed subsidies with each ton of grain, the EU shipped out the physical product as well as money from the Union, thereby pushing down prices in other markets. Consequently, a major part of the explanation for the EU's higher agricultural exports and the developing countries' declining share of EU imports in recent decades is to be found in the protectionist agricultural policy that favored EU farmers and certain consumers in non-EU countries, at the expense of EU consumers and taxpayers, and producers in the South.

Consequently, EU agricultural policy hit farmers in other countries in at least two ways. Firstly, EU products were sold abroad at artificially low prices. An excellent illustration of this was discussed in Sweden and Denmark a few years ago: Arla (a joint Danish-Swedish dairy products producer) received export subsidies to sell dairy products – milk powder – to the Dominican Republic. Subsidized EU output squeezed prices so much in that country that it bankrupted many of the local farmers. Another feature of this episode was that a few years earlier the EU provided aid to farmers in the Dominican Republic, thereby stimulating profitable dairy product production for the domestic market! The EU's subsidized agricultural exports have hit farmers in several countries in similar ways, irrespective of whether dumping involved meat, sugar or grain.

Secondly, producers in other countries suffer from the EU's high tariffs and internal support. The considerable support for EU farmers promotes higher production than would otherwise be the case. As a result, the EU reduces the potential for farmers and food producers in other countries even without any direct export subsidies. EU policy supports prices and the production of agricultural goods in the Union and pushes down prices and output outside the EU. Thus, the CAP hits hard at those dependent on agricultural production outside the EU.

Although the EU has reduced its export subsidies and Union-wide support in recent years and has also cut tariffs in many cases, agricultural policy continues to disfavor non-EU farmers. The EU still pays considerably more in support of its own farmers than the value of the total aid from EU countries, while direct EU aid is less than one tenth of the support provided for EU agriculture and rural development in the Union.

At the same time as the EU maintains a protectionist agricultural policy, it also works towards facilitating rural development and international trade in developing countries. The EU has actively enabled LDCs worldwide to sell almost all agricultural commodities, plus other goods, tariff-free to the EU. In other words, through its aid and development policies, the EU demonstrates its conviction that the world's poor are assisted by means of international trade and investments in agriculture. However, since the EU appears unable to achieve fundamental change in its own agricultural policy, it has signed a number of special agreements with a series of countries covering special products. Consequently, certain players in selected countries gain from the option to sell agricultural goods at high EU prices, subject to certain conditions. Thus, EU aid policy extends indirectly to certain producers in a number of developing countries. However, these agreements frequently apply to former colonies and LDCs worldwide, whereas the poor in other countries gain little from these contrived EU benefits.[6]

Does more liberal trade in agricultural commodities favor the poor?

EU policy disfavors farmers in other countries. Many believe that the removal of tariffs and trade barriers would offer greater progress for the majority of the world's poor. Is there really any evidence underlying theories that the liberalization of trade promotes economic development, leading in turn to a reduction in poverty? Are those arguing in favor of more liberal trade, especially in agriculture, supported in their belief that this also favors the poor or is it a misdirected attempt to reform EU agricultural policy to favor the world's poor?

If there really were an unambiguous relationship between liberalization, economic development and a reduction in poverty, we would most likely have eradicated poverty a long time ago. Despite a protracted debate and a great deal of research, there is considerable uncertainty as to how we can come to grips with poverty. Nevertheless, we do have a good deal of insight.

Research regarding the issue of the effects of the liberalization of agriculture and other sectors on poverty is complex, since it is impossible to carry out practical "controlled experiments". Moreover, apart from the difficulties in gauging such concepts as "liberalization" and "poverty", it is highly uncommon for a country to conduct a single dramatic policy change whose consequences can be isolated and tracked. Instead, researchers must frequently attempt to capture the required evidence by means of indirect estimates and methods.

Effects of liberalization on developing countries

Economists frequently point to liberalization as a key condition for growth and the combating of poverty. A recently published review on the relationship between liberalization and poverty highlights the linkage between *liberalization* and – in sequence – *growth*, and subsequently *household economy and markets, wages and employment*, and *government revenue and expenditure*.[7]

Despite the problem of finding unambiguous links, research findings indicate positive linkage between *openness and growth*, meaning that more liberal economies enjoy more favorable economic growth than closed economies. The question of whether growth also leads to less poverty is also much debated. Many studies support the argument that growth in general reduces poverty and that the subsequent growth in the wake of greater openness possibly contributes to reducing poverty at a faster pace than overall growth. At the same time, we must note that there are examples of growth actually exacerbating the situation for the most disadvantaged – though this appears to be the exception.

More open international trade also appears to lead to high productivity. High productivity and efficiency gains are key factors in combating poverty, as exemplified by what is referred to as the green revolution. If a developing country has a liberalized agricultural sector, with prices driven by the world market, producers gain the benefits of productivity increases, since world market prices are not affected if output rises in a developing country. If instead the country is insulated from the world market and prices are set solely by domestic supply/demand factors or by a government agency, any benefits are likely to accrue to consumers in the form of lower prices, which does not stimulate new investments in agriculture.

In many developing countries, poor households are synonymous with farmers who can sell their labor, basic services or agricultural products. Rising prices for what they can sell improve the *economic conditions for poor households*. Local conditions for agricultural commodities are particularly important.

If *local markets* in a particular country do not function, liberalization may not lead to any positive effects for the poorest of the population. Price changes at the border that could favor the country's poor may occasionally be lost as a result of national or local monopolies. Thus, it is often more important to ensure that functioning markets exist rather than liberalizing certain areas of international trade. On the other hand, liberalization inside a country that opens up domestic markets can strengthen the effects of higher international trade. A review of the effects of the liberalization of markets for food crops in a number of African countries suggests that liberalization measures have made a significant contribution in reducing poverty.[8]

Precisely as noted by Stefan de Vylder elsewhere in this book, there are quite a few studies showing that higher agricultural incomes lead to positive effects in other parts of the local community. Consequently, liberalization can provide the poor with *higher incomes and more*

employment opportunities. Rural households can purchase services in the local area – rural household demand is frequently locally centered. In the past, it was believed that the positive resulting effects were more common in Asia's more irrigated agricultural economies than what they would be in Africa. Later studies indicate that there are very strong side effects also in Africa, meaning that agriculture can frequently function as an engine in the local economy. In many instances, liberalization also appears to lead to higher demand for unskilled labor.

When developing countries remove part of their trade barriers, such as customs tariffs, there is the risk of a reduction in *government revenue*. Less revenue for government finances may entail reduced scope for government programs aimed at the poor, but it is difficult to find examples that unambiguously indicate that this type of trade liberalization impacts on exposed groups in a systematic manner.

The overall conclusion is that liberalization measures by developing countries frequently contribute to reducing poverty, since in many cases this action seems to lead to domestic economic progress as well as growth in household income and markets. Such actions also appear to favor wages and employment opportunities for the poor. At the same time, it is evident that liberalization programs do not per se lead to positive development, neither for countries as whole nor for the poor sections of the population. Neither can we conclude that liberalization measures are necessary conditions for positive development. On the other hand, research to date does not support the assertion that liberalization per se is negative for the South or for the poor.[9]

Impact of the liberalization of the EU's agricultural policy

Thus, research findings frequently support the idea that countries that implement liberalization are themselves beneficiaries of such action. If this is so, what would be the result of the EU thoroughly deregulating its agricultural support? How would this impact on developing countries worldwide?

In this area there are really only theoretical research and findings based on estimates derived from economic models, since the EU has not so far conducted complete deregulation and liberalization of its agricultural policy to date. However, the research available points to a number of rather obvious effects, namely, that international prices of many agricultural goods could be expected to rise and EU output decline. A reduction in output in the EU offers scope for expansion in other countries. During the past year, higher demand for bio-energy and food has, however, been more important for world market prices. Changes in EU agricultural policy in recent years supports these results, meaning that reductions in EU exports have coincided with higher world market prices. During the past year, however, higher demand for bio-energy and food have been more important for world market prices, contributing to rising prices.

Generally, poor rural dwellers in other countries gain from the EU dismantling its

agricultural policy, or at least from the reduction of trade barriers and production-linked support. We can turn to a survey in which the effects in Brazil are studied as an example of the model-based estimates so frequently used. Brazil is a huge country with a substantial poor population and considerable agricultural potential. Some critics of liberalization claim that rich landowners in Brazil would reap the gains from the EU deregulating its agriculture. However, model-based estimates indicate that since landowners gain from employing more people as part of efforts to raise output, liberalization by the EU would have a major impact on reducing poverty in Brazil.[10] The losers in Brazil are to be found among the unemployed in the slum areas of the major cities, who would be hit by higher food prices, without them collectively experiencing higher demand for their manpower. Since the number of poor in rural areas and in "poor" regions of Brazil is vast, a deregulation of EU agricultural policy would have the overall effect of reducing poverty in Brazil and leveling out incomes nationwide.

The abolition of the EU's protectionist agricultural policy would lead to generally higher prices for agricultural produce worldwide and provide more long-term price signals for all farmers. The majority of the world's poor – who in various ways depend on favorable prices for what they can produce on their land or through their work – would thus gain better opportunities if the EU terminated its tariff protection and its production-stimulating subsidies for EU farmers.

WTO and other reforms of the EU's Common Agricultural Policy

In the very lengthy and faltering WTO negotiations, one of the key issues is whether the EU and US can accept reducing their agricultural support and dismantling some of the trade barriers in the agricultural area. Many other countries demand that the EU and US terminate their export subsidies, reduce tariffs, increase access by other producers to markets in the EU and US, and cut the support for domestic agriculture. Another key issue is the reduction of tariffs by developing countries.

Current negotiations are very sluggish and although some headway has been achieved, there is a good deal of progress to be made before an agreement is reached that fulfills the intentions of the declarations made within the current framework of what is referred to as the Doha Round (Doha Development Agenda). The EU has pledged to abolish export support, but it may stay in place until 2013. Tariffs are to be reduced but countries are entitled to exempt certain products from tariff reductions. The EU has not pledged to reduce significantly its national support in the years ahead.

By being entitled to exempt "sensitive" goods from tariff reductions, the EU (and US) can protect those markets and goods that would entail substantial differences for many producers in the South. If the EU (and US) opts to classify, for example, sugar, milk, rice, cotton and beef as "sensitive" goods, this would eliminate most of the price effects from which developing countries could benefit.

The previous agreement – the Uruguay Round – included numerous detailed regulations enabling countries with a "high administrative capacity", to adjust the agreement to their own advantage. Obviously, the EU (and US) opted to adapt the agreement to favor their agricultural sectors, and there is no reason to expect they will refrain from similar amendments this time round. Consequently, those seeking more rapid liberalization in the agricultural area must hope for deeper reforms from the continuing WTO discussions.

In addition to the WTO process, there are also ongoing discussions within the EU regarding the need to reform agricultural policy. A large share of EU agricultural support goes to a small group of relatively very large farm holdings in the most fertile regions of the Union. About 80 percent of agricultural support accrues to some 20 percent of farmers. In other words, the allocation of several hundred billion Euros in agricultural support is highly uneven. Mainly large landholders and large-scale producers receive assistance, while small farmers in the EU receive merely a fraction of what large farmers gain.

One illustration of the peculiar allocation of support appeared in a recent issue of *Land Lantbruk*, the Swedish farmers journal.[11] The allocation of agricultural support was adjusted slightly in 2006 compared with 2005. The journal reported on a number of holdings that lost most as a result of the change. One of the major losers was set to lose some SEK 1 million in support. However, the one million loss would not mean any real change in farm operations. The cited response of the farmer was: "…well, it's always a setback to lose that last million", adding that he planned to offset this loss through a minor reduction in investment!

The list of organizations receiving most support in Sweden includes landed estates, major agri-business companies, the Swedish University of Agricultural Sciences, as well as relatively large farm holdings. In several cases, these farm holdings receive several hundred thousand Euros in support from EU taxpayers. The situation is no different in other EU countries, where, of course, there are even more examples of companies receiving million Euros in support.

Conclusions

In a global perspective, we have so far had no problem in providing food for the world population. Nevertheless, hundreds of millions of people live in absolute destitution and hunger. Distribution problems are enormous. In various contexts, the global community has stated its willingness to work actively in reducing the problem of poverty and eventually eradicate it. A key factor in these efforts is to ensure that the world's poor receive better pay for their produce. Since a clear majority of the world's poor live in rural areas and are directly dependent on agriculture, it is crucial that they receive better prices for their agricultural commodities and farm labor. Protectionist agricultural policies pursued by Europe and the West lead to inferior prices for agricultural goods and prevent farmers in the developing countries from winning markets for their produce.

Favorable economic development and growth in many developing countries are facilitated by productivity growth in their agricultural sectors. Investment in agriculture is obviously highly beneficial, leading to higher prices for agricultural commodities, and in turn resulting in higher income for many poor households worldwide. The latest research indicates that liberalization in developing countries frequently favors economic development and the poor. Although deregulation in the industrial countries is no guarantee for favorable development in the South, it is nevertheless a key part of the puzzle in reducing world poverty.

Favorable progress for very large sections of the world's poor who gain their livelihood from agricultural production, directly or indirectly, also requires a variety of changes in each country. This may involve the removal of export tariffs, and the development of functioning markets, infrastructure, education and investment opportunities. Frequently, such changes at the national level offer far more than adjustments of the West's agricultural policies. Nonetheless, it is clear that the industrial world's various forms of agricultural protectionism and substantial agricultural support disfavor the majority of the world's poor and are some of the obstacles blocking favorable development for hundreds of millions of rural people worldwide. Data from the World Bank, for instance, point to annual welfare gains of tens of thousands of Euros if the West terminates its internal agricultural support.

It is also clear how the EU's agricultural policy often directly counteracts efforts in other areas, such as EU programs to stimulate rural growth in many developing countries, the reduction of world poverty and the promotion of economic growth outside the EU. The Swedish aim of coordinating policy in all areas in a bid to strengthen efforts for global development is largely lacking at the EU level. What is viewed as being favorable for rural areas and agriculture in the EU partly counteracts similar interests in other countries. Millions of poor farmers and rural dwellers worldwide suffer because the EU favors its own farmers and rural population, and especially when it chooses to do so using the resources of its current agricultural policy. Consequently, the resources used in international aid may be viewed as a form of offsetting compensation for the international impact of its own agricultural policy. Any serious desire to implement an ambitious EU policy for global development requires a radical change in EU agricultural policy as its first stage.

Today, we are witnessing a significant increase in global demand for agricultural commodities and bio-energy. As pointed out by the FAO's general director, for example, equitable and liberalized international trade in bio-energy goods is just as important as in the case of food. Hopefully, and despite the obstacles, the dormant WTO negotiations may lead to the EU and US taking active measures in both agricultural policy and energy policy that favor the development of poor countries worldwide.

SUGGESTED LITERATURE

The websites of the WTO, FAO and World Bank offer a great deal of useful information on trade, agriculture and the circumstances of the world's poor and, of course, on WTO agreements. FAO has an easily accessible database with considerable information. Among other sources, EU agricultural policy is presented on the EU website, although, unfortunately, there is not a good description of its basic principles, nor any outline of how the policy impacts on markets and other countries. Moreover, since the policy has been amended successively in recent years, it is difficult to find a good, updated description of its design and primary features. However, two informative books for those interested in EU agricultural policy are *Agricultural Policy in Western Europe and the United States*, published in 1999 by Edward Elgar by Ingersent and Rayner, and another British book from 1997, *The Common Agricultural Policy and the World Economy*, 2nd edition, compiled by Ritson and Harvey, and published by CAB International.

Notes and references

1. In this section I use the terms "the West", "the industrial countries" and "the North" synonymously. Similarly, I refer to "the developing countries" and "the South" as synonyms.
2. FAO is an abbreviation of the Food and Agriculture Organization of the United Nations and is the UN's organization for food and agriculture. FAO has changed the principles underlying its computations and thus it is impossible to extend time series to encompass recent years. However, this does not change the development trend; for example, China currently has an average food supply of a little more than 3,000 calories.
3. Needless to say, the average daily calorie requirement differs among people, depending on such factors as occupation and body size, but an ordinary "clerical employee" rarely needs more than an average of 2,500 calories per day.
4. Trade statistics have been extracted from FAO, primarily from the 2005 yearbook. Stefan de Vylder outlines the same picture in his paper using somewhat different data.
5. GATT is the abbreviation for the General Agreement on Tariffs and Trade. In the past, countries negotiated on tariffs and liberalization within the GATT framework, which was reorganized as the WTO – World Trade Organization – in 1994.
6. One of the problems associated with these special agreements is discussed by Stefan de Vylder elsewhere in this book.
7. Refer to Winters, McCulloch and McKay. 2004.
8. Refer to Winters, McCulloch and McKay. 2004, page 87.
9. Refer to Winters, McCulloch and McKay. 2004.
10. Refer to Winters 2005.
11. Land Lantbruk No. 2/3, 2006.

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TOWARD A BRIGHTER FUTURE FOR FARMERS?

Some political and economic trends yesterday, today and tomorrow

Stefan de Vylder, Associate Professor, Development Economics

Over the years I have written numerous articles in various newspapers and journals; but, admittedly, few of them have triggered many comments from readers. With one exception: In winter 1983, the editor of *Kamratposten* – a leading Swedish monthly magazine for children and early teens – called me and asked if I would write an article on food and famine for the magazine's young readers. The background to the request was the intense debate in Sweden concerning surplus oat production, which had partly been used for heating purposes during the very cold winter, parallel with the appearance of newspaper articles on Europe's "meat mountain", "butter mountain", "cheese mountain" and so forth. Many children contacted Kamratposten about their concerns: How dare we burn food when there are so many starving people worldwide? Surely, it would be better to send the food mountains to all the starving children?

Today, instead of the question of using oats for heating, we have a debate on biofuels. Can the use of grain to produce ethanol be justified when 850 million people are starving?

Back to Kamratposten. The editor asked me to explain, in an easily read fashion, the food shortage in poor countries and large surpluses in the rich countries. My article had two primary themes: Poverty and power. "People are hungry because they are poor", I wrote, while warning of the exaggerated hopes associated with food aid: "Sweden contributes some food aid to countries that have experienced war or natural disaster. Swedish food is sometimes used to reduce famine worldwide. But it would not be a good idea for poor countries to become completely dependent on farmers in the rich countries. The best situation would be for poor countries themselves to produce the required food. This would provide jobs and income for their own farmers. It is better to help poor farmers to produce more than to send them Swedish food."

I described the farmers' lack of power in the following simple terms: "In poor countries, farmers frequently have little political power; the rich people in the cities decide most things." And the city dwellers want cheap food.

However, what triggered the fierce response

from the readership was not these words, but instead a few comments about the powerful European farming organizations and their considerable influence. This, I wrote, resulted in high prices, leading in turn to surpluses: farmers produce more than consumers wish to purchase. Carelessly, I added: "In Sweden, farmers – though few in number – exercise considerable power. The former government, for example, included a farmer as the prime minister, along with a farmer as the minister of agriculture and also one as the minister of industry and commerce."

I had not intended to ridicule the government of Mr. Fälldin or the Federation of Swedish Farmers (LRF), but obviously many interpreted it in this manner. A week later, a slightly despondent editor of Kamratposten phoned and said: "A few weeks ago we wrote a critical article on the Swedish Royal Family and received six angry letters, but now we've received almost a hundred in response to your article."

However, when I viewed a selection of the letters – all of which were written by parents and not the children themselves – I felt that my thesis about strong farmer organizations had been confirmed. The indignant letters were often identical, obviously the result of a well-organized campaign.

A great deal has happened since my article in Kamratposten triggered a "storm of reader protests". About 1990, a drastic liberalization of Swedish agricultural policy occurred – with some support from the Federation of Swedish Farmers – a move, however, that was suspended in conjunction with Sweden gaining membership of the EU a few years later.

Opposition to reform of the EU's Common Agricultural Policy (CAP) is currently waning in many European countries. But when I now reread the old article I can only conclude, regrettably, that the basic analysis still applies to a certain extent.

The first part of this paper may be viewed as an attempt to demonstrate that I was right in 1983, and that, unfortunately, I continued to be correct during the rest of the 1990s. In the second and final section, the purpose is more the opposite, namely, to identify a number of economic and political factors that make it likely that we may now face such major changes in global farming conditions that my article in Kamratposten may appear outdated.

But first a few words on the past, and here the old message applies: farmers in poor countries are numerous but lack strong organizations and political clout. Both the urban elites in the poor countries and powerful interests in the rich countries contribute to this situation.

Trade and agriculture – global trends

Farmers in the south – numerous but poor

More than 50 percent of manpower in developing countries has farming as the primary source of employment. Indirectly, however, agriculture plays an even greater role, since it forms the base for most rural commercial activity, with trade, transport, and small industry, etc., heavily dependent on it. Thus, any increase in farm income

INDICATORS OF THE ROLE OF RURAL AREAS AND AGRICULTURE IN CURRENT DEVELOPING COUNTRIES

	Percentage of population residing in rural areas, 1999	Percentage of labor employed in agriculture, 1999	Agriculture's share of GDP, 1998
Latin America and the Caribbean	60	56	15
North Africa and Middle East	40	34	13
Sub-Saharan Africa	68	67	29
East and Southeast Asia	64	62	18
South Asia	72	59	26
TOTAL developing countries	60	56	15

Table 1. Agriculture's share of income is consistently lower than its share of employment. Source: FAO, *Committee on World Food Security*, 2001

frequently spreads like ripples on water, and a range of developing countries provide evidence that investments to improve conditions for the farming population have a far greater impact in the form of employment and poverty reduction than similar investments in cities.

Despite accelerating urbanization in recent years, over two billion people in the South depend on agriculture for their living. Table 1 summarizes the role of agriculture in the key developing regions.[1]

As Table 1 shows, agriculture's share of income is consistently lower than its share of employment, and all economic and social indicators – income, average life span, health and education, access to clean water, credit opportunities and so forth – reveal major differences between urban and rural areas, favoring urban populations in terms of material living standards and access to various social services.

The urban share of the world's poor is growing steadily. Nevertheless, over two thirds of the world's poor continue to live in rural areas and most of these are smallholders, tenant farmers or landless farm laborers. Any discussion concerning the attainment of the first Millennium Development Goal – meaning a halving of the world's poor by 2015 – must obviously proceed

on the basis of the living conditions for the rural population and farmers.

Women are heavily over-represented among the rural poor. In certain regions, such as Sub-Saharan Africa, women account for well more than 60 percent of the total labor in agriculture. Although women constitute the base for the food supply in these countries, they are consistently discriminated against in terms of economic and legal matters: women have inferior access to credit and extension services than men; they frequently lose their right to the land if the husband dies (in many countries, this right is transferred to the man's relatives); and men frequently take charge of the sale of any surplus, thereby controlling income.

Discrimination against agriculture

It is difficult to generalize about agricultural policies in various countries, particularly over protracted periods. Naturally, there are examples of countries with good policies, notably in Asia, while others are notoriously bad. However, we can conclude that the import substitution policies that dominated the development strategies of developing countries during the 1950s, '60s and '70s were characterized by the systematic favoring of industry at the cost of agriculture.

The 1980s and '90s saw a policy reversal in many countries. The strategy of industrialization based on import substitution was steadily abandoned, having been systematically criticized by a rather cohesive choir of macroeconomists, as well as by the increasingly powerful Bretton Woods institutions, namely, the IMF and World Bank. Subsidies for industry were cut back, tariff walls reduced and exchange rates adjusted to market conditions. The explicit aim of the new policy in many countries was to favor the farming sector in general and agricultural exports in particular.

In those parts of Asia that targeted agriculture, the 1970s, '80s and '90s resulted in rising food output in the wake of a successful "green revolution" (refer, for example, to the paper *Africa's Food Crisis* in this book). In the poorest developing countries, primarily in Africa, hopes of more dynamic agricultural development were dashed, with the 1980s and '90 also being marked by a distinct urban bias.

Sub-Saharan Africa is today the only region worldwide in which food output per capita is less than it was thirty years ago. A number of governments continue to pursue economic policies that disfavor the countryside as a whole and agriculture in particular. Food prices are kept artificially low by means of imports and, in conjunction with the structural adjustment programs that overran the poor world in the 1980s and '90s, many agricultural subsidies were eliminated – such as those for fertilizer, water, seed, and credits – that had permitted some productivity increases in the 1960s and '70s, even in Sub-Saharan Africa. Inefficient, government controlled parastatals in charge of fertilizer distribution and the purchase/distribution of grain and other produce were closed down, but nothing was put in their place.

Subsidies for small farmers were terminated, but the free market forces unleashed were little interested in supplying poor farmers with input goods or buying their surplus output.

Meanwhile, trade liberalization and lower tariff protection for domestic agriculture meant that farmers in these countries found it increasingly difficult to compete with imports.

The neglect of agriculture in the least developed countries (LDCs) was accompanied by a sharp fall in international agricultural and rural development aid. Balance of payments support, debt cancellation and program assistance became the dominant forms of aid, focusing more on public sector administration rather than targeting the rural population. In the 1990s, agricultural development aid for poor farmers fell to less than half of the 1980s volume; Swedish aid policy also marginalized agricultural and rural development.

And the shortfall in food output in the poorest countries continued to grow.

World trade in food – rising surpluses in the North and shortfalls in the South

As noted in the paper *International Trade in Agricultural Products, Economic Development and EU Agricultural Policy* in this book, there is sufficient food worldwide. Measured in terms of calorie output per capita, the global supply of food has never been larger. The major problem is the distribution of food, or the power to control existing food supplies.

Data covering the overall availability of food provide no indications as to where it is produced. But a look at the statistics reveals a distinct pattern: during the final decades of the 1990s, food surpluses continued to grow in the developed countries and in a number of Middle Income Countries (MICs), while the LDCs, in particular, grew increasingly dependent on imported food.

Throughout the period 1960 to 1990, the developing countries as a whole reported a small surplus in agricultural commodities trade. Since 1990, however, the developing countries have normally been net importers of food. Thus, that part of the world in which more than half the population works in agriculture is a net importer of food from countries where agriculture employs less than 5 percent of the population.

The 50 countries that the UN categorized as LDCs – and in which far more than two thirds of the population depend on farming for their living – saw a shift in their status as net exporters to net importers in the early 1980s, with a sharp increase in the food shortfall since then. As of the 1990s, the LDCs have annually expended over 50 percent of their total export income on imported food.[2]

A look at exports of particular agricultural commodities reveals the distinct dominance of the developed countries. The US and EU account for more than 50 percent of total grain exports worldwide, with Australia and Canada providing another 15 percent. The EU and the US account for 40 percent and 19 percent, respectively, of world meat exports. Half of citrus fruit exports worldwide derive from the EU. Three-quarters of global dairy products exports originate from the EU, New Zealand, Australia, US and Canada.

As regards the composition of the developing countries' exports to the developed countries, the proportion of agricultural commodities has decli-

ned continually in recent decades. From having accounted for about 13 percent of export value in 1980, the percentage had plummeted to 8.9 percent by 2000.[3] Even if we exclude China and the so-called Newly Industrialized Countries (NICs) in Asia – whose exports are overwhelmingly dominated by industrial goods – the export share of agricultural commodities from the South to the North in 2000 was a modest 14 percent – far less than the share of oil.

Dumping

More than 95 percent of the world's farmers and farm laborers live in developing countries; however, of the total support for agricultural development from the public sector, this 95 percent must make do with no more than 5 percent of the total. Slightly more than 95 percent of the remainder goes to well-organized farmers in the rich countries and to our food industry (frequently agri-business rather than individual farmers receive public support). The configuration of the public support in the US and the European Union makes it highly regressive; it is the affluent farmers who receive most.

A decision-in-principle to eliminate the developed countries' export subsidies, and thus reduce dumping, was made already at the WTO Ministerial Meeting in Doha in 2001. The Ministerial Meeting in Hong Kong in December 2005, reiterated this pledge, but now supplemented it with a target to eliminate export subsidies by 2013 (the date by which EU-set ceilings for current agricultural support expire). However, it is important to highlight that export support per se does not play a crucial role in world market prices – it is the overall support for agricultural production that is the key factor underlying imports and the volume of the surplus placed on the world market.

Dumping of the rich countries' surpluses has been discussed back and forth over a number of decades, and since the issue is dealt with elsewhere in this book, I will limit myself to a few brief anecdotal comments.

- In many West African countries, meat from the EU costs 50 percent less than domestically produced meat.

- The EU supports the setting up of tomato growing in many countries in West Africa, at the same time as the EU's export of canned tomatoes undermines the profitability of domestic tomato growers.

- Although the EU is a high-cost sugar producer, with, for example, production costs three or four times higher than Brazil, the Dominican Republic or Mozambique, the EU nevertheless accounts for 20 percent of the world's overall sugar exports.

- Thanks to decades of subsidized surplus wheat, the EU and US have managed to entice a large share of Africa's urban population to eat wheat-based bread. Wheat can be grown in only a few countries in Africa, but wheat imports – currently accounting for two thirds of Africa's total grain imports – have radically transformed urban consumption patterns. In countries like Kenya and Ethiopia, wheat imports from the EU account for more than 50 percent of total food imports.

Of Africa's total annual supply of grain, amounting to some 145 million tons, imports in 2000 accounted for 40 million tons (with wheat representing 23 million tons, maize 9 million tons and rice 5 million tons).[4] Statistically, this means that essentially the entire urban population was supported by means of imported grain.

The extensive liberalization of agricultural imports that many developing countries – not least in Sub-Saharan Africa – have undergone in connection with structural adjustment programs and WTO reforms have not only favored the farmers in rich countries and the food industry but also food-exporting developing countries. There is, of course, every reason to encourage South-South trade, but agricultural trade among various developing countries also illustrates a difficult dilemma: can low productivity farmers in poor countries compete with rice from Thailand and Vietnam, soy from Brazil or meat from Argentina, even in their own domestic market? Will the continuing increase of food imports by the LDCs from MICs in the South further undermine incomes for millions of farming families and accelerate the reversal to subsistence farming and marginalization that is now noticeable in many LDCs?

Agricultural commodity prices – global trends

The 1980s and '90s were marked by a continual decline in world market prices for agricultural commodities. This was partly the result of rising agricultural subsidies in the industrial countries and the resulting dumping, but sharp productivity improvements in the developed countries and in a number of MICs also contributed to rising supply. The appearance of a number of new, significant exporting countries – such as Vietnam's emergence as a major exporter of rice and coffee – in the mid-1990s also had a noticeable impact on certain submarkets.

Table 2 shows the price trend for selected agricultural commodities of major significance on the world market. In several cases – such as cocoa, coffee, jute, rubber, tea, and tobacco – developing countries are net exporters and were thus hit by falling prices. In other cases, notably grain and basic foodstuffs, they are net importers, and thus we can conclude – somewhat schematically – that the urban population gained as a result of cheaper imports, while domestic farmers were exposed to mounting downward price pressure.

Naturally, the bleak price trend for a number of agricultural commodities hit producers both South and North. But nevertheless the differences are considerable, since – thanks to tariffs and price support – prices in the EU, US and Japan are largely insulated from world market prices. Farmers in the North were also able to gain some compensation in the form of higher productivity and increased support, while farmers in the poorest countries were unable to raise productivity or receive state support to cover their losses.

Trends in the processing industry and distribution channels have also resulted in a fall in the proportion of the consumer price accruing to the farmer.[5] For agricultural commodities sold on the world market, it is estimated that the producer's share of the retail price ranges from

WORLD MARKET PRICE TRENDS FOR A SELECTION OF AGRICULTURAL COMMODITIES IN REAL TERMS

	1961–1963	1981–1983	2001–2002
Bananas	100	58	51
Butter	100	92	32
Cocoa	100	125	33
Coffee	n.a.	104	21
Cotton	100	87	27
Maize	n.a.	80	31
Rice	100	78	21
Jute	100	38	22
Natural rubber	100	57	20
Sugar	n.a.	72	26
Tea	100	52	33
Wheat	100	87	35

Table 2. World market price trends for at selection of agricultural commodities in real terms, for the periods 1961–63, 1981–83 and 2001–2002.
Index 1961–63 = 100 (for coffee, maize, and sugar 1971–73 = 100).
n.a. = not available.
Source: Based on FAO *The State of Agricultural Commodity Markets 2004*, table 1, p. 38.

4 to 28 percent for various products.

In the case of bananas, for instance, only 12 percent of the consumer price is retained in the country of origin, with a mere 2 percent accruing to workers in the banana plantations.

Concentration towards a few large companies has accelerated; for example, just four companies purchase more than 40 percent of the world's coffee, and three major corporate groups account for 45 percent of coffee roasting. A key feature of global agricultural trade is that large transnational companies draw up contracts with individual producers, which can prove profitable for the large producers capable of guaranteeing reliable supp-

lies and high, uniform quality, but does nothing for the majority of small farmers.

Another trend – and one that strengthens concentration in distribution and processing – is the dramatic increase in food volumes sold via large retail chains. In Latin America, for example, the share of such chains in food sales climbed from less than 20 percent in 1990 to a full 60 percent a decade later.[6] While we cannot be certain as to what these trends entail for producer/farmer prices, there is a tendency for large retail chains – just as in the case of transnational processing companies – to prefer dealing with major producers. Parallel with these developments, there is a rapid decline in the significance of traditional local markets that allow farmers to sell their surpluses directly.

Trade obstacles in the North

For the poorest farmers in developing countries, the most destructive feature of the trade and agricultural policies of the developed countries is the dumping of food surpluses, as dealt with above, and which is also discussed in the paper *International Trade in Agricultural Products, Economic Development and EU Agricultural Policy* in this book. But even in the case of MICs with solid export potential – such as Latin America or Thailand – the tariff barriers in our home markets are a serious problem. Over ten years of WTO negotiations have done little to improve the situation.

The highlighting of agriculture in international trade policy regulations in conjunction with the establishment of the WTO in 1995 was perceived as a pledge to liberalize the agricultural trade of the developed countries. Alas, very little has been achieved. Meanwhile, although average tariff protection for industrial goods among OECD countries has declined from 45 percent to 4 percent since the Second World War, our agricultural commodities tariffs have remained rigid at more than 60 percent – currently far higher than in developing countries.

In addition, there are tariff peaks for "sensitive" products such as sugar, dairy products and meat, for which tariffs may be as high as a few hundred percent. One barrier that impacts directly on the processing industry in poor countries is tariff escalation, which entails higher tariffs on processed products – orange juice, roasted coffee, jams and marmalades, milk powder and so forth – than on the commodities from which the goods are made.

Safeguards are another common feature, which offer countries the right to impose tariffs if import prices decline (what a boon for consumers!) or import volumes rise sharply.

What this means is that a developing country that actually manages to utilize a tariff benefit also risks losing it. Exemption from tariffs applies primarily to LDCs, who cannot utilize trade benefits, since they have little to sell.

Sweden's Policy for Global Development frequently refers to the term "coherence". But what sort of coherence are we dealing with when the affluent world pays a fortune to combat narcotics production in Latin America, and simultaneously ruins farmers trying to grow alternative crops?

Food, power and the political dilemma

In one area after another, we witness how prevailing global power relationships are reflected in trade and agricultural policies pursed in the North and South in recent decades. The North's dominant position is reflected by the international institutions – WTO, IMF, the World Bank and so forth – with their decisive influence on the rules of the game, and is compounded by the submissiveness of the poor countries in the final decades of the 1990s, among other factors.

At the national level, power relationships have favored the urban elite in the South rather than the majority of the population who scratch a living from agriculture. Generally, farmers and farming organizations have lacked political power and influence. Again, this is a case of the "submissiveness of the impoverished".

Countries that have become considerably dependent on imported food are marked by an obvious political dilemma. The strongest lobby groups are urban based and seek continuing access to cheap imported food. Understandably, there is a fear that reform of the rich countries' agricultural policies will lead to higher world market prices and thus more expensive food. Short term, countries that are currently major net importers of food would experience considerable strain.

A reduction in agricultural subsidies by the US and EU, leading to higher world market prices for food, could unleash demonstrations in Paris – we're accustomed to viewing TV reports of incensed French farmers dumping tomatoes and spilling barrels of wine near the Eiffel Tower – but also in Lagos, Dakar, Lusaka and Cairo.

Irrespective of the underlying factor, any rise in world food prices would represent a major threat to the food security of many poor countries and their people. Most developing countries that are currently net importers of food have the potential to be self-reliant, although this would require time. They would need support during the transition period, perhaps even in the form food aid.

Generous pledges of greater support for food-importing developing countries in the event of rising world market prices for food – as made by the rich countries in conjunction with the WTO negotiations, for example – must be fulfilled when required, although with due account of the fact that food aid must not be controlled by commercial producer interests in the North and used to undermine the base for the domestic agricultural output of the poor countries.

A brighter future for farmers?

Political and economic trends during the current millennium

I suspect that the preceding section painted a very pessimistic picture of the power situation in the world and of the future prospects for a large share of the farmers in the South. Moving ahead, I would like to highlight a somewhat different perspective. For political and economic reasons, I believe we are about to see a swing in the pendulum, which may have major significance for agriculture's role in general and for the farmers of the developing countries in particular. It is

perhaps a slight exaggeration to speak of a "new dawn for farmers", but I believe and hope that certain trends will prove resilient.

Political trends – a less submissive stance in the South and rural areas

Perhaps I'm mistaken but I see certain signs of a less docile attitude among farmers in the South.

In certain international forums there is actually a renewed air of self-assurance, as manifested at the WTO's Ministerial Meeting in Cancún in September 2003 and elsewhere. This was the first time since the rather idealistic discussions in the 1970s on a "new world economic order" – when the so-called Third World feigned unity in its demands – that a united bloc of rather heterogeneous developing countries emerged in the international arena.

The unexpected grouping in Cancún was an alliance between seemingly contrary interests. Here, a number of major countries, with Brazil, Argentina, India, China, Mexico and South Africa in the forefront, joined forces with the Least Developed Countries, symbolized by four poor cotton producing countries in West Africa, whose major demand was the termination both of US cotton subsidies and the dumping of cotton on the world market.

The message in Cancún was unambiguous: we do not wish to participate unless the rich countries live up to their previous pledges to reform their trade and agricultural policies. Perhaps the most interesting point of the alliance of developing countries was that even the LDCs with considerable food imports supported the demands for a reduction of the developed countries' agricultural subsidies, although their stance would disfavor them in the short term.

The WTO meeting in Hong Kong in December 2005 did not provide the dividends in the agricultural area for which the South had hoped, and the visible results of the Ministerial Meeting in the form of a watered-down final resolution was generally interpreted as a setback for the developing countries. But the pressure on the industrial countries has increased and the power relationship in global trade policy regulations has continued to shift towards the South and East – slowly, of course, but nevertheless it is ongoing, as exemplified by certain pledges made in Hong Kong on tariff exemption for most the LDCs' exports to the OECD area. The North can no longer dictate terms, and in the agricultural area the question is no longer if but rather when the most grotesque features will be rectified.

The new-born defiance is also marked in regional free trade discussions, such as those between the US and Latin America. In Latin America, farmers have been the driving force in the critique of the planned pan-American free trade area.

Also, farmers from the South have been most articulate in protest actions against the WTO. The setting up a few years ago of La Vía Campesina, the international peasant movement – which is a symbol rather than a powerful movement – may be viewed as an expression of the willingness of farmers to respond to the challenges of globalization by organizing themselves worldwide. Moreover, farmer organizations have

emerged in several regions, with demands for the reform not just of the world trade system but also policy adjustments in their own countries.

The significance of these new movements must not be exaggerated, and many countries in Latin America offer a lengthy history of the rise and fall of peasant associations. Nevertheless, there are signs that the role of agriculture is witnessing a renaissance in Africa, too: for example, the leaders of the African cooperation organization, NEPAD (New Partnership for Africa's Development) have adopted a series of resolutions demanding an end to the neglect of agriculture. The food crisis that many African countries are experiencing – exacerbated by the HIV/AIDS catastrophe – has now become so critical that the farmers' situation has rightly begun to find a prominent place on the agenda.

Also in the international aid arena, the issue is gaining increasing attention, as reflected in the policy documents in recent years that underscore the need to focus on agriculture, and which clearly link the UN's Millennium Development Goals with rural development. Better late than never…

The rising clamor in the South against the OECD countries' trade and agricultural polices also has its equivalent in the developed countries themselves. Although there is stiff resistance to reforms, notably in France, the revolt by European tax taxpayers and consumers against the EU's Common Agricultural Policy (CAP) is gaining strength. And certain reforms have already been implemented, such as a reduction in price support, a decoupling of agricultural support from output, and a transfer of funds from production support to what is referred to as collective public goods, meaning an open landscape, biological diversity and a living rural community. Although it is too early to declare victory, a solid wall of opinion in many EU countries supports continuing reform of the CAP and adjusting internal EU prices to world market prices.

Longer term, US trade and agricultural policies are perhaps a more significant issue than the EU's. One concern ahead of future trade policy negotiations is the gigantic US foreign trade deficit. US borrowing to cover the current account deficit is currently running at an astronomical USD 800 billion annually. Translated into more comprehensible figures this means that – distributed among the population – a typical US family with two adults and two children borrow more than USD 10,000 annually from the rest of the world! Putting it another way, you might say the rest of the world is subsidizing the US economy to a degree corresponding to around ten years accumulated development aid earmarked to fight world poverty.

As long as China and the other major surplus countries in Asia plus the big oil exporters continue to accept US treasury bills and other American assets, this situation can continue for some time to come, but only for a limited period; sooner or later, the US must adjust its economy and this cannot be achieved without a falling dollar and a recession. There is a definite risk of greater US protectionism and populist support for the country's farmers; unfortunately, it is not difficult to imagine the coming US presidential

election being contested by two candidates who each attempt to outdo the other in blaming the country's problems on the rest of the world.

However, US foreign economic imbalances should prove to be a factor that will eventually strengthen the new defiant spirit in the South (and East), as noted above. Current relations between the world's only superpower and creditor countries such as China may well be described as a sort of financial balance of terror, nevertheless the potential of the US to dictate the terms and conditions underlying the global economic game rules is likely to deteriorate dramatically in the not-too-distant future.

Global price trends

In recent years, world market prices for a number of commodities have risen rather sharply, resulting in an improvement of the terms of trade between commodities and industrial goods in favor of the former. Oil and metals have seen the steepest price rises, but also several agricultural commodities have noted a reversal of the downward trends in world market prices witnessed in the 1980s and '90s.

Of course, there is no certainty that the upturn will be sustained, but the short and medium-term prospects certainly look promising.

As regards progress in the terms of trade – the ratio of export to import prices – for various developing countries, it is difficult to generalize and the division between North and South is of little relevance. As noted earlier, it is totally inappropriate today (though it may not be so tomorrow) to classify developing countries as a group of food exporters. Countries exporting oil and/or minerals are the major winners, along with a number of Latin American MICs that enjoy a high share of commodity exports. Apart from oil importers, of course, the losers are the developing countries with a large share of food imports. Other "losers" include the successful emerging economies in East Asia, which have seen drastically declining export prices for electronics products, for example. Plummeting prices, however, have been more than offset by dramatic productivity gains and export volumes.[7]

In individual countries, farmers may be the major winners if current trends are sustained. A little further ahead, it is likely that the current trend of rising productivity and falling relative prices in industrial production will persist, along with slower productivity gains in agriculture and steadily rising food prices. Increased meat consumption in China and other rapidly developing Asian economies, plus increased demand for biofuels and reform of the developed countries' trade and agricultural policies will work in the same direction, that is, towards rising world market prices for food. Speculating a little, we may well be faced with fairly serious supply crises in the not-too-distant future.

Will Malthus have his day?

The renowned pessimist Malthus – who at the end of the 18th century predicted difficulties in raising the per capita supply of food if the population increased beyond the then billion people worldwide – was seriously wrong in his static view of our potential to raise global food output.

It is true that the cultivable area of the globe is limited and – though Malthus failed to note – it is also declining due to extensive soil erosion and continuing urbanization, asphalting and use of arable land for non-agrarian purposes, the primary source of higher food output must be improved production methods and superior seed. Of total global food output in the past 40 years, more than three quarters derive from higher productivity, measured as yield per land unit.

Though the prophets of doom that emerged in the wake of Malthus' warning of global food crises have essentially been proven wrong to date, this does not mean they will continue to be wrong in the future. Even though the Earth's potential to supply a growing population is enormous, it is nevertheless finite, and Malthus was correct in that respect. Some expert observers warn of the risk of serious supply crises in the immediate decades. An interacting combination of economic and ecological threats casts a shadow over the world's future food supply. The recurring economic concerns noted in the debate include:

- declining grain stocks worldwide in recent years, which, in the event of harvest failures in a few key countries, threaten to unleash steeply rising world market prices and acute supply problems in several developing countries;

- exceptional economic growth in East and Southeast Asia, which lack raw materials, shows no sign of slowing and countries such as China are sweeping the world in their search for commodities, including various agricultural products. Also, countries such as Iran and Egypt have substantially increased their food imports (as has Iraq for well-publicized reasons). Not least, developments in China – which is expected to be the world's largest food importer in the near future – will play a key role in the future global supply balance in food:

- the risk of sustained rising oil prices, which will continue to threaten profitability in a substantial share of energy-, transport- and chemical-intensive production, which has been the source of most food output gains in recent decades;

- stiffer competition for farmland for the cultivation of biofuel crops, which will prove increasingly profitable in pace with rising oil prices;

- changing consumption patterns – as illustrated by the rapid increase in meat consumption in countries with rising income – impose greater demands on land and aquatic assets.

The many environmental problems, which also cause concern for the world's future food supply, include:

- declining water levels and an ever-alarming shortage of freshwater resources in a large number of countries and regions such as China, the Middle East and North Africa, parts of Sub-Saharan Africa and Central Asia;

- widespread environmental problems, such as soil erosion and contamination of land and aquatic resources, through, for example, the chemicalization of agriculture, rising industrial emissions and gigantic waste problems, not least in many of the MICs in Asia, Latin America and the former Soviet Union;

- long-term climate change that may result in sharp shifts in rainfall patterns and farming conditions, with a greater risk of natural cata-

strophes, hurricanes and flooding, both North and South.

A more optimistic scenario

We can only hope that none of the potential disaster scenarios that would entail dramatic price shocks, plus serious supply problems for poor countries and their populations will emerge. One reasonable interpretation of current signals is that – for various political and economic reasons – we are moving towards steadily rising food prices.

Generally, rising food prices are good news for farmers worldwide, even though certain factors on the supply side – such as higher costs for oil, transport and fertilizer and falling freshwater resources – will entail difficulties for many producers.

Higher food prices are hastening the shift in economic policy that has long seemed necessary in many of the poorest countries, notably in Sub-Saharan Africa. Greater self-sufficiency in food – import substitution, although now in the food sphere – will be a key development goal.

For many small farmers, technological progress, in the form of mobile telephone and wireless Internet, will be increasingly available in rural areas, providing a stronger negotiating position vis-à-vis buyers who previously capitalized on the inferior position of farmers. At minimum cost, numerous poor, illiterate farmers will be able to stay informed of current market prices and alternative buyers.

Rising energy and transport costs strengthen the competitiveness of domestic farmers worldwide. Locally produced food will see a renaissance – not only in Tanzania and Zambia but also in Sweden. This also applies to organically produced food. The absurd patterns resulting from decades of cheap oil and distorting subsidies in the global food trade – exemplified by the rich countries' mad search for protein-rich food concentrate for their livestock factories (refer to the example in the chapter *How Swedish is a Swedish Cow?* in this book) – will be less profitable, thereby encouraging a healthy differentiation of agriculture in developing countries that have focused on monocultures, based on soybean and palm oil exports, to feed European cattle and pigs.

The World Bank and other influential institutions will steadily realize that the attainment of the Millennium Development Goal also requires that the rural poor receive increased aid. The Swedish Ministry for Foreign Affairs and Sida (Swedish International Development Cooperation Agency) have also become attentive to the new signals from Washington – though it always takes some time – and are strengthening their resources in agriculture and rural development, areas that have long been neglected.

In WTO negotiations, as in regional free trade agreements, the rich countries are relinquishing their demands that the developing countries open their domestic markets to food imports. Those countries wishing to do so could do as we in the West have done, namely, to offer some border protection for their own farmers.

The OECD countries have discovered that a gradual reduction in tariff protection and price support – combined with a transition to forms of support aimed solely at small farmers in marginal

farming areas and for the preservation of environmental and cultural values – is by no means ruinous for their own farmers. Rising food prices in domestic and world markets help to reduce the effects, but perhaps the most important factor is the realization that the enormous agricultural subsidies paid in the past went primarily to regions and farmers with remarkably good competitive advantages and who can manage admirably without any assistance.

In Sweden, a biofuel niche is growing in the wake of higher oil prices and technological development, providing attractive profitability also in regions with unfavorable conditions for grain production. Another sector that has seen a sharp upturn is horse breeding, which, despite – or as, many feel, thanks to – freedom from EU rules and subsidies, developed as early as the 1990s to become the most dynamic area in Swedish agriculture.

The new agricultural policy also offers younger farmers the opportunity to establish a presence in farming without having to inherit a farm. Many previous subsidies within the CAP framework were capitalized in the form of higher prices for farmland and land leasing, discouraging all new farm establishments and leading to an ever-greater "graying" of the EU farming community. Declining prices for farmland and land leasing as a result of the abolition of a number of EU subsidies, which originated partly from the scare propaganda of European farmer organizations' predicting imminent collapse of the entire agricultural sector, offer an inducement for many young people wishing to focus on farming.

Both North and South will experience transition problems in the form of bankruptcies in the agro-industry in the North and food riots in some major African cities, for instance. Prompted by the tripling of real prices of imported bread wheat between 2005 and 2020, the urban middle classes in many countries in Africa, Asia and Central America will revolt periodically.

The UN and other aid donors will fulfill their pledges of alleviating the consequences of rising prices for the most exposed people in poor, major food-importing countries using targeted, temporary aid programs. However, these countries have steadily become fewer in number and no significant political force in the North or South demands a reversal to the trade and agricultural policies that dominated the period 1970 to 2010 – a period that contemporary agrarian historians refer to as the "crazy decades".

Notes and references

1. For simplicity, I use the terms "North" and "South" and "developed countries" and "developing countries" although I fully realiz e that the bipolar world conveyed by these opposites is completely inaccurate. The alternative of referring to high-income countries, middle-income countries, low-income countries and least developed countries offers a better picture of the situation worldwide, but becomes much more convoluted.
2. Refer to FAO, *The State of Agricultural Commodity Markets 2004*, Chapter 1, for data and diagrams.
3. The data in this section have been taken from UNCTAD, *Trade and Development Report 2005*, Table 4.9.
4. The data in this section have been taken from FAO's database: http://apps.fao.org
5. For an interesting discussion, refer to FAO *The State of Agricultural Commodity Markets 2004*, p. 300 ff. However, FAO's analysis emphasizes that all attempts to tax farmers' share of the food value chain, and the development of this share over time, are associated with considerable uncertainty.
6. FAO 2004, p. 31
7. The example illustrates the danger of using the terms of trade as an indicator of how price variations affect the value of foreign trade. By far the greatest losers in terms of export prices are the countries with a large share of PCs and similar products among their exports. However, if prices fall by 10 percent, at the same time as export volumes double each year, there is little reason to complain.

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SUSTAINABLE AGRICULTURE

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Sustainability concept

Our goal is to ensure that social development provides our children and grandchildren with at least an equally good foundation for their lives as we had for ours. Our aim is to achieve *sustainable development*. There are many ways of expressing and measuring sustainable development. It is important to find definitions that do not become linguistically rigid, since the concept can be expressed in various ways. An apt summary could read as follows:

Sustainable development attempts to preserve or increase the *total capital* at the disposal of society so that the next generation has equally ample resources for its development as we have had for ours. For the sake of simplicity, we divide *total capital* into three components: *Natural capital*, *social capital* and *institutional capital*.[1] Sustainable development means that the total of the components is constant or increases, even though relationships among the components may change.[2]

Agriculture has played a central role in the history of mankind during the past 10,000 years. The initially slow but subsequently very rapid population growth over this period means that agriculture has been sustainable up to the present day. Thousands of years of careful cultivation of the soil, water, plants, livestock and their genes have contributed to the development of advanced societies with a high level of welfare for many people – but continuing poverty for some. The world has probably never had larger social and institutional capital than it has today, and in many countries and regions natural capital has not been depleted to any appreciable extent – although there are nevertheless several regions in which it definitely has. Consequently, total capital is most likely greater today than at any time in history. The Scandinavian countries are particularly favored. The prudent use of natural resources over many generations, combined with good leadership and the prudent transfer of natural capital to social and institutional capital, has made life attractive in our countries.

However, as of now and for the next 40 years, major challenges face the Scandinavian, European and other industrial countries, and not least the developing countries, which are home to two thirds of the world's population. Agriculture and other primary sectors are crucially dependent on natural capital. No plants can grow and no livestock can be milked on the basis of social and institutional capital alone. Even though we live in countries in which gross domestic product (or similar socio-economic gauges) derives increasingly from the service sector (which is highly de-

pendent on social and institutional capital), all indications are that agriculture will continue to depend mainly on natural capital in the future. In developing countries it is frequently social and institutional capital that curtails the use of natural capital for sustainable agriculture (lack of functioning markets, organizational structures, input goods and modern know-how). Thus, overall, the global community shows a mixed picture in terms of sustainable development in agriculture.

The concept of sustainable development is of special significance for agriculture. It is not only that agriculture has historically been crucial for all of mankind and will remain so into the distant future, but also that the farmer – as the cultivator of the Earth's most fertile lands – also has (in a broad sense) stewardship responsibility for enormous portions of natural capital. Thus, modern society – both North and South – has a keen interest in securing the production of food from agriculture but also in giving agriculture the framework that secures access to the requisite natural, social and institutional structures for future agricultural production. In modern society, however, the conditions underlying stewardship are frequently split up in such a manner that responsibility for total capital is not evident to all players. Accordingly, this paper is aimed at providing a more comprehensive picture of sustainable agriculture.

Human requirements

Food security for individuals means that they can expect, with reasonable assurance, to have a sufficient amount of safe and nutritious food, lead a healthy life, be able to utilize their talents and contribute to the society in which they live and of which they are a part. Even though a family has sufficient food in average terms, there is no guarantee that food will be distributed equally. The elderly, women and children may receive too little food or nutrient-deficient food, and statistics are not always capable of identifying such unequal distribution of scare resources. The status of individual food security can only be assessed by medical examination. Local communities and entire nations may appear to provide food security – in the sense that there is a sufficient amount of proteins, calories, vitamins and minerals to cover the average requirement – but certain groups and individuals may be excluded. A lack of purchasing power is frequently the basis for collective or individual food insecurity. Full store shelves are no guarantee of full stomachs.

The good news is that never before have so many had access to a secure supply of food as is currently the case, that is, more than 5 billion people. This is an outstanding success for global agriculture, which has managed to feed a rapidly growing world population without serious problems. Farmers worldwide have shown considerable adjustment capacity, permitting them to produce sufficient food for everybody. Thus, there is no real food deficit worldwide and there is major potential to increase output. More food can be produced if political and economic conditions permit.

The bad news is that, as yet, we have not managed to reduce to less than 0.75 billion the

number of people that lack secure access to food. However, the global situation would have been far more negative if China and to a certain extent India – had not enjoyed such considerable success in agriculture. Consequently, the good results – notably those of China – conceal rising food insecurity in Africa and in poor regions of the Caribbean and Middle East.

The Millennium Development Goal[3] of halving food insecurity by 2015 is unlikely to be met. This is because the goal of halving absolute poverty by 2040 must currently be viewed as nothing more than utopia due to the political unwillingness worldwide to transform fine words into sensible action on behalf of the poor.

It is not easy to identify the maximum threshold for world food production. Theoretical estimates point to volumes sufficient to satisfy 14–17 billion people as the limit (based on photosynthesis, soil nutrients and water), but a range of unpredictable social and cultural factors controls food consumption. For instance, higher living standards in China may raise the demand for meat (which is more resource-intensive that producing vegetables). Also, North Americans may continue with their highly resource-intensive diet; the Mediterranean diet in southern Europe may be emulated in Northern Europe; or resource-light vegetarian Indian cuisine could make a breakthrough. If the population of the world peaked at 8–9 billion around 2050, it would not be an insurmountable problem to produce food for everybody. But whether everybody would have the purchasing power to obtain food is another issue.

Over the past 150 years, agricultural science has made crucial contributions to higher output per input unit (land, labor, water and capital). The use of inorganic, or commercial, fertilizer has contributed to raising or maintaining soil production capacity in respect of key nutrients (nitrogen, phosphorous and potassium). Indirectly, however, inorganic fertilizer may have resulted in the depletion of other nutrients and trace elements required by plants and livestock.

Modern technologies in the crop and livestock areas have raised the genetic potential for new strains to produce more food. The "green revolution" used the higher genetic potential in rice and wheat to provide higher yields, notably in Asia. Traditional utility plants and historic livestock breeds have, of course, valuable genetic material that is crucial to conserve for possible future use in agriculture. The agricultural sciences have developed new methods for food production and we can expect further progress in this direction in the future.

Questions should be raised regarding the sustainability of innovative methods, just as inorganic fertilizer and pesticides may be juxtaposed with organic agriculture; and methods using caged chickens and other high-input, high-output livestock production models can be contrasted with long-established animal husbandry; and traditional livestock and plant breeding may be compared with modern gene technology,

We could discuss at length whether the new, narrow genetic base for modern plant and livestock production entails a depletion of natural capital and whether the preservation of genetic material in gene banks really represents applic-

able natural capital in the long run.

We are beginning to see signs of latent threats in the wake of current intensive technologies for plant and livestock output, such as declining yields in engineered rice strains in Southeast Asia, BSE in the UK, and bird flu both in Asia and in the European hinterland. But let's not forget that calamities are not absent in traditional agriculture either. Throughout history, people have frequently had their crops wiped out by plant and animal diseases or as a result of the proverbial "seven lean years".

In a historical perspective, agriculture has never produced more food per land unit than it does currently, and with output curves rising over the past 150–200 years, it is difficult to know whether new technologies really entail a risky depletion of natural capital. However, some of us do not preclude the possibility that this may be case.

Also, on the international level – in both developed and developing countries – there is support for various types of organic agriculture to utilize traditional livestock breeds and set up and run gene banks for key utility plants. Overall, these efforts represent a form of insurance against any unforeseen decline in natural capital, at the same time as social and institutional capital is assured in the form of cultural landscapes, experiences and traditions.

Maintaining high yields and simultaneously ensuring that hazardous chemicals and dubious genetic material do not harm our daily bread and our natural surroundings is an enormous challenge. Whether it involves modern conventional farming with its large volumes of external inputs or organic production methods, agriculture has the overarching responsibility to conserve natural capital and ensure minimum losses.

A positive aspect of the intense debate regarding the alternative extremes in agricultural methods is that it has highlighted the value of natural capital as the foundation for agricultural production. Each new method or operational form is valued and measured also on the basis of how it increases or reduces natural capital. Human food requirements no longer transcend the conservation of natural capital, as was the case 30–50 years ago. Nowadays we have a long-term approach to sustainability that was not a feature of the international debate just a generation ago.

Meanwhile, we now view agriculture and its production forms from a fresh and broader perspective. In the past, food was part of the dietetics and health disciplines, two totally different sciences that previously hardly communicated with each other, while today we note a clear integration of these disciplines in theory and practice. Nowadays, it is obvious that mere access to food does not automatically provide the correct nutrient composition and that the relationship between agriculture and health is far closer than we previously anticipated. The major societal diseases in the developing world – diarrhea, malaria, leishmaniasis, bilharzia, onchocerciasis, many parasite-based illnesses and perhaps also tuberculosis – are closely related to agriculture. The form of agriculture deployed in managing and using natural resources can facilitate or prevent diseases.

Most of the world's poor reside in rural areas with very few medical services and the natural surroundings in which they live are frequently a function of their use, whether it be farming, forestry or fishing. There are indications that nutrient status and diseases are of major significance for the human immune system, which can also be affected by mycotoxins in food – such as aflatoxin in peanuts and maize. One of the factors underlying the currently rapid spread of HIV in Sub-Saharan Africa may be the particularly weak immune resistance, which in turn could be related to other diseases, nutrient deficiency and agricultural methods.

The traditional management of natural capital may be capable of changing the vectors for certain hazardous diseases, such as malaria mosquitoes in dams, irrigated lands, or water-filled clover land for livestock; bilharzias snails in stagnant water sources; tsetse flies on the savanna that transmit sleeping sickness; or sand flies in shaded coffee plantations that convey leishmaniasis. There are solid humanitarian reasons for reducing natural capital in locations in which it is proven that human health can be enhanced, thereby raising social capital.

Food production resources

Farmers have traditionally deployed three methods in their efforts to increase food output: expansion of farmland; higher production intensity, using their personal resources (primarily labor); or the use of additional inputs paid for by surplus production.

The most fertile soils worldwide are already in use and there is little unused land, at least not close to dense population centers. In many regions of the developed countries, forests have retaken substantial farmland acreage. What were once large tracts of land in the Swedish farming landscape are now forests; in Norway, 4,500 hectares of arable land and grassland revert to forest and brush each year. Although natural capital remains virtually unchanged, the countryside's social and institutional capital declines substantially in pace with reforestation.[4] By means of purchased inputs, the remaining farmland has been made more fertile, leading to increases both in yield per land unit and overall output.

In developing countries, the trend has been in the opposite direction: agricultural output has increased by bringing new land under the plow or using it for grazing. This is frequently the approach applied on less fertile land with inferior production potential or substantial constraints. These areas are readily susceptible to depletion and erosion. In Brazil, vast areas in the Amazon have been opened up in recent years.

The long-term fate of natural capital is uncertain, as witnessed by the savanna and rainforest areas (with vulnerable chemical and physical features). These less fertile regions are most easily eroded or salinized. The opening up of substantial savanna areas in Brazil, for example, for agricultural use may readily be described as agronomic achievements, but long-term progress is by no means clear. During the 1950s and '60s, vast tracts of land in West Africa were brought under the plow. This resulted in 20 years of ample

harvests, not least because of the unusually heavy rainfall during the period. But when drought set in – and thus more normal rainfall – it proved difficult to achieve acceptable harvests.

Whereas North America and Western Europe remove land from farming operations to prevent overproduction, the developing countries continually attempt to add new, vulnerable land areas that are unlikely to be suitable for sustainable production.

Agriculture is also a major water consumer. Although agriculture itself recycles considerable water resources several times over, such as in rice cultivation, there is no doubt that the most water-intensive growing farming methods are not sustainable in the long term. We must assume that a reduction in water consumption and its more efficient utilization in agriculture will emerge. Pollutants must also be taken into account; constrains are imposed on irrigated agriculture not just by the nutrient concentration in the feed water but also by excess nitrogen and phosphorous in drainage water. Salinization and alkalinization are also part of the picture. Water is clearly a constraining factor in modern agricultural systems.

The manpower available for agriculture in manual systems in the developing countries is frequently limited. This seems like a paradox, since unemployment is very high. But because most work processes (tilling, sowing, weeding and harvesting) are manual and extremely time constrained, agriculture in developing countries is plagued by labor shortages during critical periods. Moreover, low prices of agricultural commodities, a lack of reliable markets and poor or no infrastructure that can provide support in the form of mechanization result in low productivity. Also, if we take into account the impact of diseases and malnutrition on manpower resources, we get a bleak picture of the labor quality that is actually available to agriculture in the developing countries. Women – who in many communities also perform other tasks – conduct a large share of production.

There are serious doubts as to whether the poorest and most needy farming communities in Africa can mechanize their agriculture in the foreseeable future. On the other hand, there is positive experience from basic mechanization in parts of Asia in which economies are advancing, permitting access to labor during crucial periods.

In the globalization debate, even though we often – and justifiably so – focus on the dumping of surplus food output from the developed countries in the developing countries, thereby undermining local farmers' ability to gain income and a better life, we must not forget that by far the largest share of food produced is consumed locally. "Locally produced food" may be well be a positive slogan in the developed countries, boosting local farmer markets and reducing transport; but the fact is that 90 percent of rice output, for example, is consumed locally. In discussing the globalization of the food trade – which is dealt with elsewhere in this book – the promotion of locally produced food must not be overlooked. Traditional food culture is also part of social capital.

The major scenarios

Global food production continues to keep pace with population growth. The primary factor that leads to hunger is the inequitable distribution of purchasing power. Viewed from a farmer's perspective, poverty reduction is the most effective way of achieving food security. Nowadays, however, a majority of the world's poor are themselves farmers in rural areas amid poverty levels that are just bad as in the cities.

Over approximately the past 30 years, the leading global institutions and donor countries have opted for non-agricultural development models in efforts to curtail poverty. In the 1970s, Norway directed some 30 percent of its primary sector aid into rural areas; by 2000 this figure had plummeted to less than 3 percent. Meanwhile, international credit institutions noticed that the return on capital invested in agriculture was lower than in other sectors. For instance, the World Bank (WB) cut its agricultural support from about 20 percent to less than 5 percent.

Now, however, new signals are emerging from the WB and leading aid donors such as the Nordic countries, Netherlands and UK. There is greater emphasis on combating poverty in rural areas, suggesting that the primary sectors can expect better conditions in terms of aid. But the agricultural self-interest of developing countries – Norway, for example, is one of heaviest subsidizers of domestic agriculture – curbs the potential to develop effective formulas for countering poverty via agriculture. Nonetheless, the key point is that the poor countries themselves assign priority to the primary sectors in their development programs. Unfortunately, however, a reading of many national Poverty Reduction Strategy Papers (PRSP) show that only a few give priority to agriculture, including developing countries that we in the North categorize as agricultural economies.[5]

The Millennium Development Goal of reducing hunger by 50 percent no later than 2015, and poverty in a similar proportion by 2040 is appealing and easy to endorse. Individually, neither of them appears a particularly ambitious goal. However, the initial years ahead of these target dates have proved troublesome, and the world community has clearly fallen behind the schedules. The rapid economic growth of China and India mask the grim statistics in Africa and certain countries on other continents.

The scenarios presented by the Millennium Ecosystem Assessment sketch a disturbing picture of what could happen our ecosystem during the next 45 years.[6] A special survey of agriculture, IAASTD, was presented in autumn 2007.[7] Although we are only starting to study future scenarios for agriculture, many observers already believe that we will face a profound crisis in the years ahead. Some models that economists have deployed to date point to collapse and a doomsday situation.

Personally, I don't believe that agriculture is facing a generally grave crisis at the global level. Proceeding on the basis of total capital, I will explain why in the next section and in the three following subsections.

Critical factors for sustainable agriculture in terms of natural capital

Industrial agriculture is based on a positive view of living with natural constraints: They can be manipulated and altered. We can irrigate areas once drought ridden, spray pesticides if there are too many pests or weeds, spread inorganic fertilizer if soil is depleted, and medicate livestock when they are ill. Perhaps in the future we can also incorporate a few of these characteristics into plant and livestock genes. Industrial agriculture – in developed and developing countries alike – attempts continually to boost natural capital. Of course, there have been a few mishaps over the years (the Aral Sea and the "Silent Spring" cases, for instance) but the principle is nevertheless to assist natural capital in a constructive manner. Industrial agriculture has been particularly significant in managing to feed a growing world population. Just about everything seems to have worked out well – but we don't know for how long.

The opposite of industrial agriculture may most simply be referred to as organic agriculture. This approach displays a high acceptance of natural constraints and seeks, using minimal external inputs, to optimize the return from plants and livestock within the natural framework. To a lesser degree than industrial agriculture, this approach endeavors to enhance natural capital. Instead, most efforts are aimed at preventing it from being misused. Advocates of organic agriculture have a pessimistic view of the effect of inputs in agriculture and the relationship with natural capital. With considerable emphasis on biodiversity – combined with the use of natural soil improvement agents and compost, plus the intelligent deployment of natural balances – this approach attempts to ensure that the natural capital is not reduced.

Nowadays, practical agriculture in most countries lies somewhere between the extremes of industrial agriculture and the most dogmatic forms of organic agriculture. What has become evident over the past decade is that both models have become far more aware of natural capital as a way of gauging the effects of agricultural methods.

Today, there are rational choices between a broad spectrum of methods in both affluent and poor countries. In poor countries agriculture for many farmers is virtually organic, not because they planned it so but simply because they lack the purchasing power to buy additional input goods. Farmers in affluent countries make choices that are less influenced by such compelling financial factors. Politicians in developing countries readily claim that more inputs should be available for their farmers in an effort to lift them out of rural poverty.

Meanwhile, politicians in developed countries – who are more controlled by consumer interests – want to see more organic goods on store shelves and a marked biodiversity in rural areas. But in all countries there is a broad spectrum of interests and this spectrum relates increasingly to natural capital. Organic agriculture is making headway both in rich and poor countries, but still represents just a fraction of the food traded and land farmed.

Irrespective of the agricultural method we select, it is useful to value the operational form in terms of natural capital factors, meaning landscape biodiversity, genetic variation of utility plants and livestock, long term soil fertility, levels of chemical and radioactive pollution, and water consumption. A basic review of agricultural systems using these criteria offers a fairly accurate account of the impact on natural capital.

Critical factors for sustainable agriculture in terms of social capital

The transition from a rural to an urban society has been in progress over the past several hundred years. In the developed countries this process has been promoted by the mechanization of agriculture during the past 50 years. In developed countries only a small portion of the population live in the countryside and even fewer are directly involved in the primary sectors. A similar trend is visible in the underdeveloped countries but for different reasons. Sustained, profound poverty in rural areas gives young people little hope of leading a life at home; a decent life can only be found by moving away. Social capital declines in both cases; urbanization dramatically reduces the social capital in rural areas, both in rich and poor countries alike.

Relocation has also been somewhat selective: those with the most resources and the most entrepreneurial move first, while the very poorest stay on, devoid of hope. There is little doubt that the countryside today is a socially poorer community than 50 or 100 years ago. If the countryside is to be stabilized, certain social values must be preserved. These critical factors most likely include cooperation – the need to assist and support each other and to participate in the cultural and social life of others.

It is claimed that young men in developing countries without any hope of a decent life in rural areas make ready recruits for warlords and criminals. Armed conflicts, civil wars and conflicts between states are thus interpreted as a result of diminishing social justice in the countryside, such as in Liberia, Sierra Leone, Ivory Coast, Haiti, Colombia and the Philippines.

Consequently, social capital is perhaps decisive in determining whether people remain in the countryside or not. Economically sustainable agriculture entails affiliation, cooperation, knowledge and culture

Nevertheless, population movement from the countryside need not necessarily entail the elimination of social capital from the nation. The glue that binds together the cities and controls a country's policies can readily accompany the urbanization process. In Norway – and perhaps also in other Nordic countries – many urban social values derive from the countryside. Major political discussions portray definite features of rural social capital. Although no more than 2–3 percent of the population work in the primary sectors, the inheritance from rural social capital has a far greater impact nationwide than is warranted by its low proportion.

Sustainable agriculture does not only involve natural capital but also the potential of rural society to retain its own social capital, despite

the relocation of many residents to urban areas. A most extreme example of this is the ongoing HIV/AIDS pandemic in Sub-Saharan Africa. When village families can no longer mobilize the resources for care, medicine and funerals, young women turn readily to prostitution to be able to afford the necessary services for their families. This type of pandemic cannot be stopped by means of condoms alone but rather through the mobilization of the social capital that makes the sex trade superfluous. ILO – the International Labor Organization – has proposed the introduction of microfinance systems to replace and support the dissolution of social capital.

Social capital consists of many components that are not readily quantifiable; they become most evident only when they cease to exist.

Critical factors for sustainable agriculture in terms of institutional capital

The market for institutions disappears in pace with the exodus from rural societies. In market-driven societies, schools, hospitals and advice centers depend on demand and are rated accordingly. A declining agricultural sector, as we have seen in Scandinavian societies, rapidly reduces institutional capital. The closure of secondary schools leads to a sharp increase in local emigration. Frequently, public sector institutions are shut down and the market is often too small for the private sector to take over. In developing countries, the implementation of structural adjustment programs – following demands from international institutions – has dramatically reduced institutional capital. Farming and veterinary advisory services – once the natural core institutions in village society – are eliminated, with little to replace them.

Another effect of this structural adjustment on agricultural institutions is to reduce the recruitment of young people to agricultural schools and universities. The best and most intelligent pupils no longer wish to study subjects for which there are no longer institutions and, thus, no jobs or careers. While the agricultural science universities in southern Africa were still able to attract the best brightest students 15–20 years ago, they are now fighting just to fill course numbers despite much lower entrance requirements. In this respect the situation is very similar to that of agricultural studies in many developed countries, which also suffer from a lack of applicants.

Sustainable agriculture is not meaningful without a minimum of in-situ institutional capital; societies seeking sustainable agriculture must invest in institutional capital.

The grand total – can we achieve sustainable agriculture?

Most economic/political models seem to present a pessimistic picture as regards the scenarios for agriculture up to the year 2050. It is not difficult to envisage a highly industrialized, monoculture-based, super-efficient agriculture carried out by a team of tractors in an area without any institutions. However, by then, the total capital administered by agriculture would have undoubtedly declined. The components of natural capital

would be jeopardized; social capital would be almost depleted, as would institutional capital. The alternative picture that we can sketch is mixed agricultural modes – both conventional and organic – in a living rural community in which people, despite depopulation, regard themselves as part of a larger social context and where, perhaps with public sector support, central institutions remain and also provide hope for coming generations.

If the concept of total capital is a core component of sustainable development, it is society's task to identify how it can make positive contributions to it. Irrespective of whether it occurs via the WTO, EU or in a larger Europe, the new order in world trade will demand major changes in agriculture in the Scandinavian countries. Sectoral thinking frequently marks the arguments we present to our negotiators. Personally, I seldom hear people talk about total capital. You cannot expect biodiversity in the countryside without a minimum of social and institutional capital. This should be fairly easy for our rich countries to manage – provided we are permitted to do so by the global community.

The situation is totally different in countries with a more fragile economic base. Viewed in an isolated perspective, perhaps organic production of coffee or tropical fruits may contribute to the conservation or increase in natural capital, but as long as countries do not receive assistance to support their social and institutional capital, total capital will decrease. Rural areas in the poorest countries have seen that both social capital and institutional capital suffer when national or international policies for enhancing economic efficiency gain a major influence on agriculture.

The approaches that governments need to adopt regarding rural development and the direction in which we rich world citizens should direct our international aid resources must emerge from a broad dialog encompassing all components of total capital. Using this approach we can gain sustainable development in societies in which agriculture and other primary sectors dominate.

We will encounter major challenges in these efforts. Not only is the quantification of total capital a complex task, we also face new scientific findings that will not easily gain immediate acceptance. This is perhaps most evident in discussions regarding genetically modified organisms (GMO) in agriculture. Disregarding the fundamental religious problems of transferring genes across wide genetic distances, there is nevertheless a lengthy series of arguments involving natural capital, social capital and institutional capital. It is easy to say that GMO is the solution to a question that never needed to be presented to Norwegian or Swedish agriculture, but GMO represents a significant contribution to raising food security for poor farmers in developing countries. They would no longer need to lose 10, 20 or 50 percent of their harvest to pests or be dependent on toxic and costly spraying chemicals if resistance was incorporated in crop genes.

In the sustainability debate, we must be prepared to value widely varying ideas and keep an open mind regarding scientific discoveries relating to total capital and its various components.

Notes

1. Of course, total capital may be divided up in other ways using different components. This three-part subdivision is nevertheless useful for the discussion of the challenges facing agriculture.
2. When Norway extracts oil and gas, it reduces both Norwegian and global natural capital. If we invest the returns from oil production in better education of our youth or in better care of our senior citizens, we increase the social and institutional capital. The sum of the three capital components (one negative and two positive), may thus be neutral or positive. If we use the funds for higher alcohol or tobacco consumption, to play Internet poker or spend on big cars, we most likely reduce the total capital, which does not lead to sustainable development.
3. Millennium Development Goals.
4. Interestingly, the salinization of the soil may be increased by the expansion of coniferous forests, but – from the viewpoint of natural capital – it is possible to discuss whether soil with a low pH is less valuable than spoil with a high pH.
5. Poverty Reduction Strategy Papers.
6. Millennium Ecosystem Assessment
7. International Assessment of Agricultural Science and Technology for Development (IAASTD) a three-year consultation 2005–2007 is out for comments on the following issues:
 - Reducing hunger and poverty.
 - Improving nutrition, health and rural livelihoods.
 - Facilitating social and environmental sustainability.

THE BIOSOCIETY

Karl Erik Olsson, Farmer, Member of the European Parliament and former Swedish Minister of Agriculture

This paper does not claim to be to be comprehensive. Thus, already at this stage I would like to note that many future potential opportunities are disregarded. For example, I do not deal with resource inflows from other planets, or future inventions (which will undoubtedly occur), or the large-scale use of safer nuclear power and perhaps fission power, or subsurface carbon dioxide storage.

Instead, I deal with the biosociety, partly perhaps because I am more familiar with it but particularly because I believe this is where mankind belongs.

Background

Living off of life

Man is a biological being. During most of his existence, mankind has completely lived off of and alongside biological resources. Like all other creatures, we have been compelled to turn to organic compounds for our sustenance and for life in general. There were, of course, minerals in these organic compounds, but it was these combined with air and water that constituted the life source and gave life the potential to continue and develop.

Living off of finite resources and old life

Rather late in his progress, man discovered how to utilize finite natural resources, such as minerals, to make tools and buildings. This evolutionary process lent its name to various periods such as the Stone Age and Iron Age, etc.

Later on, man learnt to use accumulated carbon compounds – or stored biological resources – such as coal and oil, to a degree that led to complete dependence.

Instead of gaining our sustenance from living life, we began to live by using old life in a non-renewable form. Mankind rearranged the order that nature had attained over millions of years, meaning that what did not favor life on the surface of the Earth was placed far down in the bottom strata – or, put another way, that life on the surface of the Earth emerged from and adapted to its immediate surroundings. From subsurface deposits, we convey coal into the atmosphere; we extract hazardous substances and spread them across the surface, thus making environmental problems a reality.

This event in the history of the planet and mankind marked dramatic transformations and changes in the conditions underlying life. A long-term historical perspective shows indisputably that this process cannot continue for much

longer. Resources will not suffice and the environmental burden will be excessive. The Earth, and probably also its ecosystem, can survive without people; but people cannot survive without the ecosystem.

The future – a reversion?

So the future will be different. But will it involve a reversion to the "natural" conditions prior to industrialism and consumerism? Will it be a society marked by hunger and poverty? Will it be a society in which we can utilize our growing knowledge to create the necessities for human well-being, perhaps formulated differently from today, and most likely amid a heavily impacted environment? No option may be precluded, but only the last mentioned is worthy of our endeavors. However, its attainment may require considerable effort!

Growth – what is what and for whom?

Population

The global population is now twice as large as it was when I attended school; in other words, it has doubled in the space of 50 years. The next 50 years may show a similar increase; however, the growth rate is dipping, with the curve likely to level out at about 10 billion.

Economics

Another form of growth – that most frequently cited – is economic growth. In our conceptual world, economic growth is synonymous with greater prosperity, and though often true, it is not always so.

It is not necessarily the case that the overall quality of life improves as a result of higher income and thus greater consumption. But it is important to remember that what we currently feel is a requisite standard – such as the necessary level of public service and social security – entails high costs, which in turn require high income and a robust economy.

It is worth noting that economics is the only contrived "science" in existence. It is not based on the progress made by the natural sciences but is more the product of human hypotheses. You could say that economics has more in common with religion (or superstition) than it has with science.

Economic growth measures the value of all economic transactions, with the result derived from the multiplication of volume by price. It doesn't matter which of these two factors increase, and though we often think in volume terms, added value and higher prices can provide the same result. Neither is the source of demand of any relevance, the end result is the same whether it derives from desperate shortages among impoverished people or from higher consumption by the world's elite.

The volume may consist of physical goods or intangibles, such as services and feeling/experiences. For the poor, it always primarily involves the bare necessities. For the materially wealthy, the key factor is growth in services and recreational feelings/experiences (frequently resource-light).

However, one weakness seems to be that, irrespective of the level of economic growth, it

appears almost impossible to manage a static economy. Evidently, economic theory has not developed a model to deal with "maturity" in the economy, meaning a type of final stage in which we can live at a high, sustainable and resilient standard without additional growth. This is a problem for global development, since it makes it difficult for affluent countries to "stop and wait" for the rest of the world.

Economics clearly suffers from a considerable lack of measuring methods: only monetary transactions count. Work and production in the household or social sectors are not included, and neither is "black" nor "grey" labor. Growth increases if we place these activities on the market or in the public sector, although this so-called growth is simply an illusion. This means that "less developed" countries and economies with self-sufficient agriculture and a large household sector are continually "undervalued" vis-à-vis the so-called developed economies.

Consumption

Growth involves the attainment of a series of requirements stages. Understanding what growth will entail and comprise requires that we know where it will occur and who will be affected.

We are currently enjoying record global economic growth, thanks to the populous areas of South and East Asia, which account for almost two thirds of the total global population, with almost a quarter of the world population in China alone. When a region of this size attains growth rates of 5–10 percent, the implications can prove difficult to comprehend.

Food Feeding a few extra hungry mouths does not change matters much. But when the vast masses of the poor gain a better life and change their dietary habits to resemble ours in the West, then things begin to happen. Producing calories in animal form requires three to ten times more land, plus other resources, compared with production in vegetable form.

Moreover, it is impossible to extract more animal protein from the oceans than is currently the case. This has been the source for the required increase over the past 50 years.

Energy Meanwhile, energy requirements rise dramatically. Heating and cooling, production and transport require greater resources. Each extra square meter of housing, each new workplace and each new office for public administration and service need more energy. Currently, the simplest approach is to satisfy these needs using oil or gas, supplied via pipelines; or, alternatively, using electricity, which is transmitted via cables but must be derived from coal, oil, gas or nuclear power or to some extent by means of renewable resources, such as water and wind.

Poor people walk; those slightly better off cycle. (In the early 1900s my father's family, being rather musical, discussed a joint investment in a violin or a bicycle. The outcome was a bicycle! They had not yet progressed materialistically to the extent that their need for culture – represented by the violin – gained the upper hand).

The next stage is that people buy a moped, motorcycle and then a car. Moreover, growing numbers of people use aircraft for business or leisure travel: the rise in energy consumption is exponential.

Consumer goods and gadgets A small house contains some furniture, household appliances, bathroom equipment and so forth. Expanding space means greater requirements. Also, requirements are added to the useful products noted above: cars get bigger and more numerous, and increasingly feature redundant equipment (as exemplified by SUVs). We create gadgetry requirements for exercising, walking, relaxing, working and vacationing.

But perhaps there is a limit to our gadget requirements; in purely physical terms, our consumption is not endless. Thus, resource requirements increase more when poor people experience economic growth than when the already affluent do so.

Feelings/experiences When the need for consumer goods and gadgets is satisfied, attention turns to recreational interests, as exemplified by the rapid growth in the music and tourism sectors. These sectors must be regarded as "feelings/experiences" industries, although they can also be considerably gadget heavy. However, there is always a trade-off between services and goods. This issue has not been dealt with seriously in most developed economies; instead, labor (meaning people) is taxed much higher than goods, despite clear evidence of the negative impact of material consumption. (In Sweden, for example, only about one third of the total wage cost accrues to those performing the work, while essentially 25 per cent is charged in VAT (= 1/5 of the value, in addition to certain selective purchase taxes and production taxes).

Culture The fine arts – literature, theater, music, and the graphic arts, etc. – have always sought to imbue their surroundings with various feelings or experiences. Historically, such enjoyment has been the privilege of a small elite. Higher education and better income open up these worlds to ever more people. Thus, it is hardly surprising that culture is increasingly commercialized, allowing it to make a more substantial contribution to economic growth.

Tourism and recreation People in the developed world have ever more leisure time. And they can afford it. This permits a greater number of people to take care of recreation seekers during evenings, weekends and on vacation. Since most countries levy excessive taxes on labor compared with taxes on natural resources, these activities do not live up to their potential in terms of jobs. For example, those wishing to utilize labor (people) during their recreation activities must pay several times more in tax than those using cars and fuel to drive about alone.

Growing interest in culinary experiences and gastronomy is one way of adding new value to the food we eat without increasing resource utilization. However, if dining takes the form of restaurant visits, the meal marks a transfer of work from the social economy to the market.

The gap between recreation on the one hand and nursing/care on the other seems to be closing. These functions will undoubtedly converge in pace with the development of a society centered on services and feelings/experiences.

Existential values

The West is probably approaching the end of an unusual era. The combination of scientific pro-

gress, inventions and the discovery of and access to seemingly unlimited resources has meant that this period of industrialism, materialism and consumerism has idolized mankind itself. We can do everything! We know essentially everything! What we don't know we can find out!

Given these circumstances, it is quite natural for secularized societies to emerge, that is, societies in which issues relating to life concepts and religion gain little attention: we replace faith with knowledge, even when the latter is occasionally fictitious. Europe is sometimes said to suffer from "Christ-phobia", meaning, we fear and are unwilling to admit that we basically have a Christian perception of life. Even though Christianity has been distorted, misinterpreted and used as a pretext for innumerable evil actions, it has constructive values – including human rights and respect for our fellow men – which are crucial and should be acknowledged for their religious origins.

If mankind encounters serious problems in pace with the extension of Western consumption patterns to encompass the entire globe, issues concerning life concepts, the meaning of life, the why and whither of everything, and about the beginning and the end will gain greater attention. Religion – meaning various religions – is likely to gain significance and it is important that it is acknowledged as part of efforts to create positive global development.

World market and trade

Following two world wars – plus an inter-war depression period – international trade was considerable curtailed, not only as a result of embargos and war but also because of protective tariffs and import barriers. Negotiations within GATT (General Agreement on Tariffs and Trade) from the 1950s to the end of the 20th century led to heavy cuts in trade barriers for industrial goods.

Meanwhile, during the course of these negotiations, scientific progress and new technology achieved a level of globalization that far exceeded the results of political discussions. Modern transport technology and, not least, superior radio, TV and IT communications now link up the world. The individual has noted this progress thanks to the breakthrough of the Internet and the potential to conduct speedy electronic payments, for example.

The public debate has long been marked by complaints of the lack of progress in reducing trade barriers for agricultural commodities. It was not until the GATT Uruguay Round – commencing in 1986, with full implementation in 1999 – that agricultural commodities and food were included for the first time. Demands for the cutting of trade barriers and the reduction of trade-distorting support for agriculture led to relatively far-reaching decisions in various countries and regions in the 1990s. Sweden's decision in 1990 to deregulate agricultural policy was one such measure and, after New Zealand's reforms, was the most radical move in the industrial world. The McSharry reform in the EU, while less far-reaching than the Swedish action, was also an adjustment to international demands, as was the so-called Freedom to Farm Act in the US.

The aim was to commence negotiations with-

in the World Trade Organization, WTO, the new world trade organization set up in Seattle in 1999. However, it proved impossible to agree on the principles underlying negotiations and thus the start-up was deferred to the Doha Meeting in 2001. The Doha Round focused largely on agriculture and intellectual rights.

It may be worth noting that most foodstuffs never leave the country of origin. In the case of grain, including rice, which is the major traded foodstuff, only 12–13 percent of global output reaches the world market. This corresponds approximately to EU production, or two thirds of US output, or two fifths of China's. As regards meat products, world trade is about half of this, or 6 percent, while for dairy products it is no more than 2 percent. With a surplus of about 10 percent in dairy products, the EU was the world's largest exporter over a lengthy period, accounting for about one third of world trade; however, it has now been surpassed by New Zealand. The dairy sector is highly illustrative: you could say that the EU, with its relatively large dumping of dairy products on export markets, reduces world market prices and, in turn, is compelled to protect its production, using high import barriers, against the low prices of its own making.

A good deal occurred ahead of the WTO meeting and during negotiations. In the US, the Freedom to Farm Act did not function smoothly, making it necessary to reintroduce an agricultural support system. The EU decided on a new agricultural policy in 1999, Agenda 2000, which was designed to pave the way for the WTO and for the EU's eastward enlargement. As a result of France sticking its foot in the door, progress fell well short of what was originally envisaged. As a result, it was decided to conduct a Mid-Term Review in 2003. The proposal presented was more far-reaching than initially expected and developed to become the most radical reform during the EU's almost fifty-year-old agricultural policy. Despite the Council of Ministers imposing adjustments and limitations, the reform was ratified in 2004.

Nevertheless, it is fair to say that the dynamism of the WTO negotiations exceeded anticipations. Over the course of development, new groupings have emerged alongside the traditionally strong EU and US. The most interesting of these is the G20 Group, comprising major future producers, led by Brazil, and including substantial consumer-nations such as China and India. The LDCs (Least Developed Countries) have also displayed greater confidence and a more confrontational approach than in the past, which must be welcomed. A meeting in London in autumn 2005 of the US, EU, Brazil, Australia and India gave rise to a new grouping, FIPs, (Five Interested Parties) – which seems to suggest these countries were more interested than others!

No major events took place at the WTO's Ministerial Conference in Hong Kong in December 2005. It could perhaps be claimed that the pledges already made regarding the removal of export subsidies by 2013 were confirmed in the form of slightly more stringent formulations.

Essentially nothing happened in 2006, although there may well be some progress in 2007. However, it is doubtful that the US can achieve much during President Bush's final year in

office. Consequently, negotiations may need to be extended in time and even a collapse cannot be ruled out. This situation has always been met by certain skepticism on the part of Sweden, an attitude is quite normal and reasonable: no negotiations can run into the sand unless one alternative is a complete collapse. Any resulting agreement will take at least five years to implement and thus 2013–2015 seems like a reasonable horizon.

However, the question is the degree of progress even in the event of a result. And whether it is possible to deal with foodstuffs and biomass as if they were nuts and bolts that can be readily stored and used to meet any shortages. This is not so in the case of food. We will deal with this issue in greater detail below.

One issue that has not yet been discussed, but which is interesting for the future, is how to handle the surplus that will undoubtedly arise over a number of years as a result of unforeseen climatic conditions. By definition, deficits never arise, since the threat of a deficit boosts prices, resulting in a redistribution of resources. One possibility was offered by the agricultural policy of the European liberals a few years ago, namely, that surpluses – perhaps in the form of intervention stocks – should not be placed on the world market, thereby distorting prices, but should instead be managed outside of the market by a UN agency based in FAO and WFP.

Do we have a chance – a global challenge for the Earth's surface

It is evident that production on the Earth's surface, primarily through photosynthesis and the processing of photosynthetic products in the animal kingdom – ranging from monocellular organisms to highly developed mammals – must be utilized in an increasing number of areas.

Simplifying matters a little, the various application areas may be described as the four Fs:

Food
Fuel
Fiber
Feelings/experiences

If we assume that the growth in material consumption, meaning the demand for natural resources, increases in pace with economic growth – say 3 percent over the coming 50 years – this demand will thus increase some 7 times over the next five decades. Parallel with this, natural factors will compel a reduction in the extraction and consumption of fossil assets.

If the entire population of the globe is to attain a living standard equal at least to that of Sweden in the 1960s, while the world population rises by 50 percent, this will require a four- to eightfold increase in food output (including a higher share of animal protein). Also, if the surface (soil, forest and water resources) is to produce more energy and industrial goods, production requirements imposed on agriculture – and perhaps even more so on forestry – will be several times greater. Moreover, a sustainable and more efficient use of aquatic areas is likely to be required; these represent a potential that has been somewhat overlooked to date. Let's not forget that the water surface of the globe is far larger than the landmass.

In brief, the above assumptions may be expected to entail that demand for biological goods increases 10 to 20 times. But we have not taken in account the rising demand for feelings/experiences. Intensive resource utilization will require the setting aside of substantial land sites for recreation and tourism – areas for the enjoyment of natural beauty and spiritual rehabilitation. In addition, the efficient use of biological resources means that the preservation of biological diversity must be guaranteed largely through allocations for nature reserves.

What then will be the direction for future agriculture, forestry and water resources? Will it primarily be a question of calories for food or heating? Or will it involve added value in the form of proteins and exclusive food features and special gourmet flavorings? Or special plants offering unique properties for chemical or industrial applications? These questions are by no means easy to answer.

However, one answer should be rather evident. In ten or twenty years time, the debate will certainly not center on enlargement but rather on how we can produce intensively and sustainably. There are already major differences in output per hectare. Using grain as a norm, we can conclude that grain offers the cheapest calories in the food area, in terms of current energy costs and labor. But it is possible to produce two to three times as much root vegetables, potatoes and many vegetable varieties. Meanwhile, transformation (processing?) to animal protein gives rise to a substantial calorie loss. The production of poultry entails a loss of about two thirds, while pork and milk production results in a decline of about three quarters, with the production of beef leading to a loss of some nine tenths! Of course, beef cattle can graze on grass and herbs on land unsuitable for crop growing or forestry and in such cases it is excusable; otherwise, beef production is difficult to justify when demand for calories outstrips supply.

Thus, we can be sure that there will be considerable variations in potential as regards the direction of bioproduction than what we have been accustomed to with the monocultures from the grain steppes of industrial agriculture. Also, utilization will be broadened dramatically to encompass all the four Fs. The boundaries between food, energy and industry will be erased. New conflicts will arise. The rich countries' energy requirements or luxury consumption will compete with the needs of the poor for food in a far more brutal fashion than is currently the case.

Political control

Over the past 50 to 75 years, all or parts of the industrial world have pursued a supply-side governed agricultural policy based on the control of the food supply. Political decisions steered the production focus and output volumes, leading to a surplus in relation to purchasing power worldwide. Marginal surpluses not consumed in the industrial countries at domestic prices were exported to a world market frequently marked by insufficient purchasing power. This gave rise to a split market with export subsidies and tariffs.

However, the sharp fall in world market prices during the past 30 to 40 years is not simply the effect of dumping, On the contrary, the price of grain, for example, has continued to fall in real terms over the past fifteen years, while export support and ex-

port subsidies declined. This is because of greater production efficiency, leading to cheaper food – a situation that most consumers welcome I'm sure.

A scenario that can be expected to emerge in the future is one in which purchasing power in the populous regions of the world rises sharply, leading steadily to demand-driven bioproduction. The big question is which sector will see the earliest and most rapid increase.

Thus, we face new and more complex distribution problems than anything experienced in the past. Distribution conflicts exist among countries and, of course, between various groups in these regions. However, these conflicts will emerge to a greater degree among various societal sectors, since these compete for the same raw materials, namely, from bioproduction.

One reason that political control has been common in the food sector is that it is difficult to produce exactly the amounts required. Since food must be provided each day, prices surge in the event of shortages, and thus there is a desire to hedge against such shortages. Difficulties arise in controlling output volumes. Biological production is always affected by factors beyond the control of mankind, such as the weather, even though forecasting has improved as well as the potential to gain protection from "abnormal" weather conditions. In a bid to avoid shortages, planning by society and individual holdings has focused on production targets that were really a little too high and frequently exceeded – things are seldom as bad as anticipated.

Accordingly, these are the primary factors underlying food surpluses on the world market. The substitutability of food and energy also exacerbates the problem.

Greater purchasing power

It was noted above that greater demand for biological products could lead to higher demand-driven production. Meanwhile, and taking into account what was noted above on the political control of food production, it is necessary to see the risk of this phenomenon spreading to other areas of bioproduction. This has already occurred, de facto. Nowadays we have energy taxes that make fossil energy more expensive than it actually is, along with subsidies that promote bioenergy production.

The current debate on the deregulation of the global food trade appears to involve an increasing number of countries and – with appropriate and reasonable management – could probably favor rich and poor countries alike. However, the question arises as to whether many countries in recent years or decades have commenced the regulation of an even larger portion of production, amid a notable lack of warning voices. At the EU level, I have personally presented warnings to the effect that we have moved from food regulation to energy regulation in an effort to guarantee energy supplies, combined with landscape and environmental regulation to preserve biological diversity and natural beauty. Such intervention in the market economy obviously influences where and at what price a good can be produced and thus also world trade and global distribution.

Consequently, the risk arising from this trend is that the problems we have witnessed in the agricul-

tural and food sectors could spread further to more and larger sectors of our economy and trade. As a result, rational production, allocation and global distribution could also become more difficult.

The experience of the agricultural debate suggests that this type of development must be avoided. But the other side of the coin must also be taken into account: Is it reasonable and fair that the market should determine the volumes and locations for future raw material production, as well as its distribution worldwide and consumption in the form of totally different products for totally different applications?

One extreme variety of an unregulated, ultra-liberal biomass market could look as follows: Reduced supply and higher prices of fossil energy result in excess demand for biomass (in every form), which is expected to be sustained and, thus, raise prices sharply. Big companies in major countries seek to rapidly dominate (buy) as much as possible of the "surface" (reminiscent of the massive buyout of Swedish forests in the late 19th century when forest holdings began to take on a monetary value). Output is sold to those offering the best prices; in other words, affluent groups in well developed countries. They seek substantial amounts of meat, large houses, big cars and considerable energy, representing the least efficient use in practical terms and the least necessary production from a global perspective. Meanwhile, poor people in poor countries would find it increasingly difficult to get reasonably priced food and other goods for their subsistence.

This outcome is likely in a globalized biosociety – precisely in line with the conclusions of many politicians and scientists previously. Neither a completely liberal and deregulated market nor total political control of goods distribution is ideal. In the swing of the pendulum that characterizes a dynamic society, we are now on our way to the right-wing turning point – extreme liberalism. I am convinced that it would be beneficial to prevent the pendulum from swinging fully to the right, simply because the impetus to revert to the left then becomes so much greater. The lack of a responsible distribution of biological resources could mark the starting point of a renewed global swing to the left.

Perhaps we should strive to proceed as far as possible in political globalization so that we gain some regulation to ensure global equalization, as opposed to the current regulation that generally favors the preservation of injustices.

Sustainability

True to its nature, mankind is straining its living space geographically, technically and biologically.

With the reaching of a limit, which currently seems to be the outer one, considerable risks also emerge. This is the case whenever countries attempt to expand their territory, leading to war. Our attempts to raise our material well-being using rough-hewn technology and untested chemicals lead to resource destruction, environmental problems and disease.

When we strain our living space in our endeavors to reach the upper limit for biological production on the Earth's surface, we threaten biological diversity, nature's own equilibrium levels and thus sustainability. Consequently, the key demands to be imposed on higher output are

sustainability and resilience. This is to ensure that our efforts to meet current requirements do not jeopardize future production. What this requires is selecting technology that is efficient, productive and also sustainable.

As a layman it is difficult to lead a discussion regarding appropriate technologies; many experts present contradictory opinions. However, as a politician, I am compelled to adopt a position based on common sense and the expertise of others.

One rather simple principle to observe is nature's own cycle. This involves the water cycle, which we have previously tampered with and manipulated. The amount of water worldwide is constant, but not its location and flows. Large densely populated areas are beginning to experience serious water shortages due to human mismanagement; others are suffering from increasingly frequent flooding.

The carbon cycle – meaning how we manage all organic substances to gain the maximum amount of life and avoid excessive carbon emissions into the atmosphere, leading to climatic change – is equally important. Energy management is vital in this context.

Other key nutrients for plants and animals, such as phosphorus, sulfur, lime, magnesium, potassium and sodium, etc., are also meant to move through the cycle without being lost and accumulating in the wrong place. There is no waste in nature. Provided that we avoid including inappropriate, hazardous substances in the cycle, no waste is created. Waste is simply too much of a particular material in the wrong place.

However, in the case of an advanced welfare society, "spills" or leakage from the cycle are unavoidable, and should be rectified as far as possible. As regards stored resources, these may be increased and reduced with the aid of man, but utilization must never be so high as to distort long-term equilibrium.

All scientific expertise and available technology must be deployed to recreate functioning "sealed" cycles. In this context, we must remember that the more we eat of the tree of knowledge, for good or for bad, the greater the risks that arise. Thus, caution must rise in line with knowledge. Many environmental problems have arisen not so much as a result of man using new knowledge but because man has not shown sufficient care in applying this knowledge.

What is referred to as organic cultivation has attempted to come to grips with environmental problems and imbalances in agriculture. Organic production has preserved and further developed knowledge of how man produced without the use of certain chemical and technology resources. This is of major benefit to our continuing efforts, although it may not always provide the greatest utility in the present and does not always offer maximum utilization of the environment. For example, the stringent ban on the use of chemicals in this type of production means instead that – as long as we continue with monocultures – weed control must be done mechanically, leading to higher energy requirements and subsequent major nutrient leaching.

Instead of using various skills to the maximum on different occasions, future biological production will definitely need to maximize the

application of all forms of expertise to attain optimal and sustainable production.

Another question concerns the species and types to be produced and the genes used in the production of biomass.

Ever since man moved from the hunter-gatherer stage, he has attempted to identify the best species and variants in nature to cultivate on his own behalf. Through selection in plant cultivation and animal breeding, man has made substantial progress and, thus, our cultivated plants and livestock most likely have little in common with their natural predecessors.

Genetic technology offers the potential, now and in the future, to combine natural characteristics, not just by crossbreeding (which must be restricted to one species) but also by cutting and stitching together the desired characteristics. This is essentially no different from traditional plant cultivation and livestock breeding, the difference is merely in the approach.

Sensible and cautious application of biotechnology will definitely help us make greater progress in creating an optimally sustainable biomass production with minimal leakage into the natural cycle and minimum negative impact on the environment.

Global development – a prerequisite for a positive future

All the indications are that the problem profile facing us in the future will be more complex and more difficult to resolve than that experienced by previous generations. This is because there are more of us, plus the fact that we all demand a higher living standard and well-being. Moreover, during the past century, man has made several scientific discoveries that threaten life itself. Of course, progress has also been made that can promote life, but this is not quite as noticeable and, in the short term, has not proved as equally beneficial to exploit economically. Meanwhile, our skills in managing and resolving problems have improved – but have they done so at a similar pace?

Mankind, in terms of intellect and emotions, has not changed significantly during the last few thousand years. Accordingly, the individual's spontaneous reactions are more or less similar when faced with problems. And it appears there is little difference if the particular individual happens to be the leader of a superpower.

A person faced with the problem of scarcity has a natural tendency to summon all his strength to procure for himself – or simply grab – as much as possible while there is still something to be had. Hoarding is a familiar phenomenon throughout the ages, with some frightening examples in modern history. Why did Hitler wish to create "Lebensraum" for Germany; why did the US so willing enter the Korean and Vietnam wars if it wasn't because of the threat of losing control of significant natural resources around the Yellow Sea and the Gulf of Tonkin; and why did the US, under the pretext of democratization, launch a war against oil-rich Iraq?

Scarcity leads to tension. War is terrorism; terrorism is war. Which is which is determined by the party issuing the statement. When the poor

resort to violence to gain access to resources, it is frequently described as terrorism. Of course, such action is unacceptable, as is the situation in which the already affluent use violence (frequently on a greater scale) to protect their privileges. The old saying from feudal times "When the common people begin to assume the manners of the upper classes, society is on the road to perdition" applies also today in the international community. However, the real problem lies with the particular "manners"!

The combination of scarcity, unequal distribution and access to destructive know-how and technology is dangerous, to put it mildly. To counteract tensions, violence, terrorism and war, we must create a more equitable world. It feels repugnant to have to forewarn of this threat, but it is a realistic one.

It would be far more enjoyable to preach the message of love, equality and solidarity; that man is good and wishes only the best for others. Unfortunately, this is not quite the case. By nature, man is partly a predator, and as such, is "evil" in a certain sense and must learn to be better. The New Testament states: "So in everything, do unto others as you would have them do unto you". Many of us have heard it and are reminded of it frequently; but how many have really heeded this counsel. Not even many of the so-called Christians. And it's not easy to practice. Not in the local community or nationwide, not among nations or regions, and certainly not on the global level.

Independently of any political decisions, science and technology have led to a globalized society in which all people have the potential to be immediately informed; one in which messages, images, and payments are electronically transmitted worldwide in a few seconds – all of which is beneficial.

Knowledge has long been in short supply in developing countries. With rising economic growth, their stock of knowledge is also increasing sharply. It is considerably easier to oppress or ignore the ignorant. The West's advantage has long rested on this imbalance.

The situation is now changing. Increasingly stronger forces will emerge to change the balance between the rich and the poor. This trend is reflected in the constellations involved in the final stages of the WTO negotiations. It really makes no difference whether we react in an effort to offer aid or in a spirit of solidarity or simply from fear. The primary point is that we realize that the Earth is limited and vulnerable and that we must take care of it, utilize its surface for maximum sustainable production, and strive to attain a distribution of output that is as equitable as possible.

This is really the only direction open to global development policy.

SUMMARY AND THE WAY FORWARD

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Introduction

Twenty-five years ago, and on a commission from the Joint Nordic Committee of Senior Officials for Development Assistance Questions, we jointly drafted the first public report in the Nordic region on how environmental and natural resource issues – and their close linkage with agricultural questions – could be better integrated into Nordic development cooperation.[1] Since then we have in various ways worked with or closely monitored the relationships between agriculture, trade and development from an agricultural perspective and from other angles. Both of us have been active in different ways in this sector. Having previously attracted little attention, the issue has in recent years gained increasing importance and – following a decision of the Swedish Parliament on a coordinated policy for global development in 2003 – has become a significant component in Swedish development and aid policy.[2] Its relevance has been amplified by the 2008 World Bank Annual Report, with the subtitle "Agriculture for Development".[3] The last time these issues were dealt with in a similar report was 1982.

The various chapters in this anthology show clearly how most issues surrounding agriculture, trade and development – both North and South – are closely interrelated and inter-dependent, in addition to the fact that they depend on and influence natural resources and the environment. Thus, Swedish agricultural policy is linked closely to agricultural development in the South. Swedish food consumption impacts the environment in other countries. As noted in the book, the lack of a holistic view of these issues is a major factor underlying the shortcomings and problems that considerably affect the food supply, natural environment and overall basis for life, including the development potential for a vast number of people in the South in the short term, and probably to an even greater degree in the long term. But they also influence the industrial countries in various ways and thus – directly or indirectly – affect us as part of the privileged part of mankind. Thus, an obvious starting point for a discussion of these issues is the need for a holistic view of them and how this can be achieved.

In recent years, the international community has agreed at state and government levels on a number of key documents that offer goals and guidelines for future development as well as political undertakings to promote their fulfillment. The goals and guidelines are of major importance as lodestars for development at all levels (global, regional and local). One such document of major political significance is the Millennium

Declaration of 2000[4], which, among other goals, states that:

– globalization shall become a positive force for all the world's people,
– the proportion of the world's people whose income is less than one dollar a day shall be halved by 2015,
– the proportion of people who suffer from hunger shall be halved by 2015,
– the proportion of people unable to access or afford safe drinking water shall be halved by 2015,
– development shall be sustainable in line with previous agreements, and
– Africa's specific requirements need particular attention.

The key messages in these goals and guidelines may be summarized in the concept of sustainable development, which was coined by the Brundtland Commission in 1987 and ratified by the UN Global Conference on the Environment and Development (UNCED) in Rio de Janeiro in 1992. This is defined as "development that satisfies the needs of the present generation without compromising the ability of future generations to satisfy their own needs". Sustainability includes ecological as well as socio-economic progress and is now a generally accepted goal for development (although the general nature of the concept has made its actual content the subject of various interpretations). The analyses in this chapter proceed from the concept of sustainability as a development goal. In this context, the original interpretation of the concept as defined by UNCED in 1992 has been applied, particularly in what is referred to as the Rio Declaration on Environment and Development.

The various chapters in the book have been written by authors with different backgrounds, focuses, starting points and perspectives. Problem formulations, analyses and conclusions vary. This arrangement was chosen in view of the subject's considerable range and complexity, and the variety of opinions on a number of issues dealt with in the book. Apart from providing a forum for these viewpoints, the goal has been to ensure that the combined inputs cover the most salient points of the subject. However, for practical reasons, certain aspects have been handled in a more general manner than others, and these we have attempted to treat in greater detail in this concluding summary and analysis.

In this final chapter, we attempt to summarize and analyze the various sections primarily from the book's coherence perspective and highlight aspects that we feel should be underscored for various reasons. We outline the authors' conclusions and our own in bullet form before finally dealing with how greater coherence in agriculture, trade and development can be attained in scenarios for future development.

Concise conclusions of the book's various chapters

Overall conclusions

- Over the next 50 years, the global population will increase some 50 percent to about 10 billion. Supplying food for the additional population and the more than 800 million malnourished will be

a major challenge during the immediate decades. A prerequisite for solving this gigantic task is a greater emphasis on and better coordination of agricultural, trade and development policies as well as increased research and education programs. This applies nationally and internationally, North and South. Also, there is a need to underscore environmental and natural resource features.

- Today, hunger is not the result of a global shortage of food, but is instead due primarily to poverty. However, the situation may change in the years ahead in view of agriculture's rapidly growing role as a producer of bio-energy. Sugar cane – a typical agricultural crop – is one of the most attractive raw materials for biofuel production. Alongside population growth, an ever-increasing share of animal protein in the human diet will raise the demands imposed on agricultural output.
- Most of the poor worldwide live in rural areas and have agriculture as their primary means of living. Thus, agriculture is crucial not just for food production but also for the livelihood of a majority of the world's poorest people.
- We must affirm and promote the development of agriculture, notably in the problematic Sub-Saharan Africa, which is the only region worldwide in which food output per capita is currently lower than 30 years ago. African agriculture must emulate the progress achieved in other parts of the South. By means of steady efficiency enhancement, progress can be made from the currently insecure subsidence farming in many areas to greater food security for family/kin before moving on to the production of a surplus that can initially be sold locally, then regionally and subsequently nationally, after which export production may commence. By this means, agriculture can act a powerful engine for economic development.
- Agriculture is likely to gradually gain greater significance, both North and South, because it controls the basic production resources that bind solar energy and convert it into food and other biological output. The significance of this output can only increase in the future.
- Mankind must live from life, from living things. In the long term, we cannot rely on fossil energy, meaning old life that cannot be renewed; instead, we must gradually shift to renewable raw materials for energy and other applications. We must realize that continuing social development must be based on a basic biological perspective. This applies in particular to food production, but has wider implications than this. Biological production is based on very different conditions than those governing industrial production. Growth in the conventional economic sense is an insufficient gauge of biological production, ecosystem services, environmental conservation and so on.
- Agriculture plays a key role in efforts to deal with the climate threat. Firstly, many areas – not least in Africa – will be heavily impacted by future climate change. Secondly, it can contribute to reducing the emission of greenhouse gases through the production of raw materials to replace fossil sources.
- In the agricultural context, we must manage the total capital, which is made up of natural capital, social capital and institutional capital.

Totality is the most important aspect, but we must not over-exploit natural capital. Nowadays, there is frequently a lack of overall responsibility for the stewardship of total capital.

Agriculture and food from an environmental and natural resource perspective

- Fresh water will be a limiting factor for agriculture worldwide. Access to *green water* – that is, soil humidity resulting from infiltrated rainwater – is often more important that *blue water* – that is, water in liquid form. This applies particularly in savanna areas, where a lack of plant nutrients is also just as serious as the water problem. These are key issues underlying food supply in many areas that currently demonstrate the worst hunger problems, especially in Africa, and risk being hard hit by future climate change, which may further restrict water availability. Consequently, Africa is the focus of the presentation. Here, agriculture faces the tremendous challenge of having to improve its management of the already precarious water situation – including extreme variations in precipitation with recurring, protracted droughts – if the Millennium Declaration's hunger goals are to be met.
- A shortage of water in current savanna farming is more often due to inferior production methods than climatic conditions. As opposed to meteorological drought, farming-related drought – when crops suffer from a shortage of green water in the root zone – can be considerably alleviated through programs for water management, soil management and so forth.
- Traditional irrigated agriculture will be unable to expand to any great extent. Water availability is too limited for this purpose, while the various environmental consequences will also curtail such expansion. In particular, the environmental and socio-economic drawbacks associated with large-scale, water infrastructure projects, such as the construction of dams and river diversion, must be underscored.
- Improved water management can and should primarily be achieved through small-scale biological and technical measures that lead to more appropriate crops, crop sequence and so forth, with reductions in surface runoff/higher infiltration, reduced evaporation, as well as improved collection and storage of water and less soil erosion. Such technical measures may consist of terraces, dividing ditches, small ponds and non-plowing cultivation. Major productivity gains can be achieved by this means. There are no hydrological barriers to gaining twofold or manifold increases in savanna harvests.
- But even if water management can be considerably improved, it is anticipated that the necessary increase in food production – in, for example, savanna regions worldwide – would entail a greater use of water in agriculture at the cost of the natural ecosystem. However, in practice it is difficult to provide an unequivocal answer to the complex issue of how much water is required in order to protect various environmental interests. For example, the ecosystem makes a major contribution to water management, thereby facilitating agriculture. Important systems in this respect include forests, especially at higher altitudes, and wetlands. Consequently, it is impossible to state

generally how much water should be used for one or the other purpose. Instead, measures should be adapted to supply agriculture with water based on a holistic view for each individual area, with an appropriate balancing of various interests.

- A holistic view can be expressed through the integrated planning of water and land use, in which agriculture and environmental conservation are key components in a broad sense. This type of planning, as well as implementation in the form of small-scale, locally based measures for water and soil management and nature protection, etc. currently represent a neglected but vital area for additional programs in development and aid policy.
- Agriculture is highly dependent on biological diversity to produce key ecological goods and services, such as crop pollination, nutrient circulation and pest control. This applies universally but is frequently more evident in developing countries, where production inputs such as inorganic fertilizer and biocides are used to a lesser degree. Dependence is likely to increase in the longer term as a result of the declining use of inorganic fertilizer due to rising prices. Here, there is a relationship between the trend in fossil oil and gas prices, in pace with a steady decline in remaining deposits. Consequently, the ongoing impoverishment of biological diversity is a serious threat not only to today's agriculture but to an even greater degree to future agricultural development.
- Biological diversity in soil is of crucial significance for agriculture through its influence on fertility, structure, water-retention capacity and so forth. This in turn is affected by the type of crops, cultivation methods, and fertilizer processes, etc. Efficient land care, which is frequently a prerequisite for sustainable agriculture in tropical and subtropical areas, must use biological diversity both in and on farmland and its surroundings. Except in certain cases, such as those affected by young volcanism, tropical soils are ancient, deep weathered and lacking in nutrients. Generally, all of these circumstances increase the dependence on biological diversity compared with agriculture in the North.
- Biological diversity in agricultural areas offers a range of benefits in addition to agricultural output and the ecosystem services that are directly linked to it. These include berries, fruit, fungi and nuts, game and fish, timber and firewood, fibers, medicinal herbs and so forth. These are of decisive importance in the South, but also play a key role in the North. In our case, special note must be made of the increasingly important complementary use of the agricultural landscape for recreation and tourism, which are closely linked to the availability of a rich biological diversity.
- Land destruction through water and wind erosion, depletion of plant nutrients, salinization, and waterlogging, etc. is common primarily in tropical and subtropical areas. In many cases, these problems reduce agricultural productivity, notably in developing countries where they also generally tend to increase in scope (some 25 percent of arable land and about 75 percent of grazing land are estimated to be affected.)
- Agriculture also has a substantial impact on biological diversity. The impact can be positive,

especially through traditional small-scale agriculture featuring natural grazing and hay meadows, functioning plant nutrient circulation and so forth. It can also be negative, notably through various forms of large-scale agriculture. Not least, the transformation of original natural land – forest, savanna and wetlands – to farmlands entails major losses of biological diversity.

- The necessary increase in agricultural output, especially in developing countries, must occur primarily on existing farmlands. These generally offer substantial potential for increased production. However, the scope for new cultivation is limited in many areas due to environmental factors, for example.
- Some former farmlands in Sweden have reverted to forest, resulting in a substantial depletion of biological diversity. At the same time, gigantic swathes of tropical forests and other natural land areas have been transformed into farmland in such countries as Brazil, Indonesia and Malaysia – a dubious development in terms of long-term productivity and a definite disaster for biological diversity.
- Considerable natural and cultural values – including a very rich biological diversity, with a large number of threatened natural types and species – are linked to the remainder of the most ancient Swedish farm landscape. This mosaic-like landscape, with its distinct profile in the Swedish popular image, is threatened by agriculture's ongoing transformation especially in forest-based and mixed agricultural communities – with farm closures, rationalization and mergers, etc. – in which the declining small-scale meat and dairy operations are major components.
- For a variety of reasons, the continuing cultivation of grazing land is crucial in being able to protect the remainder of the traditional Swedish farmlands. This is one objective of the environmental policy approved by the Swedish Parliament. Substantial EU support is expended for this purpose. Meanwhile, the potential to attain the requisite grazing area is reduced as a result of higher meat imports from Brazil and other countries, where production is based substantially on forest felling followed by grazing on the cleared land. In these circumstances, the implications for biological diversity are negative both North and South.
- Genetic resources linked to the agricultural landscape, particularly in the South, represent considerable potential value, as do the traditional skills concerning its use. This may apply to traditional species of cultural plant and domestic livestock or their wild relatives as well as to other biological resources used – or have been used – in the domestic economy. Negotiations are in progress under the auspices of the UN concerning the practical application of international agreements to give host countries – and the affected agricultural and local population in general – their rightful share of future benefits from any commercialization of these resources; however, success in these endeavors has so far been limited due to opposition from developed countries and other factors.
- All the indications are that agriculture in the future must be more environmentally friendly, both North and South. For various reasons, mo-

dern high-tech, large-scale agriculture in its present form is not sustainable in the long term. Also, traditional small-scale farming in many parts of the South results in highly negative environmental effects through the over-exploitation of local natural resources, land destruction, new cultivation of natural land and so forth. Eutrophication (over-fertilization) of seas, lakes and watercourses, excess utilization of surface and ground water resources, and enrichment of biocide residuals in groundwater, etc., cannot continue as they have hitherto. This also applies to the depletion of biological diversity. Land care aspects such as problems of a reduced humus content, nutrient depletion and soil compaction are more notable in temperate climates.

- Ecological farming offers substantial potential. As stated recently by the FAO (The Food and Agricultural Organization of the United Nations), this applies in particular to Africa, where agriculture is characterized by its small scale and a lack of purchasing power for commercial fertilizer and other input goods. At the same time, it is necessary in many areas to utilize opportunities for rapid production increases offered by commercial fertilizer, especially in the short term.
- The dependence of modern agriculture on oil and other fossil resources will gradually decrease, since these are finite and will become more costly, as well as due to their negative direct and indirect environmental consequences (including climate impact). Similarly, for the same reasons, the use of chemicals will decline and become more specific and tailored to environmental needs and local requirements. Measures aimed at recovering lost biological diversity in areas with intensive agriculture will become increasingly necessary. Overall, the indications are that agriculture will gradually be more adapted to – and dependent on – various natural conditions. Generally, it will be easier for agriculture in the South than in the North to undertake this type of transformation.

Agriculture and food from a trade perspective

- Global exports of agricultural products have increased in absolute terms, although their share of total exports has declined. This also applies to countries in the South, whose exports have clearly fallen; though their proportion of total imports has increased.
- Swedish policy for global development affirms that all policy areas must contribute to the realization of the Millennium Declaration's goals. Among other things, this means that international trade in food must contribute to equitable and sustainable development worldwide. However, the current order shows major problems from the viewpoint of justice and sustainability.
- In particular, the configuration of EU and US agricultural policies and international trade regulations heavily disfavor agriculture in developing countries. Subsidized food exports – which occasionally are no more than a form of dumping – reduce prices in the importing developing countries. High tariff barriers and domestic farm support schemes impede or simply prevent exports from developing countries to the world's two largest trading regions. The same applies to biofuel, which

is subsidized in the US and EU. The least developed countries (LDCs) essentially have free access to the EU market, but currently have little of interest to offer. However, the EU receives most of the limited exports that the poorest countries sell in the affluent world, while the US share of these exports is negligible. Meanwhile, countries in the South have been compelled to reduce their own tariffs, frequently as a result of pressure from the World Bank and IMF. Their imports have increased, which, combined with pressure on prices, have added to difficulties in developing their own agriculture. Imports account for almost one third of Africa's cereal grain consumption, corresponding approximately to the urban population's share of consumption.

- Naturally, greater access to markets in the developed countries is crucial for the developing countries. However, a great deal of evidence suggests that major benefits for the developing countries are offered by a reduction in tariffs among them as a group. The significance of this becomes even more evident in view of the fact that growth in trade in agricultural products in the years ahead is expected to occur primarily among these countries. A particularly significant factor for the future will be the growing trade relations that are now developing between China and many African countries, which are partly the result of an ever-rising demand for animal protein among the growing Chinese middle class.
- If the EU and US cease their discriminatory agricultural policies vis-à-vis the developing countries and a general liberalization of trade is achieved, agricultural development, growth and the combating of poverty in these countries would be considerably advanced. But a condition for this is that the development of agriculture and rural business also receives substantial support from governments in developing countries. It is in the domestic market that agriculture in developing countries faces its greatest task in the foreseeable future. The development of agriculture and trade in agricultural products are major factors in boosting growth. It is particularly important that such deregulation and liberalization lead to an increase in world market prices for various agricultural goods and that EU output declines. The incipient competition for available farmland for biofuel can be expected to contribute further to this. This would favor the impoverished farm and rural population, which represents a large majority in most developing countries. By contrast, the urban population would be disfavored in the short term due to its dependence on imported food products, but would be favored in the long term by overall economic growth.
- The minor progress made in recent years, in the form of international trade agreements aimed at improving the situation for developing countries, has had only a limited effect. Developed countries have frequently been able to turn these agreements to their advantage by restructuring support to their own farmers. For example, the positive effects of support from the EU and individual EU countries for agriculture in developing countries is almost negligible compared with the negative effects of the Union's agricultural policy. We conclude that, to date, the WTO negotiations and other international regulations have not been marked by any sig-

nificant solidarity with the poorest countries.

- The discriminatory treatment of agriculture in the developing countries has, however, begun to attract increasing attention. The initial steps – although minor and of little effect – towards an improvement of the situation were taken in the form of decisions at the WTO meeting in December 2005, for example. In addition, we have seen rising world market prices in recent years, following a declining trend during the 1980s and 1990s. At the same time, there is a slight trend towards a greater impact of comparative advantage in the international food trade. Primarily the more developed countries in the South – such as Argentina and Brazil – have been able to capitalize on the changes to date.
- There are many other examples of direct and indirect links between agriculture, trade and the environment, both regionally and globally. Although some 90 percent of all agricultural products worldwide are consumed in their country of origin, the remaining 10 percent represent a substantial total. Moreover, this portion is increasing and the incipient but increasingly explicit liberalization of world trade in the years ahead is likely to strengthen this trend. This applies in particular to Sweden, whose rising import share derives from both the EU and the rest of the world. More than one third of our food consumption depends on ecosystems in other countries, thereby affecting their environments. The ability to take into account the environmental consequences of these Swedish imports and their subsequent sale is limited as a result of WTO rules and a lack of insight into the production process. This situation hampers sustainable development, especially in developing countries. It is crucial that individual consumers who buy products that have an environmental impact have a real opportunity to take this into account in their purchases. We cannot disregard our responsibility for the environmental effects associated with the production of goods imported into Sweden.
- One particular problem is the serious loss of biological diversity in many tropical areas through the use of forestland and savanna for the export-driven production of soybeans, palm oil and sugar cane. Some of the products processed from these imports include feed concentrate, which is imported as fodder for Swedish beef cattle, and ethanol. Another example is the use of pesticides on export crops in developing countries that lack environmental protection programs. Negative effects can arise in consumption in importing countries when the hazardous content is too high. Also, imported feed concentrate can include relatively high levels of cadmium. Export countries frequently view restrictions on such imports as a breach of trade agreements.

Agriculture and food from a development perspective

- Agriculture in developing countries also encounters problems caused by domestic factors, notably in Africa. Despite various attempts, it has proved impossible to implement an Asian-style green revolution, primarily due to political factors. As opposed to Asia, the food situation in sparsely populated Africa was relatively favorable over a protracted period. When it worsened during the

1970s, there was a focus on state farms, monopolization, regulation and so forth that met with little success. Of course, there was some progress in the form of producer cooperatives, but these also were frequently state controlled. Low consumer prices favoring the urban population were continually given priority rather than higher producer prices, which could have contributed to the development of agriculture and rising standards for the rural poor majority. Farmers were given no real opportunity to organize. From the end of the 1980s, this was followed by structural adjustment programs to meet the demands of the World Bank and IMF. Among other results, this meant a drastic reduction in government support for the farming sector and the abolition of government agencies, usually without their functions being taken over by other organizations. Furthermore, there was a 50-percent reduction in aid, which hit agriculture particularly hard. For example, its share of Norwegian aid was cut from 30 percent to 3 percent over a thirty-year period. Moreover, gross misgovernment in many countries exacerbated these trends.

- The worsening situation in agricultural resulted in food imports and aid, with negative implications for domestic production and markets.
- However, the situation in Africa, which is underscored in this book, is not hopeless. African agriculture has considerable potential, primarily in the form of a significant rise in output from existing farmland. New land can also be utilized to a certain extent. Thus, if the anticipated changes in trade policy occur, there are opportunities for a tangible improvement in the agricultural situation, with all the consequences that this implies. Agricultural development is the engine for overall development and growth in large areas of Sub-Saharan Africa. Investments aimed at improving the conditions for the farming population have far greater effects in the form of higher employment and poverty reduction than similar investments in urban areas. In addition, women are highly over-represented among the rural poor.
- These circumstances warrant a far greater focus on agriculture in development and aid policy. A number of factors suggest that this approach would be successful. A limited use of commercial fertilizer, combined with a high frequency of nutrient-deficient soils, means that even a minor addition of nutrients has significant effects. A number of high-yielding crops have emerged that are suitable for African conditions. Farmers are generally positive to modern farming technology and many understand the need to organize – and which they now have the possibility to do. However, the necessary regard for and care of environmental and natural resources impose certain limitations on and the need for adjustments in agricultural development. The core messages from the World Bank, most recently in its 2008 report, and from UN's food and agricultural organization (FAO) are clear: Rural development – with agricultural as the engine – must be given priority if development, especially in Africa, is to gain momentum.
- Following years of falling world market prices for grain, the trend has now reversed and prices are climbing. Of course, this prompts headlines about how high food prices risk hitting hard at

impoverished people worldwide, threatening malnourishment and food riots. At the same time, however, it is important to realize that higher global food prices may in the longer term offer a historic opportunity for poor countries to develop. This is the stimulation that far-sighted governments and hardworking small farmers in poor developing countries may need in order to see the potential to develop their agriculture. A steady increase in domestic production of and trade in agricultural products could thus lay the basis for the economic growth for which many LDCs have so far lacked the conditions, especially in Africa. The emergence of this also requires a positive accord with the developed countries and richer developing countries. It requires that we jointly support such development. Naturally, rising food prices hit those who have to buy their food, but they also offer the multitude of poor farmers a key incentive to grow more and improve the quality of their produce, thereby permitting food production and trade to increase.

- Swedish agriculture has certain cost disadvantages that will gradually reduce the competitiveness of certain products, thereby favoring imports. This trend will gain pace in line with the growing deregulation of the EU's agricultural sector. The current trend towards falling Swedish production of basic foodstuffs will most likely strengthen, notably in the case of beef. This trend could impede efforts to protect agriculture especially in forest-based and mixed farming communities, with all that entails in terms of a living rural society and the conservation of traditional farmlands.
- Food consumption and livestock production in Sweden have changed in recent years – and will continue to do so – in a negative manner for the environment, and not just the environment in countries from which we import finished products and inputs but also in Sweden. Meat consumption has risen sharply, although not of grazing animals (beef and sheep) but of pork and poultry. Meanwhile, imports have risen, including beef imports. Domestic meat production has become increasingly dependent on cereals and imported feed concentrate, and less dependent on Swedish pasture and grazing land.
- Parallel with the noted general developments in the Swedish food market, a trend is emerging towards a greater demand for ecological and local or regional brands (such as pasture-based meat from a certain region and so forth), which are distinctive in terms of environment or quality but also command a higher price. A strengthening of this trend would certainly facilitate the anticipated adjustment of Swedish agriculture.

Agriculture, trade and development – achieving greater accord

Against the background of the analyses and conclusions presented in this chapter, the final discussion concerns how we can gain greater accord between agriculture, trade and development, which is the focus of this book. We face major, inevitable changes in agriculture and trade in the years ahead. The interests of developing countries will emerge in a far more distinct manner than to date. This applies in particular to the least developed countries, many of which are in Africa. These

changes have already commenced to a certain degree and appear to offer the potential to contribute significantly to the greater accord that we seek. With the political will and appropriate measures – nationally and internationally – it should prove possible to achieve such accord both in theory and practice. Agriculture, trade and development offer the conditions to work together and attain synergism to a far greater degree than has hitherto been the case. A contributory factor is the increasingly urgent need for all countries to agree on a joint action plan to combat climate change.

Biological production will gain greater significance in the future. In this respect, farmland is a basic resource, which is used by agriculture. This also applies considerably to Sweden. Within a few decades we must produce enough food worldwide for perhaps one and a half times as many people as we do today. In addition, the currently almost one billion starving people (due more to poverty than a real shortage of food) must attain an acceptable food standard. Also, we can expect an ever-increasing share of animal protein in the human diet – not least in the developing countries in pace with their rising standard of living – which in turn requires a higher production of vegetables than if these were consumed directly. Moreover, there is an increasing need to use farmland for the production of biofuel and other non-food crops. Overall, these factors mean that the demand for biological raw materials may show a manifold increase over the next 50 years, as well as greater competition between production for food and for other applications. Finally, we must compensate for the inferior production conditions that may result from future climate change and continuing environmental destruction, such as erosion.

Even though farmland in many areas of the world can be expanded, there are limits in the form of necessary environmental restrictions and so forth. Moreover, for natural reasons, such expansion would generally be from the least productive lands that have not yet been used.

The conclusion of this reasoning is that existing farmland represents a valuable resource that we must protect globally and whose yield must be increased considerably in the future if the global community's requirements are to be satisfied. This entails the long-term development of agricultural production processes that are both high yielding and sustainable, which will definitely demand major investments in the form of research and development, not least in the area of biotechnology. This conclusion is not affected by the fact that biological production alongside that conducted on farmlands must also be capable of being used for energy applications, etc. The only factor that could reduce the need for farmland production in the future is that forestry begins to produce raw materials for biofuel on a larger scale, which we believe is unlikely.

It should also be noted that excess farmland could emerge in Sweden and other countries in the North if current farm output were to decline significantly before the need for other crops, primarily for biofuel, emerges to a significant degree. In such a situation, it is important to manage this unused land so that it can promptly be cultivated again, parallel with the extensification of agriculture during this period.

Current EU and US agricultural policy – which appears completely unreasonable from a global development perspective, European consumer perspective and the perspective of ecological sustainability – will most likely be phased out or considerably amended. It is impossible to say how fast this will occur or the form that it will take. However, we are evidently moving towards deregulation, fewer subsidies and free trade. The competitiveness of EU agriculture, which is now maintained by artificial means, will decline in the case of traditional foodstuffs, which will most likely affect output volumes. The inferior competitiveness of Swedish agriculture vis-à-vis other countries, especially in the EU, may accelerate. However, there is little reason to fear competition from Africa's small farmers in the foreseeable future.

Moreover, more costly oil may lead to a certain extensification of agriculture. In the longer term, there are many indications that we will return to farming based more on ecological recycling – although in a modern form. Higher oil prices may also raise the cost of transport and favor local production, a factor that could be boosted by the fact that transport in the future will increasingly be expected to pay for its environmental costs. The indicated changes, combined with probably greater environmental awareness in Sweden, may also contribute to a decline in the import of feed concentrates (palm oil and soybeans) from countries in the South, which is a positive factor for these countries (but negative for the economy in the short term). Such a decrease in imports would also favor the production of Swedish feed concentrate and possibly contribute to extensified meat production.

In the years ahead, Swedish agriculture must expect generally more stringent environmental requirements, which may also lead to some extensification. The environmental quality goals set by the Swedish Parliament for agriculture are far from fulfillment in many instances and require additional measures for their attainment, such as those in respect of nutrient leaching. Also, the results of the global research program "Millennium Ecosystem Assessment" must be taken into account. This points to a number of environmental problems associated with agriculture – in terms of both causes and effects – and highlights more clearly than previously how dependent agriculture is on biological diversity and the attendant ecosystem services.

The sectoral responsibility principle is enshrined in Swedish environmental policy and is also a major feature of European environmental policy in general. This principle, which entails that the party responsible for environmental damage is also responsible for eliminating or limiting it, has not yet had a full impact on the agricultural sector. Stricter regulations can be expected in this area through, for example, the widening of the concept of good faming practice to encompass greater consideration of the exterior environment than is currently the case. It is unlikely that agriculture – as opposed to other sectors – can avoid the application of this principle in the longer term. The same applies to another key feature of Swedish environmental policy, namely, the precautionary principle. This is illustrated by biotechnology,

which offers considerable potential for agriculture but also entails major risks. In this area, we should seek prudent and sensible application.

As a result of the indicated changes – which are to a great degree hypothetical and may almost be viewed as examples of possible outcomes – Swedish agriculture will most likely experience diversification, in addition to extensification as noted above. Traditional staple goods will lose their significance; new, more profitable production segments will most likely gain importance. As noted earlier, this probably applies to biofuel. One question affecting the entire agricultural sector is the effect of anticipated climate change. This could impact on agriculture in various ways. The long-term indications are that we will need to use all our arable land and that the farming sector can look positively to the future, even though various transitional problems may lead to serious difficulties. However, we feel that, in the years ahead, the farmer will need to be more of an entrepreneur and less of a land steward than is currently the case.

Entirely new products may also emerge, such as various types of edible fungi and rapid-growth tropical fish that can be bred indoors in recirculation systems and fed with in-house produced vegetable matter, such as silage. Currently existing production methods than can be expected to see greater significance include specialization in highly processed products, local processing and sales through proprietary brands, organic certification and so forth, as well as farm-related recreational and tourist activities. The latter are viewed as offering substantial development potential in such areas as hunting (also in wild game enclosures) and angling, where a great deal can be achieved with relatively minor changes in current production focus. This sector also includes the expanding equine segment.

A key question for agriculture and nature conservation in Sweden is how cultivation of traditional small-scale farmlands should be secured in connection with anticipated changes. This applies in particular to natural grazing lands, which, according to the Swedish Parliament's environmental bill, should be preserved in their entirety. This possibility exists, especially if it proves possible to attain more extensive meat production, supplemented by sheep and horse grazing. Despite the change in EU agricultural policy in other respects, the future will almost certainly also see EU support for the cultivation of natural grazing lands, probably to a greater extent than at present. Hopefully, this will encompass a broader selection of grazing land than is currently the case. As a result, society can pay for such public goods in the form of biological diversity, cultural values, recreational lands and so forth, for which agricultural producers currently receive only a fraction of the cost via the product price.

Payment for nature conservation, along with extensive ranching operations featuring, for example, limited fodder inputs, cooperation among several farmers in an effort to gain economies of scale, and active marketing of local brands as well as the highlighting of the production's environmental value and meat quality are viewed as offering the potential to preserve natural grazing lands. These represent the core of traditional

small-scale farmlands and cannot be used in other agricultural production. The favoring of Swedish pasture-based meat should not be interpreted as meaning that we disfavor poor farmers in the South, as Swedish meat imports from those areas will derive primarily from large-scale, company-owned ranch production, which also frequently entail clearly negative environmental effects.

In addition, there are changes in biologically and environmentally friendly directions – greater recycling of plant nutrients, more organic fertilizer/less inorganic fertilizer, superior adjustment to local biological conditions, greater dependence on ecological goods and services, better water management, and less soil preparation, etc. – which in the longer term are expected to result from the rising shortage and, thus, the higher price of fossil fuel. As noted earlier, current Swedish environmental requirements will most likely be steadily tightened in the years ahead, which will impact agriculture in the same direction. It is impossible to foresee when this change will become seriously significant, or its precise scope and direction, but that its emergence in some shape or form – both in Sweden and other countries – seems inevitable. One particular challenge will be to harmonize this development with the demand for higher productivity. Generally, such a transformation entails smaller changes and is thus easier to undertake in the South than in the North, even though the supply of nutrients to depleted soils in many tropical areas requires special programs. It is important that the greater global solidarity, which is now beginning to appear, does not fade as a result of future transition problems.

Even though trade in agricultural products will be extensive and is likely to rise in the future, there is undoubtedly greater scope for local, frequently small-scale, production primarily for a local market. This applies to developed as well as developing countries. In the case of Sweden, this type of production could mean a great deal for regional development, open landscapes and so on.

The radically changed conditions for Swedish agriculture that are anticipated in the future offer possibilities and problems. There will be major challenges, both for the sector as a whole and for individual farmers. A key aspect will be a change in mindset – such as depending more on the solar energy that now radiates rather than on that which radiated millions of years ago, as well as by ensuring that all actions are permeated by an ecological approach; and to show solidarity with poor farmers in the South by always placing Swedish agriculture in a global setting.

We need to reconsider unconditionally what we can – and ought – to grow and what we should import. We who are active in shaping agricultural and food policies must adopt a position on how we can best assume our responsibility for sustainable development in the South. A specific Swedish problem is how we can retain sufficient agricultural expertise when the sector employs only two or three percent of the population. Sustainable agriculture requires greater focus on the social and institutional capital required for rural development. This applies in particular to education and research that will be particularly important ahead of the changes awaiting agriculture, and as

regards ecology and other respects. Even though the challenges are great, the indications are that our agriculture should be able to emerge vibrant from the impending period of change.

Agriculture in the South has everything to gain from the anticipated deregulation and liberalization of agricultural and trade policies in the North. This applies not only to the EU, but also to the US and other countries. The development of agriculture can in turn act as a driving force for overall growth and social development that the countries in the South so urgently require.

However, the situation particularly in Sub-Saharan Africa is so problematic that additional measures are needed in most cases to ensure progress in agriculture. For example, countries there require functioning markets, infrastructure, education and investment opportunities. In addition, there is a need for temporary inputs – primarily in the form of aid – to limit the transition problems that may arise for poor people in the cities as a result of higher prices resulting from future changes.

It is necessary that the countries themselves as well as the bilateral and multilateral aid donors realize agriculture's fundamental significance in order to alleviate poverty and hunger, in addition to serving as the overall engine for development. Considerably greater efforts in agriculture and rural development, especially in Africa, are required than those seen in recent decades. This applies particularly during the initial stages of a development process. The development of research and research capacity, as well as education at all levels, is likely to be a key input. Activities should be conducted in the developing countries themselves as far as possible. In this context, it is important to underscore hitherto poorly treated environmental and resource aspects so that development is steered into sustainable paths from the very beginning. The vitally necessary relationship in the tropics between agriculture and forestry (including agroforestry and woodlots, etc.) must always be taken into consideration. Studies of how positive experience from Asia could be transferred to Africa are also required. Other key issues in which research and/or education are required are plant breeding, animal health, food management, establishment of collection and sales organizations in the form of, for example, producer cooperatives, credit-granting opportunities and so forth as well as the stimulation of trading and rural development. Sweden has considerable expertise to offer in these areas. In addition, we have an agricultural university in the process of change. To date, this has focused mainly on Swedish requirements, but now the conditions should exist to extent activities so that we gain the international natural resources university that we require.

More liberal trade in agricultural products facilitates the efforts of various countries and regions to utilize their natural comparative advantages and produce for export to a greater degree. For example, developing countries generally tend to have superior natural conditions for the production of energy raw materials than developed countries, as in the case of sugar cane for ethanol production. In the case of cereal grains, for example, the situation is the reverse. This may prove of major

importance for developing countries in the future when agricultural biofuel increasingly assumes the role of fossil fuels.

Significant animal production can continue to be conducted to a certain extent alongside traditional agriculture. This potential should be used to a greater extent than is currently the case. For example, fish farming plays a key role in the supply of animal protein in large areas of Southeast Asia. There is considerable potential for increased fish farming in Africa and certain other tropical areas, although this requires a higher output of fish feed. Game and other wild biological diversity already represent a key protein source in the South particularly, but greater utilization is possible in many areas. This applies particularly in tropical and sub-tropical areas, but frequently this initially requires programs to build up stocks to an optimal level. In certain areas – not least in Africa's savanna areas – the economic value of game production can increase considerably through allowing part of taxation to take the form of hunting tourism, which can offer substantial employment and income. Notably in areas with little rainfall – which may worsen as a result of climate change – this is the most efficient and most sustainable manner of producing animal protein. Meat production can be substantially higher than using domestic livestock. However, the potential to raise marine fish catches is limited, simply because most stocks are essentially overfished already.

One consistent theme in this book is the need for the liberalization and deregulation of agriculture and trade in agricultural products to facilitate development in the South and achieve other objectives. We believe that such a change process will commence seriously within the next decade, a development that we must welcome. Meanwhile, we would like to point to a number of circumstances that distinguish agriculture from most other forms of production. It is linked to location-related natural resources. It affects – and is simultaneously affected by – the natural environment, even in the case of long distances via trade. It creates benefits and depends on resources that cannot be attributed any economic value. It represents the only employment opportunity for hundreds of millions of the world poorest people. Thus, we feel that a certain need for regulation can arise in special cases, for example, to protect weak countries or group interests as well as environmental interests. In these cases, what is involved is an issue of regulation to reduce apparent injustices or problems, unlike current arrangements that create or preserve these.

We are convinced that the interests of agriculture, trade and development can be harmonized. Also, environmental interests relating to agriculture can steadily be satisfied, at least in the North. In the South, the situation is troublesome and there are few improvements in sight. There are hardly any conflicts of interest between Swedish farmers and the large majority of farmers in the South. However, such conflicts can arise with large-scale industrialized export-driven farming in the South, which often involves ruthless exploitation of people and the environment alike. In these cases we must all work towards imposing the same considerations and care in these

countries as in our part of the world by means of international cooperation and informed purchases.

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The overwhelming majority of people living in poverty are small-scale farmers and agricultural workers. To reach the UN Millennium Development Goals of halving world poverty by 2015, agricultural development and enhanced productivity must play a key role.

Can agriculture in the developed and developing countries progress in harmony with each other? The international debate points to conflicts of a political and commercial nature, as witnessed by the recurring failures to reach agreements on agricultural trade in the WTO. But there are also golden opportunities to reconcile the interests of rich and poor countries.

After decades of declining world market prices for agricultural products, and heavily regulated and protected food markets in the industrialized countries, the last few years have witnessed a recovery of food prices. A number of factors – such as increased demands from China and other rapidly growing Asian economies, competition from biofuels and adverse climatic factors – are responsible for this development, which represents both threats and opportunities.

Taking Sweden's "Policy for Global Development" as the point of departure, the purpose of this book is to highlight linkages and conflicts of interest between the developed and developing countries in agriculture, trade and environmental management, as well as the potential for enhanced coherence.

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The Royal Swedish Academy of Agriculture and Forestry (KSLA) is a meeting place for the green sector. The Academy is a free and independent network organization working with issues relating to agriculture, horticulture, food, forestry and forest products, fishing, hunting and aquaculture, the environment and natural resources, and with agricultural and forest history. We deal with issues that concern all and interest many!