Annual Report 2006

Centre for World Food Studies
Stichting Onderzoek Wereldvoedselvoorziening

SOW-VU

Annual Report

2006

Centre for World Food Studies

Stichting Onderzoek Wereldvoedselvoorziening van de Vrije Universiteit

Colophon

Text: Centre for World Food Studies
Vrije Universiteit
De Boelelaan 1105
1081 HV Amsterdam
www.sow.vu.nl

Printing: MultiCopy Amsterdam

Cover photo: A construction worker and farmer, Mozambique (Lineair Fotoarchief).
Photo page I: Stephanie Savariaud/WFP
Photo page 1: Peter Albersen/SOW-VU
Photos page 1 and 13: Ben Sonneveld/SOW-VU
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Introduction

World food situation in 2006

In the past decades world food production has kept up with global population growth while meeting a fast rising demand for animal feeds. Global cereals production has been increasing from approximately 1800 million tons per year in the early 1990s to between 2000 and 2100 million tons in most recent years, and for the year 2007 a record cereals production is expected of almost 2100 million tons (Figure 1). Furthermore, global food reserve stocks, which were falling around the millennium turn, have now stabilized at a level of approximately 450 million tons, corresponding to a reserve for about 2½-3 months of global demand. Global meat production - and consumption - pursues its spectacular and almost linearly rising trend, from below 200 million tons in 1992 to close to 300 million tons in 2007.

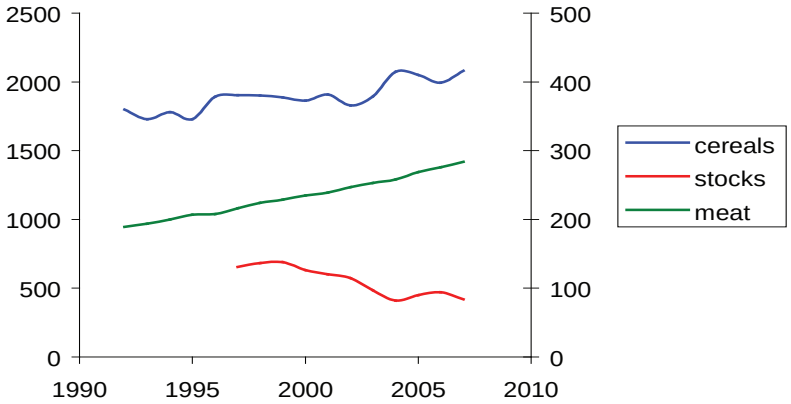


Figure 1. Global cereals production and stocks (left axis) and global meat production (right axis)

With global population still increasing at a rate of approximately one percent annually, and with rapidly growing economies such as China and India, the global demand for food and feed, and most likely also for biofuels, will continue to rise. Therefore, it may not be surprising that world food prices have in 2006 left their relatively stable course of decline of the past 10-15

years. The IMF food price index, in terms of current dollars, returned in 2005 slowly to the 1995 level, after a decade of depressed prices, and then started climbing with marked price increases for wheat, maize and rice, of 19, 31 and 6 percent, respectively. Yet, single-year events cannot mark a trend. As long as the US keeps 6.8 percent of arable land uncultivated through its conservation reserve program and the EU 5.8 percent through its set aside program – of which, however, 15 percent can be used for cultivation of industrial crops – there should be sufficient room to avoid lasting price rises, as is also predicted by OECD-FAO, 2007. Nonetheless, the upward trends in meat and biofuel demand raise many questions for the future, to be studied in their relation to predicted climate change, with particular reference to how the poor will be affected.

Climate Change, Agriculture and Poverty

In connection with climate change, the most publicized event was presumably the release of Al Gore's documentary "An Inconvenient Truth", a film that by now has been watched by millions of people all over the world. But also in various other ways, 2006 has been a year with increasing attention for the many aspects and problems of climate change. In October 2006, the 700 pages "Stern Review on the Economics of Climate Change" was published (Stern, 2006), and more recently, in the beginning of 2007, the Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report (IPCC 2007a, 2007b, 2007c). Furthermore, a new report by FAO (Steinfeld et al., 2006) argues that the livestock sector is responsible for 18 percent of greenhouse gas emissions measured in CO_2 equivalents, which is more than the transport sector.

The main characteristics of climate change are now well documented: increasing atmospheric levels of CO_2, methane, and NO_2, global warming, long-term changes in global precipitation patterns, higher frequency of extreme weather events, and increasing sea water levels. But possibly more significant is that in the latest reports the margins of uncertainty are much lower, particularly in connection with the already measurable impact of human activity that is expected to become more manifest in the coming decades.

Yet, also with this improved reliability of climatic projections, actual projections differ remarkably between the various climate change models that

are currently being used, whose specifications vary widely from relatively simple to highly complex formulations, such as the atmospheric-oceanic general circulation models. With each of these models, different scenarios are run that assume different levels of projected global economic growth and demographic change, as well as different levels of mitigation of greenhouse gas emissions. Hence, it is hardly surprising that even when individual models come up with reduced margins of uncertainty, between models and scenarios the range of projections remains wide.

As world's largest user of fresh water and with climate change particularly affecting rainfall patterns, agriculture plays a significant part on this scene. Crop, livestock and fishery production, all could be affected significantly. Moreover, the changing temperatures themselves, and the changing atmospheric concentrations of CO_2 will have an impact. The fourth IPCC report is the first in the series to present a regional breakdown on the likely effects of climate change. It foresees that effects will in the near future be negative in most tropical zones, and generally positive in moderate zones. For example, according to one model outcome (Figure 2), and under the assumption of zero or limited mitigation, climate change will by 2080 have caused major reductions in cereal yields in Central America, in parts of Central and Southern Africa, and in South Asia, while in large parts of North- and South America, and also in China, these effects would on balance still be positive (Parry et al., 2005). It should be added, however, that various other combinations of models and scenarios lead to rather different conclusions, sometimes even turning losses into gains and vice versa. Yet, in the long run, with further increases in atmospheric greenhouse gas concentrations and global temperature, projected impacts are negative for practically all regions in the world.

Besides affecting global agriculture and food production, climate change may also impact directly on human health. Increased frequency of extreme weather events, such as floods, violent storms and droughts, augments the direct threats to life. Through the changing precipitation patterns and higher temperature the spread of waterborne and vector-borne illnesses, such as diarrhea and malaria, may increase. For example, model studies for Sub-Saharan Africa have revealed changing patterns in malaria prevalence, with in particular an increasing malaria pressure in the highlands of Ethiopia and in parts of southern Africa (WHO, 2003; Tanser et al., 2003). Livestock health may be affected in a similar way, e.g. via a changing habitat

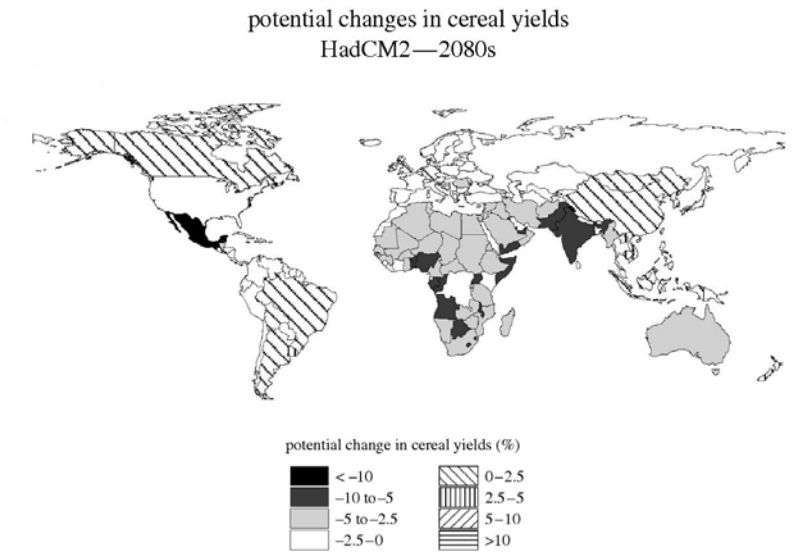


Figure 2. Possible effects of climate change on cereals yields, unmitigated emission scenario (Source: Parry et al, 2005)

pattern of the tsetse fly that spreads the sleeping disease, which is particularly lethal for ruminants, donkeys and horses, depriving the population of draft and packing animals, and more generally of the benefits of mixed crop-livestock farming.

It appears that poor people are more vulnerable to the effects of climate change than non-poor people, for a number of reasons (Poverty and Climate Change, 2003). First, in developing countries, poor people generally live in the more vulnerable parts of their country, for example in areas where soils are of lower quality, where availability of water for agriculture is less favorable, or in places which are most disaster stricken. Second, in terms of sources of livelihood, poor people are generally more dependent on agriculture, the sector to be affected most by climate change. Also in urban areas, the poorer segments of the population are more vulnerable to possible consequences of climate change, such as increasing food prices resulting from poor or erratic harvests. Third, poor people have limited possibilities to adapt or respond to adverse conditions. For example, they may

lack the financial resources that are needed to protect themselves, or their lands, against increased risks of flooding, or cannot afford to buy pesticides and other forms of plant protection when, as a result of higher mean temperatures, the occurrence of plant diseases increases. At the same time, one may note that reducing the vulnerability of poor people may be easier. For example, in highly productive agriculture that makes full use of available resources, reduction in average water availability inevitably translates into a drop in yield, whereas in less productive systems, increased efficiency of water use and intensified input application can act as compensatory measures. Furthermore, farmers whose cultivation relies on physical infrastructure, like roads, buildings, equipment and canals, may find it more difficult to migrate to new territories with a more favorable climate.

Mitigation of greenhouse gas emissions

It is now widely accepted that increasing atmospheric concentration of greenhouse gases is the main factor responsible for human induced global warming and associated climate change. Thus, reducing the emissions of greenhouse gases, or increasing their capture or sequestration, appears to be the obvious measure that needs to be taken.

Figure 3 shows the various sources of greenhouse gases, and reveals that some 65% are related to energy usage and some 35% related to non-energy uses (Stern, 2006). Of the non-energy emissions, the largest share (18%) stems from changes in land-use, and is mainly in the form of CO_2, released for example as a result of deforestation or other forms of land use change. Another large share (14%) comes from agriculture, mainly in the form of methane and NO_2. Methane originates from the decomposition of organic matter, e.g. in the soil of flooded rice fields, and also from the digestive process of ruminants. Emission of NO_2 results from converting land to agricultural use, and also from the application of nitrogen fertilizer.

Deforestation contributes significantly to CO_2 emissions, primarily because less carbon will be kept in the biomass cover, but also because a large amount of organic materials in the soils will be broken down in the process, with an associated release of CO_2, hence the rising emphasis on prevention of deforestation, and on reforestation. Agro-forestry therefore helps, but reduction of greenhouse gas emission can also be made within the crop and livestock sectors themselves through improved nitrogen application

techniques, while methane emissions can be reduced by improved rice cultivation techniques and better livestock and manure management.

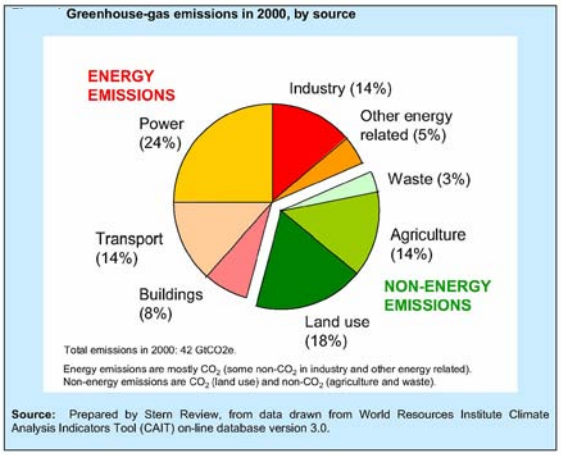


Figure 3. Greenhouse gas emissions by source (Source: Stern, 2006)

Biofuels

Among the mitigation strategies that are currently being initiated, replacement of fossil fuels by biofuels plays a major role. In recent years the rise in production and use of biofuels such as ethanol (from sugar and maize) and biodiesel (from oilseed crops, such as soybean, oil palm and rapeseed) has been spectacular, from about 4.5 billion gallons in 2000 to more than 9 billion gallons in 2005. The most remarkable example is Brazil, where nearly half of the sugarcane crop is now converted into ethanol, accounting for 40 percent of the country's fuel use in transportation (WRI, 2007). Yet, at a global scale the contribution of ethanol and biodiesel is still rather modest, with 1% and 1.5% of global transport fuel use, respectively. Its future as a source of energy and in reducing global CO_2 emissions will depend on a range of factors.

One of these factors is the "CO_2-efficiency" of biofuel production. While in principle the growing of crops and their subsequent usage as fuel is CO_2-neutral, fuel is also needed in, for example, the production of fertilizers, in the industrial production of ethanol from sugarcane or maize, and in trans-

porting the final products to their destination. It is very difficult to arrive at exact comparisons between technologies in this respect, because this requires all the inputs along the delivery chain to be taken into consideration as well as the mode of production of these inputs and so on. In practice, the "lifecycle analysis" (or LCA)-studies analyzing this classical problem of "production of commodities by means of commodities" (Sraffa, 1960), all have to truncate the process somewhere, and unfortunately differ significantly in the depth of investigation, even within the same study between various technologies.

For example, in case of biodiesel, the chain comprises the fertilizers used in cultivation, the energy inputs for harvesting and crushing oilseeds, the transformation from vegetable oil to biodiesel and the energy used for transport at the various stages. For use in e.g. urban public transport, a comparison of emissions can be made with petroleum diesel (see Sheehan et al., 1998). With respect to biodiesel, it appears that (i) the biodiesel production process loses some carbon along the processing chain (13%), due to byproducts and waste, (ii) for the production of biodiesel from (in this case) soybeans, each unit of energy in biodiesel requires an additional 24% of fossil fuel, (iii) biodiesel combustion also leads to higher emissions of greenhouse gases such as NOx than petroleum diesel. With respect to petroleum diesel, it appears that the production process of diesel, in particular the refinery process, also requires energy, adding another 20% of fossil fuel. By contrast, the CO_2-emission associated to the energy use in petroleum diesel drilling, extraction, transport and processing for diesel production, is significant as well, particularly on marginal fields. In all, net CO_2 gains using biodiesel are considerable in this particular study, due to the fact that released CO_2 has been fixed earlier by the crop; for one unit of energy delivered net CO_2 is 78% lower than using petroleum diesel. In the case of ethanol made from maize, greenhouse gas emissions are reduced by about 10-30% in comparison with fossil fuels (Braun and Pachauri, 2006). However, in the case of ethanol produced from sugarcane, the positive impact on greenhouse gases emissions is much larger, with reductions of up to 90% in CO_2 emissions, due to the fact that sugarcane residues can be utilized for generating the heat, needed in the production of ethanol.

Another important issue is whether the production of biofuels will compete with the production of food. Or, as it is sometimes phrased, will there be "food for the poor or fuel for the rich". At present, biofuels are largely

produced from crops which can also be utilized for human consumption or which are grown on land that could be used for the production of food crops. In developed countries this is strongly driven by subsidies to producers of energy crops and tax exemptions for green fuels. As a consequence, significant price increases for maize occurred, which triggered the "tortilla protests" in Mexico, at the end of 2006 and the beginning of 2007, and which can be considered an expression of poor people's concerns about their food security.

Therefore, the growing of crops for biofuel production will be much less threatening to food security if biofuel feedstocks were obtained from sources that do not compete significantly with existing agriculture, through intensified use of crop residues. Cultivation on poor and marginal soils is another option. An example is the growing of jatropha, which is now taking place on marginal lands in India, and also on low quality lands in Southern Africa (UN-Energy, 2007). Yet, the real breakthrough will depend on the "second generation biofuels" that are much more effective compared to current feedstocks for biofuels. The technology for converting cellulosic plant materials into biofuels is complex and capital intensive, and commercially profitable production processes are not yet available. It essentially amounts to scaling up the digestive processes of ruminants to industrial level and will have to build on scientific progress in "green chemistry", so as to offer a substitute for current petrochemical processes.

Finally, taxation aspects have to be taken into consideration, which are largely neglected in the current literature on biofuels. On average, European OECD countries levy 59 percent excise and value added tax on gasoline but in the US this is only 15 percent (OECD, 2007). Levies on other uses are highly differentiated and much lower but significant as well. To assess whether biofuels could compete with fossil fuels, reviewing the logic and justification of energy taxation would seem essential. Fossil fuels are mainly taxed at two points: the well, where royalties are collected, and the final use. Royalties can also be collected via joint ownership of the well and the refineries by the country of origin and the company or consortium in charge. They are designed to tap the rent of the mineral deposit. End user taxes generally have five motivations that would, for an efficient choice of energy policy, have to be expressed in quantitative terms as separate amounts. The first two are "sin taxes", one on environmental emissions such as greenhouse gases and fine dust, one on contribution to traffic conges-

tion; the third would be a correction on the market price to promote energy resource conservation; the fourth an attempt to recover part of the rent on mineral resources accruing to the energy exporting countries; and finally the fifth would be a plain collection of tax revenue to finance expenditures, with a relative luxury good and a limited and well monitored number of providers (gas stations) as object of taxation. Decomposing the total tax into its constituent parts is essential when deciding how to tax new energy sources such as biofuels, and through it almost passing final judgment on their profitability: the environmental component should be proportionate to actual emissions, the contribution to congestion should remain and so would the plain revenue collection, but the resource conservation and rent recovery component should obviously be waived. Clearly, regulations that force fuel producers to use minimal proportions of biofuel bypass all these considerations but beyond the initial stage of innovation for which an infant industry argument can be invoked, they become highly questionable as they virtually force the economy to give priority of fuel production over food and environmental considerations.

Therefore, whether first generation biofuel production from food crops will eventually be profitable, strongly depends on the taxation. Current projections range from a few percent to 20 percent of global fuel consumption for transport by the year 2020 (Braun and Pachauri, 2006; IPCC, 2007c). From a pure production perspective, one would expect that in densely populated areas with small farm sizes crop production for biofuel is not a good proposition, since it essentially extracts only the calorie content of the crop. For oilseeds, from which protein-rich cake for use in livestock production can be obtained in parallel with oil, the bottom line might be somewhat more promising, but in general smallholders will have to look for higher value crops and for livestock. At present, the main implications would be that once the land currently set aside in both the US and the EU will have been brought back under cultivation, as will inevitably happen given the current policy emphasis on biofuels and the rise in demand for animal feeds worldwide, the very long period of surpluses on the world market will come to an end, and with it a main incentive for developed countries to protect their agriculture. Export ambitions will gradually take over from fear of imports.

Adaptation to adverse effects of climate change

Apart from mitigation, in many regions adaptive responses to the adverse effects of climate change will be needed, due to the long-term impact of higher levels of CO_2 concentration, but also because of the volatile dynamics of the climate systems themselves, which are still hardly understood. The type of adaptive responses will depend on the particular circumstances, whereas vulnerable regions typically face multiple stresses in combination with poverty, diseases pressure, conflicts and other life and livelihood threatening conditions.

Some straightforward responses can be identified immediately. For example, in case of increased occurrence of droughts, farmers may switch to more drought resistant varieties, make adjustments in the agricultural calendar, or changes in types of crops being cultivated (IFPRI, 2006). When in low lying coastal areas, as a result of a higher mean sea level, the risk of flooding increases, there will be a need to improve protections in the form of dikes and dams, and also to upgrade existing drainage systems. Large coastal cities such as Lagos and Maputo may be forced to make major infrastructural adjustments in the coming decades, or otherwise large numbers of people will have to find other settlement areas. Institutional changes will be needed as well, e.g. the need for development of better climate information and early warning systems, and the preparation of disaster response mechanisms. Also new forms of crop insurance schemes may be part of strategies to reduce risks of harvest failures related to climate change (Stern, 2006).

In line with this research agenda that asks to look into the specifics, the Centre has concluded two projects that directly respond to these demands. First, in the Rivertwin project it studies the impact of climate change on the agricultural and health sector of the Oueme River Basin (ORB) in Central Benin, taking a detailed look at local circumstances and locally available adaptation mechanisms. It also developed new techniques for provision of index-based crop and weather insurance schemes. In a World Bank supported project conducted in Ghana the scope for such financial instruments as part of a social safety net is explored. Both projects will be described in some more detail. Also in the newly started project "Chinese Agricultural Transition: Trade, Social and Environmental Impacts" (CATSEI), in which six organizations participate with SOW-VU as coordinating institute, environmental issues and impacts of climate change feature in the analysis.

The impact of climate change on crop production and health in West Africa

In West Africa, the Northern Sahelian zone and the coastal areas are densely populated but the Middle Belt in between is in general sparsely settled. While the historical reasons for this phenomenon are only partly understood and include explanations relating to slavery, the high diversity and small size of tribes as well as to poor soil conditions, the fact remains that the Middle Belt has underutilized land resources and may, therefore, be an important asset for future development of the agricultural sector in the region. This holds particularly under climate change, because the climate in the area is expected to remain more moderate than in the drier Sahel and more humid coastal zone. Increased settlement into the area is already taking place at a significant scale from the North and the South, in response to environmental degradation and mounting population pressure. Northern regions are especially threatened by encroaching deserts, the borderline of which gradually shifts to the lower latitudes, while the agricultural production capacity in the intensively cultivated South is endangered by nutrient mining.

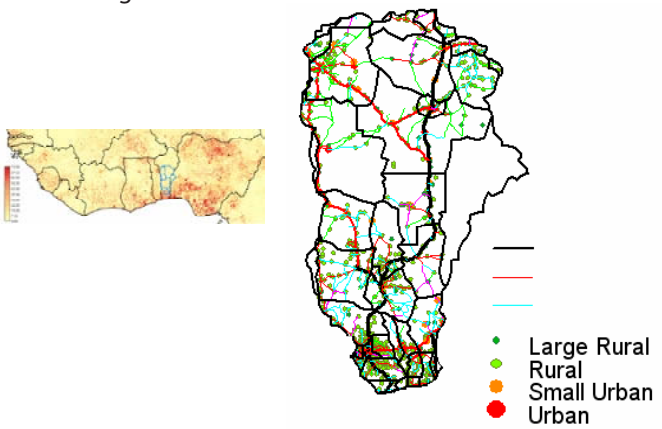


Figure 4. Infrastructure and settlement areas in the Beninese area of the ORB. The map insert shows the population of West Africa and the 'empty' middle belt

Under climate change, this situation is most likely to worsen, with accelerated desertification in the North and more frequent occurrence of torrential rains and floods in the South, but much less in the Middle Belt. This motivates to study the impact of climate change on the agricultural income and the health situation of future inhabitants of the Middle Belt, specifically on the Middle Belt part of the Oueme River Basin (ORB) in Central Benin, see Figure 4.

The agriculture component of the study makes use of a detailed spatial and temporal assessment of climate change impacts, using a calibrated hydrological model of the ORB that calculates soil moisture balances with daily time steps for a 3x3 km grid, for the prevailing land use categories. For the main crops the effects on yields, area, and revenue per ton are considered. Yields can adapt through irrigation, adjusting water availability to crop demands, and improved provision of agricultural inputs as hybrid seeds and fertilizers. Regarding cropping areas, adjustment of the cropping pattern enables farmers to adapt to new soil moisture conditions. Finally, prices may adjust in response to changed scarcity on the market at national level, as well as to changed net selling positions at commune level. As climate change will expectedly create conditions in the Basin that are similar to those in the areas surrounding it, particularly in the drier North, and the more humid South, we base our projections for the Basin on relationships estimated for the Beninese territory as a whole. With these relationships and under scenarios representing different assumptions on climate change and policy interventions, we conduct model simulations, with irrigation, improved provision of inputs, and area expansion as policy levers.

The model simulations show that the reduced rainfall and increased rainfall variability that generally emerge under climate change have very different effects on various crops. For remunerative staples such as Maize and Yam the yields fall on average, while crop failures under drought become more frequent, whereas for Cotton, the most rewarding cash crop, and for Groundnut yields improve on average. Comparing mean farm income under climate change to the historical period, without price and area share adjustments, shows that rather dramatic income losses will be found throughout the basin except for some parts in the North-West and South. In response to these changed conditions farmers can adapt their cropping pattern, and it appears that expansion of Cotton and Sorghum at the expense of Maize and Yam in many parts of the region compensate to a great

extent for the revenue loss due to climate change. Once price adjustments in response to changed scarcities of local crops are accounted for, the losses are reduced further. It is even found that losses can turn into gains once fallow is reduced through application of modest amounts of fertilizer, which is a promising option for agricultural intensification since this requires few adjustments in prevailing farming practices, exploits the potential of uncultivated land and improves the water use efficiency. Indeed, reduction of fallow is key to maintaining the Oueme River Basin's capacity to absorb migrants in the future. Nonetheless, successful development of the basin cannot rely on agricultural development alone and future growth in fact largely depends on success of urbanization, building on expansion of the trade, transport and agricultural processing sectors as well as large introduction of cash crops and expansion of livestock production, for exports to the richer neighboring Nigeria.

The health and sanitation component of the project analyzes the prevalence of diarrhea in relation to the access to drinking water. Diarrhea prevalence is seen as a good indication of water impurity in general, and is in itself important as well, because it is considered the major cause of the high infant mortality in West Africa, as argued e.g. in the Human Development Report 2006. Prevalence of diarrhea, especially amongst children, has been a persistent problem and increased from 105 cases per 1000 children in 1995 to 121 cases in 1999, with as most vulnerable group the children below one year. Using outcomes from the Demographic and Health Surveys, household prevalence of diarrhea in Benin has been computed at district level. Figure 5 shows that prevalence rates vary strongly across the communes and reach values up to 600 per 1000 children. Overall, we observe that the most affected areas lie in the mid-north west and to a lesser extent in the south. Hence, also against the background of the foreseen immigration into the Middle Belt, it is important to identify effective strategies in fighting diarrhea.

The relation of this high diarrhea prevalence with poor sanitation facilities and restricted access to reliable water sources is also clear: a household with good hygienic practices and access to clean water, irrespective of other conditions, will not suffer diarrhea very often. The study confirms this, showing on the basis of DHS-data for Benin that the richer and better educated segments of the population suffer much less from the disease and can secure safe water for their households. Yet, the data also point to

important geographical differences within the Oueme River Basin, regarding groundwater availability and quality that reflect in diarrhea prevalence. It is also found that "stand-alone" interventions of access to water have limited effect, albeit that it is not very costly. Improving private and public hygiene seem to be at least as important in villages with ample water supply as well as in villages where there is significant stress on water resources, suggesting that "hand washing" programs as promoted by the World Bank are to be undertaken in tandem with measures to improve the quantity and quality of public service provision.

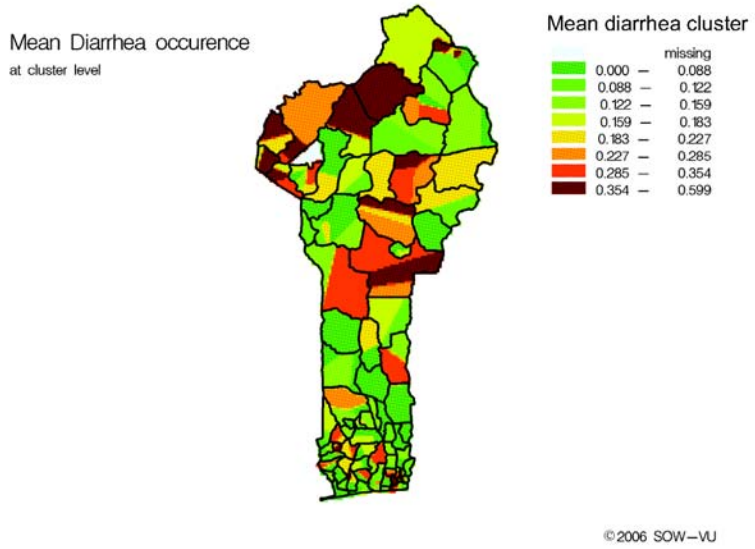


Figure 5. Diarrhea prevalence in Benin

Novel crop insurance products for rural Africa

Farm communities worldwide face difficulties when trying to insure income against price and weather fluctuations. In principle, they can choose between self-insurance, mutual insurance and market insurance. Self-insurance generally operates through measures in the real sphere such as the development of irrigation and spreading of insecticides, whereas mutual insurance shares the risk among farm households and comprises both physical activities, such as helping out at harvest time or in case of an accident, and income transfers in cash and in kind. Combined, both types provide the main risk coping mechanism for farmers throughout Sub-Sahara Africa. However, these traditional instruments prove to offer insufficient coverage against aggregate risks such as those originating from droughts, floods and price shocks that threaten all members of the local communities at the same time. The alternative of market insurance of crops would seem a natural candidate instrument. Insurance arrangements increasingly figure on the policy making and research agenda, due to the increased attention to social safety nets as part of an overall assistance strategy, the scope to provide income transfers via insurance schemes that are compatible with WTO legislation and the introduction of risk management tools as part of agricultural policy packages in developed countries. Yet, market insurance is also plagued by excessive monitoring costs in avoiding the two classical problems of adverse selection and moral hazard (overrepresentation in the pool of insured of people with higher risks and overstating of damages, negligence of insured property, and defaulting on premium payments by the insured and on compensation payments by the insurers). In the Sub-Sahara African context it is also unrealistic to expect farmers to pay the premium ahead of the harvest.

Despite these difficulties, developing countries are looking for ways to enhance market insurance arrangements in some mixed public-private form. In urban areas, targeted instruments such as health insurance and free provision of drugs have been introduced for this purpose. However, in rural areas, where few public facilities are available, more general arrangements such as crop insurance, possibly subsidized, seem preferable.

As compared to purely publicly funded schemes, possibly subsidized market insurance offers the advantage that the insured groups pay some premium themselves. Besides alleviating the pressures on the already overburdened national budgets, this reduces the scope for free riding on arrangements, since premium payers will tend to exercise some countervailing pressure. Furthermore, by creating pools of policy holders with different risk profiles, say, of farmers with different cropping patterns, it offers possibilities for mutual insurance at above village level, and also for solidarity between population groups within the limits set by political realities, of course. Finally, at the international level, market insurance enjoys increased popularity because of some further advantages: since the economies in rural Sub-Sahara Africa are small by international standards, reinsurance on the international financial markets is relatively easy; also, even when subsidized, crop insurance arrangements are considered less distortive than many other farm support measures and so far enjoy a Green Box status at the WTO.

Yet, at present crop insurance in Sub-Sahara Africa is still practically non-existent. Consequently, poor farmers often find themselves trapped in poverty, unable to take advantage of upcoming profitable opportunities. The risk is too high for them to take a chance.

This situation has become a major concern of the development community, particularly at a time that arrangements to control the markets directly, through prices and stock management, have been discarded as less effective. The search for new financial arrangements to help building social safety nets in rural Africa has led to several initiatives. Notably, in recent years, a new product has been piloted that seeks to address problems of insurance by conditioning the indemnity payments on a set of agreed upon conditions that is independent from both farmers' and insurers' decisions. Such index-based insurance pays out when an agreed upon indicator falls below an agreed upon threshold. Classical examples are payments triggered by the recorded rainfall at a particular weather station or, by the price at a particular market, or by weather-price conditions simultaneously.

Ongoing research and experience indicate that it is not easy to piece together an index function that predicts well the actual individual damages on the basis of selected weather and price variables, i.e. an index function that has a low basis risk. Poor farmers tend to be reluctant to buy

index-based insurance, despite significant subsidies often offered on the premiums. One reason may be that based on the indemnifications paid so far, they consider the basis risk relatively high under the proposed schemes. Another reason may be that they do not see how the current participation by their neighbors could ever overcome the problems of covariate risk they so often faced under mutual insurance arrangements.

This has motivated research at SOW-VU to improve the design of index-based insurance products. In particular, a new technique has been developed to estimate an index-based indemnification scheme that minimizes basis risk – specified as the shortfall of income below a specified poverty line – , that can be specified for any pool of farmers willing to share risk, and that adapts to a given level of self-financing. The technique adapts semi-parametric techniques from Support Vector Regression, considers a set of weather and price variables, and constructs a function that is flexible and converges to the scheme that is closest to a given ideal scheme, i.e. a scheme that eliminates all basis risk and brings all farmers at or above the poverty line.

The technique was applied to rural Ghana, where it appears that over the period 1980-2005 about half of the farm households had a living standard below the poverty line. Calculations on the historical data indicate that, with a small mark-up for the cost of monitoring and reinsurance, an ideal national mutual insurance scheme with a per hectare premium of 12 per cent of mean income could have avoided all shortfalls below the poverty line. As group-specific schemes by region or by quintiles lack the solidarity implicit in such a national arrangement, the ideal requires important subsidies from government or donors in case of a regional scheme, say for poor groups in Northern Ghana.

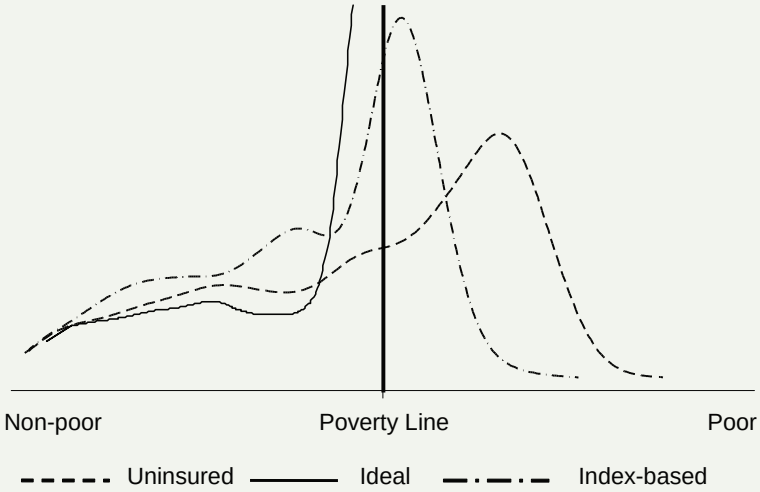
Simulations with index-based insurance products that try to fit the ideal indemnity payments on rainfall and prices show, as expected, that lower rainfall and lower prices imply higher payments. Specifically, among these variables, rainfall is the best predictor, followed by the price of staple crops, which might reflect the relatively high vulnerability of staple crop farmers in the Northern part as compared to the better-off situation of cash-crop farmers in the Southern part. The simulated effects on poverty appear to be substantial, as explained in Box 1. Poverty prevalence reduced on average while also the depth of poverty decreased. It further appears that com-

monly employed parametric forms have a relatively poor capacity to fit the ideal indemnification scheme, whereas the corresponding semi-parametric forms perform much better.

Although index-based insurance seems to be a promising adaptation of classical crop insurance, an important caveat applies. By construction, index-based insurance involves basis risk giving up the option of full adaptation to individual needs of the poor. One reason is that the policy uniformly applies to all policy holders with many individuals having the same observed prices and weather, about the same farm size but, say, different cropping patterns, yields, and personal situations. Whatever its shape, an index-based insurance will only compute a single indemnity payment for all of them. The second reason is that the insurance contract has to apply in the future, under circumstances other than those found in the historical record. Therefore, it is important to avoid overfitting whereby the contract may nicely fit the past but performs poorly under conditions beyond the historical record.

This project is partially supported by the World Bank and has been executed in cooperation with researchers from the Ghana Statistical Service and the Vrije Universiteit.

Box 1. Estimated income distribution of Ghanaian farm households



The graph shows the income distribution of Ghanaian farm households estimated and simulated for 100 different types of farmers under 26 various states of the world reflecting price and weather conditions from 1980 to 2005. The fat vertical line represents the poverty line, and income shortfalls are displayed to the right of this line. The dashed line represents income shortfalls in the uninsured (historical) case, the continuous line depicts an ideal insurance to which all farmers subscribe, while the dashed-dotted line refers to outcomes under a semi-parametric index-based insurance scheme. The comparison of the incidence and depth of poverty under the various arrangements illustrates how insurance can reduce poverty. In the uninsured case the probability of shortfall below the poverty line is high (the area to the right of the poverty line is 47% of the total), while under the ideal national insurance, as expected, this probability is reduced to zero. Due to the premium payments, many farmers are moving towards the poverty line in many states of the world, and, for example, the share with an income exceeding twice the poverty line is only 13 percent, half of the percentage in the uninsured case. In the case of an index-based insurance, the shortfalls to the poverty line diminish significantly (from 47% to 28%) but obviously much less than in the ideal case. The depth of poverty is reduced as well, as can be seen from the narrowing of the right-hand side tail of the distribution.

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Staff

List of staff members

The following staff members were working at the Centre by the end of 2006:

Bart van den Boom	Economist
Le Chen	Economist
Michiel Keyzer	Economist/Director
Rian Kriesels	Secretary
Max Merbis	Economist/Deputy director
Vasco Molini	Economist
Maarten Nubé	Nutritionist
Saket Pande	Economist
Huanguang Qiu	Economist
Ben Sonneveld	Agronomist
Kees Traas	Administrator
Wim van Veen	Economist
Roelf Voortman	Ecologist
Lia van Wesenbeeck	Economist

Board and Advisors

The Board

Mr. E.P. Woltjer	Chairman
Prof.dr. E.H. Bulte	Wageningen University; upon nomination by the Minister of Foreign Affairs
Prof.dr. M. Lindeboom	Department of Economics, Vrije Universiteit
Prof.dr.ir. G. Meester	Ministry of Agriculture, Nature and Food Quality
Prof.dr. H. Verbruggen	Department of Economics, Vrije Universiteit

The Scientific Advisory Committee

Prof.dr. A.J. Dolman	Faculty of Earth and Life Sciences, Vrije Universiteit
Prof.dr. J. van der Gaag	Department of Economics, University of Amsterdam
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Prof.dr. E.M.A. Smaling	Wageningen University, Wageningen
Dr. T.N. Srinivasan	Yale Growth Center, Yale University, New Haven, USA
Prof.dr. H.A. Verhoef	Department of Earth and Life Sciences, Vrije Universiteit
Prof. dr. P. van der Zaag	Technical University, Delft

In 2006, Prof Arie Kuyvenhoven, after serving the Board for more than 15 years, left for retirement and was succeeded by Prof Erwin Bulte. Prof Age Bakker resigned from the Board to become the Dutch representative at the IMF, Washington D.C. and was succeeded by Prof Maarten Lindeboom. Dr Ad Koekoek left the Scientific Advisory Committee to become deputy Chief of Mission at the Dutch Embassy in Djakarta; Prof Claus Weddepohl left for health reasons. Prof Peter Ho will join the Committee in 2007.

The Scientific Advisory Committee convened on December 22, at their annual meeting. The meeting started with an overview of the world food

situation and on-going projects at the Centre, emphasizing the remarkable achievements in poverty reduction obtained in Asia and the lessons which can be derived from it for Sub-Saharan Africa. Subsequently, various staff members presented specific topics in applied projects, covering the impact of climate change on crop production and health in West Africa (Benin), an analysis of novel crop insurance products for rural Africa, and an investigation into the role of vegetation patterns in determining fertilizer strategies in certain biomes of Sub-Sahara Africa. The committee commented on the empirical strength of the approaches, and critically discussed the relevance of some of the underlying assumptions.

Accounts and result for 2006

Key figures of SOW-VU's Balance per December 31, 2006

Assets		
Fixed assets	€	39,289
Current assets	€	526,455
Liquid assets	€	871,554
Total Assets	€	1,437,298
Liabilities		
Capital	€	257,566
Provision for personnel risks	€	67,951
Current liabilities	€	1.111,781
Total Liabilities	€	1,437,298

Key figures of SOW-VU's Operating Account 2006

Expenses		
Research activities	€	1,157,795
Specific material expenses on research	€	67,889
Institutional costs	€	63,605
Total Expenses	€	1,289,289
Earnings		
Subsidies:		
- Ministry of Foreign Affairs	€	636,722
- Ministry of Agriculture	€	150,000
- Vrije Universiteit	€	377,372
Other income	€	186,457
Total Income	€	1,350,551
Result	€	59,513

Publications and activities, 2006

The Centre's research output is split into academic (refereed) and professional publications, followed by a selection of other activities related to education and capacity building efforts. Downloadable publications can be found at the Centre's website http//www.sow.vu.nl.

Academic publications

Keyzer, M.A., Y. Ermoliev, and V. Norkin, 'General Equilibrium Models with Discrete Choices in a Spatial Continuum' in Coping with Uncertainty, Modeling and Policy Issues by K. Marti et al. (eds.), pp. 133-154. Lecture notes in economics and mathematical system 581. Springer, Berlin Heidelberg.

Keyzer, M.A. 'Modelling global trade reform. Some reflections' in P. van Dijk & G. Faber (eds.) Developing Countries and the Doha Development Agenda of the WTO, pp. 59-67. Routledge Studies in the Modern World Economy, Routledge, Abingdon.

Keyzer, M.A., book review of 'Dealing with Terrorism, Stick or Carrot?' by B.S. Frey, De Economist 154: 315-316.

Keyzer, M.A., and C.F.A. van Wesenbeeck, 'The Millennium Development Goals, How Realistic Are They?' De Economist, 154(3): 443-466.

Lyon, K.S., and S. Pande, 'The costate variable in a stochastic renewable resource model.' Natural Resource Modeling, 19(1): 45-66.

Nubé, M. 'Nutritional Deprivation and Gender', in P. Bharati & M. Pal (eds) Gender Disparity: Manifestations, Causes and Implications, pp. 148-175. Anmol Publications, New Delhi/Bengalore.

Sonneveld, B.G.J.S. 'Compilation of a soil map for Nigeria: a nation-wide soil resource and land form inventory' in Nigerian Journal of Soil Research Vol. 6: 71-84.

Wesenbeeck, C.F.A. van, book review of 'Frontiers in Applied General Equilibrium Modeling' by J. Kehoe, T.N. Srinivasan and J. Whalley (ed.), De Economist 154: 475-476.

Zhu, X., C.F.A. van Wesenbeeck, and E.C. van Ierland, 'Impacts of Novel Protein Foods on Sustainable Food Production and Consumption: Lifestyle Change and Environmental Policy' in Environmental & Resource Economics, 35(1): 59-87.

Dasgupta, P., R. Saha and M. Nubé., 'Changes in body size, shape and nutritional status of Middle-class Bengali boys of Kolkata', India, 1982-2002, draft report.

Keyzer, M.A. 'Van Rosa Luxemburg tot Alan Greenspan: De gedrevenheid van economen' in Vuurwerk, 2(3): 28-35.

Keyzer, M.A., V. Molini and G.J.M. van den Boom, 'Risk minimizing index functions for price-weather insurance with application to rural Ghana', draft report.

Keyzer M. A., B. G.J.S. Sonneveld, and S. Pande, 'The impact of climate change on crop production and health: an assessment for the Oueme River Basin'. Report to the European Commission. Rivertwin project: GOCE-CT-2003-505401.

Pande, S. 'Generative model-based kernels in support vector analysis', draft report.

Sonneveld, B.G.J.S., and D.L. Dent 'How good is Glasod?', draft report.

Keyzer, M.A., B.G.J.S. Sonneveld, and W.C.M. van Veen, 'Valuation of natural resources: efficiency and equity', background paper prepared for the GEO-4 Outlook, UNEP, Nairobi.

Keyzer, M.A., M. Nubé, G.B. Overbosch, and R.L. Voortman, 'Syria, Rural Poverty Assessment and Mapping', in cooperation with Agricultural Extension Directorate and Ministry of Agriculture and Agrarian Reform, Government of Syria, Damascus, project report for IFAD. Amsterdam: SOW-VU, 154 pp.

Keyzer, M.A., V. Molini and G.J.M. van den Boom, 'Can Price-Weather Insurance Reduce Poverty in Rural Ghana?', project report for the World Bank under Research Grant no. 7131322, 44 pp.

Fischer, G., J. Huang, M.A. Keyzer, H. Qiu, L. Sun and W.C.M. van Veen, 'Managing a successful transition of China's agricultural transition', draft Summary report of the Chinagro project on the sustainable adaptation of China's agriculture to globalization. International Scientific Cooperation Project ICA4-CT-2001-10085. Amsterdam: SOW-VU, 99 pp.

Voortman, R.L. 'On the origin of low fertilizer use levels in Africa: poor policies, unruly soils, ignorant farmers or inappropriate technologies?', draft report.

Working papers

Nubé, M. and R.L. Voortman, 'Simultaneously addressing micronutrient deficiencies in soils, crops, animal and human nutrition: opportunities for higher yields and better health', Working Paper 06-02. Amsterdam: SOW-VU, 47 pp.

Overbosch, G.B., 'Inside the Map Factory: Note on making maps with SAS', Working Paper 06-01. Amsterdam: SOW-VU, 35 pp.

Keyzer, M.A., M. Nubé, C.F.A. van Wesenbeeck, 'Estimation of calorie intake in Africa: methodology, findings and implications for Africa's record', Working Paper 06-03. Amsterdam: SOW-VU, 29 pp.

Conference, seminar, workshop

Boom, G.J.M. van den, presenting 'Integrating hydrologic and economic approaches to increase water use efficiency' at ASEMWATERNET Workshop and Kick-off Meeting, Hanoi City, Vietnam, 29 May–1 June.

Keyzer, M.A. presenting 'Voedselzekerheid in Afrika: achtergrond en kanttekeningen' at Afrikadag 2006, Evert Vermeer Stichting, 22 April.

Keyzer, M.A. Brussels, 27 april, presenting 'Support Vector Regression and Classification, an Introduction', Seminar in the Econometrics series, at ECARES, ULB.

Keyzer, M.A., M. Nubé and G.B. Overbosch, presenting project findings and final report 'Syria Rural Poverty Assessment and Mapping', workshop organized by Ministry of Agriculture and Agrarian Reform, Damascus, 28 June.

Keyzer, M.A., V. Molini and G.J.M. Boom, presenting 'Risk minimizing index functions for price-weather insurance with application to rural Ghana' at the workshop 'Can Price-Weather Insurance Reduce Poverty in Rural Ghana?', Ghana Statistical Service, Accra, 12 July.

Keyzer, M.A., presenting 'Agenda of Food Policy Research for Africa', at the International Policy Workshop "Agriculture and Development" in preparation of the World Development Report 2008, The World Bank and InWEnt, Berlin, 4-6 September.

Keyzer, M.A., presenting 'Asian Lessons for Africa' at the second expert meeting in preparation of World Food Day: Global Action for Food Security, Amsterdam, 27 September.

Keyzer, M.A., presenting 'Risk minimizing crop insurance policies', at Seminar in honor of Yuri Ermoliev, IIASA, Austria, 6, November.

Keyzer, M.A., presenting 'Millenium Development Goals on Poverty and Malnutrition', Director's seminar IIASA, Austria, 6, November.

Keyzer, M.A. presenting 'Nutrition in Developing countries: perspectives in Africa and lessons from the Asian case-studies', at the international symposium 'What future framework for agricultural policies in Europe and developing countries?', Notre Europe, FARM and Pluriagri, Paris, 27-29 November.

Keyzer, M.A., presenting "Scope for co-operation between Institute of Economics and Forecasting, National Academy of Sciences Ukraine, and SOW-VU", Kiev, Ukraine, 11-13 December.

Keyzer, M.A., presenting discussant's note on paper "Food and agricultural policy to mitigate the impact of HIV/AIDS" by Hans Binswanger, at workshop 'The economic consequences of HIV/AIDS', AIID, Amsterdam, 15-16 December.

Merbis, M.D. and C.F.A. van Wesenbeeck, presenting 'Towards a Food Atlas for Subsaharan Africa, Food availability, deficits and aid deliveries', World Food Program (WFP), Rome, 28 September.

Molini, V., presenting paper 'Is the nutritional status of males and females equally affected by economic growth? Evidences from Vietnam in the 90's' by V. Molini and M. Nubé at UNU-WIDER Project Meeting on 'Gender and Food Security', Calcutta, India, 12-14 December.

Nubé, M. and W. Klaver, contributed paper 'The MDG's on Poverty and Hunger: How reliable are the hunger estimates?', ASC-Conference 'The end of poverty in Africa? Five decades of development and what now?', African Study Centre, Leiden, 16-17 March.

Nubé, M., invited panel-member at World Food Day Expert-meeting 'Local action for food security', Stichting Wereld Voedselvraagstuk, Wageningen, 12 September.

Nubé, M., invited participant Stakeholder Meeting 'Rethinking Agriculture in Development', organized by Ministry of Agriculture, Nature and Food Quality (LNV) and Wageningen University and Research Centre (WUR), Kijkduin, 14 December.

Qiu, H. and J. Huang, contributed paper 'Consumers' Trust in Government and Their Attitudes Towards Genetically Modified Food: Empirical Evidence form China', IAAE conference, Queensland, Australia, 12-18 August.

Sonneveld, B.G.J.S., presenting 'Keynote on Valuation of Natural Resources'

at GEO-4 Human Well-being Working Group Meeting, UNEP, Nairobi, 30 January–3 February.

Sonneveld, B.G.J.S., invited speaker at 'Spatial Integration Workshop', University of Hohenheim. Germany, 28 June 2006.

Sonneveld, B.G.J.S., invited speaker at 'Atelier International Perspectives futures de la gestion intégrée de l'eau dans le bassin de l'Ouémé', Parakou, Benin, 7 November.

Sonneveld, B.G.J.S., invited speaker at 'Integrated River Basin Management in contrasting climatic zones', University of Hohenheim, Germany, 6 October.

Lectures

Keyzer, M.A. and H. Qiu, 'A Bird's Eye View of Economic Development in China', lecture for FEWEB students in preparation of visit to China, 22 February.

Keyzer, M.A. guest lecture on 'Algorithms for combined use of censuses, maps, surveys, and district data: rule-besed and support vector regression approaches' at the Ghana Statistical Service, 14 July, Accra, Ghana.

Keyzer, M.A. 'Het wereldvoedselvraagstuk', at FEWEB course 'Interfacultaire cursus ontwikkelingsvraagstukken: Kennis, Informatie en Innovatie. Sleutels voor mondiale ontwikkeling?', 28 September.

Sonneveld, B.G.J.S., 'Land degradation and natural resource valuation', lecture for MSc students, Faculty of Earth Sciences, University of Utrecht, 26 October.

Advisory Work

Keyzer, M.A., Presentation for special task force "Préparation du rapport des perspectives agricoles en France et en Europe", Office of the Prime Minister, Paris, on 20 June.

Keyzer, M.A. and M.D. Merbis, input to 'Letter of Minister for Development Co-operation to the Parliament on "Structural causes of hunger in Afrika"', Ministry of Foreign Affairs, 'Kamerbrief inzake toezegging overzicht structurele oorzaken Hongerproblematiek Afrika', 4 October.

Traineeships/ visiting researchers

Arouna Aminou, research assistant at the Institute National des Recherches Agricoles Benin, counterpart in Rivertwin project, training in (spatial) data management and production function analysis, 16 January–15 May.

Epiphane Sodjinou, Chercheur Agro-économiste, Programme Analyse de la Politique Agricole, CRA-Agonkanmey/INRAB, Benin, counterpart in Rivertwin project, training in (spatial) data management and production function analysis, 16 December 2006–15 February 2007.

Dr. Euan Phimister (University of Aberdeen/Agricultural Economics Research Institute, The Hague) research on problems of debt at family farms in Western Europe, March-July.

Prof. N.N.N. Nsowah-Nuamah, Ghana Statistical Service (GSS), strengthening of the collaboration between the GSS and SOW-VU, identifying the final activities in the project "Can Weather and Price Insurance Reduce Rural Poverty in Africa? The Roles of Self-Insurance, Mutual Insurance and Market Insurance", 15-20 May.

Prof. Laixiang Sun, London School of Economics, cooperation in the context of the follow up of the Chinagro project.

Dr. Huanguang Qiu, CCAP, Beijing, China, temporarily SOW-VU staff member, cooperation in the context of the embassy project 'Options for Agricultural Development in China' follow up of the Chinagro project.

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