

NORTH-SOUTH CENTRE

Research for Development

Annual Report 2010



ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



North-South Centre
Research for Development

Vision for the ETH Zurich

The ETH Zurich is a leading institution on North-South matters in its field. It has a long-term commitment to research and education in support of globally accessible knowledge for sustainable development.

Mission of the North-South Centre

The North-South Centre promotes research and education in the field of international development and cooperation. It facilitates collaboration with relevant institutions in developing countries, emerging economies and Switzerland in the technical, natural, human and social sciences. These activities are visible nationally and internationally.

Goals

- The North-South Centre promotes long-term research collaboration with partners in developing countries and emerging economies placing emphasis on both interdisciplinary research projects and the link to capacity development.
- The North-South Centre supports students from developing countries and emerging economies at the Master of Science, doctoral and post-doc levels as well as ETH students interested in topics relevant to development.
- The North-South Centre establishes and maintains contacts among its members, within the ETH Zurich and in national and international networks. In Switzerland and beyond, the North-South Centre aims to be recognised as the focal point of the ETH Zurich in all affairs that involve developing countries and emerging economies.

Editorial

The annual report 2010 focuses on food security, a topic that has always been the main subject of the North-South Centre and its predecessor organisations. In 2010, the North-South Centre hosted the *Tropentag*, a major conference on food security which was held for the first time outside of Germany. This congress attracted about 800 participants from all over the world and was a big success.

The importance of food security should be clear to everybody who reads the newspaper. Food prices went up in 2008 and remained volatile until today, probably announcing that the time of cheap food is over. This is not of too much concern to the affluent. Less than 20% of their income is spent on food. However, the poor who spend up to 80% of their income on food will suffer.

Recognising the relevance of food security, the leadership of the ETH Zurich established a new competence centre devoted to the World Food System. This centre will strengthen the food and agricultural sciences. Hopefully, a wider context will be found together with the chairs of the ETH Zurich in the fields of health, energy, environment and social sciences. No plant will grow without water, the energy input in modern agriculture is enormous, and it is not sufficient to develop new high-yielding or heat- and drought-tolerant species – they have to be introduced to the farmers in the developing world. Implementation is the most challenging and time consuming step in the chain from research to practice. After all, food security is not only a technical problem. It is even more an ethical and political problem of distributing the resources of the earth in a fair manner among its inhabitants. Only a broad and interdisciplinary collaboration with expertise from all departments as well as international cooperation can ensure that an essential contribution to sustainable food production and distribution is made by the ETH Zurich in the future. The special aspects of developing countries taken care of by the North-South Centre remain pivotal.

The North-South Centre's current status as a competence centre has been prolonged by the Vice President Research and Corporate Relations until the end of 2012. Afterwards, a new form of organisation will be implemented, ensuring the continued promotion of North-South activities covered by the members of the North-South Centre. I sincerely hope that the ETH Zurich remains committed to the poor in the developing world. Especially in the field of capacity development, we face a substantial task.

How to engage in this task is vividly illustrated by this annual report, which shows once more the variety and breadth of projects that many ETH professors and researchers are working on.



Wolfgang Kinzelbach, President



Wolfgang Kinzelbach,
President of the North-South Centre



Chicken breeding is a common income-generating strategy for Honduran women in times of need

It's the little things citizens do.
That's what will make the difference.

Wangari Maathai,
African environmentalist

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Weighing the harvest for green bean export in Tanzania

Words mean more than what is set down on paper. It takes the human voice to infuse them with deeper meaning.

*Maya Angelou,
American author*

Expanding and repositioning

The structure of this annual report reflects the new Strategy 2010–2016 of the North-South Centre by presenting our activities according to our four research topics. While all programmes in the areas of food security and natural resource management continued, new activities were taken up in the area of urban and rural transformation. Beyond the ongoing research collaboration and capacity development programmes, the external evaluation in April and the *Tropentag* conference in September 2010 were of particular importance to the North-South Centre.

2010 saw little changes in the composition of the membership and governance bodies. The number of members increased by 10%, from 103 at the end of 2009 to 113 one year later, mainly by new members from the departments of architecture and humanities. As in 2009, the North-South Centre was represented in ten out of 16 departments. Nearly half of all members belong to the departments of agricultural and food sciences as well as environmental sciences. In contrast, the disciplines of engineering sciences as well as natural sciences and mathematics remain a challenge for North-South collaboration, with only eight members so far.

Two members of the Steering Committee changed in the course of 2010. Gerald Haug handed over his position to Jean-Pierre Burg (both D-ERDW). Marc Angélil was elected as successor of Emmanuel Frossard (D-AGRL). He will

resume this position when his term as Head of the Department of Architecture ends in 2011.

At the end of the year, the management team underwent some changes. Patricia Heuberger-Meyer and Monika Lusser joined the team as substitutes for Emma Lindberg and Ursula Gugger Suter, who both went on maternity leave in January 2011. Andreas Sicks started in November 2010 as successor to Manfred Kaufmann, who left the North-South Centre in order to continue his career in development cooperation with the Swiss Agency for Development and Cooperation (SDC).

Implementing the new strategy

Since our Strategy 2010–2016 was approved in November 2009, this annual report is structured along these new lines. The strategy defines four research areas: (i) food security, (ii) natural resource management, (iii) urban and rural transformation and (iv) technology and infrastructure. The first two areas have always been well covered by our past and ongoing programmes. The latter two are new challenging topics, where we have just started to build up expertise. This comprises two dimensions: First and foremost, the respective topic needs to be represented by our members; secondly, we have to develop activities based on the expertise of these members.

With respect to the research area on urban and rural transformation, the main activity in 2010 was the ETHiopia Urban Laboratory Summer School in June and July (see page 77). This was jointly carried out by ETH Sustainability, the Department of Architecture and the North-South Centre, together with the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC). 18 students from the ETH Zurich and 36 of their Ethiopian counterparts worked together in Addis Ababa for three weeks, generating solutions for sustainable urban housing. The North-South Centre contributed to the preparation and



Barbara Becker, Managing Director
of the North-South Centre

management of the summer school. More importantly, several of its members participated in the teaching. In addition to the teaching on architecture and construction led by Philippe Block, these members provided the interdisciplinary perspective, covering water and sanitation (Chris Zurbrügg), entrepreneurship (Philipp Aerni) and economics (Isabel Günther).

Under the supervision of the EiABC, the participants of the ETHiopia Urban Laboratory Summer School were involved in the construction of a Sustainable Urban Dwelling Unit (SUDU). Expanding this successful experience, the private Waser Foundation agreed to fund a pilot project for the construction of a Sustainable Rural Dwelling Unit (SRDU) in Ethiopia. The project will be carried out in 2011 and will help to further establish the research area on urban and rural transformation.

The fourth research area on technology and infrastructure is still in its infancy. In the course of 2011, it will be addressed more explicitly.

External evaluation

In April 2010, the North-South Centre underwent an external evaluation, commissioned by the School Board of the ETH Zurich. The principal reviewer was Joachim von Braun, former Director General of the International Food Policy Research Institute (IFPRI). The evaluation was based on terms of reference prepared by the School Board. They built on the self-evaluation report prepared by the management of the North-South Centre. During the visit of Joachim von Braun, several members presented their activities, covering a broad range of topics, instruments and types of collaboration of the North-South Centre.

The review report contains specific conclusions and recommendations on our constituency, the institutional set-up and the implementation of our strategy, as well as general

conclusions on our recognition, external and internal visibility, research, teaching and resources. In our follow-up activities, we addressed all conclusions and recommendations in detail. Our response to the School Board is a strategic analysis of the evaluation related to the networking capital, strategic competence, visibility, thematic scope and external environment.

We greatly appreciated the judgment of Joachim von Braun as a constructive view from outside. His main conclusion was: *“The North-South Centre is a valuable asset of the ETH Zurich. Its added value in research lies in the considerable networking capital, in its potential to mobilise resources and in the outcomes of its research partnerships. It should be given due recognition, visibility and resources. As the global science system advances and expands rapidly in the developing world, a stronger North-South Centre at the ETH Zurich can also be recommended from an ETH’s self-interest perspective.”*

Maintaining dialogue

The North-South Centre is actively involved in networking at both the operational and the strategic levels, nationally and internationally. Through its networking activities, it participates in strategic debates on research for development in Switzerland and abroad.

Many members of the North-South Centre are represented in various strategic bodies of the ETH Zurich, as well as in national and international scientific associations, advisory boards etc. Within the ETH Zurich, the North-South Centre positions itself among other ETH units with an international mandate, such as the Postgraduate Studies for Developing Countries (NADEL), International Institutional Affairs (IIA) or – with a somewhat different profile – ETH Sustainability. Another important partner is the ETH Foundation, which supported us in various ways in our efforts to attract external resources.

Nationally, the North-South Centre relates as peer to the National Centre of Competence in Research North-South (NCCR North-South) and to our sister unit cooperation@epfl. We are an active member of the Commission for Research Partnerships with Developing Countries (KFPE) and the Swiss Forum for International Agricultural Research (SFIAR). Furthermore, we have continued to host the secretariat of LivestockNet, a Swiss association for the improvement of Swiss actions and strengthening of the Swiss position in livestock and development issues.

Enhanced visibility

The North-South Centre continued its efforts to present the activities of its members to internal and external stakeholders and collaborators through a number of events and by various communication tools and channels.

The *Tropentag* conference in September was the largest event ever hosted by the North-South Centre. It attracted some 800 participants from about 80 countries. Some extracts of this conference on “World food system – A contribution from Europe” are presented on the pages 21–23.

A number of smaller events were organised throughout the year. The North-South Forum is held twice yearly and has become a well-established occasion to present and discuss development-related topics. In spring, we dealt with transnational land acquisitions, so-called “land grabs”. In autumn, we addressed the issue of green economy. Both fora were jointly organised with the NCCR North-South, alternating between the ETH Zurich and member universities of the NCCR North-South.

In response to the stakeholder survey conducted in 2009, the North-South Centre launched a new communication tool in 2010. In March, the first issue of the public newsletter “Perspectives” was released and distributed electronically to some 1'500 readers. In view of the forthcoming

Tropentag, it focused on food security as our “topic of the year 2010”. The second edition of “Perspectives” was published in November 2010 on the topic of the UN International Year of Biodiversity. Both themes are well covered by the research expertise of our members.

Moving in a dynamic environment

Two changes in the external environment of the North-South Centre have sparked a number of consultations on new forms of future collaboration: First, the ETH Zurich has decided to reorganise its agricultural and food sciences department. As of January 2012, the food sciences will be incorporated into the new Department of Health Sciences and Technology (D-HEST), while the agricultural sciences will be merged with the environmental sciences to form the new Department of Environmental Systems Science (D-USYS). With the majority of its members and activities represented in the new D-USYS, the North-South Centre will reposition itself in this context.

Secondly, SDC underwent an external evaluation of its research collaboration in 2009. The review report was released in spring 2010 and prompted a series of discussions between SDC and the Swiss research community. The new SDC research policy is expected to be implemented in the course of 2011 and 2012. In view of the time lag between the expiring SDC contracts of the North-South Centre and the new policy instruments becoming effective, SDC extended both ongoing contracts for another year.

Barbara Becker



Women ranking preferences for various landscape types in Madagascar

Including the value of natural resources and our social capital in national accounting is a vital step to achieve economic growth that is equitable and sustainable.

*Achim Steiner,
United Nations Environment Programme (UNEP)*

Rationale and strategy

The North-South Centre is the focal point of the ETH Zurich in all affairs that involve developing countries and emerging economies. It promotes research collaboration and capacity development in international development and cooperation covering the technical, natural, human and social sciences. The North-South Centre builds on the comparative advantage of the ETH Zurich as one of the leading technical universities worldwide. It uses the competences of its members and their disciplinary strengths. Thus, the research activities of all members represent the core of the North-South Centre. Resulting partnerships with research institutions, governmental organisations, development agencies and other stakeholders in the North and in the South are an important pillar of the Centre.

The activities of the North-South Centre cover three main areas: (i) research collaboration, (ii) capacity development and (iii) networking and communication. Thereby, the North-South Centre promotes the ETH Zurich as a leading institution on North-South matters in its field – research and education.

The Strategy 2010–2016 positions the North-South Centre within the ETH Zurich by relating it to the overall ETH strategy, its international strategy and the strategies of individual departments. The strategy of the North-South Centre lays out the conceptual approach of research for development. It defines sustainable development for human well-being as overall goal and identifies four thematic research areas: (i) food security, (ii) natural resource management, (iii) urban and rural transformation, and (iv) technology and infrastructure. In addition, it draws attention to three transversal topics, which cut across the four research areas: gender, good governance and impact generation.

With regard to capacity development, the strategy highlights the importance of individual capacity development

as primary task of the North-South Centre. We serve our target groups through a variety of instruments such as grants or scholarships, support to visiting scientists or for teaching stays, through summer schools and a colloquium for doctoral candidates.

In the area of networking and communication, strengthening the networks with our strategic partner institutions in Switzerland and in developing countries is one of the key tasks. The North-South Centre maintains a range of communication tools to address its internal and external stakeholders.

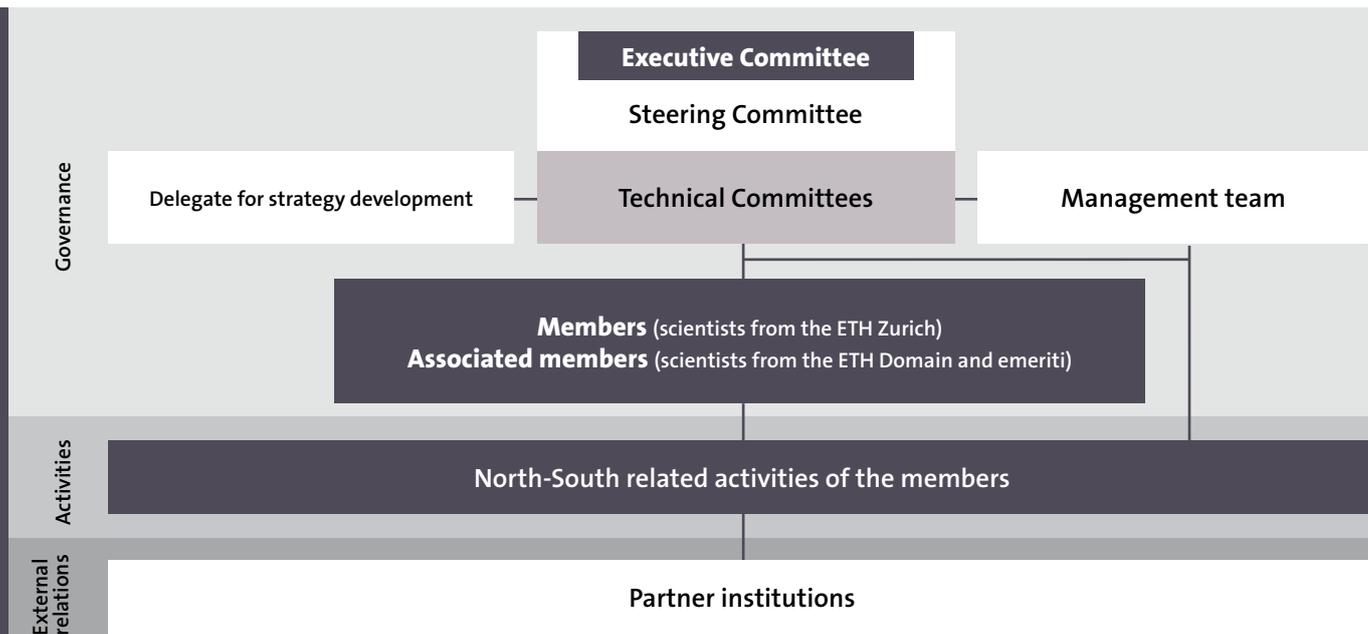
Membership and organisational structure

Department	Professors	Senior scientists and post-docs	Doctoral students	Total
Department of Agricultural and Food Sciences (D-AGRL)	11 (0)	8 (0)	6 (0)	25 (0)
Department of Architecture (D-ARCH)	3 (+2)	1 (0)	3 (+2)	7 (+4)
Department of Biology (D-BIOL)	1 (0)	2 (0)	1 (-1)	4 (-1)
Department of Civil, Environmental and Geomatic Engineering (D-BAUG)	5 (+1)	3 (0)	3 (0)	11 (+1)
Department of Computer Science (D-INFK)	1 (0)	1 (0)	0 (0)	2 (0)
Department of Earth Sciences (D-ERDW)	4 (0)	3 (+1)	0 (0)	7 (+1)
Department of Environmental Sciences (D-UWIS)	13 (0)	8 (+2)	8 (-2)	29 (0)
Department of Humanities, Social and Political Sciences (D-GESS)	4 (+1)	1 (+1)	2 (+1)	7 (+3)
Department of Information Technology and Electrical Engineering (D-ITET)	1 (0)	1 (0)	0 (0)	2 (0)
Department of Management, Technology and Economics (D-MTEC)	2 (+1)	1 (0)	1 (0)	4 (+1)
Associated members	10 (0)	5 (+1)	0 (0)	15 (+1)
Total	55 (+5)	34 (+5)	24 (0)	113 (+10)

Membership as of 31 December 2010; the numbers in brackets show the difference as compared to 31 December 2009

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Facts and figures



Organisational structure of the North-South Centre

Committees and management team

Executive Committee

Wolfgang Kinzelbach, D-BAUG (President)
Stefanie Engel, D-UWIS (Vice-President)
Michael Kreuzer, D-AGRL (Vice-President)

Steering Committee

Wolfgang Kinzelbach, D-BAUG (President)
Stefanie Engel, D-UWIS (Vice-President)
Michael Kreuzer, D-AGRL (Vice-President)
Marc Angéilil, D-ARCH (elected 2010, assuming office in 2011)
Jean-Pierre Burg, D-ERDW (as of September 2010)
Silvia Dorn, D-AGRL
Ines Egli, D-AGRL
Emmanuel Frossard, D-AGRL (until June 2010)
Jaboury Ghazoul, D-UWIS
Gerald Haug, D-ERDW (until September 2010)
Rolf Kappel, D-GESS
Renate Schubert, D-GESS
Rainer Schulin, D-UWIS
Barbara Becker, Managing Director (*ex officio*)

Technical Committees

Food security
Michael Kreuzer, D-AGRL (Chair)
Silvia Dorn, D-AGRL
Ines Egli, D-AGRL
Emmanuel Frossard, D-AGRL
Bernard Lehmann, D-AGRL

Natural resource management

Stefanie Engel, D-UWIS (Chair)
Nina Buchmann, D-AGRL
Jaboury Ghazoul, D-UWIS
Stefanie Hellweg, D-BAUG
Dani Or, D-UWIS

Urban and rural transformation

Marc Angéilil, D-ARCH (Chair)
Isabel Günther, D-GESS
Margrit Hugentobler, D-ARCH
Renate Schubert, D-GESS
Chris Zurbrügg, Eawag

Technology and infrastructure

Wolfgang Kinzelbach, D-BAUG (Chair)
Hans Jürgen Herrmann, D-BAUG
Hans Hinterberger, D-INFK
Thomas F. Rutherford, D-MTEC
Gerhard Tröster, D-ITET

Capacity development

Rainer Schulin, D-UWIS (Chair)
Jean-Pierre Burg, D-ERDW (as of September 2010)
Gerald Haug, D-ERDW (until September 2010)
Rolf Kappel, D-GESS
Michael Siegrist, D-AGRL
Jean-Pierre Sorg, D-UWIS

Delegate for strategy development

Olaf Kübler, former President of the ETH Zurich

Management team

Barbara Becker, Managing Director
Mathias Egloff, Programme Officer
Isabelle Gómez, Programme Officer (until February 2010)
Ursula Gugger Suter, Communication Manager
Patricia Heuberger-Meyer, Programme Officer (as of December 2010)
Manfred Kaufmann, Programme Officer (until December 2010)
Emma Lindberg, Programme Officer
Monika Lusser, Interim Communication Manager (as of December 2010)
Roger Merz, Programme Assistant
Dorota Niedzwiecka, Programme Assistant
Andreas Sicks, Programme Officer (as of November 2010)



The North-South Centre management team in December 2010 (from left to right): Patricia Heuberger-Meyer, Barbara Becker, Roger Merz, Dorota Niedzwiecka, Emma Lindberg, Mathias Egloff, Ursula Gugger Suter, Andreas Sicks, Monika Lusser

Financial statements

Administratively, the North-South Centre is a unit of the ETH Zurich funded partially by ETH credits and by third-party contracts, primarily from the public sector. All funds are allocated to predefined activities according to the objectives of the Centre and its specific contracts.

All accounts were audited externally and internally and were unconditionally approved.

Balance sheet

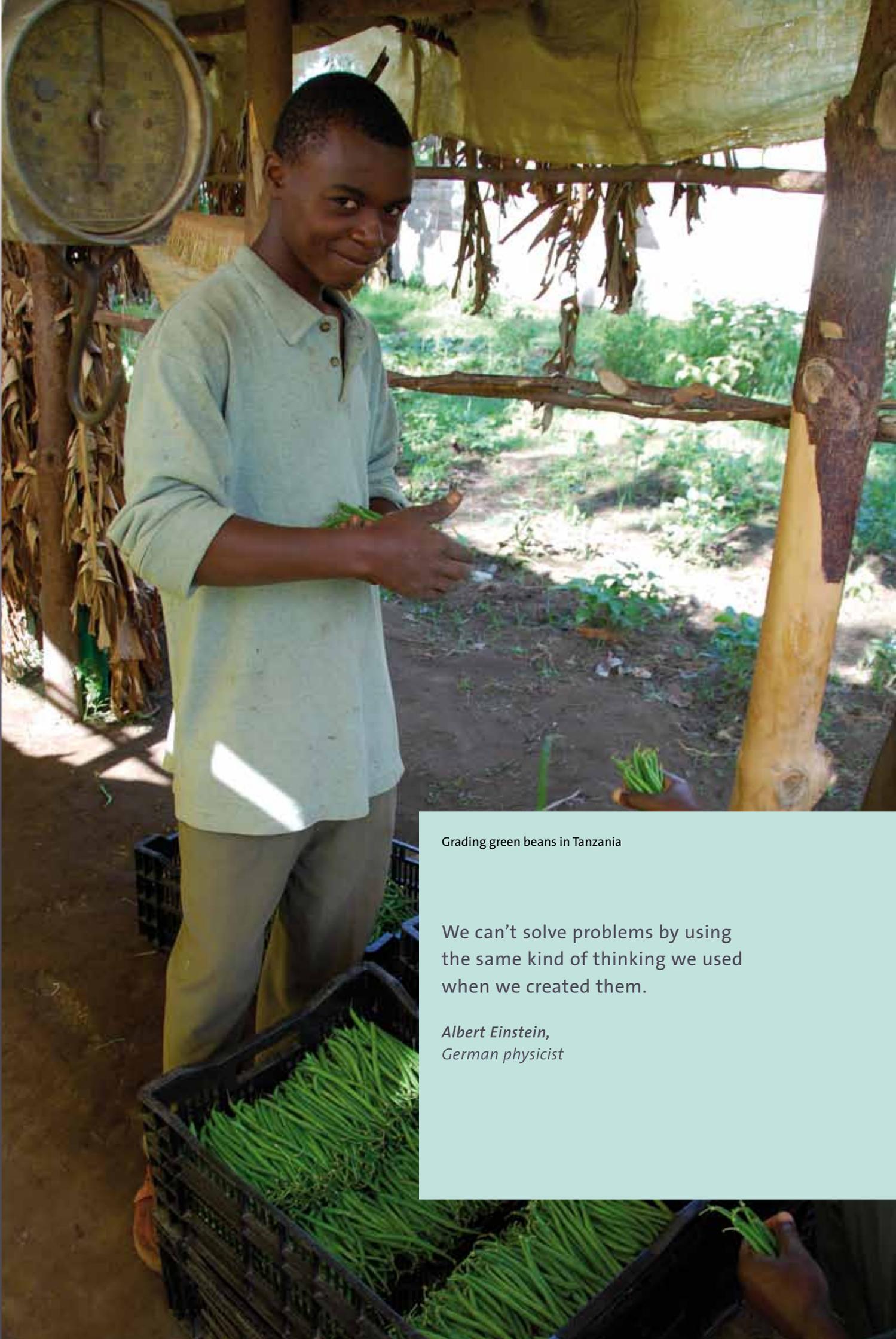
Assets	
Management	
Cash	300
Operating funds (ETH accounts)	535 484
Receivables, third parties	88 576
Subtotal assets, management	624 360
Programmes	
Operating funds (ETH accounts)	1 329 314
Receivables, third parties	21 355
Subtotal assets, programmes	1 350 669
Total assets	1 975 029
Liabilities	
Management	
Equity	655 279
Liabilities, third parties	2 800
Accruals (S-ENETH contribution 2011)	50 000
Over-expenditure	-83 719
Subtotal liabilities, management	624 360
Programmes	
Equity	1 471 594
Over-expenditure	-120 925
Subtotal liabilities, programmes	1 350 669
Total liabilities	1 975 029

Income statement

Expenditure	
Management	
Personnel *	421 389
Operations	32 117
Public relations	151 494
Subtotal expenditure, management	605 000
Programmes	
Seed money and grants (ETH contribution)	100 746
Livestock systems programme (SDC contribution)	506 165
RFPP fellowships (SDC contribution)	573 879
Sawiris scholarships	108 079
Bioenergy	1 083
Subtotal expenditure, programmes	1 289 952
Total expenditure	1 894 952

* Personnel expenses for the Managing Director are covered by the ETH Zurich through the D-UWIS directly.

Income	
Management	
Member contributions	40 300
Contribution S-ENETH 2010	50 000
SDC management contributions (livestock systems programme & RFPP)	205 714
Other income, third parties	225 268
Subtotal income, management	521 282
Programmes	
ETH contribution (seed money and grants)	50 000
SDC contribution (livestock systems programme, research projects)	600 000
SDC contribution (RFPP fellowships)	423 737
Sawiris scholarships	303 281
Bioenergy	32 033
Subtotal income, programmes	1 409 051
Transfer management and conferences	-240 025
Total income	1 690 308
Over-expenditure	-204 644



Grading green beans in Tanzania

We can't solve problems by using the same kind of thinking we used when we created them.

*Albert Einstein,
German physicist*

How to feed 9 billion people in 2050

Research collaboration on food security has always been a strong pillar of the North-South Centre. Securing sufficient, healthy and accessible food for all has been and remains one of the largest challenges to which science can contribute. Triggered by the food price crisis in 2008, the topic has gained new public attention. This is – amongst others – reflected in one of the future strategic priorities of the ETH Zurich.

Since the inception of the North-South Centre, we have always chosen a topic for the *Focus* chapter of the annual report which had some relation to an event or strategic debate in the course of that year. After focusing on ecosystem services (2007), integrated water resources management (2008) and research for development (2009), this annual report highlights the topic of food security. “World food system – A contribution from Europe” was the title of this year’s *Tropentag* conference, organised by the North-South Centre. In addition, many members of the North-South Centre contribute to research on food security. The overview of their North-South related research starts on page 26 with the chapter on food security and is an impressive list of 34 projects, covering a wide range of aspects along the entire food chain.

The *Focus* section of this annual report is composed of two contributions. The first article is an invited contribution by Papa Abdoulaye Seck, the Director General of the Africa Rice Center in Cotonou, Benin. Rice is the most important food commodity worldwide. Increasing the rice production in Africa is a particular challenge, because the continent is still largely dependent on rice imports, thus spending valuable foreign currency on this staple food. Therefore, producing sufficient rice for the growing population in Africa would not only contribute to food security, but also free resources for economic growth in other sectors. Papa Abdoulaye Seck concisely presents the facts and challenges within the agricultural sector as well as the conditions in other sectors of the society in order to nourish the world in 2050.

The second chapter in this section presents a debate on food security, which dominated the *Tropentag* conference in September 2010. While the participants had ample opportunity to attend more than one hundred presentations on all facets of the world food system, two keynote speeches stood out and triggered a lively debate among

the participants. Paul Collier provoked the audience with his statements on the benefits of genetically modified organisms (GMOs) and commercial agriculture, while Jack Heinemann held the opposite view. He shared his critical assessment of GMOs and advocated agricultural diversity for small-scale farmers.

In the course of 2010, the Executive Board of the ETH Zurich decided to give higher recognition and visibility to the World Food System by adding the topic to its portfolio of strategic initiatives and launching a new competence centre. The North-South Centre welcomes this initiative and is in continuous discussion on how to best join forces for contributing science-based solutions to the question on how to feed 9 billion people in 2050.



Vegetable market in Bamako, Mali

Drivers for global food security



Fish – vital for food and nutrition security of low-income households in sub-Saharan Africa – being sold at the Waterside Market in Monrovia, Liberia

staple food prices are inflicting serious damage to food security of the poorest households. Poverty still remains high in rural areas, where at least 70% of the world's very poor are living (IFAD, 2011).

Moreover, the rate of yield growth of the major cereal crops has been steadily decreasing. It dropped from 3.2% per year in 1960 to 1.5% in 2000 (FAO, 2011). While environmental degradation is intensifying in several parts of the world, the potential for an increased use of agriculturally critical natural resources such as land and water is declining. Climate change is adding to the severity and uncertainty of weather events, while aggravating farmers' exposure to catastrophic welfare losses.

However, such concerns over global food security are not new. In the 18th century, Thomas Malthus postulated that human population growth was not sustainable because the world population was growing at an exponential rate, while food production was increasing at an arithmetical rate. The imbalance between population growth and food capacity was supposed to trigger major famines. Yet, the food crisis projected by Malthus never really materialised, primarily due to improvements in agricultural technologies. Just like technology-induced productivity growth helped obviate a Malthusian famine in the past, progress in science and technology could further expand the world's agricultural frontier. Thus, sufficient food could be produced to nourish the growing population in the future.

We believe that SSA will play a significant role in global food security of the coming decades. Unlike Asia and Europe, where the availability of potential land and water for agriculture is declining, Africa still possesses a large reservoir of underutilised agricultural land and water resources. The total land area in Africa potentially suitable for crops is estimated at 874 million hectares (ha). Today, only 150 million ha are harvested yearly (Henao and Baanante, 2006). Regarding water, Africa currently uses about 4% of its resources (UNEP, 1999). Moreover, Africa's annual renewable water resources amount to about 5'400 billion m³ per year. In the rice sector, it is now well established that irrigated rice production in SSA is a viable investment with adequate economic returns (World Bank, 2007).

Moreover, several staple food crops are produced at competitive costs in SSA. This production is profitable in its

Current projections show a continued increase of world population from about 6.8 billion people in 2010 to 9.1 billion by 2050. Developing countries will account for much of this expected increase, with sub-Saharan Africa (SSA) leading the way, as its population is assumed to double from 770 million inhabitants in 2005 to 1.5 billion by 2050. This represents both a significant demand-side pressure and a powerful driving force to transform the contribution of agriculture to the economic growth of SSA. According to FAO, the global food production must increase by 70% in order to feed the world population, while in developing countries, food production must double.

With the historical records of inadequate performance of agriculture in several developing countries, particularly in SSA, concerns over how the world will ensure food security for its growing population are justified. The challenges of nourishing the world have never been as demanding as now, mainly in the face of soaring food prices and climate change. Recurrent episodes of sharp increases in

domestic markets, but not competitive in the world market due to high logistical expenses (Seck *et al.*, 2010; World Bank, 2009). Yet, the recent upward trends in the agricultural commodity prices reinforce the competitiveness of agricultural production in SSA. Economic incentives for investing in agriculture are provided, particularly in the development and dissemination of new technologies, cropping practices, skills and physical infrastructure.

In order to be able to feed 9.1 billion people in 2050, agriculture in developing countries requires the net investment of about USD 83 billion per year (FAO, 2009). In the past two decades, agriculture was neglected both by developing countries and by donors. In 1981, official development aid rendered to agriculture in Africa amounted to almost USD 1.921 million against USD 1.687 million in 1991 and USD 997 million in 2001 (World Bank, 2007). The OECD estimates that official development assistance devoted to agriculture fell by 43% between the mid-1980s and 2008.

In SSA, agriculture remains a powerful engine for economic growth, food security and poverty reduction. Investment in agricultural growth stimulates economic growth through the high multiplier effects of agriculture. Each dollar of additional farm income leads to an increase in revenue in the overall economy, e.g. USD 1.88 in Burkina Faso, USD 1.48 in Zambia and USD 1.24–1.48 in Senegal (Delgado *et al.*, 1998). The agricultural sector in SSA accounts for 35% of GDP, 75% of employment and 40% of exports. Despite agriculture being the principal economic activity and source of livelihood, SSA governments have failed to prioritise the sector and reverse decades of policy bias against agricultural production.

Yet, African countries adopted in 2003 the Comprehensive Africa Agriculture Development Programme (CAADP) in Maputo, Mozambique, in order to reverse low public investment in agriculture. The main goal of CAADP was the achievement of 6% annual agricultural growth. At the beginning of their economic take-off in 1980, emerging Asian countries were spending nearly 10% of their public expenditure on agriculture. Noting that, African governments pledged to increase agricultural spending to at least 10% of the total governmental budgetary resources by 2008. This pledge is known as the Maputo Resolution. But, according to Fan *et al.* (2009), only eight countries – Burkina Faso, Ethiopia, Mali, Malawi, Ghana, Niger, Senegal and Zimbabwe – have reached the 10% budgetary allocation to agriculture. For the continent as a whole, the



Papa Abdoulaye Seck

Papa Abdoulaye Seck is a specialist in agricultural policy analysis and strategy. He is a permanent member of the Academy of Science and Technology of Senegal and has the rank of Director of Research. Currently, he is the Director General of the Africa Rice Center (AfricaRice), which belongs to the Consultative Group on International Agricultural Research (CGIAR). In addition, Papa Abdoulaye Seck is on the advisory board of several research bodies, including the Strategic Orientation Council of Agreenium, France, the Executive Committee of the Global Forum on Agricultural Research (GFAR) and the Executive Committee of the Gender & Diversity Program AWARD.

Before taking up his position at AfricaRice, Papa Abdoulaye Seck was the Director General of the Senegalese Institute of Agricultural Research (ISRA) as well as the Technical Advisor to the Prime Minister of Senegal and elected Chair of the Forum for Agricultural Research in Africa (FARA). In 1989, he earned his doctoral degree in agricultural economic analysis and policy from the University of Dijon, France. His areas of specialisation cover research on agricultural product supply to cities, modelling of technical and economic information systems and agricultural research management.

Papa Abdoulaye Seck has received the title of Chevalier in the Order of Agricultural Merit of France as well as the title of Chevalier in the National Order of Lion and Officer in the Order of Merit of Senegal. Furthermore, he holds a Certificate of Recognition from FARA.

average share of agricultural spending in total government spending has ranged from 4–6%. Without consistently investing in its own domestic resources in agriculture, SSA will not fully seize the unprecedented opportunity for transforming that strategic sector.

To nourish global population in 2050, investments in agricultural research and extension need to be substantially increased, particularly in SSA, where agricultural productivity generally lags behind the rest of the world. Paddy yield in Asia has almost doubled from 2.06 t/ha in the 1960s to 4.06 t/ha in the 2000s. In SSA, its increase from 1.81 t/ha to 2.31 t/ha over the same period was quite modest. To improve agricultural productivity, it is crucial to invest more in agricultural research capacities. Generally, investments in international and national agricultural research and development programmes often generate high payoffs. In SSA, the internal rate of return on agricultural research is above 20%.

Given the context specificity of agriculture, technology transfer has limited effectiveness. In the 1960s, it was assumed that there was a stock of proven agricultural technologies available in Asian countries, which – after being imported into Africa – would be adapted to African conditions. Unfortunately, this strategy failed. Many of the imported varieties failed to outperform local species. Of more than 2000 varieties of mangrove rice imported from Asia for testing in the African environment, only two had a performance comparable to the best local species (Matlon and Spencer, 1984). Mostly, the varieties imported from other regions into SSA were not only less resistant to biotic and abiotic stresses, but also more dependent on fertilisers and labour.

The failure of direct technology transfer underscores the vital need for developing endogenous research capacities in SSA. Despite its high potential payoff, agricultural research and development in SSA has suffered from decades of inadequate investments, particularly in the 1980s and 1990s, when most SSA countries were compelled to reduce budgetary allocation to agriculture through structural adjustment policies. However, a recent report indicates a reversal of the trend of public spending on agricultural research and development by stating an increased spending of 20% between 2001 and 2008 (Beintema and Stads, 2011). Furthermore, the report indicates that on average, SSA invested USD 0.61 for every USD 100 of agricultural output when the total public agricultural research and development spending is measured

as a percentage of agricultural GDP. This was below the national research and development investment target of at least 1% of GDP, as defined by the New Partnership for Africa's Development (NEPAD). Only 8 out of 31 Agricultural Science and Technology Indicators (ASTI) countries for which data are available have met this 1% target. Burundi, Kenya, Mauritania, Namibia, South Africa and Uganda recorded ratios between 1.2% and 2.0% in 2008, whereas Mauritius and Botswana recorded particularly high ratios of 3.9% and 5.2%, respectively (Beintema and Stads, 2011).

Agricultural extension and advisory service is another key area of investment in order to stimulate agricultural productivity in SSA for greater dissemination of new information and knowledge. Integrated crop management (ICM), a gradual approach for integrating new technological options into production systems with full farmer participation, offers important potential for increasing productivity. Because of the large gaps between actual farmers' yields and attainable yields under better management, ICM has particular promise in SSA. Using existing technologies, strong agricultural extension systems will play a key role in bridging the yield gap for major staple crops in SSA. In Mali, ICM technological options contributed to increased average yield in the irrigated ecology from 2 t/ha to 6 t/ha (Defoer *et al.*, 2004). Given this convincing result, the research and agricultural extension systems need to be strengthened to disseminate ICM options to a larger number of farmers.

The prospect for increasing the yield of roots, tubers and cereal staple crops by closing the exploitable yield gap is also tremendous. With improved crop establishment, average yields of cassava more than doubled from 8.6 t/ha to 20.8 t/ha under farmer management (Fermont *et al.*, 2009). Application of inorganic fertiliser can increase mean maize yields from 1.4 t/ha to 3.9 t/ha (Sileshi *et al.*, 2010). In the strategic rice sector in SSA, the attainable yield in the irrigated ecology is 7–9 t/ha, in the lowland ecology 3–6 t/ha, and in the unfavourable upland ecology 4 t/ha, against 3–6 t/ha, 1–3 t/ha and 1 t/ha in farmers' fields, respectively.

Closing the yield gap for the main staple food crops in SSA constitutes a critical lever for increasing agricultural productivity while meeting the regional and global food security challenge. A recent simulation performed by AfricaRice illustrates this point well. By bridging the attainable yield gap in the three main rice ecologies and doubling

the areas under irrigated and lowland rice production, SSA can meet its consumption requirements in rice and even produce a surplus of 5 million tons for export.

However, even when proven agricultural technologies exist, the dissemination and adoption by farmers are hampered by limited effective demand, restricted access to information and credit as well as confined institutional and infrastructural development. Despite the availability of improved seed technologies developed by agricultural research organisations in Africa, their widespread adoption by farmers' remains limited. Greater involvement of public authorities is necessary in order to overcome market failures affecting the national seed system.

On average, the amount of fertiliser applied in SSA is estimated at only 9 kg/ha in 2002, against a global average amount of 101 kg/ha. This result clearly indicates the enormous potential in terms of increased productivity which African agriculture has through better access to fertilisers.

However, only if investments are made in infrastructure development in developing countries, investments in agriculture and agricultural research will generate an adequate impact on nourishing the world in the future. Core infrastructure such as electricity, storage, cold chain, road networks and rural roads are vital for agricultural transformation in SSA. For instance, the development of road infrastructure helps reduce the transportation costs and improves access to the market.

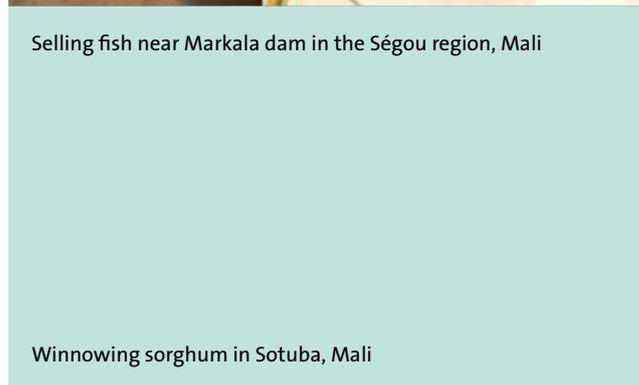
Yet, producing enough food at the aggregate level will not necessarily translate into adequate food security and equitable access to food by all. The strategy of improving agricultural productivity should be a constitutive part of a pro-poor growth strategy that sustains the generation of sufficient off-farm employment opportunities.

To nourish the world in 2050, we believe that an intelligent combination of four factors is essential: appropriate technologies, a good infrastructure, a favourable economic and institutional environment, and the preservation of natural resources. Only then can science be certain of creating the maximum impact on the resource-poor producers and the burgeoning urban populations of the world in 2050.

*Papa Abdoulaye Seck,
Director General of the Africa Rice Center, Benin*



Selling fish near Markala dam in the Ségou region, Mali



Winnowing sorghum in Sotuba, Mali





Women selling local rice at the Mopti market in Mali

Farmers in Paynesville, Liberia, harvesting the lowland NERICA rice, developed by AfricaRice scientist Moussa Sie



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World food system – A contribution from Europe

The *Tropentag* is an annual development-oriented and interdisciplinary conference organised by German universities since 1997. It addresses issues on tropical and sub-tropical agriculture and natural resource management, forestry, fisheries, food, nutrition and related sciences in the context of rural development, sustainable resource use and poverty alleviation worldwide. In 2010, it was hosted by the North-South Centre under the title “World food system – A contribution from Europe”. Some 800 participants from about 80 countries attended the event.

The programme consisted of five keynote addresses in an opening and closing plenary session, 126 presentations in 24 parallel thematic sessions, and a poster exhibition with more than 400 posters selected from 1180 abstracts. The majority of the individual contributions were submitted by young scientists, two-thirds thereof from developing countries. To increase the outreach of the event, a team of twelve international student reporters from nine different universities of eight countries contributed to a multi-author blog with text and visual content. In this blog, the student reporters summarised the keynote discussions and reported on recent trends, hot topics and emerging issues. All keynote addresses are available as video stream on the website www.multimedia.ethz.ch/conferences/2010/tropentag, while the abstracts of all the presentations and posters as well as the blog can be accessed on www.tropentag.de.

Highlights of the programme were the two contrasting keynote addresses of Paul Collier in the opening session and Jack Heinemann in the closing session. From opposite viewpoints, both speakers succeeded in challenging the audience with their scientific, yet passionate presentations. They triggered lively interactions among the participants. The following paragraphs shall reflect this debate and provide the reader with a flavour of the *Tropentag* discussion.

How to feed the bottom billion?

Paul Collier is Professor of Economics and Director of the Centre for the Study of African Economies (CSAE) at the University of Oxford. He is the author of “The bottom billion. Why the poorest countries are failing and what can be done about it”. Speaking on “How to feed the bottom billion?”, Paul Collier challenged the audience with some provocative hypotheses. He started by alerting the participants to the astounding fact that mass hunger still prevails. Since the scientific as well as the economic solutions for ending



In semi-arid areas of Africa, sorghum is dehulled and then pounded into flour, using a mortar and pestle

Across West Africa, women and girls often sell foodstuff at the local markets





Girls crossing the Niger River in Bamako, Mali, on their way to sell bananas

In Benin as well as throughout Africa, rice is quickly becoming a popular staple food for rich and poor people alike



hunger in the world are well-known, this seems like a spectacular failure of implementing this knowledge.

Paul Collier sees the reason for rising food prices in the growing food demand of Asia. Therefore, solutions have to come from increasing world food supply in order to keep pace with the growing demand. Yet, this is a challenge for the agriculture in Europe, the United States and Australia, much less for Africa. However, instead of trying to mitigate this precarious situation, several industrialised countries even aggravate the food price crisis by avoidable distorting policies: First, the incentives for biofuel production in the United States can be seen as “burning food”, due to which the poor are suffering. Secondly, Europe’s ban of genetically modified organisms (GMOs) since 1996 has worsened hunger in Africa. Thirdly, the export bans in 34 countries in response to the world food crisis pushed food prices even higher and discouraged producers to invest in food production. Finally, “mega land grabs” such as South Korea’s attempt to buy a huge chunk of Madagascar threaten to preempt world food supply.

Poor people are highly vulnerable to rising food prices, since they spend about 50% of their budget on food. They have no means to buffer against food price shocks, since their incomes as well as their food production are too low and volatile. This already precarious situation is now further exacerbated by climate change. Although climate change is predominantly caused by rich, industrialised countries, it is the poor that suffer most from the deterioration of their environments. What is worse, climate change increases their vulnerability for the next fifty years, since the damage caused by rising atmospheric CO₂ concentration is already done. Therefore, mitigation seems nearly irrelevant for Africa. Instead, Africa should focus on adaptation in order to prevent losing its comparative advantage in agriculture.

Based on these facts, Paul Collier suggested an adaptation agenda for Africa with a couple of uncomfortable options both within the agricultural sector and within the economy at large. For the agricultural sector, he suggested two policies, explicitly taking the audience into a “discomfort zone”: First, he recommended the adoption of GMOs. In his opinion, adaptation to climate change must use all available technological options. Claiming that GMOs have not yet caused any deaths, he criticised their ban in Europe which resulted in the equivalent ban in Africa, worsening hunger there.

His second recommendation for the agricultural sector was “big is beautiful”. Africa should be more permissive of commercial agriculture, taking advantage of economies of scale with respect to logistics, input and finance services, and exploiting the greater potential for use of technologies and innovation. In addition, Paul Collier proposed introducing insurance against shocks. Although Africa is highly shock-prone, it is the least insured continent.

Beyond the commercialisation of agriculture, Paul Collier took adaptation to a higher stage, up to the economy at large. While climate change directly affects agriculture, it hits the industrial or the services sector much less. Therefore, Africa should shift out of agriculture more rapidly and focus instead on industrialisation.

Paul Collier closed his lively and provocative keynote speech by appealing to the audience: “It is our responsibility to scientifically inform the public, since this is the only defense against the lack of food supply”.

Agriculture at a crossroads

Jack Heinemann, Professor for Genetics and Gene Ecology at the University of Canterbury in New Zealand and author of the book “Hope not hype: The future of agriculture”, presented his perception of the world food system under the title “Agriculture at a crossroads – Beyond IAASTD”. He commented that the *Tropentag* gives a legacy to the milestone report “International Assessment of Agricultural Knowledge, Science and Technology for Development” (IAASTD), published in 2008 and approved by 58 countries in the final intergovernmental panel.

Jack Heinemann largely challenged the positions presented by Paul Collier. He argued that in order to meet development and sustainability goals (e.g. the Millennium Development Goals), the problem is not just yield, and the solution is not just tinkering with markets and technology. Instead, the multifunctionality of agriculture and the concept of food sovereignty will provide sustainable solutions. In his view, business as usual with poor resource stewardship in both rich and poor countries is not an option. Neither is research as usual. Jack Heinemann recommended six strategies for future agriculture. As most promising pathways besides eliminating market distorting subsidies, he suggested promoting agricultural diversity and developing technologies for sustainable high output farming.

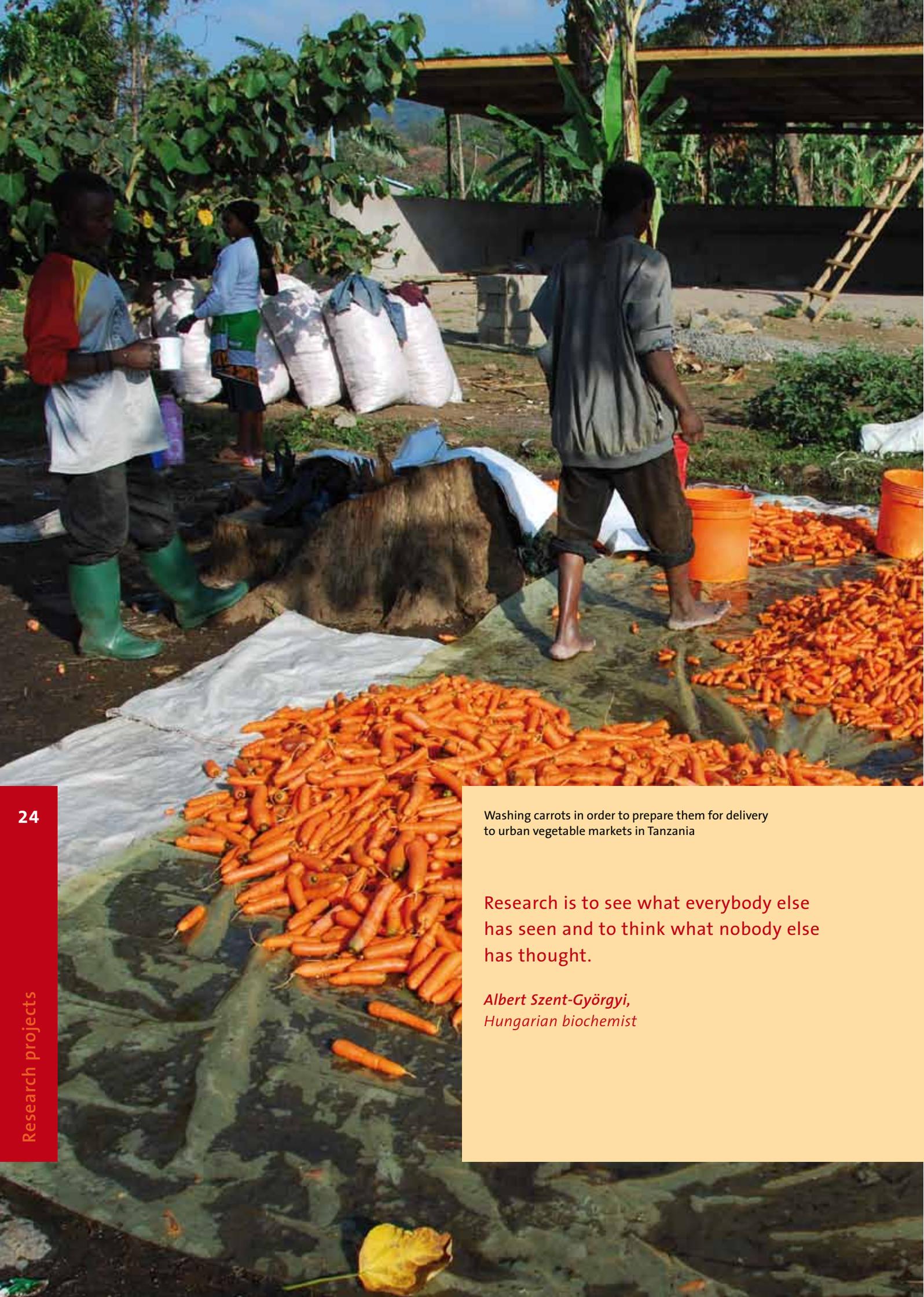
Jack Heinemann stated that technology has its place, but it has to be the right technology and must be delivered in the right manner. In order to support industrial agriculture, biotechnology will be needed in some parts of the world, but should be phased out. In most places, GMOs will not be the appropriate biotechnology, and surely nowhere in the long run. GMOs have not yet delivered sustainable solutions for agriculture, neither in rich nor in poor countries. So far, there is no evidence that genetic engineering has produced crops needed by the majority of the world’s farmers: neither with respect to sustained or reliable increase in yield from GM crops and regarding a sustainable reduction in pesticide use, nor with respect to a sustained reduction in costs and a sustained and reliable increase in profits for such farmers. In particular, genetic engineering may not be the best way to manipulate important and complex adaptive traits in plants or animals. In contrast, traditional breeding technologies have been immensely successful and are indeed largely responsible for the high yields associated with contemporary agriculture. Successful examples are abiotic stress tolerance or increased micro-nutrient content.

Current business models for research and development and farmer uptake do not manage to solve the problems of the poor. Technological innovation and improvements in technologies that support agro-ecological methods should be the priority. These technologies must be customised as necessary to agro-ecosystems and societies, where they should be adopted.

World food system – A contribution from Europe

The summaries of the presentations delivered by Paul Collier and Jack Heinemann indicate that the GMO controversy is an example of a European debate with implications on the world food system. Furthermore, their references to global policies, the concept of multifunctionality originating in the Swiss agricultural policy, or the role of informed citizens show the responsibility of the ETH Zurich and other European universities to contribute to food security worldwide. Confronting the participants with their potential role in this huge task of securing food for all was the aim of the *Tropentag*.

*Barbara Becker,
Managing Director of the North-South Centre*



Washing carrots in order to prepare them for delivery to urban vegetable markets in Tanzania

Research is to see what everybody else has seen and to think what nobody else has thought.

*Albert Szent-Györgyi,
Hungarian biochemist*

Research projects related to developing countries

More than 10% of all professors at the ETH Zurich pursue activities in or related to developing countries. The majority of them are members of the North-South Centre. A particularly great wealth of research is dedicated to food security and natural resource management. Many development-related research projects cut across disciplines and integrate colleagues from various institutes and departments.

This chapter is a response to one of the recommendations of the external evaluation of the North-South Centre in April 2010. Instead of distinguishing the North-South Centre managed activities, the reviewers suggested emphasising the full research portfolio of the ETH Zurich related to developing countries. Assuming that the North-South related projects conducted by the members of the North-South Centre are a faithful reflection of the development-related research of the ETH Zurich, the lists on the following pages give account of the breadth and depth of this portfolio.

In congruence with the strategy of the North-South Centre, the individual projects are grouped according to the four thematic research areas food security (FS), natural resource management (NRM), urban and rural transformation (URT) and technology and infrastructure (TI), complemented by some projects in the area of policy. Approximately half of the members of the North-South

Centre belong to the departments of agricultural and food sciences or environmental sciences. Therefore, the majority of the projects belong to the research areas food security and natural resource management. The topic of urban and rural transformation is being built up gradually, while so far there are few activities in the area of technology and infrastructure.

While the five presented topics permit the assessment of the wealth of research in each particular field, they do not adequately reveal the interdisciplinary nature of most of the projects, nor the somewhat blurred delineations between the different research areas. For this reason, all projects holding a strong correlation with a neighbouring research area are marked in the list with a vertical bar and the respective acronym FS, NRM, URT, TI or Policy. In addition, the projects that are part of a North-South Centre managed programme have a reference to their detailed description on the respective page.



Geographic distribution of research projects conducted by members of the North-South Centre in 2010

Food security

Food security results from the interactions of four components: (i) food availability including sustainable production and processing, (ii) physical and monetary access to food, (iii) food use including quality and safety as well as the effect on human health and well-being, and (iv) environmental, economic and political stability.

The food price crisis in 2008 brought food security back on the political agenda. Research on food security will have to contribute to solving global challenges such as feeding one billion malnourished people in the world.

Increased population growth, urbanisation and higher incomes (changing the consumption pattern towards more animal source foods) additionally accelerate the need to multiply global agricultural production. Furthermore, new demands and potentially conflicting interests for bioenergy or industrial purposes of crops will put growing pressure on already scarce resources like water, soil, biodiversity, fossil energy and raw materials. Today, food security cannot be achieved without sustainable management of water, soil, biodiversity and the atmosphere. Climate change will increase uncertainty of food production and pose new threats to human health. In most regions, fewer people will be living in rural areas and even fewer will be farmers. They will need new technologies in order to grow more from less land, with fewer labour resources.

The North-South Centre has always had a strong focus on food security, both at the level of its individual members and at the level of its programme management. The programme on “Livestock research in support of poor people” has laid a solid foundation on which future activities can build. For example, a strong element in this programme has been the interdisciplinary collaboration among ETH scientists, in particular between groups of food and nutrition, agriculture, and environmental sciences. Content-wise, it has not only addressed livestock-related topics, but has reflected more and more on the impact pathways of the results. Therefore, the North-South Centre will continue to address food security in an interdisciplinary approach. Areas of expertise cover soil use and management, crops and fodder plants, livestock, water, land use, adaptation to climate change, agricultural value chains, food security, human nutrition and health, and many more.

In 2010, the ETH School Board decided to strengthen research on food security by creating a competence centre for the World Food System. The North-South Centre is actively engaged in defining the interface and future synergies between the two centres.

Is there a bigger challenge than securing food supply in the future? The ETH Zurich strengthens its activities by implementing the World Food System strategy.

Michael Kreuzer, Chair, Technical Committee on food security, North-South Centre



Traditional wholesale market in Morogoro, Tanzania

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Agricultural and Food Sciences (D-AGRL)				
Agri-food & Agri-environmental Economics				
Bernard Lehmann, Peter Stamp, Armin Grün <i>see page 45</i>	Martijn Sonneveld, <i>cand. doc</i> ; Chaminda Egodawatte, <i>cand. doc</i> ; Henri Eisenbeiss, <i>post-doc</i>	Reversing soil degradation by tropical legume trees using GIS analysis <i>10/06–12/10</i>	R. Sangakkara and C. Bogahawatte, Peradeniya University, Sri Lanka; K.R.M.U. Bandara and L. Samarakoon, AIT Bangkok, Thailand	Sri Lanka
Bernard Lehmann <i>see page 56</i>	Marc Zoss, <i>cand. doc</i>	Governance, collective action and development interventions in vegetable value chains in Tanzania <i>08/08–08/11</i>	S. Révillon, Agridea, Switzerland; A. Tenkouano, AVRDC, Tanzania; A. Temu, SUA, Tanzania	Tanzania
Bernard Lehmann <i>see page 63</i>	Hermann Comoé, <i>cand. doc</i>	Contribution to food security by improving farmers' responses to climate change in northern and central areas of Côte d'Ivoire <i>10/09–10/12</i>	B. Bonfoh and D. Dao, CSRS, Côte d'Ivoire; M. Tanner, Swiss TPH, Switzerland; A. Tikir and M. Dumondel, ETH Zurich, Switzerland	Côte d'Ivoire
Bernard Lehmann	Janine Rüst, <i>MSc stud.</i>	Socio-economic analysis of tomato production, supply for local food processing in Tanzania <i>09/10–06/11</i>	M. Zoss, ETH Zurich, Switzerland	Tanzania
Agronomy and Plant Breeding				
Peter Stamp, Rainer Messmer	Quanjai Rupitak, <i>cand. doc</i>	The temporal dynamics of kernel set in tropical sweet maize (<i>Zea mays</i> L.) determined by visual markers <i>03/07–05/10</i>	S. Jampatong, Kasetsart University, Thailand	Thailand
Peter Stamp, Rainer Messmer	Chi Dang, <i>cand. doc</i>	Improvement of protein quality in waxy maize (<i>Zea mays</i> L.) by doubled haploid and marker assisted selection techniques <i>10/07–06/10</i>	Huy Ham Le, Institute of Agricultural Genetics, Vietnam	Vietnam

NRM



Fieldworkers at the Suwan Farm in Thailand



Working on bacteria isolated from camel milk products at Analabs in Nairobi, Kenya

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Animal Nutrition				
Michael Kreuzer <i>see page 47</i>	Souheila Abbeddou, <i>cand. doc</i>	Improving small ruminant productivity in dry areas through cost-efficient animal nutrition and improved quality of milk and dairy products <i>10/06–12/10</i>	B. Rischkowsky, L. Iñiguez and M.E. Hilali, ICARDA, Syria; H.D. Hess, ALP, Switzerland; A. Oberson and B. Lehmann, ETH Zurich, Switzerland	Syria
Michael Kreuzer	Céline Clément, <i>cand. doc</i>	Development of a fertility enhancing supplement for breeding bulls based on the Andean plant species Maca (<i>Lepidium meyenii</i> Walp.) <i>12/07–11/10</i>	I. Manrique and T. Bernet, CIP, Peru; D.D. Ponce Aguirre, National University Daniel Alcides Carrion, Peru; I.A. Khan and B. Avula, University of Mississippi, USA; U. Witschi, Swissgenetics, Switzerland	Peru
Svenja Marquardt, Michael Kreuzer	Janina Meier, <i>cand. doc</i>	Testing the concept of diversity in feeding in the tropics and subtropics: Effect of experience, adaptation and choice on feed selection, intake and foraging behaviour of sheep <i>09/09–08/12</i>	B. Rischkowsky and M. Louhaichi, ICARDA, Syria; A. Abdalla, CENA, Brazil; V. Rodrigues Vasconcelos, Universidade do Piauí, Brazil	Syria, Brazil, Switzerland
Food Biotechnology				
Leo Meile, Christophe Lacroix, Zakaria Farah <i>see page 48</i>	Christoph Jans, <i>cand. doc</i> ; Patrick M.K. Njage, <i>cand. doc</i> ; Martina Haug, <i>post-doc</i> ; Joséphine Bugnard, <i>MSc stud.</i> ; Stefania Dolci, <i>MSc stud.</i> ; Andrea Gerber, <i>MSc stud.</i> ; Anna Condrau, <i>MSc stud.</i> ; Dasel Mulwa, <i>MSc</i> , KARI, Kenya	Camel milk products of high hygienic quality and safety, increasing the income and reducing health risks in Kenya <i>06/07–12/10</i>	J. Wangoh, University of Nairobi, Kenya; M. Younan, KARI, Kenya; J. Zinsstag, Swiss TPH, Switzerland	Switzerland, Kenya
Leo Meile	Christoph Jans, <i>cand. doc</i> ; Patrick M.K. Njage, <i>cand. doc</i> ; Martina Haug, <i>post-doc</i> ; Marc Stevens, <i>post-doc</i> ; Dasel Mulwa, <i>MSc</i> , KARI, Kenya	Pathogenic streptococci in East African milk products: Prevalence, diversity and health hazards for children <i>09/10–07/11</i>	M. Younan, KARI, Kenya; B. Bonfoh, CSRS, Côte d'Ivoire	Kenya, Côte d'Ivoire
Human Nutrition				
Richard Hurrell	Maria Andersson, <i>cand. doc</i>	Impact evaluation of food fortification with iron in school children and women of reproductive age <i>01/07–06/10</i>	St. John's Research Institute, Bangalore, India	India
Richard Hurrell	Barbara Troesch, <i>cand. doc</i>	Correcting iron deficiency with a low iron micronutrient powder – A promising approach for malarial areas and beyond <i>10/07–12/10</i>	United Nations World Food Programme, Italy; Medical Research Council, South Africa; North-West University, South Africa	South Africa
Richard Hurrell, Rita Wegmüller	Siwaporn Pinkaew, <i>cand. doc</i>	Triple fortification of rice with iron, zinc and vitamin A <i>01/08–01/12</i>	Mahidol University, Thailand	Thailand
Richard Hurrell, Ines Egli, Rita Wegmüller	Colin Cercamondi, <i>cand. doc</i> ; Marica Brnic, <i>cand. doc</i>	Novel staple food-based strategies to improve micronutrient status for better health and development in sub-Saharan Africa <i>2008–2013</i>	Université d'Abomey-Calavi, Benin; Institut de Recherche en Sciences Appliquées et Technologies, Burkina Faso; Valid Nutrition Nairobi, Kenya	Benin, Burkina Faso, Kenya

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Richard Hurrell, Rita Wegmüller	Dominik Glinz, <i>cand. doc</i>	Aetiology, prevention and control of anaemia in sub-Saharan Africa 07/09–06/12	Université de Cocody-Abidjan, Côte d'Ivoire; CSRS, Côte d'Ivoire	Côte d'Ivoire
Richard Hurrell, Ines Egli	Maren Fischer, <i>cand. doc</i>	Improving iron and zinc nutrition in Ethiopian children consuming injera based diets 11/09–10/12	Addis Ababa University, Ethiopia	Ethiopia
Richard Hurrell, Ines Egli	Nico Petry, <i>cand. doc</i>	Testing the efficacy of biofortified beans to improve iron status in Rwandan women 2009–2011	HarvestPlus	Rwanda
Richard Hurrell, Ines Egli		Malaria and the safety of iron interventions 2009–2013	G. Brittenham, Colombia University, USA; Mahidol University, Thailand	Switzerland, Thailand
Plant Nutrition				
Emmanuel Frossard; Sévérin Ake, University of Cocody, Côte d'Ivoire	Kouassi Valery Kouamé Hgaza, <i>cand. doc</i>	Understanding yam (<i>Dioscorea</i> spp.) response to fertilizer application 12/05–12/10	T. Bi Tra, Ecole Supérieure d'Agronomie, Côte d'Ivoire; L. Diby, CSRS, Côte d'Ivoire; G. Nziguheba, IITA, Nigeria	Côte d'Ivoire, Nigeria
Emmanuel Frossard, Astrid Oberson <i>see page 46</i>	Sabine Douxchamps, <i>cand. doc</i>	Realizing the benefits of cover crop legumes in smallholder crop-livestock systems of the hillsides of Central America 01/07–03/11	M. Kreuzer, ETH Zurich, Switzerland; I.M. Rao, A. Schmidt and R. van der Hoek, CIAT, Nicaragua; M. Mena and A. Benavidez, INTA, Nicaragua; C. Binder, University of Graz, Austria	Colombia, Nicaragua
Biology (D-BIOL)				
Plant Biotechnology				
Wilhelm Gruissem, Hervé Vanderschuren	Isabel Moreno, <i>cand. doc</i> ; Evans Nyaboga, <i>cand. doc</i> , University of Nairobi, Kenya; Huahong Wang, <i>post-doc</i>	BiocassavaPlus 07/05–07/11	IITA, Nigeria; CIAT, Colombia; University of Bath, UK; Donald Danforth Plant Science Center, USA	Nigeria, Uganda, Kenya, Tanzania
Wilhelm Gruissem, Hervé Vanderschuren; Morag Ferguson, IITA, Kenya <i>see page 60</i>	Charles Orek, <i>cand. doc</i>	Characterisation of drought tolerance in cassava (<i>Manihot esculenta</i> Crantz) 07/09–07/12	J. Kamau, KARI, Kenya	Kenya
Wilhelm Gruissem, Hervé Vanderschuren <i>see page 64</i>	Ravi Bodampalli Anjanappa, <i>cand. doc</i>	Reducing the impact of cassava brown streak disease 04/10–04/13	M.M.N. Gowda, University of Greenwich, UK; E. Kanju, IITA, Tanzania	UK, Tanzania
Hervé Vanderschuren		Knowledge and technology transfer partnership: Cassava transformation platform establishment 06/10–06/12	Mikocheni Agricultural Research Institute, Tanzania; University of Bath, UK	Tanzania
Wilhelm Gruissem, Hervé Vanderschuren	Emily McCallum, <i>post-doc</i>	Molecular and genomic strategies to engineer durable and sustainable disease resistance to bacterial blight of cassava 06/10–06/13	B. Staskawicz, UC Berkeley, USA; A. Bernal, Universidad de Los Andes, Colombia	Colombia

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Civil, Environmental and Geomatic Engineering (D-BAUG)				
Ecological Systems Design				
Stefanie Hellweg	Carmen Mosquera, <i>cand. doc.</i> , Universidad Nacional, Colombia; Alexander Erazo, <i>cand. doc.</i> , Universidad Nacional, Colombia; Camilo Lesmes, <i>cand. doc.</i> , University of Graz Austria; Ronnie Juraske, <i>post-doc</i>	Life cycle human exposure and risk assessment of pesticide application on agricultural products in Colombia 05/09–05/12	Universidad Nacional, Colombia; Universidad de Boyaca, Colombia; University of Graz, Austria	Colombia, Austria, Switzerland
Environmental Sciences (D-UWIS)				
Aquatic Chemistry, Eawag				
Hong Wang and Bernhard Wehrli, Eawag, Switzerland	Jafet Andersson, <i>cand. doc.</i> , Eawag, Switzerland	Rainwater harvesting and ecological sanitation for smallholder agriculture in southern Africa 04/07–03/11	A. Zehnder, TripleZ, Switzerland; G. Jewitt, University of KwaZulu-Natal, South Africa	South Africa
Ecosystem Management				
Jaboury Ghazoul <i>see page 44</i>	Smitha Krishnan, <i>cand. doc.</i> ; Virginie Boreux, <i>cand. doc.</i>	An ecosystem service approach to agricultural security in a sacred landscape mosaic 10/06–12/10	J.-P. Sorg, ETH Zurich, Switzerland; U. Shaanker and C.G. Kushalappa, UAS Bangalore, India	India NRM
Environmental Biogeochemistry, Eawag				
Stephan Hug, Janet Hering and Andreas Voegelin, Eawag, Switzerland <i>see page 50</i>	Linda Roberts, <i>post-doc.</i> , Eawag, Switzerland	Arsenic contamination of paddy soils in Bangladesh: Risks for wet season rice production in non-flooded and shallowly flooded soils 05/10–04/11	M.A. Ali and A.B.M. Badruzzaman, BUET, Bangladesh; M.A. Hamid Miah, IRRI, Bangladesh; M.R. Islam, BAU, Bangladesh	Bangladesh NRM



Porewater sampling in an experimental rice field in Jessore, Bangladesh



Colonies of the giant honey bee *Apis dorsata* on trees in the Kodagu district, India

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Soil Protection				
Rainer Schulin, Richard Hurrell, Emmanuel Frossard <i>see page 49</i>	Nazanin Roohani Sharaki, <i>cand. doc.</i> ; Mahin Karami, <i>cand. doc.</i> , IUT, Iran; Manouchehr Amini	Zinc fluxes from the soil into the food chain in arid agro-ecosystems – A case study in Iran 07/07–06/10	M. Afyuni and A. Khoshgoftarmanesh, IUT, Iran; C. Binder, University of Graz, Austria; A. Keller, ART, Switzerland; R. Wegmüller, ETH Zurich, Switzerland	Iran
Rainer Schulin	Anja Gramlich, <i>cand. doc.</i> ; Forough Aghili, <i>cand. doc.</i> ; Mojtaba Norouzi, <i>cand. doc.</i> , IUT, Iran; Susan Tandy, <i>post-doc.</i> ; Vajiheh Dorostkar, <i>MSc stud.</i> , IUT, Iran; Somayeh Ghasemi, <i>MSc stud.</i> , IUT, Iran; Hadi Habiby, <i>MSc stud.</i> , IUT, Iran	Agronomic biofortification to fight human zinc deficiency in arid regions 03/09–02/12	R. Hurrell, R. Wegmüller, E. Frossard and J. Jansa, ETH Zurich, Switzerland; B. Nowack, Empa, Switzerland; M. Afyuni and A. Khoshgoftarmanesh, IUT, Iran	Iran
Rainer Schulin <i>see page 62</i>	Somayanda Impa Muthappa, <i>post-doc.</i> , IRRI, Philippines	Healthy rice for healthy people: Biofortification of zinc in rice 08/09–08/11	S. Beebout, IRRI, Philippines	Philippines
Humanities, Social and Political Sciences (D-GESS)				
NADEL				
Rolf Kappel <i>see page 52</i>	Jan Schübach, <i>cand. doc.</i> ; Ivan Pavletic, <i>post-doc</i>	The impact of foreign direct investment in agriculture in developing countries: Selected aspects at the global level and country level 09/10–08/13		Zambia

NRM



Investigating the biofortification of zinc in rice at IRRI, Philippines



Women preparing the soil for a plant experiment at ICARDA, Syria

Natural resource management

Today, one billion people have no access to clean drinking water and more than two billion people live without functioning energy supply. Sustainable management of natural resources such as land, water and soil is one of the central challenges of developing countries, particularly focusing on how management affects the quality of life. It includes the protection of ecosystems and biodiversity. Ecosystems provide a broad range of services with high (economic) value to society, such as supply of water, food, fibre and timber, as well as recreational and cultural services. Amongst others, research is needed on the monetary valuation of such ecosystem services and their contribution to poverty alleviation, as well as to the design of policy and economic incentives for their provision.

Rural transformation, economic development and climate change will continue to have strong impacts on ecosystems, changing the potential use of natural resources and requiring adequate adaptation and mitigation measures at the level of technologies as well as of policies.

Besides the focus on food security, research on natural resource management is already a strong component of the portfolio of the North-South Centre, both at the level of its individual members and at the level of its programme. Areas of expertise include biodiversity, ecosystem services, resource scarcity, pollution, energy, climate change mitigation and adaptation, integrated water resource management, life cycle assessment (LCA), socio-cultural aspects of land use, environmental decisions, clean development mechanisms (CDM), policy approaches, and many more.

In 2010, the ETH School Board decided to strengthen the link between resource management and food production by merging the environmental and agricultural sciences into one department (as of 2012). The new Department of Environmental Systems Science will be a strong basis for the North-South Centre.

The degradation of ecosystem services is likely to increase with global population growth. Incentives are needed to make the provision of these services worthwhile for local resource managers.

Stefanie Engel, Chair, Technical Committee on natural resource management, North-South Centre



Montane forests across East Africa contain a unique biota of plants and animals

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Agricultural and Food Sciences (D-AGRL)				
Animal Nutrition				
Florian Leiber, Michael Kreuzer	Anuraga Jayanegara, <i>cand. doc</i>	Impact of increasing the complexity of forage composition in ruminant feed on ruminal biohydrogenation and methanogenesis 12/08–11/11	S. Marquardt and C.S. Soliva, ETH Zurich, Switzerland; E. Wina, IRIAP, Indonesia	Switzerland, Indonesia
Svenja Marquardt, Michael Kreuzer	Shanker Raj Barsila, <i>cand. doc</i>	Improving grazing systems with Nepalese yak crossbreds to foster livelihood of mountain farmers in the Taplejung district of Nepal 09/09–08/12	N.R. Devkota, Tribhuvan University, Nepal	Nepal
<i>see page 66</i>				
Applied Entomology				
Silvia Dorn, Karsten Mody	Judith Riedel, <i>cand. doc</i>	Exploiting beneficial insects and defensive plant traits to limit pest damage and support growth of native timber trees in Panama 04/10–04/13	C. Potvin and H. Barrios, STRI, Panama	Panama
<i>see page 65</i>				
Grassland Sciences				
Nina Buchmann, Lutz Merbold	Hermegast Ambrose Makoi, <i>cand. doc</i>	Monitoring of forest carbon stocks in the Miombo woodlands in western Tanzania 09/10–08/13	B. Wolfgramm, University of Bern, Switzerland; H. Hurni, NCCR North-South, Switzerland; P.K. Mwanukuzi, University of Dar es Salaam, Tanzania	Tanzania
<i>see page 67</i>				
Plant Nutrition				
Emmanuel Frossard, Else Bünemann	Knut Ehlers, <i>cand. doc</i>	Composition and dynamics of bacterial phosphorus in phosphorus deficient soils 10/07–04/10	L. Bakken, University of Norway; A. Bationo, AfNet, Kenya	Norway, Kenya
Emmanuel Frossard; M.P. Sedogo, INERA, Burkina Faso	Delwendé Innocent Kiba, <i>cand. doc</i>	Impact of organic amendments on the phosphate nutrition of crops and on phosphate transformations in lixisols from semi-arid West Africa 05/09–05/12	S. Koala, CIAT, Kenya; A. Bationo, AGRA, Ghana	Burkina Faso, Kenya, Ghana
<i>see page 59</i>				
Emmanuel Frossard, Else Bünemann, Astrid Oberson	Lalajaona Randriamanantsoa, <i>cand. doc</i> ; Oliver Zemek, <i>cand. doc</i>	Nutrient use and dynamics in conservation agriculture including legumes in the Midwest of the Malagasy highlands 09/10–08/13	L. Rabeharisoa, Laboratoire des Radio Isotopes, Madagascar; J. Rakotoarisoa, FOFIFA, Madagascar	Madagascar
<i>FS</i>				
Civil, Environmental and Geomatic Engineering (D-BAUG)				
Ecological Systems Design				
Stefanie Hellweg, Roland Scholz; Thomas Köllner, University of Bayreuth, Germany	Michael Curran, <i>cand. doc</i> ; Francesca Verones, <i>cand. doc</i> ; Laura de Baan, <i>cand. doc</i> ; Karin Bartl, <i>post-doc</i> ; Michael Eisenring, <i>MSc stud.</i> ; Vidhya Chittoor Viswanathan, <i>MSc stud.</i>	Assessing and compensating the ecosystem impacts of agricultural products in the North-South context – myEcosystem 2009–2012	UNEP, Kenya; University of Bayreuth, Germany	Peru, India, Kenya
<i>see pages 69–72</i>				

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Hydrology and Water Resources Management				
Francesca Pellicciotti	Silvan Ragettli, <i>MSc stud.</i> ; Cyrill Bürgi, <i>MSc stud.</i>	Modelling the impact of a changing climate on basin ecosystems and sediment transport in the dry Andes of Chile and in the Swiss Alps: A comparative study 12/10–03/11	J. McPhee, University of Chile; M. Konz, ICE, UK; D. Molnar, ETH Zurich, Switzerland	Chile
Environmental Sciences (D-UWIS)				
Aquatic Chemistry, Eawag				
David Senn, Bernhard Wehrli and Alfred Wüest, Eawag, Switzerland	Philip Meier, <i>cand. doc.</i> ; Claudia Casarotto, <i>cand. doc.</i> ; Roland Zurbrügg, <i>cand. doc.</i> , Eawag, Switzerland; Manuel Kunz, <i>cand. doc.</i> , Eawag, Switzerland; Thomas Simfukwe, <i>MSc stud.</i> ; Jason Wamalume, <i>MSc stud.</i> , University of Zambia	African Dams Project (ADAPT) 2008–2012	T. Bernauer, W. Blaser, P. Edwards, R. Kappel, W. Kinzelbach and H. Olde Venterink, ETH Zurich, Switzerland; A. Schleiss, EPFL, Switzerland; H. Chabuella, G. Shanungu and I. Nyambe, University of Zambia; Zesco Power Company, Zambia	Zambia, Zimbabwe, Mozambique
Aquatic Physics, Eawag				
Alfred Wüest and Martin Schmid, Eawag, Switzerland	KellyAnn Ross, <i>cand. doc.</i> , Eawag, Switzerland; Fabrice Muvundja, <i>cand. doc.</i> , DR Congo; Augustin Gafasi, <i>MSc stud.</i> , KIST, Rwanda	Lake Kivu: Learning from the past for managing its future 06/09–06/12	P. Isumbisho, ISP Bukavu, DR Congo; T. Nkurunziza, KIST, Rwanda; M. De Batist, Ghent University, Belgium; F. Anselmetti, ETH Zurich, Switzerland	DR Congo, Rwanda
Ecosystem Management				
Jaboury Ghazoul	Aline Finger, <i>cand. doc.</i> ; Chris Kettle	Ecological and genetic restoration of inselberg plant populations 04/08–04/11	Ministry of Environment, Seychelles	Seychelles
Jaboury Ghazoul, Jean-Pierre Sorg, Hans-Rudolf Felber, Gabrielle Rajoelison, ESSA, Madagascar <i>see page 57</i>	Zora Lea Urech, <i>cand. doc.</i> ; Mihajamanana Fetra Rabenilalana, <i>cand. doc.</i> , ESSA, Madagascar	The importance of forest fragments in local livelihood systems 09/08–09/11	J.-L. Pfund, CIFOR, Indonesia; E. Andriamapandry, AIM, Madagascar	Madagascar
Lian Pin Koh		Ecosystem and societal impacts of biofuels 10/08–11/10	J. Ghazoul, ETH Zurich, Switzerland	Global
Chris Kettle, Jaboury Ghazoul	Sascha Ismail, <i>cand. doc.</i>	Impact of forest fragmentation and invasive species on gene flow among tropical trees 10/08–10/11	Forest Research Centre, Malaysia; University of Aberdeen, Scotland	India
Lian Pin Koh, Jaboury Ghazoul	Janice S.H. Lee, <i>cand. doc.</i>	Modelling land use for decision support in the context of biofuel expansion 06/09–05/12	CIFOR, Indonesia; Musim Mas Group Plantations, Indonesia; National University of Singapore	Indonesia
Jaboury Ghazoul	Claire Tito de Morais, <i>cand. doc.</i> ; Chris Kettle	Genetic processes underlying species coexistence in tropical rain forests: Is competition intensity shaped by genetic relatedness? 10/10–10/13	Forest Research Centre, Malaysia; University of Aberdeen, Scotland	Malaysia
Lian Pin Koh		Environmental iTools: Mobile applications for land-use decision support in developing countries 12/10–05/11	Odeon Consulting Group, Singapore; Musim Mas Group Plantations, Indonesia; Wildlife Works Carbon, Kenya	Switzerland, Singapore, Indonesia, Kenya

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries	
Environmental Policy and Economics					
Stefanie Engel; Charles Palmer, LSE, UK		The effectiveness of community conservation agreements in the periphery of Lore Lindu National Park in Sulawesi, Indonesia 2006–2011	A. Pfaff, Duke University, USA	Indonesia	Policy
Stefanie Engel	Tim Schlöndorn, <i>cand. doc</i> ; Marcella Veronesi, <i>post-doc</i> ; Astrid Zabel, <i>post-doc</i> ; Simon Urech	ClimPol, sub-project: Designing payments for environmental services under uncertainties 01/08–12/11	C. Palmer and L. Taschini, LSE, UK	Brazil, Kenya	Policy
Stefanie Engel; Charles Palmer, LSE, UK <i>see page 58</i>	Saraly Andrade de Sa, <i>cand. doc</i>	Ethanol production impacts on land use and deforestation 02/09–02/12	C. Opal, Roundtable on Sustainable Biofuels/EPFL, Switzerland; S. Wunder, CIFOR, Brazil; P. Moutinho, IPAM, Brazil	Brazil	
Michele Baggio		Welfare effect of a potential biological invasion: The case of Lake Maracaibo, Venezuela 02/10–12/10	E. Lichtenberg, University of Maryland, USA; F. Troncone, ICLAM, Venezuela; FAO, Italy	Venezuela	Policy
Stefanie Engel; Michael Kosfeld, Goethe University Frankfurt, Germany <i>see page 51</i>	Devesh Rustagi, <i>post-doc</i>	Diffuse and leader-based sanctioning institutions for the management of forest commons in Ethiopia 07/10–06/11	G. Gubissa, Oromia Forest Enterprises Supervising Agency, Ethiopia; M. Neumann, GTZ SUN, Ethiopia; G. Manske and F. Gatzweiler, ZEF, Germany	Ethiopia	
Stefanie Engel	Tim Schlöndorn, <i>cand. doc</i> ; Marcella Veronesi, <i>post-doc</i> ; Astrid Zabel, <i>post-doc</i>	Establishing permanence in REDD+ schemes 10/10–08/11	Wild Life Works Carbon Ltd.	Kenya	
Society, Environment and Culture					
Klaus Seeland, Peter Edwards	Franz Huber, <i>cand. doc</i>	What defines sustainability? An ecological and societal analysis of wild medicinal plant and mushroom collection in the Hengduan Mountains, Southwest China 04/09–04/12		China	
Humanities, Social and Political Sciences (D-GESS)					
Economic Research					
Renate Schubert		Global climate change – Technological and institutional innovations 2008–2011	WBGU, Germany; J. Blasch, ETH Zurich, Switzerland	Switzerland	URT, TI
Renate Schubert		Financial crisis and climate policy 2009–2010	WBGU, Germany; J. Blasch, ETH Zurich, Switzerland	Switzerland	TI
NADEL					
Rolf Kappel, Wolfgang Kinzelbach	Li Haitao, <i>post-doc</i>	Water management for sustainable agriculture in the Yanqi Basin, China 01/09–12/12	CIGEM, China; Agricultural University Urumqi, China; Water Authority of Xinjiang, China	China	
Isabel Günther	Elizabeth Tilley, <i>cand. doc</i>	Incentivizing sanitation through urine collection 10/10–10/14	Eawag-Sandec, Switzerland; eThekweni Water and Sanitation, South Africa	South Africa	

Urban and rural transformation

The global proportion of the urban population has risen dramatically from 13% in 1900 to 50% today. It is projected that by 2050, over 6 billion people – two-thirds of humanity – will be living in towns and cities. With regard to future trends, it is estimated that more than 90% of urban growth will occur in developing countries, with the fastest growing cities located in Africa. This poses immense challenges to rural and urban dwellers, the environment and social cohesion. The rapid and unplanned expansion of slums in urban and peri-urban areas often occurs in an environment lacking good governance. Usually, there is no corresponding expansion of public services, facilities and job opportunities. If this is not addressed, continued urbanisation will result in increasing urban poverty, inequality, insecurity and conflict.

The other side of the coin to urbanisation is equally rapid rural transformation. The rural sector faces the challenges to satisfy the demand of a generally young, rapidly growing, ever more urban population. Within an environment of changing climate and opening-up of markets, it is important to create employment and to reduce poverty in the rural environment. Providing adequate infrastructure and services to large, less densely populated rural areas is by far more challenging than in urban environments and requires innovative technological and institutional solutions.

Both challenges, urban and rural transformation, cannot be separated and have to be approached in an integrated manner. Furthermore, they are both highly interlinked with resource use and the entire food chain.

There is a great potential in developing the thematic area of urban and rural transformation together with the relevant ETH scientists who have a wealth of expertise, covering the topics of architecture, energy, water and sanitation, social behaviour, transportation, public services, conflict management, urban agriculture, solid waste management, mobility, rural livelihood systems and many more.

In addition, the ETH Zurich has identified future cities and sustainable construction as one of its future strategic initiatives. Planning and building are becoming ever more sophisticated: Rather than setting a course for rapid growth, researchers are increasingly concerned with management strategies for prudent preservation and for transformation, limitation and urban concentration. The central focus is on a sustainable, culturally high-quality environmental design adapted to human needs.

The North-South Centre can help to channel these efforts into research partnerships with developing countries and emerging economies. The topic offers great potential for mutual learning, since partners in the South will bring their own perceptions, problem definitions and know-how.

Cities cannot be dealt with independently from their global *hinterland*: Both urban and rural environments are in a symbiotic relationship, albeit one marked by conflict.

Marc Angélil, Chair, Technical Committee on urban and rural transformation, North-South Centre



Slums within formal neighbourhoods in Mumbai, India

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Agricultural and Food Sciences (D-AGRL)				
Agri-food & Agri-environmental Economics				
Bernard Lehmann	Laura Marty, <i>BSc stud.</i> ; Florian Studer, <i>BSc stud.</i>	The potential of microfinance for rural farming, household's welfare and rural development in the department of Toumodi, Côte d'Ivoire 09/10–11/10	CSRS, Côte d'Ivoire	Côte d'Ivoire
Architecture (D-ARCH)				
Architecture and Design				
Dietmar Eberle, Margrit Hugentobler	Andrea Gerlinde Hagn, <i>cand. doc</i>	Informal settlements of the urban poor in a small Indian city: The relationship between spatial structure, socio-economic characteristics and access to the Jawaharlal Nehru National Urban Renewal Mission's sub-project Basic Services to the Urban Poor 10/10–09/13 <i>see page 68</i>	C. Schmid, ETH Zurich, Switzerland; S. Banerjee-Guha, TISS Mumbai, India	India <i>Policy</i>
Civil, Environmental and Geomatic Engineering (D-BAUG)				
Sustainable Construction				
Holger Wallbaum	Sabrina Krank, <i>cand. doc</i>	Assessment of sustainable urban development in Asian megacities of developing countries 06/07–09/10	A. Grêt-Regamey, ETH Zurich, Switzerland; R. Mahon, Pragna Research and Consultancy Service, India; 29 institutions in Jakarta, Indonesia; Bangkok, Thailand; Shanghai, China; Hyderabad and Ahmedabad, India	Indonesia, Thailand, China, India
Humanities, Social and Political Sciences (D-GESS)				
NADEL				
Isabel Günther		Differential mortality in sub-Saharan Africa 08/08–12/11	University of Göttingen, Germany	Sub-Saharan Africa



Sustainable urban development is needed for the fast-growing population in Asian megacities



Informal housing construction in Mathura, India

Technology and infrastructure

The ETH Zurich has much to offer in engineering sciences and advanced technologies in order to achieve the goal of “sustainable development for human well-being”. The rapid spread of mobile phones in the most remote areas of developing countries is a good example for unexpected economic impact of technologies, which were not originally designed for poverty alleviation. If adapted strategically, such technologies bear a great, untapped potential in the development context.

Engineering knowledge and expertise does not only contribute directly to helping poor people to meet their basic needs in a sustainable manner (e.g. for safe drinking water, water for food production, secure shelter, sanitation and waste management etc.). It is essential for economic growth which is required to achieve sustainable improvements for poor people, supported by appropriate national and local government policies. This holds true of information and communication technology for development, which can greatly improve the quality of life for the people most in need. It also applies to transportation, energy systems, infrastructure and medical technologies for improved health. Furthermore, new technologies and infrastructure will be applied in both urban and rural environments. They will impact natural resources and entail new opportunities and risks for developing countries.

The results of such research may take various forms: Hardware such as tools and facilities or software in the form of techniques, concepts or systems. Sometimes, these results may be adopted and applied directly by the beneficiary – whether this is by an individual, a household or some larger formal or informal group. However, it is more common for engineering knowledge to be adopted by an intermediary such as a government body or a local entrepreneur.

The field of technology and infrastructure will be gradually explored as another new field within the profile of the North-South Centre. Thereby, the challenge for the North-South Centre lies in channeling the great potential of available expertise of the ETH Zurich into impact-oriented research for the benefit of poor people. This expertise includes topics such as water-use, energy, infrastructure, sanitation, transportation, information and communication technology (ICT), disaster risk reduction, nanotechnology, climate change and others.

Technology is definitely boosting economic development in the developing world. Yet, alleviating poverty is more complex than just applying technology.

Wolfgang Kinzelbach, Chair, Technical Committee on technology and infrastructure, North-South Centre



Local school children observing the set-up of geophysical instruments used in an earthquake hazard project in Bhutan

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Earth Sciences (D-ERDW)				
Engineering Geology				
N.M.S.I. Arambepola, ADPC, Thailand; Rajinder Bhasin, NGI, Norway		RECLAIM III: Asian program for regional capacity enhancement for landslide impact mitigation 2010–2012	A. Kos, ETH Zurich, Switzerland	Thailand, Norway
Rajinder Bhasin, NGI, Norway; Boop Singh, Ministry of Science and Technology, India		DST-NGI India-Norway institutional cooperation project 2010–2013	A. Kos, ETH Zurich, Switzerland	Norway, India
Geochemistry and Petrology, High Pressure Group				
György Hetényi		Earthquake hazard mapping in Bhutan 07/10–12/11	W. Roder and N. Tshering, Helvetas, Bhutan; D. Drukpa and J. Chopel, Department of Geology and Mines, Bhutan; S. Lechmann, ETH Zurich, Switzerland; R. Cattin and T. Berthet, Université Montpellier 2, France	Bhutan
Humanities, Social and Political Sciences (D-GESS)				
NADEL				
Isabel Günther	Elena Gross, <i>cand. doc</i> , University of Göttingen, Germany	Effectiveness of water infrastructure programs 01/09–12/11	University of Amsterdam, Netherlands; Amsterdam Institute for International Development, Netherlands	Benin
Isabel Günther	Alexandra Horst, <i>cand. doc</i>	Economics of sanitation in developing countries 10/09–10/13	Harvard School of Public Health, USA; Eawag-Sandec, Switzerland; Makerere University, Uganda	Uganda



Women collecting water from a traditional well in Benin



Landslides triggered by monsoon rainfall are a widespread problem hindering development in the Lower Himalaya in India

Policy

In the context of development, the definition and implementation of policies has far-reaching effects on the well-being of the population. Development-related policy research aims at understanding the mechanisms behind the conditions for improving the livelihoods of the poor, fostering beneficial institutions and good governance. Development-related policy research will ultimately lead to recommendations to policy-makers at all levels, from local to global and cutting across sectors.

While the four research topics in the preceding chapters have been identified as focus areas in the strategy of the North-South Centre, policy-related research deserves a separate presentation for the purpose of highlighting the specific expertise of our members. It cuts across the topics of food security, resource management, urbanisation, technology and infrastructure. In addition, it addresses topics at various scale levels and other issues not fully covered elsewhere.

Beyond taking care of its internal networking function of bringing together researchers from different disciplines, the North-South Centre strives to share the expertise of its members for advisory services. Policy research is among the fields of expertise which can meet the demand of our stakeholders outside academia in transdisciplinary settings or by direct policy advice.

The strategy of the North-South Centre has identified three transversal topics which cannot be pinned down to any disciplinarily defined research area: gender, good governance and impact generation. In a similar sense, policy research as a field within social sciences is a necessary complement to the natural and engineering sciences dominating the four strategic research areas.

We must strive to better understand policies and institutions and the motives and constraints of decision-makers: These are the major determinants of development.

Rolf Kappel, Member, Steering Committee, North-South Centre



Farming in the arid Ethiopian Highlands

Project leader(s), Supervisor(s)	Researcher(s), Academic degree(s)	Project title, Duration	Project partner(s)	Countries
Environmental Sciences (D-UWIS)				
Environmental Philosophy				
Gertrude Hirsch Hadorn	Gabriela Wuelser, <i>cand. doc</i> ; Christian Pohl	Structuring the science-policy nexus in sustainability research 04/08–03/12	H. Wiggering, ZALF, Germany; B. Hubert, INRA and EHESS, France; G. Bammer, Australian National University, Australia; A. Wiek, Arizona State University, USA; U. Wiesmann, University of Bern, Switzerland	Global
Environmental Policy and Economics				
Marcella Veronesi		Climate change adaptation and food security in Ethiopia 06/09–12/10	S. di Falco, LSE, UK	Ethiopia
Stefanie Engel	Tilman Silber, <i>MSc stud.</i>	Conservation and restoration of peatlands in Indonesia: Can the private sector do the job? 11/10–04/11	H. Joosten, University of Greifswald, Germany; Wetlands International, Netherlands	Indonesia
Natural and Social Science Interface				
Roland W. Scholz; Christoph Renner, University Hospital Zurich, Switzerland; Simeon Taquira Sipac, Mayan Council of Elders, Guatemala	Monica Berger-Gonzalez, <i>cand. doc</i>	Maya and contemporary conceptions of cancer: Cultural formation of environmental literacy 09/10–06/13	C. Perez Oxlaj, Mayan Council of Elders, Guatemala; Councils from regions Kaqchikel, K'iche, Mam, Mopan and Q'eqchi, Guatemala; W. Guerra, INCAN, Guatemala; C. Zilbermann, Universidad del Valle de Guatemala	Guatemala
Humanities, Social and Political Sciences (D-GESS)				
NADEL				
Isabel Günther	Jonathan Gheysens, <i>cand. doc</i>	Risk preferences in poor rural environments 07/10–07/12		Benin
Isabel Günther	Laura Metzger, <i>cand. doc</i>	New perspectives on aid effectiveness 10/10–03/14	KfW Entwicklungsbank, Germany	Global
Center for Comparative and International Studies (ETH Zurich/University of Zurich)				
Katharina Michaelowa	Sophia Limpach-Hänny, <i>cand. doc</i>	Aid and democratization 09/06–12/10	A. Bächtiger, University of Bern, Switzerland	Global
Katharina Michaelowa	Anke Weber, <i>cand. doc</i> ; Patrick Nkengne Nkengne, <i>cand. doc</i> ; Sebastian Fehrer, <i>post-doc</i>	Education policy in sub-Saharan Africa and other developing countries 09/06–12/11	J. Bourdon, IREDU, University of Burgundy, France; M. Fröhlich, University of Mannheim, Germany; P. Gonon and M. Maurer, University of Zurich, Switzerland	Global
Katharina Michaelowa	Aliya Khawari, <i>cand. doc</i>	The political economy of microfinance 01/09–12/11	P. Finke, University of Zurich, Switzerland; I. Günther, ETH Zurich, Switzerland; NEED, India; KASHF Foundation, Pakistan	Pakistan, India
Katharina Michaelowa	Linda Maduz, <i>cand. doc</i>	Analyzing the causes of welfare state development in East Asia 09/09–08/12	H. Kriesi and S. Trakulhun, University of Zurich, Switzerland	Indonesia, South Korea, Thailand
Katharina Michaelowa	Paula Castro, <i>cand. doc</i> ; Florens Flues, <i>cand. doc</i> ; Martin Stadelmann, <i>cand. doc</i> ; Axel Michaelowa	International climate policy 09/06–12/12	Öko-Institut, Germany; Perspectives GmbH, Germany; Ecologic Institute, Germany; Stockholm Environment Institute, Sweden; Point Carbon, Norway	Various developing countries

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NRM

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Women collecting water from an improved water pump in Benin

Development-related research and research partnerships with institutions in developing countries are long-term tasks. Such partnerships depend on security and stability to build up the respective expertise and mutual trust.

*Joachim von Braun,
Center for Development Research (ZEF)*

Programmes managed by the North-South Centre

The North-South Centre manages a series of programmes by which individual projects of its members are co-funded or otherwise supported. Some of these programmes have been ongoing for many years, while others are more recent initiatives.

Dating back to 1994, the SDC-funded contract on international agriculture is our most long-standing programme. Since 2002, it has been focused on “Livestock systems research in support of poor people”. In 2010, most of the projects in this programme were concluded or in their final stage. SDC granted a contract extension for a number of postdoctoral projects. These projects were not restricted to livestock systems but could cover any topic in the two research areas of food security and natural resource management.

Investing in the capacity development of young scientists is one of the most promising tasks of any university. The North-South Centre contributes to this task with a couple of externally funded fellowship programmes. The Research Fellow Partnership Programme for Agriculture, Forestry and Natural Resources (RFPP) is funded by SDC. It covers doctoral and postdoctoral projects on food security and natural resource management.

Since 2009, the “Sawiris Scholarships – Science & Technology for the South” complement the RFPP. Donated by the Sawiris Foundation for Social Development, these scholarships are open to doctoral candidates of all disciplines at the ETH Zurich. The goal of the programme is to promote the development of products or methods which are directly relevant for improving the livelihoods of poor people in developing countries.

The North-South Centre is responsible for a Memorandum of Understanding (MoU) between the United Nations Environment Programme (UNEP) and the ETH Zurich. The interdisciplinary research project “myEcosystem” was implemented under this MoU and commenced in 2009. It comprises three interlinked doctoral theses and a post-doctoral project on assessing and compensating ecosystem impacts of agricultural products.

Finally, the ETH Zurich enables the North-South Centre to provide its members with small grants as seed money for new partnerships. In addition, it supports short-term activities such as visiting scientists from developing countries or teaching stays at universities in developing countries.

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An ecosystem service approach to agricultural security in a sacred landscape mosaic

Agricultural fields proximal to natural habitats benefit from important pollination services provided by wild bees. Although coffee is a wind-pollinated species, an increased attendance by bees enhances crop yields. Additionally, the crop yield can be enhanced by applying suitable management interventions. However, an increase in bee abundance might be contingent upon the extent of the adjoining forested habitat in combination with the proximity to such habitats.

In a coffee producing region in southern India, bee visits to coffee flowers have been quantified at different distances from forest fragments and under a variety of management interventions and agro-forest characteristics. Thus, the relative impact of pollination, management practices and coffee agro-forest variables on coffee production could be evaluated. This project aimed at determining the pollination services to coffee provided by forest fragments, as well as assessing bee diversity in remnant forests adjoining coffee agro-forests.

The results from more than 100 coffee plantations in the Kodagu district showed that pollination by bees enhances coffee production even when accounting for the various management practices employed in coffee agro-forests. Flowering initiated by irrigation greatly increases

pollinator abundance and hence coffee production. The irrigation leads to isolated pockets of rich floral resources which concentrate bee abundance, whereas the simultaneously flowering rain-fed agro-forests lead to an ample dispersion of bees over the landscape. In the rain-fed agro-forests, proximity to forest and increase in forest size played a significant role in enhancing social bee abundance. In irrigated agro-forests however, bee abundance was high irrespective of the size or distance from the forest. In both cases, the giant honey bee *Apis dorsata* was the main pollinator and the number of its colonies grew with an increase in size of the forest habitats. Solitary bees were low in numbers, accounting for less than 2% of all coffee flower visitors. Their apparent paucity was also reflected in their low occurrence within the forest fragments.

In conclusion, coffee planters benefit from higher crop yields through the pollination services provided by wild bees. The planters could increase bee abundance and thus coffee pollination by irrigating their estates asynchronously with their neighbours. At the same time, larger forest remnants harbour more colonies of *Apis dorsata* than smaller ones. Therefore, maintaining large forest habitats may additionally increase the provision of pollination services to coffee.

Project leader

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Principal investigators

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Collaborators

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Duration

October 2006 – December 2010



The giant honey bee *Apis dorsata* on coffee flowers in India

Reversing soil degradation by tropical legume trees using GIS analysis

The aim of this project was the evaluation and analysis of the incorporation effects of the legume tree *Gliricidia sepium* (*Gliricidia*) on soil productivity and on the livelihoods in the Meegahakivula region in Sri Lanka.

The agronomic project component showed the potential of *Gliricidia* for increasing productivity in fields and home gardens. This potential is restricted by increasing inclination and drought. Frequent incorporation of green or composted manure from *Gliricidia* enhances soil organic matter content and crop yields – more pronounced at slighter slopes and in home gardens. Home gardens as typical agroforestry systems are usually characterised by higher species diversity and greater soil fertility than fields. High impacts in home gardens may directly contribute to improved food security and a higher income through enhanced sales of fruits and vegetables of smallholder farms.

The socio-economic part of the project highlighted changes in market prices of products and production factors as well as off-farm labour salaries as main driving forces for smallholder production and consumption decisions. Increased productivity or changing overall economic framework conditions are needed to improve the financial situation of the households.

The photogrammetric project component provided the basic data layer such as orthophotos for interdisciplinary GIS analyses. Additionally, a webGIS was established to link and analyse the spatially-related environmental, agronomic and socio-economic data of the study area. This webGIS system allows the visualisation of various combinations of different parameters in the context of an interactive map.

The final workshop in Kandy, Sri Lanka, was the highlight of the project in 2010. The research team informed a large audience of scientists and students from Peradeniya University as well as farmers and extension officers about the scientific outcome and the practical implications of the project. The team provided innovative inputs to the discussion on agroforestry systems, on their contribution to the provision of food on one hand and their potential to mitigate climate change on the other.

Bringing together the competences of scientists from different disciplines of the Peradeniya University and the ETH Zurich, combined with the knowledge of farmers and a private company, successfully accomplished the introduction of *Gliricidia* to improve the productivity and sustainability of crop production in smallholder hill country farming systems.



The final workshop in Kandy, Sri Lanka

Project leaders

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Duration

October 2006 – December 2010

Benefits of cover crop legumes in smallholder systems in Central America

In smallholder farming systems of the Nicaraguan hillsides, intensification of land use has led to soil nutrient depletion and a decrease in crop and livestock productivity. In order to sustain the agricultural production, the drought-tolerant cover legume *Canavalia brasiliensis* (Canavalia) has been introduced as green manure and forage into the maize-bean-livestock system. From January 2007 to December 2009, the project “Benefits of cover crop legumes in smallholder systems in Central America” investigated the adoption effects of this forage legume. The results showed that Canavalia can potentially improve the productivity of traditional smallholder crop-livestock systems in the drought-prone Nicaraguan hillsides. Through biological nitrogen fixation, it adds a significant quantity of nitrogen to the system. Furthermore, when Canavalia is used as forage, the increasing amount and quality of dry season feed leads to a higher milk production.

In August 2010, an impact generation project started as the next step, in order to facilitate sustainable adoption of Canavalia by the farmers. The objectives were (i) to disseminate the information gathered during the above project by developing and distributing user guides and leaflets, (ii) to enhance farmers’ seed production and (iii) to facilitate the release process in collaboration with the authorities in Nicaragua.

So far, the dissemination material has been prepared. After final revision by local extension specialists, two thousand manuals will be printed. The preparation of the user guide raised strong interest both within Nicaragua and abroad. The documentation for the seed release has been submitted to the Nicaraguan Ministry of Agriculture. Farmers continue using the new dry season forage and green manure legume technology. They are strongly involved in validation trials and seed production, managed by the Nicaraguan Institute of Agricultural Technology (INTA).

It is expected that the dissemination of information on the use of Canavalia in mixed crop-livestock systems will be continued by CIAT, INTA and other local institutions, with spillover effects to other countries in the region and beyond. Canavalia is currently being integrated in further projects aiming at promoting eco-efficient systems in Nicaragua. In combination with better seed availability and continuous institutional support, adoption of Canavalia could be enhanced, thus leading to a sustainable increase in agricultural productivity.

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Project leaders

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Collaborators

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Duration

January 2007 – March 2011



On-farm experiments with Canavalia stimulate discussions between researchers and farmers in Condega, Nicaragua

Improving small ruminant productivity in dry areas

In many developing countries, food security is compromised by recurrent and severe droughts coupled with the still ongoing food crisis. Consequently, there is a need to replace cereals with alternative feeds – including wastes and by-products from agro-industry – in order to avoid competition with human nutrition. This is especially true in a country such as Syria, where livestock is the main resource for many small-scale farmers and an important element in the country's economy.

The aim of this project is the sustainable use of natural resources in order to achieve food security. It aims at the identification and detailed evaluation of various forages and agro-industrial by-products available in the dry Mediterranean basin as feeding options. Once these options have been established as suitable feeds for small ruminants, they may be strategically used for extending the feed basis, preventing overgrazing of the rangelands and promoting recultivation of deserted areas. However, these feeding options are often unbalanced in their nutritional composition, as they may be high in lipid, salt or lignin. Furthermore, they may also contain anti-nutritional factors like polyphenols or other potentially detrimental ingredients.

The results of the determination of the principal feeding values such as palatability, digestibility and energy content indicate that some of the tested feeds may be included in the diets of small ruminants at rather high dietary proportions. Still, balancing is necessary in some cases, especially with regard to energy. Feeding such balanced diets to lactating fat-tailed Awassi sheep confirmed that these feeds do not impair performance. The tested feeds even showed beneficial effects for human health based on the fatty acid profile of the milk fat. In an on-farm experiment, two selected diets were tested in order to demonstrate their utility, to confirm their effects and to help the farmers implementing the feeding options correctly.

A final part of the project dealt with the fertiliser value of fresh and composted manure from these feeding options and their respective influence on nitrogen fluxes in the soil-plant system. For this purpose, fresh faeces and composted manure produced from the experimental animals were tested for their effects on microbiological and chemical soil properties as well as on barley yield (fertiliser use efficiency). The project was completed in 2010 with a closing participatory workshop in Syria.



Preparation of feed concentrate from tomato pomace at ICARDA, Syria

Project leader

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Collaborators

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Duration

October 2006 – December 2010

Camel milk products of high hygienic quality and safety

In East Africa, camel milk is consumed as untreated fresh milk or as fermented milk, known as “suusac”. Uncontrolled spontaneous fermentation due to unhygienic conditions or low quality of the raw material often lead to incomplete inhibition of pathogenic microorganisms (MO) in suusac, thus representing health risks for consumers.

The objective of this project is to improve existing camel milk products. Through investigation of the microflora of camel milk, starter cultures for the production of improved fermented milk shall be developed while risky MO shall be reduced, hence preventing a negative impact on human health.

From 2007 to 2009, more than 1500 bacterial and fungal isolates of over 130 milk product samples from Kenya and Somalia were collected, identified and characterised. The microflora revealed a concerning predominance of pathogenic species such as *Staphylococci*, *Enterobacteriaceae* and *Streptococcus agalactiae* in raw milk, as well as *Streptococcus infantarius* in suusac. Thereof, *S. infantarius* seems to be the predominant fermentative organism in East and West Africa. An African variant was detected and described, carrying a novel metabolism potentially responsible for the predominance observed. For safety reasons, the pathogenic MO *Enterobacteriaceae* and *Staphylococci* were screened in detail for the presence of antibiotic resistances.

Worrying resistances to a number of antibiotics were detected. These findings coupled with the extended diversity analysis of pathogens imply the need for improved hygiene practice at all levels in the production and supply chain.

At the same time, potential starter culture lactic acid bacteria (LAB) were isolated from suusac and identified as *S. thermophilus*, *Lactococcus lactis* subsp. *lactis* and *Lactobacillus* spp. These starter LAB were further screened in order to obtain the most promising strains based on acidification capabilities, aroma and bacteriocin production as well as absence of antibiotic resistances.

In 2010, lab-scale, pilot-plant and field trials with the novel starter strains were successfully conducted in Switzerland and Kenya, followed by sensorial trials at the University of Nairobi. In the near future, starter cultures will be tested for their ability to compete with *S. infantarius*. In addition, the pathogenic potential of *S. infantarius* will be further assessed in order to estimate its putative health risks for consumers or its utilisation as a highly competitive novel indigenous African fermentative strain.

Project leaders

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Principal investigators

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Collaborators

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Duration

June 2007 – December 2010



Women with camels at a waterhole in the Garissa district, Kenya

Zinc fluxes from the soil into the food chain in arid agro-ecosystems – A case study in Iran

Zinc (Zn) deficiency is considered a major problem in human nutrition, particularly in arid regions where the population depends on cereals as staple foods. This case study in central Iran served to investigate the Zn fluxes from soils into crop plants and from agricultural food products into human nutrition. The goals were (i) to analyse the effects of agricultural practices on grain Zn and phytate (PA) concentrations in cereals, (ii) to assess the impact of these cereals on human nutrition and (iii) to evaluate agricultural options reducing dietary Zn deficiency.

A field survey across three central Iranian provinces and a regional-scale analysis of Zn fluxes into agricultural soils revealed that on average, Zn inputs with the application of manure and inorganic fertilisers were several times larger than outputs with crop harvests. The data demonstrate that problems of insufficient Zn supply to crops are not due to absolute Zn deficiency in the soils, but to insufficient Zn bioavailability. The results suggest that there is substantial scope for increasing grain Zn concentrations in cereals by adapting agricultural management practices without resorting to excessive Zn fertilisation rates.

In a suburban population of Isfahan and in a rural community, two surveys on human Zn intake were conducted, using the method of three-day weighed food records. In addition, the serum samples of the participants were analysed in order to evaluate their physiological Zn status. In both populations, the major staple foods were bread and rice. Meat and dairy products were also consumed on a regular basis, but in much lower amounts. The dietary surveys for bread revealed a molar PA:Zn ratio higher than 18, the relevant threshold value above which Zn absorption from a diet becomes strongly reduced. For cooked rice and prepared dishes however, the ratio was below this value. The diet of both populations was a mixed diet with an average molar PA:Zn ratio of 10.3 ± 0.3 . Based on the serum Zn analyses, Zn deficiency prevalence was moderate in both study areas, with 5–10% on average and a maximum of 16.7% in rural men.

Data from national surveys on stunting in Iranian children show that conditions are much worse in the more remote parts of Iran. Thus, it seems reasonable to assume that human Zn deficiency is indeed an important public health issue in Iran. Biofortification of cereals with Zn might have a considerable potential to fight this problem.



Project collaborators, colleagues, MSc students and doctoral candidates from the ETH Zurich and the IUT, Iran

Project leaders

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Duration

July 2007 – June 2010

Impacts of water management on arsenic uptake by rice in Bangladesh

Groundwater irrigation of dry season rice (*boro*) has greatly improved food security in Bangladesh. However, due to high concentrations of arsenic (As) in many groundwater resources used, irrigation is leading to increased As levels in paddy soils and rice and may also compromise rice yields in the long term.

Owing to the gradual accumulation of As in paddy soil, the adverse effects of groundwater irrigation also extend to monsoon rice (*aman*) cropped under rain-fed or river-flooded conditions. Arsenic is strongly redox-sensitive and predominantly mobilised into soil pore water when soils are flooded and reducing conditions prevail. Irrigation management during the dry season and the water regime during the monsoon may thus significantly influence As uptake by *boro* and *aman*, respectively.

This research project compares As uptake by *aman* under intermittently and continuously flooded conditions. The field work was conducted in Jessore district in south-western Bangladesh, in an area where *aman* has been cropped in rotation with groundwater-irrigated *boro* for the past 15 years. Two fields were selected in which flooding due to rainfall is generally intermittent. By simulating additional rainfall with As-free pond water, one

field was to be kept continuously flooded. However, due to exceptionally scarce precipitation, all fields in this region required supplementary irrigation, and groundwater was the only water source available in sufficient quantity. Therefore, two subplots were constructed in each experimental field, in which the flooding regime was controlled by pond water, while groundwater containing $160 \mu\text{g L}^{-1}$ As was used for the remainder of the fields. In each field, one subplot was located near the irrigation water inlet where soil As content was particularly high and one subplot was situated at the far field end characterised by low soil As.

Throughout the growing season, water levels were monitored in the subplots and the main fields. In the subplots with high soil As content, As pore water dynamics were monitored over time and depth. Upon crop maturity, soil, rice straw and grain samples were collected in each subplot and across the lateral gradients in soil As content within the study fields. The collected data will allow the comparison of grain and straw As contents of *aman* cropped under intermittently versus continuously flooded conditions. In addition, a differentiation between *aman* irrigated with As-free pond water versus As-contaminated groundwater will be possible.

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Post-doc fellow

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Supervisors

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Collaborators

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Duration

May 2010–April 2011



Farmers threshing rice in Jessore, Bangladesh

Diffuse and leader-based mechanisms in forest commons management in Ethiopia

The success of commons management programmes depends on solving cooperation dilemmas. Diffuse punishment of free riders is one way to achieve this. However, this generates second order dilemmas. In addition, punishment only has a cooperation-enhancing impact when targeted at free riders and not spitefully at cooperators. Laboratory experiments show that leader-based punishment not only avoids second order dilemmas but also raises cooperation to the same level as diffuse punishment, leading to higher group profits as punishment efforts are not duplicated. However, these studies do not specifically address the problem of spiteful punishment. Moreover, in contradiction to many cooperation settings, leadership is arbitrarily and exogenously assigned to a student player in these experiments.

For this study, 200 members and actual leaders engaged in forest commons management took part in two punishment mechanisms: Diffuse (DP) and Leader (LP). While in DP each player could punish another player in his group, in LP a player could only indicate his punishment decision and the punishment authority rested with the leader. Two treatments were implemented in the LP and members were randomly assigned to these treatments. In the first treatment, punishment financing was endogenously determined but monitoring was exogenously fixed by the experimenter. In the second treatment, these patterns

were reversed. The mechanisms were implemented using the public goods game – a framework for obvious interest in cooperation dilemmas.

In order to identify punishment mechanisms that discourage free riding and spiteful sanctioning the most, contributions, punishments and payoffs in DP and the first treatment of LP were compared. A preliminary analysis suggests that contribution across the two mechanisms is not significantly different. In both mechanisms, a player receives the more punishment the more his contribution deviates from the group's average contribution. This effect proved to be stronger in LP. However, the extent of spiteful punishment and payoff losses due to punishment is significantly lower in LP, even after adjusting the sample size. These results imply that leader-based sanctioning mechanisms could perform better than diffuse sanctioning mechanisms. Sequential games are required to observe a full spectrum of behavioural changes in response to different punishment incentives.



Playing the public goods game in order to raise individual cooperation and to reduce excessive punishment in Ethiopia

Post-doc fellow

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Supervisors

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Collaborators

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Duration

July 2010 – June 2011

The impact of foreign direct investment in agriculture in Zambia

Investment in the Zambian agricultural sector has been low until recently. Zambia has thus stepped up efforts to attract foreign direct investment (FDI) by stabilising its economy and removing existing market distortions.

Given the recent hikes in international food prices, public and private investors from resource-constrained countries have seized this opportunity to secure their future supplies of food and other agricultural products through investment in land and agricultural production abroad. This is likely to have far-reaching social and economic consequences, as a large part of the population in Zambia derives its income from farming.

This research project was set up in order to investigate the impact of agricultural FDI on food security in Zambia. The study aims at answering the following questions: Under which conditions can FDI contribute to increasing food supply and food security in receiving countries? Which starting conditions and causal linkages allow some population groups to benefit from FDI? Which ones generate negative impacts on other groups? How can a maximum of the winning potential be gained? How can possible losers be protected and/or compensated?

The research project draws on a two-pronged methodology, combining both quantitative and qualitative methods. First, there is a thorough review of literature on past, recent and ongoing agricultural deals involving foreign investment in Zambia. Second, in-country research is carried out to obtain empirical evidence of what is happening on the ground.

In order to gain valuable insights on drivers, scope and implications of foreign investment in the agricultural sector, an initial fact-finding mission will take place between January and February 2011. Semi-structured interviews shall be conducted with government representatives, investors and population groups at the local level, as well as with representatives of private or public international organisations.

Considering the rather superficial and speculative media discourse on FDI in land and agriculture, the study can foster a more objective debate on the role of FDI in agriculture. The comparative analysis of investment projects may provide government officials and investors with analytical and empirical information, enabling them to minimise negative impacts and maximise potential benefits of current and future investment projects.

Post-doc fellow

Ivan Pavletic, ETH Zurich, Switzerland

Supervisor

Rolf Kappel, ETH Zurich, Switzerland

Collaborator

Jan Schüpbach, ETH Zurich, Switzerland

Duration

September 2010– August 2013



Meeting with the local representative of the Zambian Ministry of Agriculture as well as extension officers and small-scale farmers in Zambia



The *Tropentag 2010* provided a perfect networking platform for many of the researchers involved in the North-South Centre programmes

Exploring the effects of anti-tick vaccines on the transmission of *Theileria parva*

Tick-borne diseases (TBD) affect approximately 80% of the world's cattle population. Anti-tick vaccines (ATV) serve as a method for TBD control in cattle livestock systems by decreasing the number of ticks in successive generations and reducing the likelihood of infection with TBD. At the same time, the overwhelming burden of TBD faced by both large-scale and subsistence farmers is alleviated.

This project aims at evaluating the merits of using ATV as a control method for *Theileria parva*, the causative agent of East Coast Fever in cattle. During the course of this study, two ATV were evaluated for their adequacy to interfere with the transmission ability of *Rhipicephalus appendiculatus* ticks, the vector for the parasite *Theileria parva* to cattle.

The first trial evaluated the *R. appendiculatus* Ra86 antigen for its ability to block both the uptake of parasites by ticks feeding on infected cattle and the reproductive capacity of the ticks. Compared to prior reports, Ra86 vaccination showed an increased effect by decreasing the average engorgement weight of an adult female tick from 0.4637g to 0.4487g. Most notably, a previously unreported effect was evaluated: the effect of Ra86 vaccination on the moulting of nymph ticks to adults. A significantly higher percentage

of nymphs (14%) fed on Ra86 vaccinated animals failed to moult, compared to 3.5% of nymphs fed on control animals. This parameter is an important factor in disease control, as ticks infected in the nymph instar are responsible for *T. parva* transmission during subsequent adult feeding. In addition, the infection rates were lowered in ticks fed on animals which had been vaccinated. Each of these parameters has the potential to affect transmission dynamics.

The second trial evaluated a multivalent vaccine which simultaneously targeted the tick and the parasite. Consisting of various tick antigens and the parasite antigen p67 to inhibit parasite entry into the cattle host cells, the vaccine was a novel attempt to block disease transmission to naïve cattle. Evaluation of the vaccine's efficacy made use of a tick strain specifically designed to simulate field conditions. With 75% of animals contracting the disease in the vaccinated group compared to 90% in the control group, the vaccine lowered the incidents of East Coast Fever. In addition, the extent of disease development in the vaccinated group was lower. The results from this trial showed the potential of the vaccine itself. Furthermore, it became clear that tick-based challenge can be used as a method for evaluating tick vaccines – an invaluable resource for future research.

Research fellow

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Supervisors

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Collaborators

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Duration

May 2008 – September 2011



East Coast Fever is a disease particularly devastating to smallholder farmers who often rely on a single animal, such as these farmers in Neyri, Kenya

Understanding the views of the rural poor in two territories in Honduras

In Honduras, about half of the population live and work in rural areas dominated by steep hills and mountains. Their economic activity is based on agriculture, predominantly small-scale or subsistence farming. Access to services and economic opportunities other than agriculture is low and the poverty rate is very high. In order to fight poverty and to receive debt relief, Honduras introduced an ambitious poverty reduction strategy (PRS) in 2001. This strategy includes measures such as a general increase in social expenditure, the set-up of a decentralised poverty reduction fund for local projects, or programmes such as access to agricultural land or reactivation of the rural economy. However, neither in rural nor in urban areas did the poverty rates decrease significantly between 2001 and 2008.

This project aims at analysing the PRS, its implementation and its benefits for poor and marginalised households in view of future development strategies. Thereby, the livelihood situation of rural poor is compared with the PRS process in two municipalities in western Honduras.

Based on a household survey as well as landscape and history mapping carried out in 2009, two contrasting villages (*aldeas*) were selected from each case study municipality. In each *aldea*, approximately 15 poor and

extremely poor households were chosen for in-depth interviews in order to reveal the local livelihood situation and strategies. The selection process was iterative, aiming at reaching a contrasting sample. As the fieldwork in the same *aldea* lasted for numerous days, several informal conversations with interlocutors took place after the actual interviews. This was a complementary data-gathering method, whereas the qualitative interviews represent the core empirical data of this project. These informal conversations were decisive for gaining insights into poor people's perceptions of their livelihood strategies, including forms of political participation.

The two study locations showed clear differences in opening up political space for their citizens. Yet, the results of the interviews indicate that the PRS did not enhance the political participation of poor and extremely poor people in either municipality. Several exclusion mechanisms hinder poor people from actively getting involved in these processes. Hence, instead of using political means, poor people try to improve their livelihood situation using other strategies. In terms of resources and assets, these strategies range from diversification of income sources or loans from local credit associations to migration.



Election of the transparency commission which is responsible for auditing local PRS projects in Honduras

Research fellow

Sandra Contzen, University of Zurich and SHL, Switzerland

Supervisors

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University of Zurich, Switzerland;
Urs Scheidegger, SHL, Switzerland

Collaborators

Maria Eugenia Baltodano, CIAT, Nicaragua;
Arie Sanders, Zamorano University, Honduras;
Rudi von Planta, SDC, Nicaragua

Duration

June 2008 – May 2012

Governance, collective action and development interventions in vegetable value chains

High-value agriculture is the fastest growing agricultural sector in developing countries. Vegetables are considered to be part of the high-value agricultural products. They have relatively high unit values, a high income elasticity of demand and their production offers considerable amounts of labour. Due to rapid urbanisation in developing countries and globally changing consumption patterns, the demand for vegetables is expected to rise substantially. As a result, the sector has received considerable attention from the donor community with the focus on how to integrate smallholders into these emerging value chains.

This project aims at analysing the potential for African smallholders to benefit from these developments. In particular, the study addresses three areas: (i) the governance modes of vegetable value chains, (ii) the aspects of collective organisation for marketing the produce, and (iii) the interventions of external facilitators in vegetable value chains.

Since northern Tanzania is a major vegetable growing area, it was chosen as study region. It has a favourable climate and abundant water resources, and its production is not only of domestic but also of regional relevance. Furthermore, there is a small but growing industry of high-value vegetables for export to developed countries.

In 2010, a typology of generic vegetable value chains was developed and mapped, comprising the following value chain types: Local vegetable markets, urban vegetable markets, processed vegetables, vegetable seed production, institutional procurement, catering and tourism industry, and fresh vegetable export to developed countries.

In a next step, stakeholder-specific quantitative surveys were developed and conducted at retail, wholesale, transportation and producer level. This was complemented with a qualitative survey on interventions of development agencies. Since the research indicated that local vegetable markets are the most important value chains (both by volume and by value), a price-monitoring scheme was set up. Thus, tracking of the weekly prices at wholesale and retail level was possible for all major vegetables on four important markets in the Arusha area.

Preliminary results indicate that smallholders are the main production basis for vegetables. However, while the integration of smallholders into the more sophisticated vegetable value chains has been accomplished for individual cases, their long-term viability is confronted with multiple challenges.

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Research fellow

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Supervisor

Bernard Lehmann, ETH Zurich, Switzerland

Collaborators

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Abdou Tenkouano, AVRDC, Tanzania;
Andrew Temu, SUA, Tanzania

Duration

August 2008 – August 2011



Sorting and packing of tomato for processing and seed production in Tanzania

The importance of forest fragments in local livelihood systems

On the East Coast of Madagascar, forests are increasingly being pushed back as a result of shifting cultivation pursued by the majority of the local land users. Slash-and-burn activities are the most important direct reasons for deforestation. In the period between 2004 and 2009, the annual deforestation rate of the remaining forest of about 30'000 ha was over 5%.

The study site in Manompana lies in a very remote area of the East Coast. All farmers are smallholders, relying on the production of mountain rice cultivated after slash-and-burn. The cohesive large forest is continuously fragmented by this burning system. What remains are forest fragments in a mosaic landscape. This research project focuses on ways to improve the management of forest fragments with regards to biodiversity and local livelihood strategies.

Results show that the diversity of tree species in the study site is higher in forest fragments than in large cohesive forest areas, while precious woods are significantly more abundant in large cohesive forests. This is due to illegal logging of precious woods in the past, mainly carried out in areas close to roadways and in fragmented forests. For their own consumption, farmers prefer trees with small diameters (<30 cm). Accordingly, this diameter class has a low abundance in forests near villages.

During the last phase of this project, traditional harvest practices and their impact on *Pandanus guillaumetii* were analysed. *P. guillaumetii* is one of the most important non-timber forest products identified in our study site. It only grows in the tropical humid forests on the East Coast of Madagascar. Leafs of the plant are used for weaving mats, either for personal use or for selling at local markets. In order to understand the influence of human pressure on the plant population, plant inventories were conducted as well as interviews and participatory observation with local people harvesting the plant. The results suggest that local communities apply practices minimising the harvest impact on the plant. However, the availability of plants of sufficient quality to produce mats is significantly influenced by human pressure.

Working closely together with a local forestry project realising decentralised community forest management, the information gained during this study will be communicated and implemented. New management rules should consider traditional harvest practices and customary rights in order to minimise possible conflicts and to respect local people's interests and rules.



Farmers collecting wild honey in forest fragments in Madagascar

Research fellows

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Supervisors

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Gabrielle Rajoelison, ESSA, Madagascar

Collaborators

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Etienne Andriamapandry, AIM, Madagascar

Duration

September 2008 – September 2011

Ethanol production impacts on land use and deforestation

Less-developed countries such as Brazil and Indonesia with established biofuel production capacities and high land surpluses stand to benefit from increasing biofuel demand in both developed and developing economies. However, there is currently a debate on potential negative impacts of biofuels. More precisely, the links – either direct or indirect – between bioethanol production, land use and forest conversion are still not well-understood, neither at the conceptual nor at the empirical level. Therefore, the objective of this project is to fill the gap in the literature by investigating these direct and indirect links and by measuring them empirically.

The first phase of the project consisted of conceptualising the impacts of ethanol production, resulting in a theoretical paper identifying three potential effects of ethanol production on land use and deforestation: First, the standard and well-documented effect of direct land competition between rival uses, thereby increasing deforestation and decreasing food production. Second – provoked by a shift in food price – an indirect displacement of food production across regions, thus increasing deforestation and reducing the total output of the food sector. Finally, labour mobility between sectors and regions, tending to decrease food production as well as deforestation. The overall impact of

ethanol production on forest conversion is ambiguous, providing a number of interesting pointers to further, empirical research.

The second phase of the project is currently in progress. It consists of testing the theoretical results, using empirical data from Brazil, the world's second largest bioethanol producer and a major consumer country. An important panel dataset has now been assembled and the empirical analysis is being undertaken.

The research findings from this project are expected to be useful for optimal policy design both in current biofuel producer and consumer countries. Potential future producers such as South Africa, Colombia and Angola may also benefit from policy implications derived from the research output.

Research fellow

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Supervisors

Stefanie Engel, ETH Zurich, Switzerland;
Charles Palmer, LSE, UK

Collaborators

Charlotte Opal, Roundtable on Sustainable Biofuels/EPFL, Switzerland;
Sven Wunder, CIFOR, Brazil;
Paulo Moutinho, IPAM, Brazil

Duration

February 2009 – February 2012



Sugarcane harvesting in São Paulo State, Brazil

Phosphate nutrition of crops in lixisols from semi-arid West Africa

A very large proportion of the population living in the semi-arid areas of sub-Saharan Africa lives from subsistence agriculture and is suffering from extreme poverty and food insecurity. Research conducted in West Africa has shown that organic matter and phosphorus (P) inputs are essential to restore the fertility of the fragile soils (lixisols) and to improve crop production in the region. However, there is a lack of information on how organic amendments affect P availability to crops in these lixisols.

This project conducted in the centre of Burkina Faso aims at evaluating the effects of organic amendments on soil P dynamics, on crop nitrogen and P nutrition, as well as on crop productivity. The model crops used are sorghum (*Sorghum bicolor*), which is widely cultivated in the area, and promiscuous cowpea (*Vigna unguiculata*), which is an important cash crop.

From July to December 2010, various experiments were conducted. Amongst others, the impact of different treatments on sorghum yields, soil available P and soil microbial P was studied in the long-term field experiment of the Saria research station in Burkina Faso.

The treatments consisted of: No nutrient added since 1960 (control), low mineral fertilisation, low mineral fertilisation and low manure input, high mineral fertilisation, and high mineral fertilisation and high manure input. Furthermore, a lab experiment was set up to investigate soil microbial P limitation using soil samples taken on the horizon 0–10 cm of the respective treatments.

In addition, nitrogen fixation by cowpea in farmer's fields was investigated, using the natural abundance method. For this purpose, microplots of 32 m² were placed in 33 cowpea fields. Cowpea yields were measured on the microplots at harvest and soil was sampled for chemical characterisation. The 33 farmers were questioned about their fertilisation strategies practiced during the last five years.

The objective of this part of the project is to understand the practices of farmers and to compare these practices with the fertilisation strategies used in the long-term trial. Based on this, the study aims at identifying fertilisation strategies which can be recommended to farmers.



Cowpea growing on microplots in Burkina Faso

Research fellow

Delwendé Innocent Kiba, UPB, Burkina Faso, and ETH Zurich, Switzerland

Supervisors

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Collaborator

Saïdou Koala, CIAT, Kenya

Duration

May 2009 – May 2012

Characterisation of drought tolerance in cassava

The agricultural sector directly or indirectly employs more than two-thirds of Kenya's 39 million people. An estimated one-third of this population lives in the arid and semi-arid lands (ASALs) that constitute 80% of Kenya. ASALs are fragile, often over-grazed and prone to frequent droughts. However, more than 50% of these lands have agricultural potential if adequate irrigation systems are installed and drought-tolerant crops are available.

This project is focused on cassava (*Manihot esculenta* Crantz), one of the most widely cultivated staple crops in Africa. Cassava is the world's fifth important staple crop following rice, wheat, maize and potato, providing food for nearly a billion people in 105 countries of the tropics and sub-tropics. Cassava yields more than most staple crops – not only under optimal circumstances but also under prolonged drought conditions. Cassava cultivars with longer leaf retention – called “staygreen” – have been found to produce more total fresh biomass and higher root dry matter under drought conditions.

The research aims at characterising drought tolerance in cassava at the phenotypic, physiological and molecular level. In the initial phase, the performance of “staygreen” cassava cultivars was evaluated under field conditions in Kenya. Several cultivars showed contrasting responses

to drought, which is why they are being characterised for leaf shedding and yield performance in a second field trial. This first project phase will generate essential data to help cassava breeders select parental material for their cassava breeding programmes.

In the second phase of the study, contrasting cassava cultivars were selected in order to decipher the molecular mechanisms conferring “staygreen” traits to those of cassava. In Switzerland, the chosen cultivars have been submitted to drought under controlled greenhouse conditions. Candidate genes were selected and molecular methods developed to quantify their expression. In order to decipher differential regulations, the expression profile in various cassava cultivars shall be characterised upon drought treatment. These molecular studies will allow developing potential markers, essential for efficiently introgressing “staygreen” drought tolerance traits into African farmer-preferred cultivars.

So far, six drought-tolerant cultivars and some cultivars moderately tolerant to drought were identified. Thirty-five genes involved in response and tolerance to drought have been selected from other plant species and their cassava orthologs have been identified. Furthermore, primers have been designed for transcript quantification analysis.

Research fellow

Charles Orek, ETH Zurich, Switzerland

Supervisors

Wilhelm Gruissem and Hervé Vanderschuren, ETH Zurich, Switzerland;
Morag Ferguson, IITA, Kenya

Collaborator

Joseph Kamau, KARI, Kenya

Duration

July 2009 – July 2012



Harvesting and weighing of cassava storage roots in Kenya

Whole genome profiling of *Theileria parva* isolates

East Coast Fever (ECF) is a fatal lympho-proliferative disease in cattle, caused by the protozoan *Theileria parva* and transmitted by the brown ear tick. ECF is endemic to East, Central and Southern Africa, causing an annual loss of 1.1 million cattle and an annual economic loss of at least USD 168 million. About 28 million cattle are at risk of contracting the disease. In sub-Saharan Africa, ECF is primarily controlled by the use of chemical acaricides. However, this is becoming unsustainable due to high costs, increasing risks of emerging acaricide-resistant tick strains and the retention of toxic residues of the chemicals in meat, milk and the environment.

One of the measures for controlling the disease is through the infection and treatment method (ITM). Although not widely adopted in the past due to policy constraints to production and delivery, recent successful immunisations of cattle in the pastoralist system in Tanzania have triggered an increased demand for ITM in other ECF-endemic parts of Africa.

So far, the focus of this project has been on preparing sequencing material. The first genome sequence of *T. parva* was published in 2005, providing a wealth of information on the gene content, gene arrangement, structure and basic physiological processes in this important parasite. However, it has become increasingly apparent that by sequencing additional genomes within a single species, considerable

value could be added to the whole genomic data. This includes both defining levels of genetic polymorphisms in important genes and conversely identification of functionally important conserved sequences, particularly within non-coding regions. With the next generation of sequencing technologies, large amounts of genomic data can be generated at substantially lower costs. In this study, one of these novel sequencing technologies was used: Roche/454 pyrosequencing. It is applied to sequence the genomes of several *T. parva* isolates, including two of the three components of the ITM vaccine.

Genome comparisons were carried out for specific genomic regions. Four of the six known cytotoxic T lymphocytes antigens showed polymorphisms between isolates. Localisation of 60 known satellite markers was ascertained in the genomes and copy numbers for these are being determined for all the isolates. From the satellites analysed so far, four show unique size alleles that could be used as markers for differentiating *T. parva* isolates. Satellite data will be combined with single-nucleotide polymorphism analysis to construct a high-resolution map of the frequency and distribution of polymorphic sites in the *T. parva* genome.



The infection and treatment method vaccine being administered to a calf in Kenya

Research fellow

Sonal Patel, ILRI, Kenya

Supervisors

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Richard Bishop, ILRI, Kenya

Collaborators

Weihong Qi, University of Zurich, Switzerland;
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Duration

August 2009– August 2011

Healthy rice for healthy people: Biofortification of zinc in rice

Zinc (Zn) deficiency is one of the most widespread nutritional disorders affecting mainly resource-poor women and children in South and Southeast Asia. The deficiency is observed in nearly 50% of soils used for cereal production in the world. In rice – a major staple cereal for more than 2.5 billion people – Zn deficiency is usually detected soon after flooding, due to reduced conditions as a result of submergence. Ultimately, the inability of rice plants to take up Zn from soil results in the Zn deficiency-induced micronutrient disorder in humans consuming rice as staple food. Biofortification of rice is a cost-effective strategy to overcome this deficiency. Although several rice lines with high grain-Zn have been developed through conventional breeding, the grain-Zn content is highly influenced by soil physicochemical properties. Understanding the physiological mechanisms influencing Zn uptake from soil and its allocation under different soil environments into various plant parts is therefore one of the prerequisites for developing Zn-biofortified rice.

The objectives of this project are (i) to characterise the Zn uptake mechanisms by roots as well as the Zn transport and remobilisation mechanisms from roots or leaves to grain in existing high and low grain-Zn rice genotypes, and (ii) to understand how key soil and crop management practices affect Zn uptake and transport mechanisms within various soil environments.

The range of Zn concentration causing deficiency/toxicity in rice is very narrow. Therefore, identifying the optimum concentration of Zn required for normal growth of rice is essential. For this reason, an experiment was carried out at IRRI, growing a lowland Zn deficiency-susceptible rice variety (IR74) in agar nutrient solution (ANS) until maturity. Zn was supplied at six different concentrations ranging from 0.005 μM to 6.5 μM of ZnSO_4 . Lower deficiency symptoms with higher biomass accumulation and translocation of Zn from roots to stem and leaves at 1.5 μM Zn supply indicated it as the optimum concentration of Zn required for the normal growth and development of rice in ANS.

A second experiment was carried out in order to physiologically characterise 10 rice genotypes contrasting for high grain-Zn and Zn efficiency at the following two Zn levels: 0.005 μM (Zn-deficient) and 1.5 μM (Zn-sufficient) ZnSO_4 . At all growth stages, significant reduction in various traits such as plant height, maximum root length and total dry matter was seen at 0.005 μM Zn supply compared to 1.5 μM Zn. Compared to low grain-Zn lines, high grain-Zn lines maintained viable roots at 0.005 μM Zn supply. Moreover, IR74 showed higher accumulation of Zn in the roots, whereas Zn-efficient and high grain-Zn lines showed higher translocation of Zn to upper plant parts.

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Research fellow

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Supervisors

Sarah Beebout, IRRI, Philippines;
Rainer Schulin, ETH Zurich, Switzerland

Collaborator

Abdelbagi Ismail, IRRI, Philippines

Duration

August 2009 – August 2011



Quantifying zinc in agar nutrient solution using a flame-atomic absorption spectrometer at IRRI, Philippines

Farmers' responses to climate change in northern and central areas of Côte d'Ivoire

As in most developing countries in Africa, climate change in Côte d'Ivoire is manifested by a general reduction in annual precipitation as well as a late beginning and early ending of the rainy season. Consequently, the dry season is getting longer both in the northern and central part of the country. This aggravates the already existing water shortage problem, which in turn severely affects both food crops and livestock. Today, climate is one of the most constraining factors for the agricultural sector in Côte d'Ivoire.

Therefore, this project aims at elaborating effective and acceptable adaptation strategies regarding climate change. This is achieved by analysing farmers' decision-making processes related to climate change and their risk management strategies when faced with its negative impacts. Furthermore, farmers' perception of climate change and their adaptation behaviour will be investigated, taking into account: (i) the institutional context in Côte d'Ivoire, (ii) the socio-economic as well as the market conditions, and (iii) the individual factors such as personal values and climate risk perception.

Accordingly, the focus of this study lies on identifying, analysing and assessing

- the personal decision field of farmers regarding farm management;
- the farmers' behaviour related to uncertainties of climate change;
- the relevant determinants of the decision behaviour of farmers leading to the adoption of certain adaptation strategies – with a special emphasis on water shortages;
- the institutional context regarding climate change and food security, including the interplay between the relevant institutions and farmers;
- the adaptation strategies and necessary conditions that lead to an active response to climate change by farmers;
- the feasibility of these adaptation strategies;
- the factors which prevent farmers from participating in adaptation strategies.

Data will be obtained through qualitative interviews, focus groups and surveys. The data analysis will be carried out using common statistical tools. Based on the results, feasible and acceptable adaptation strategies to climate change will be elaborated. Recommendations for the successful implementation of these strategies will be formulated. Finally, direct suggestions on how to transfer the gained knowledge to the stakeholders will be presented.



Interview with breeders in Korhogo, Côte d'Ivoire

Research fellow

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Supervisors

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Dao Daouda, CSRS, Côte d'Ivoire

Collaborators

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Duration

October 2009 – October 2012

Reducing the impact of cassava brown streak disease

Cassava serves as staple food for nearly a billion people in 105 countries of the tropics and sub-tropics, where it provides as much as one-third of the daily calories. Particularly in Africa, the root is regarded as food insurance of the poor, since it produces stable yields even in the face of prolonged drought conditions, low soil fertility and low labour input. Cassava is vulnerable to at least 20 different viral diseases. More recently, cassava brown streak disease (CBSD) has caused devastating losses in cassava fields in East Africa. CBSD is endemic to Africa and caused by the cassava brown streak virus (CBSV).

In the initial phase of this project, the natural resistance/tolerance was evaluated both in the existing elite cultivars and in the material bred for CBSD resistance by Tanzanian and Kenyan breeders. The grafting method under controlled greenhouse conditions and coupled to the quantitative detection of the viral load provided a reliable evaluation approach for CBSD resistance. This initial phase will generate essential information for rapidly identifying CBSD resistance and integrating the selected elite lines in existing breeding programmes. In addition to the CBSD resistance characterisation, the best performing elite lines and cultivars were tested for CBSD resistance against a collection of CBSV species and isolates in order to evaluate their potential for sustainable resistance in the field.

In the second phase of the study, cutting-edge high-throughput sequencing technology shall be applied in order to investigate the transcriptome modulation in CBSD-susceptible and CBSD-resistant germplasm. The use of contrasting cultivars will allow deciphering differential gene regulation in the cultivars contrasting for CBSD resistance. Genes with differential gene regulation will then be validated in selected cassava cultivars. Thus, new markers for CBSD resistance in cassava shall be provided.

So far, the elite lines of the ETH Zurich cassava germplasm have been multiplied and cassava lines from breeding programmes of KARI in Mombasa and IITA in Dar es Salaam have been obtained. Furthermore, the initial virus resistance evaluation of the selected cassava lines with CBSV revealed three cassava lines remaining symptomless upon grafting on infected rootstock. Since these CBSV-resistant lines remained symptomless also when grafted on rootstock infected with the moderately severe species CBSV Uganda, these results prove that the resistance is stable across CBSV species. In addition, the molecular characterisation demonstrated that CBSV is not replicating in the CBSV-resistant lines.

Research fellow

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Supervisors

Wilhelm Gruissem and Hervé Vanderschuren, ETH Zurich, Switzerland

Collaborators

Maruthi M.N. Gowda, University of Greenwich, UK; Edward Kanju, IITA, Tanzania

Duration

April 2010 – April 2013



Evaluating the resistance/tolerance of selected cassava lines with CBSV

Enhancing tree growth by exploiting beneficial insects and defensive plant traits

Planting native timber trees on deforested land such as cattle pastures in Central and South America can protect remaining forests while sustaining local communities by generating income and restoring degraded land. Such timber trees may provide small-scale farmers with additional income as well as shade and fodder for cattle and wood for multiple purposes. Furthermore, they improve the soil structure and ultimately increase milk and meat production. However, the successful establishment and growth of timber trees is often impeded by insect pests, thus rendering the design of cost-effective and environmentally-friendly pest management strategies a meaningful development goal.

In order to enhance tree growth through favourable planting systems, this project aims at investigating the following two pest management strategies: (i) the impact of beneficial insects (top-down) and (ii) the impact of defensive plant traits (bottom-up). Beneficial insects may comprise ants or parasitoid wasps. Defensive traits are chemical or physical plant properties that either reduce the survival and performance of pest species (antibiosis) or make the plant less attractive to them (antixenosis).

Two innovative planting systems have been established in an experimental plantation in Central Panama: A pasture-afforestation system and a silvopastoral system. In the pasture-afforestation system, the native timber tree species *Tabebuia rosea* is planted in high-density plantings in a classical monoculture as well as in a three-species mixture. The silvopastoral system with its low-density planting is considered a promising option to cultivate valuable timber trees within existing pastures, while at the same time maintaining livestock. A field study was carried out to measure relevant tree parameters and to collect herbivores and their natural antagonists from the tree crowns for subsequent identification. Furthermore, experiments were conducted in order to gain information on the role of ants in this tropical system. Results are expected to reveal the impact of selected groups of beneficial insects on herbivory as well as the effect of the novel planting systems on arthropods and timber tree growth.



Local assistants measuring the growth of native timber trees in Panama

Research fellow

Judith Riedel, ETH Zurich, Switzerland

Supervisors

Silvia Dorn and Karsten Mody, ETH Zurich, Switzerland

Collaborators

Catherine Potvin and Hector Barrios, STRI, Panama

Duration

April 2010–April 2013

Improving grazing systems with yak-cattle crossbreeds in Nepal

The transhumance livestock system of northern Nepal plays an important role for the livelihood of rural Sherpa communities. The objective of this project is to study the production performance of yak-cattle crossbreeds (*chauries*) and female yaks (*naks*) at different altitudes along a transhumance route and, in case of the *chauries*, at different stocking densities.

In a first step, a household survey was conducted between February and April 2010 within four areas inside the Kangchenjunga Conservation Area in the Taplejung district. Altogether, 240 households were included. The aim of the survey was to characterise the local farming system traditionally practised in the northeastern part of the Himalayan Mountains. Furthermore, a preparatory field based pasture and grazing route assessment was carried out in order to select a study site for the subsequent grazing experiment. A traditional transhumance route used by yak and *chaury* herders from Olangchung Gola was selected. It included several different pastures covering altitudinal ranges from 2000m to 5000m. In addition, five pastures at different altitudinal levels (3200m, 4000m, 4500m, 4000m and 2600m) were chosen for the controlled grazing study conducted between May and November 2010.

Among these, three were used for assessing the ascending transhumance herd movement while the other two should help to simulate the descending herd movement.

At each of the five study sites, fenced paddocks were constructed in order to study the effects of different stocking densities on forage intake, animal live weight and animal behaviour as well as on milk production performance and quality of milk and milk products such as butter and ghee. Two paddocks were stocked with two *chauries* each, while two further paddocks of similar size were stocked with four *chauries* each. At the three highest assessment sites, two additional paddocks were stocked with two *naks* each for genotype comparisons. The information gathered on milk yield and composition was determined using a portable milk analyser operated by a portable solar collector. Data on animal body weight could be gathered by portable scales, forage intake by using the double alkane technique and animal behaviour by using pedometers. Butter and ghee were produced applying self-constructed butter-making equipment with four units and a traditional dehydration method. Additionally, standing biomass and botanical composition of the pastures were recorded.

Research fellow

Shanker Raj Barsila, ETH Zurich, Switzerland

Supervisor

Michael Kreuzer, ETH Zurich, Switzerland

Collaborators

Svenja Marquardt, ETH Zurich, Switzerland;
Naba Raj Devkota, Tribhuvan University, Nepal

Duration

September 2009 – August 2012



Herders helping to weigh a calf on portable scales at a pasture site in Nepal

Monitoring of forest carbon stocks in the Miombo woodlands in western Tanzania

Growing concern about climate change caused by rising atmospheric CO₂ concentrations has drawn attention to the role of forests in absorbing and sequestering carbon. Under the concept of the REDD mechanisms (Reducing Emissions from Deforestation and Forest Degradation), forests are now taking centre stage of international climate negotiations. It is anticipated that the global leaders will reach a consensus on the REDD scheme package that will enable communities to earn money by not clearing trees. Intact forests will provide communities with numerous additional benefits such as improved soil quality, reduced runoff, water supply and food.

In Tanzania, rural communities living in the Miombo woodlands have been engaged for years in a number of forestry conservation activities, thus qualifying for benefiting from the global REDD carbon credit process. However, barriers such as a lack of technical know-how as well as high costs of professional carbon measurements and verifications have prevented their market access so far. This access is further aggravated by the fact that every local forest project must provide detailed information on the extent to which its interventions result in carbon storage and enhancement.

By developing methods for studying the Miombo woodlands in terms of forest carbon stocks, this study aims at

removing some of the above mentioned obstacles in order to help local communities to enter the REDD process. Using satellite technology for earth observation, a range of participatory tools will be prepared to estimate the landscape-level forest carbon stocks. Subsequently, a methodological approach for the use by local communities shall be designed. A remote-sensing GIS field guide will serve as the research product, demonstrating local communities and their domestic supporting organisations how to monitor carbon stocks in their forests. It shall be proven that remotely sensed data are able to quantify changes in the forest carbon stocks. Yet, simply detecting the changes will not be sufficient for the purposes of the REDD market according to the reporting guidelines of the United Nations Framework Convention on Climate Change (UNFCCC). Therefore, additional information on the reason of the changes is required, such as natural disturbance or direct human-induced change.

The local community will be trained to use hand-held computers in order to carry out a number of activities such as (i) marking forest boundaries, (ii) measuring and recording key tree variables, (iii) interpreting satellite images, (iv) locating permanent sample plots using GPS, and (v) retrieving plots for future assessments.



Timber processing as an economic activity in the Miombo woodlands, Tanzania

Research fellow

Hermegast Ambrose Makoi, ETH Zurich, Switzerland

Supervisors

Nina Buchmann and Lutz Merbold, ETH Zurich, Switzerland

Collaborators

Bettina Wolfgramm, University of Bern, Switzerland;
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Phillip K. Mwanukuzi, University of Dar es Salaam, Tanzania

Duration

September 2010 – August 2013

Access of the poor to India's National Urban Renewal Mission in a medium-sized city

In 2005, the Indian Government promised slum dwellers in 65 cities to provide better access to basic services and other civic amenities, including tenure security and improved housing. This initiative was part of the urban governance reform and infrastructure investment programme Jawaharlal Nehru National Urban Renewal Mission (JNNURM), which is now in its final stage.

Slums as settlements of the urban poor are a key spatial characteristic of India's urbanisation process. While these represent important components of the emerging urban fabric, the contribution of the poor to the development of Indian cities is rarely acknowledged. Instead, the poor are treated as a problem. Therefore, this study will contribute to the current debate by engaging policy analysis and urban studies from a poverty perspective. In order to realise benefits offered by programmes such as JNNURM, the location and socio-economic composition of slums seem to be the critical factors for the prospects of poor communities. Therefore, the main focus of this research is on the resources and strategies of these communities for improving their neighbourhoods. In short, the project aims at exploring the reasons that make some poor communities more successful in accessing governmental support than others.

After a preparatory phase, the spatial and socio-economic structure of slums will be analysed using the medium-sized city Puri as case study area. Important questions in this regard are: Where are the slums located? What is their spatial and socio-economic relation to the city? What development perspectives are available to them? To answer these questions, existing reports and surveys will be assessed and site visits and discussions with local stakeholders will take place. A series of citywide qualitative socio-spatial maps will be produced, which will be used to develop a typology of slums and to identify four poor communities for in-depth study.

In a second step, detailed case studies will be conducted. Combining interviews, discussions and participant observations, questions will be addressed such as: How are these communities organised (formally, informally)? Which strategies have they developed to improve living conditions? On which resource bases (cultural, traditional, political) can they draw? With whom do they interact (urban local bodies, wards, political/religious leaders)? Who supports them, how and why? In the end, findings from the community level will be visually and analytically integrated into a citywide analysis, in order to provide insights of relevance to Indian policy makers.

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Research fellow

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Supervisors

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Collaborators

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Duration

October 2010 – September 2013



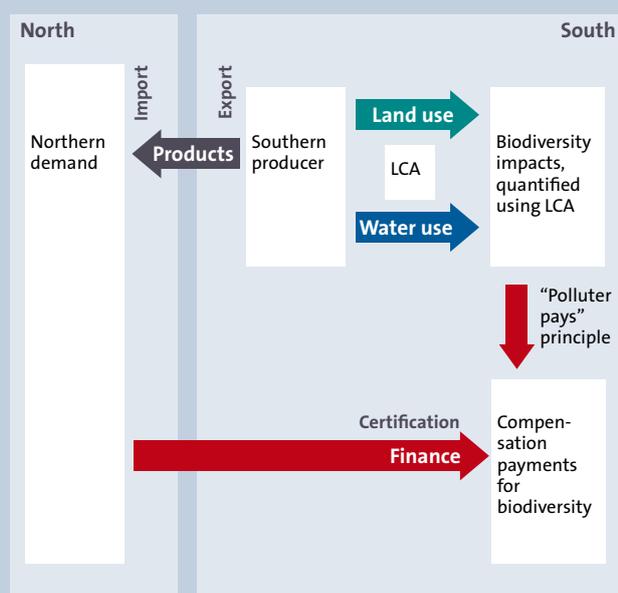
Community making a living from waste collection and recycling in Mathura, India

Assessing product-related impacts of land use on biodiversity at global scales

Many agricultural commodities consumed in the industrialised world originate from developing countries and emerging economies. Products such as coffee, soya or palm oil create multifaceted environmental impacts in the countries of origin. Biodiversity loss due to land use change is amongst the most severe impacts, occurring not only at the production phase but also along the entire global supply chain. In order to achieve more sustainable consumption, decision-support tools such as life cycle assessment (LCA) can be used to quantify the overall impact along the life cycle of a commodity. LCA calculates inputs and outputs (i.e. resource use and emissions) during the various stages of a product's life cycle, from extraction of raw materials to production, use, and finally disposal or recycling. All environmentally relevant impacts of inputs and outputs should be assessed to generate a comprehensive picture of potential trade-offs between different effects such as climate change and biodiversity loss. In a second step, the environmental impacts are modelled. However, for assessing the important aspect of land use impacts on biodiversity, a method for comprehensive life cycle impact assessment is still lacking.

This study therefore aims at developing a global, spatially differentiated assessment method for measuring the land use impacts on biodiversity, compatible with LCA. In order to assess these impacts, the difference in biodiversity between a production system (e.g. arable land) and a reference situation (e.g. a semi-natural ecosystem) is assessed in the same region. Thereby, the difference in biodiversity is measured as changes in species abundance and richness. Data is derived from a meta-analysis of peer-reviewed publications. The aim is to quantify region-specific impacts of various land use types on biodiversity at a global scale. If region-specific data is missing, impacts will be approximated by average data across larger spatial scales such as biomes. In addition, globally available data on species richness, endemism and ecosystem vulnerability provided by the World Wide Fund for Nature (WWF) will be used to further account for region-specific differences.

In a second step, a more detailed regional method will be developed. This method will allow accounting for spatial patterns in biodiversity and land use related drivers of biodiversity loss. It can be applied in case studies where additional biodiversity and supply chain information is available, such as during the process of product certification.



Project leader

Stefanie Hellweg, ETH Zurich, Switzerland

Supervisors

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Roland Scholz, ETH Zurich, Switzerland

Principal investigator

Laura de Baan, ETH Zurich, Switzerland

Collaborators

Gemma Shepherd, UNEP, Kenya;
Mario Boccucci, UNEP, Kenya

Duration

July 2009 – July 2012

Within the UNEP-ETH collaborative project "myEcosystem", two doctoral students are developing methods to assess production-related impacts of land and water use on biodiversity, using life cycle assessment (LCA). A third doctoral student is developing a framework for compensating these impacts based on the "polluter pays" principle. The methods are applied in several case studies, amongst others by a postdoctoral scientist in Peru.

Overview of the linkages in the UNEP research project "myEcosystem" (see pages 69–72)

Method development for assessing impacts of water use on terrestrial ecosystems

Many commodities consumed in industrialised countries are produced in developing and transition countries. A considerable part of these exporting countries are located in semi-arid and arid regions, where water is generally a scarce resource, available only seasonally. In order to expand agriculture into areas previously considered unsuitable due to lack of water availability, a lion's share of global water withdrawal is used for irrigated agriculture. As an example, Saudi Arabia uses 90% of its total water withdrawal for agriculture. 96% of this water stem from largely non-renewable, deep aquifers. In many cases, the water resources pumped from aquifers or diverted from rivers and lakes are used in a non-sustainable manner, thus leading to resource depletion, increased water scarcity and damages to ecosystems. In spite of this precarious situation, a comprehensive assessment for estimating the impact of water use on ecosystems is still missing within the framework of life cycle assessment (LCA).

Therefore, the aim of this study is to develop a spatially differentiated methodology which is compatible with LCA for assessing the impacts of agricultural water use on terrestrial ecosystems. The focus lies on semi-arid and arid regions, with an emphasis on impacts on flora.

The most relevant ecosystems are wetlands and springs, as well as groundwater-dependent terrestrial keystone species such as large savannah trees and riparian ecosystems.

For fostering methodological development, a combination of approaches on different geographical scales is used. An initial prioritisation of global semi-arid and arid areas according to their water use levels and water stress helps identify the most relevant areas (top-down approach). In a second step, remotely sensed leaf area index pictures help detect "green spots" in an otherwise dry environment, thus identifying irrigated areas or areas where additional water sources are available. On a smaller geographical scale, these results help locate potentially relevant areas for more explicit case studies, serving to derive impact factors in detail (bottom-up approach).

One case study is currently being carried out in the Santa Rosa wetland in Peru, investigating the impact of agricultural water use on wetlands in the coastal area. The next steps are the identification of further case study areas as well as the establishment of a rough top-down assessment scheme for supporting the prioritisation of areas on a global scale.

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Project leader

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Supervisors

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Stephan Pfister, ETH Zurich, Switzerland

Principal investigator

Francesca Veronesi, ETH Zurich, Switzerland

Collaborators

Patrick M'mayi, UNEP, Kenya;

Thomas Chiramba, UNEP, Kenya

Duration

September 2009 – September 2012



Santa Rosa wetland in the province of Lima, Peru

Compensating biodiversity loss due to land use and water use in agriculture

The environmental externalities framework in economics posits that markets fail because they do not adequately price impacts to the environment, such as the loss of biodiversity and ecosystem services caused by land and water use in agriculture. Global patterns of agricultural production and consumption are skewed, since richer northern nations predominantly consume, while poorer southern nations predominantly produce. Yet, the majority of biodiversity impacts occur during the production phase. Thus, external costs of biodiversity loss are often concentrated in tropical regions of high population density, poverty, inequality and biodiversity value. External costs are therefore frequently levied upon nations and peoples with the lowest relative capacities to afford them.

The concept of “true costing” attempts to deal with economic externalities by pricing goods and services through premiums or taxes at a level sufficient to prevent the existence of negative external costs or at least compensate their effects. Thus, the “polluter pays” principle is applied. Despite its attractiveness, the concept remains difficult to operationalise with unresolved issues of impact modelling, valuation and socio-economic feedbacks. This study investigates taking a safe minimum standard approach towards internalising costs of biodiversity loss. The approach

requires setting an ecologically and socially defined minimum target of biodiversity persistence in anthropogenically-modified landscapes. Furthermore, it implies internalising the cost of meeting this target into the price of agricultural commodities produced within the landscape.

The current framework is being tested in two case study areas in East Africa and Costa Rica, where biodiversity patterns are being mapped using distribution modelling. Anthropogenic pressures from land and water use are overlaid onto the resulting layers to assess regional biodiversity impacts, involving life cycle assessment methods developed in the studies of Laura de Baan and Francesca Veronesi. The costs of meeting regional conservation targets under a safe minimum approach are then estimated using conservation prioritisation methods and socio-economic data. The total cost (e.g. landscape conservation fund) is apportioned to agricultural products based on a combination of remote sensing information, agricultural inventory data and crop production requirements. In late 2011/early 2012, local data will be gathered to test the feasibility of the current framework and the validity of the modelling results.



Threats to afro-tropical forests and other habitats include burning and clearance for small-scale agriculture

Project leader

Stefanie Hellweg, ETH Zurich, Switzerland

Supervisors

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Annette Köhler, PE International, Switzerland

Principal investigator

Michael Curran, ETH Zurich, Switzerland

Collaborators

Nicolas Bertrand, UNEP, Switzerland;
Benjamin Simmons, UNEP, Switzerland

Duration

July 2009 – July 2012

Life cycle assessment of agricultural production in a Peruvian watershed

On the central Peruvian coast, the valleys are intensively used for agriculture, with water being one of the most important limiting factors for production. The region is characterised by a desert climate with no more than 16 mm annual precipitation (Donoso station, Chancay, 2008). All agricultural production depends on underground water or on water from the nearby river, brought to the cultivation sites by an extensive irrigation channel system. In the coastal part of the Chancay-Huaral watershed, situated about 50 km north of the capital Lima, agriculture is an important economic activity. This region is part of the Lima milk shed, one of the three most important milk producing areas of Peru.

The objective of this study is to carry out a life cycle assessment (LCA) of agricultural production in the coastal part of the Chancay-Huaral watershed. Special attention will be paid to water use for irrigation and its effects on the biodiversity of a coastal wetland. The wetland is connected with the agricultural area by an aquifer, thus receiving the excess irrigation water as only water supply.

So far, a LCA has been calculated for the milk of a smallholder system and a semi-industrialised system, as well as for tangerines, which are one of the most promising products in the region.

The milk results were calculated for energy corrected milk (ECM), which is standardised milk with 4% fat, 3.2% protein and 4.8% lactose. First results indicate smaller environmental impacts per kg ECM in total for the semi-industrialised system than for the smallholder system. Whereas differences between the systems regarding global warming potential and eutrophication are small (3.16 ± 0.035 kg CO₂ equivalents/kg ECM and 8.65 ± 0.269 g PO₄ equivalents/kg ECM), acidification is significantly higher for the smallholder system (7.55 g SO₂ equivalents) than for the semi-industrialised system (4.35 g SO₂ equivalents). This is mainly due to a higher milk yield of the cows in the semi-industrialised system, thus generating a dilution of emissions related to the annual milk production.

For 1 kg tangerines produced in an average production system, 0.46 kg CO₂ equivalents, 6.69 g PO₄ equivalents and 11.79 g SO₂ equivalents were emitted.

The next project steps will be the calculation of LCAs for other important agricultural products from the region. Furthermore, the integration of a new method for estimating the impacts of water use on biodiversity is intended.

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Project leader

Stefanie Hellweg, ETH Zurich, Switzerland

Principal investigator

Karin Bartl, ETH Zurich, Switzerland

Collaborators

Ricardo Jimenez, Terra Nuova, Peru;
Beatriz Rosario Alcántara Medrano,
Gobierno regional Lima, Peru

Duration

June 2009–December 2012



Tangerine plantations in the Chancay-Huaral watershed, Peru

Short-term activities

The North-South Centre offers small grants to its members as seed money for establishing partnerships or strengthening impact generation by enabling the implementation of given research results. Seed money projects are always carried out in partnership with scientists from developing countries. In addition, the North-South Centre supports teaching stays where ETH scientists or ETH emeriti lecture at partner institutions in the South. Finally, two types of

activities are funded for visiting scientists: Research stays of scientists from the South at the ETH Zurich, and support for the attendance of scientists from developing countries at conferences organised by the ETH Zurich.

Topic	Scientist(s)	ETH unit(s)
Seed money		
Earthquake hazard mapping in Bhutan	György Hetényi	Department of Earth Sciences; Institute of Geochemistry and Petrology, High Pressure Group (Max W. Schmidt)
Risk preferences in poor rural environments in Benin	Isabel Günther	Department of Humanities, Social and Political Sciences; Centre for Development and Cooperation NADEL (Isabel Günther)
Climate change modelling in Chile – Ecosystems and sediment transport	Francesca Pellicciotti	Department of Civil, Environmental and Geomatic Engineering; Chair of Hydrology and Water Resources Management (Paolo Burlando)
Visiting scientists		
Modelling of water transport through the dense reservoir of the Upper Jaguaribe Basin	George Leite Mamede, Universidade Federal do Ceará, Fortaleza, Brazil	Department of Civil, Environmental and Geomatic Engineering; Chair of Computational Physics for Engineering Materials (Hans Jürgen Herrmann)
Participation of doctoral students from developing countries in the winter school	Lipokmar Dzuwichu, Centre for Historical Studies, Jawaharlal Nehru University, New Dehli, India; Harsha Man Maharjan, Tribhuvan University, Kathmandu, Nepal	Department of Humanities, Social and Political Sciences, Chair of History of the Modern World (Harald Fischer-Tiné)
Agronomic biofortification to fight human zinc deficiency in arid regions	Majid Afuni, Amir H. Khoshgoftarmansh, Banafshe Khalili, Mojtaba Norouzi, Vajihed Dorostkar and Somayeh Ghasemi, Isfahan University of Technology, Iran	Department of Environmental Sciences; Chair of Soil Protection (Rainer Schulin)
Workshop on Research and Design at the ETH Zurich, in collaboration with the FAU São Paulo	Angelo Bucci and Milton Braga, Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo, Brazil	Department of Architecture; Chair of Architecture and Technology (Annette Spiro)
Water governance and economics in the Kafue River Basin	Thomas Simfukwe, Ministry of Agriculture and Cooperatives, Lusaka, Zambia	Department of Humanities, Social and Political Sciences; Centre for Development and Cooperation NADEL (Rolf Kappel)
Impact of shrub encroachment on plant diversity and herbivory in the Kafue Flats floodplain	Griffin Shanungu, Zambia Wildlife Authority, Chilanga, Zambia	Department of Environmental Sciences; Chair of Plant Ecology (Peter J. Edwards)
Teaching stays		
ETHiopia Urban Laboratory Summer School, Ethiopia	Philippe Block, Philipp Aerni, Isabel Günther and Chris Zurbrügg	Consortium of ETH Sustainability, D-ARCH and North-South Centre
University of Peradeniya, Sri Lanka	Caspar Wenk (emeritus)	Department of Agricultural and Food Sciences



School children setting up a tree nursery in Tanzania

Knowing is not enough; we must apply.
Willing is not enough; we must do.

*Johann Wolfgang von Goethe,
German writer*

Capacity development

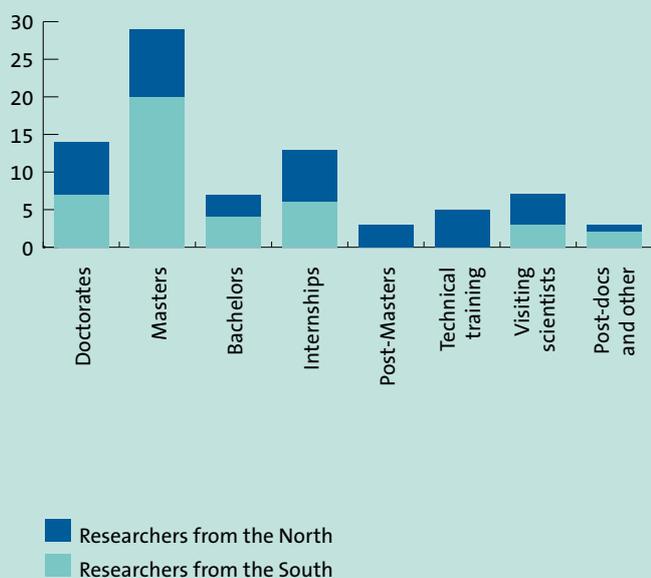
Capacity development can target three different levels: individuals, institutions or the enabling environment. The North-South Centre activities take place mainly on the individual level, supporting both scientists from developing countries and from emerging economies, as well as researchers from the ETH Zurich dealing with development-related topics.

The North-South Centre targets Master students, doctoral students, post-docs and scientists. We serve them through a variety of instruments such as grants or scholarships and by supporting visiting scientists or teaching stays (see pages 42–73). The North-South Centre as competence centre is only partially involved in teaching. One example is our annual colloquium (see page 76). In 2010, we additionally organised the ETHiopia Urban Laboratory Summer School (see page 77).

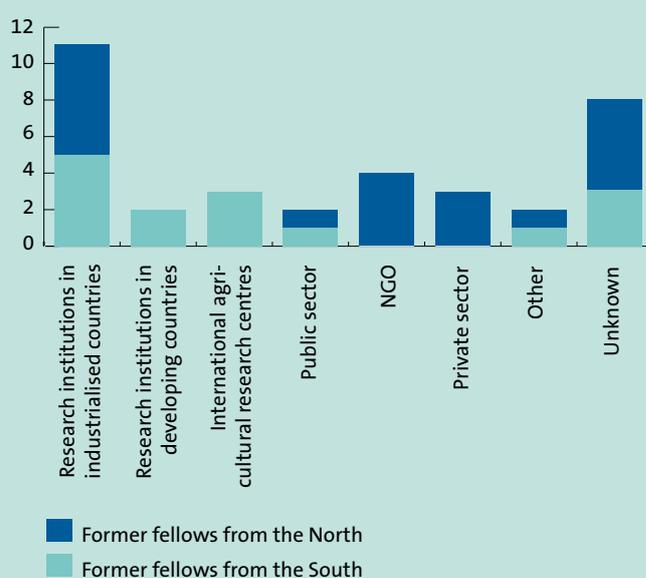
At the ETH Zurich, two postgraduate studies cover North-South topics: the MAS in Sustainable Water Resources as well as NADEL (see page 78). In addition, the majority of the professors who are members of the North-South Centre include aspects of developing countries in their curriculum at the Bachelor and Master level.

In 2010, the North-South Centre analysed the capacity development effect of its research programme on livestock systems. The analysis showed that this research partnership has yielded nearly thirty Master students as a “by-product” of eight research projects with a total of 14 doctoral students, two-thirds of them from the South. Based on this analysis, we concluded that Master grants should preferably be embedded in a wider research partnership with research institutions in the South instead of establishing a separate programme for Master students.

In addition, we analysed the outcome of the capacity development investment in the Research Fellow Partnership Programme for Agriculture, Forestry and Natural Resources (RFPP) since 1996. The majority of former fellows pursue their careers either in science or in development cooperation.



Multiple capacity development opportunities generated by the livestock systems programme



Positions of former RFPP research fellows

Colloquium “Selected aspects of sustainable development”

The annual colloquium on selected aspects of sustainable development of the North-South Centre brings together young scientists with different backgrounds working on development-related topics. The aim of the colloquium is to provide doctoral students with the chance to discuss their projects with an interdisciplinary audience in order to hear new viewpoints and get surprising and unexpected feedbacks on their research. In 2010, eleven young scientists exposed their projects to a critical and interested public. All participants conduct their research at the ETH Zurich. The topics ranged from business models in rural electrification in Laos or arsenic contamination of rice paddies in Bangladesh to behavioural heterogeneity in human cooperation in Ethiopia, giving thereby evidence of the manifold aspects of development.

As an introductory lecture, Jon-Andri Lys, Executive Secretary of the Swiss Commission for Research Partnerships

with Developing Countries (KFPE), spoke about the scientific asymmetries between northern and southern institutions. He emphasised the challenges arising from North-South research partnerships and presented core principles and questions to overcome imbalanced relationships. Maud Châtelet, CEO of Howtopedia, presented the collaborative internet platform she initiated. The platform is similar to Wikipedia, but mainly contains practical knowledge, simple technologies and research results. By publishing this information, the online library aims at fostering technology and knowledge transfer. The good accessibility and easily understandable presentation of the platform should facilitate implementation of research results into practical use in everyday life.

Despite the variety of topics, the participants could benefit from the interesting and productive debate. One of the common aspects was the challenge with which all projects are ultimately confronted: How to render the obtained results relevant for people in developing countries? This topic is a constant companion of the work at the North-South Centre. Thanks to the contributions of all participants, the colloquium fulfilled its objective of being a forum for lively exchange and discussion. The constructive exchange of ideas has been continued at a lunch meeting taking place every first Tuesday of the month. This “regulars’ table”, initiated in 2009 for young scientists interested in development issues, is always very well visited and highly appreciated. All interested doctoral candidates are welcome to join.



Isabel Moreno and Wilhelm Gruissem discussing the different strategies to engineer cassava brown streak virus resistance in cassava with the interdisciplinary audience at the colloquium

ETHiopia Urban Laboratory Summer School

Within the next 15 years, Ethiopia will be confronted with population growth resulting in an additional 45 million people. This poses a huge challenge with respect to shelter in not yet existing – or already overstressed – urban settlements, in addition to the basic needs of food, water and safety. To meet these challenges, innovative housing solutions are desperately needed. Together with the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), the ETH Zurich initiated the ETHiopia Urban Laboratory Summer School, a programme with seminars, lectures and practical projects. The goal of this programme was spreading knowledge and finding solutions related to sustainable urban housing. EiABC is an autonomous institute under the umbrella of the Addis Ababa University. The ETH Zurich was represented by ETH Sustainability, the Department of Architecture and the North-South Centre.

In summer 2010, 18 BSc, MSc and doctoral students from different disciplines of the ETH Zurich as well as 36 of their Ethiopian counterparts worked together in Addis Ababa for three weeks. During the first week, local and external experts gave lectures on the socio-economic and infrastructural requirements in Ethiopia, local building materials and pioneering construction techniques as well as on some broader themes of architecture and construction, water and sanitation, and entrepreneurship. In the ensuing two weeks, the students – all future architects, environmental engineers, scientists or economists – worked on practical tasks. These case studies were related to the Sustainable Urban Dwelling Unit (SUDU), a two-storey low-cost house, built with local materials and local construction workers, which served as a research prototype for urban housing solutions in Ethiopia and other developing nations. The SUDU is expected to offer the poorer population an alternative and easy to build form of housing. The architecture students worked on the SUDU construction site, while the environmental engineers and scientists proposed a design

for a wastewater treatment plant for the SUDU and the entrepreneurs drafted a business plan for loam bricks, a major component of the SUDU.

During the three-week course, the students from Ethiopia and the ETH Zurich sought to understand the current trends and future problems regarding the housing needs of a developing country, while generating the tools and ideas to help solving them. Through intensive collaboration and communication with all people involved – from the professors to the day labourers – the students learned how to build sustainably and cost-effectively under the given circumstances. The final presentations illustrated that the students gained knowledge and skills that will help them to find sustainable solutions for the future demands of their pursuits in urban design.



Ethiopian and Swiss researchers and students at the Sustainable Urban Dwelling Unit (SUDU) construction site in Addis Ababa, Ethiopia

Postgraduate and advanced studies

NADEL – Postgraduate Studies for Developing Countries

NADEL, a unit of the Department of Humanities, Social and Political Sciences (D-GESS) at the ETH Zurich, provides training, research and consultancy in the field of cooperation with developing countries.

The *Master of Advanced Studies in Development and Cooperation* prepares students with a university degree or an equivalent qualification for working with developing countries. It starts every second year and consists of three parts: a full-time study semester, a project assignment in a developing country and a concluding advanced semester for deepening and broadening the acquired knowledge. The *Certificate of Advanced Studies in Development and Cooperation* is an academic training for promoting the professional competences of the participants in key areas of development cooperation. The graduates are introduced to the main instruments used in development cooperation and trained in central topics of the debate on international development policies.

Research at NADEL focuses on providing empirical results and operational solutions. As part of the overarching objective to alleviate poverty in developing countries, the main areas of research are economic and institutional reforms, strategies to reduce poverty and the means of verifying their effectiveness, as well as issues of sustainable resource use.

The staff members of NADEL regularly carry out consultancy assignments for both governmental and non-governmental development agencies. Key areas of consultancy are strategic and operational planning as well as implementation of development cooperation projects and programmes. Furthermore, NADEL provides expert advice on rural development and natural resource management issues as well as on economic and political reforms.

www.nadel.ethz.ch

Master of Advanced Studies in Sustainable Water Resources

The Master of Advanced Studies in Sustainable Water Resources (MAS ETH SWR) is offered by the Institute of Environmental Engineering (D-BAUG) at the ETH Zurich. It advocates an integrated vision of sustainable water resources management. The programme is designed to advance the education of scientists and policy-makers on the importance of water availability and water scarcity in a changing world. It is preparing the participants to face challenges such as climate and land use change, increased water use and population growth. The programme is interdisciplinary and focuses on case studies from around the world and serves to generate international collaboration in water-related research.

Participants in the MAS acquire skills which will enable them to become leaders in implementing sustainable and environmentally conscious water policies in their home countries. The students propose their own research topics, around which a tailor-made study programme is established. The full-time twelve-month programme includes Master level courses, offered by the Institute of Environmental Engineering and other institutes at the ETH Zurich, as well as a Master thesis. The thesis topics comprise water quality and quantity, water for agriculture and for the environment, adaptation to climate change and integrated water resource management.

www.ifu.ethz.ch/MAS_SWR

The North-South Centre successfully brokered grants for two participants in the MAS in Sustainable Water Resources from the *Oeuvre St-Justin* (www.justinus.ch). In addition, the *Oeuvre St-Justin* provides affordable rooms in the *Justinus-Haus* for all participants of the MAS course. The first two grantees concluded their MAS course in 2010 and two new candidates started in autumn 2010. The *Oeuvre St-Justin* indicated interest in a long-term commitment for Master students at the ETH Zurich and the University of Zurich.

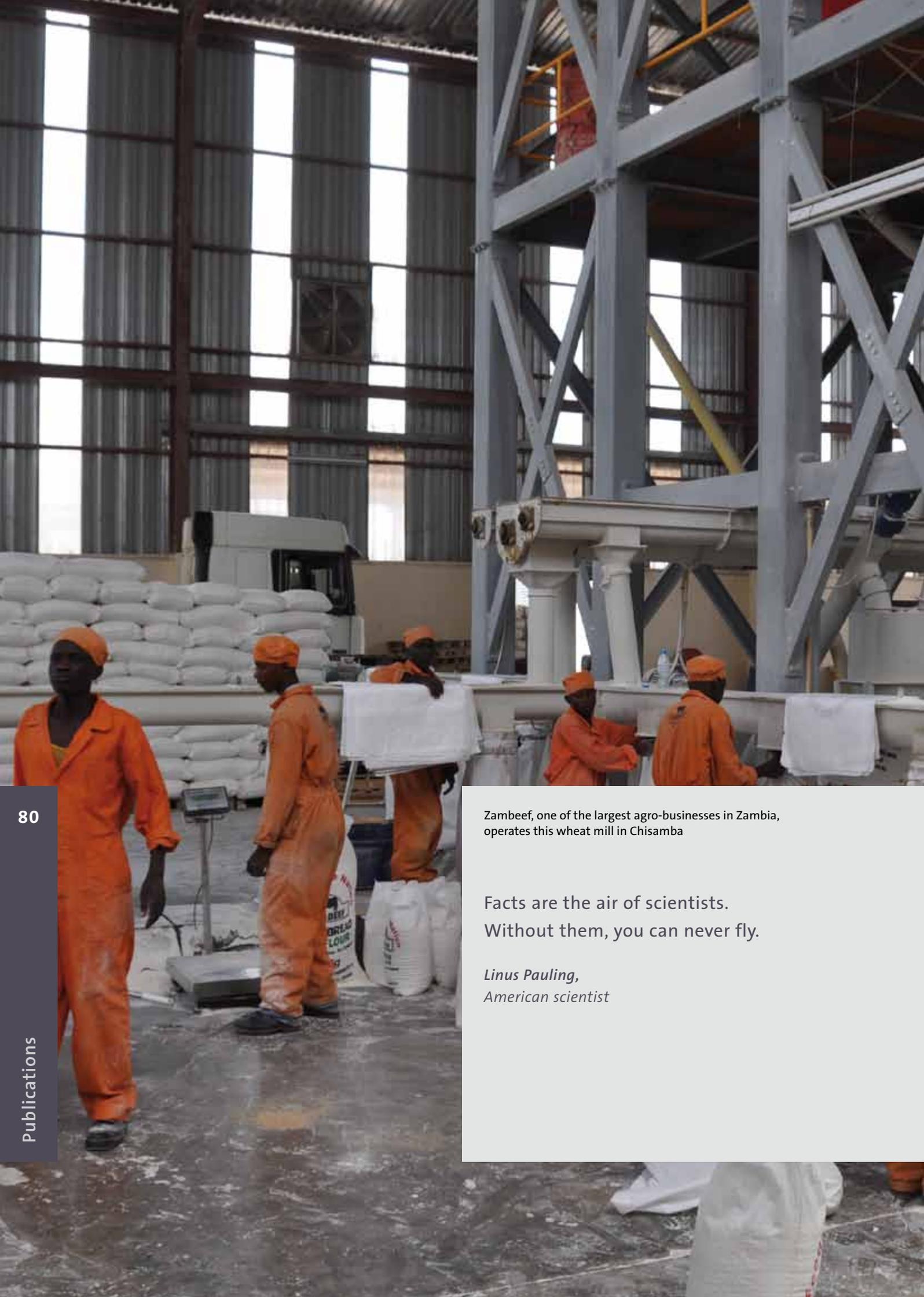
Development-relevant teaching at the ETH Zurich

Teaching at the ETH Zurich lies in the responsibility of the individual departments. They develop and approve the curricula at the Bachelor and Master level. The table below shows the degrees offered by the ETH Zurich which explicitly include aspects relevant to developing countries. The

classification is based on our own assessment and the statements of our members. Most of them integrate their experiences in developing countries in their curriculum at the Bachelor or Master level. The full teaching programme is available in the course catalogue on the ETH website.

Study programmes grouped according to disciplines	Bachelor degree (Fig.: total number of BSc courses)	Master degree (Fig.: total number of MSc courses)	North-South aspects
Architecture and Civil Engineering	4	5	
Architecture	■	■	Optional
Civil Engineering	■	■	Optional
Environmental Engineering	■	■	Integrated, specialisation possible
Geomatic Engineering and Planning	■	■	Optional
Spatial Development and Infrastructure Systems		■	Integrated, specialisation possible
Engineering Sciences	5	12	
Energy Science and Technology		■	Optional
Management and Social Sciences	1	3	
Management, Technology and Economics		■	Optional
Comparative and International Studies		■	Integrated, specialisation possible
History and Philosophy of Knowledge		■	Optional
Natural Sciences and Mathematics	10	15	
Biology		■	Optional
Health Sciences and Technology		■	Optional
System-oriented Natural Sciences	4	6	
Earth Sciences	■	■	Optional
Applied Geophysics		■	Optional
Atmospheric and Climate Science		■	Optional
Environmental Sciences	■	■	Integrated, specialisation possible
Agricultural/Agroecosystem Science	■	■	Integrated, specialisation possible
Food Science	■	■	Integrated, specialisation possible

- Some North-South aspects included in general courses
- Broader coverage of North-South aspects; focus on development-relevant topics possible



Zambeef, one of the largest agro-businesses in Zambia, operates this wheat mill in Chisamba

Facts are the air of scientists.
Without them, you can never fly.

*Linus Pauling,
American scientist*

Publications

Refereed publications

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Aghili, F., Frossard, E., Jansa, J., Schulin, R., Khoshgoftarmansh, A.H., Afyuni, M., 2010: Improving zinc nutrition of wheat in Iran. Symposium Plant Science Center, Zurich, Switzerland, September 10.

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Jans, C., Bugnard, J., Gerber, A., Njage, P.M.K., Lacroix, C., Meile, L., 2010: *Streptococcus infantarius*: Lactose metabolism in fermented camel milk. 22nd International ICFMH Symposium, Food Micro 2010, Copenhagen, Denmark, August 30 – September 3.

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Meier, P., Frömel, A., Niedermaier, M., Kinzelbach, W., 2010: Real-time hydrological modeling and floodplain modeling in the Kafue River. Latsis Symposium Research in Environment and Sustainability – Insights and Conclusions, ETH Zurich, Switzerland, November 15–17.

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Ratanapradit, P., Chaiwang, N., Piawong, W., Boonmee, T., Wicke, M., Kreuzer, M., Jaturasitha, S., 2010: Effect of purple rice (*Oryza sativa* L.) on the meat quality of finishing pigs. Landwirtschaftliche und veterinärmedizinische Tierernährungsforschung im Verbund. Tagung ETH Zurich, Switzerland, May 6.

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Troesch, B., Van Stuijvenberg, M., Smuts, C., Kruger, H., Biebinger, R., Hurrell, R., Baumgartner, J., Zimmermann, M., 2010: A micro-nutrient powder with low doses of highly absorbable iron and zinc reduces iron and zinc deficiency and improves weight-for-age Z scores: A double-blind randomized controlled trial in South African children. Bioavailability 2010, Asilomar Conference Grounds, Pacific Grove CA, USA, September 26–30.

Verones, F., Nägeli, C., Koehler, A., Hellweg, S., Pfister, S., 2010: Developing a methodology for assessing the impacts of agricultural water needs on groundwater-dependent terrestrial ecosystems. 20th SETAC Annual Meeting, Seville, Spain, May 23–27.

Verones, F., Bartl, K., Koehler, A., Pfister, S., Hellweg, S., 2010: Water use related impacts on terrestrial ecosystems: The case of milk production in Peru. EcoBalance 2010, Tokyo, Japan, November 9–12.

Wueller, G., Pohl, C., Hirsch Hadorn, G., 2010: Structuring the science-policy nexus in research for sustainable development. Latsis Symposium 2010: Research in Environment and Sustainability – Insights and Conclusions, ETH Zurich, Switzerland, November 15–17.

Wueller, G., Pohl, C., Hirsch Hadorn, G., 2010: Structuring the science-policy nexus in sustainability research. 2nd International Conference on Sustainability Science, Rome, Italy, June 23–25.

Zhao, J., Avula, B., Clément, C., Kreuzer, M., Khan, I.A., 2010: Metabolic differentiation of *Maca (Lepidium meyenii)* accessions using NMR and multivariate data analysis. 2010 Joint Annual Meeting of the American Society of Pharmacognosy & the Phytochemical Society of North America, St. Petersburg, USA, July 10–14.

Invited oral presentations

Curran, M., 2010: Biodiversity and Life Cycle Assessment. 42nd LCA Discussion Forum, Lausanne, Switzerland, November 19.

de Baan, L., Koellner, T., 2010: Quantifying biodiversity in Life Cycle Assessment. International GCE Summer School, Thurnau, Germany, October 11–15.

de Baan, L., 2010: A global approach to assess land use impacts on biodiversity in Life Cycle Assessment. 42nd LCA Discussion Forum, Lausanne, Switzerland, November 19.

Engel, S., Palmer, C., 2010: The complexities of decentralization in a globalizing world. CIES, Geneva, Switzerland, December 8.

Engel, S., 2010: Ökonomische Aspekte von Biodiversität. Symposium Biodiversität – Eine Herausforderung des 21. Jahrhunderts, ETH Zurich, Switzerland, November 10.

Farah, Z., Eberhard, P., Meyer, J., Wangoh, J., Gallmann, P., Rehberger, B., 2010: Effect of ultra-high-temperature treatments of camel milk. International Camel Symposium, Garissa, Kenya, June 7–11.

Gruissem, W., 2010: Novel crops and novel traits: Risks and challenges for modern agriculture. Euroscience Open Forum 2010 on Passion for Science, Torino, Italy, July 2–7.

Gruissem, W., 2010: Crop improvement and biofortification – GMO or non-GMO? Plant Biology 2010, Montreal, Canada, July 31 – August 4.

Gruissem, W., 2010: Food security – Risks and challenges for the European Bioeconomy. 5th EPSO Conference on Plants for Life, Oslo, Finland, August 29–September 2.

Gruissem, W., 2010: Feedstocks for the knowledge based bio-economy – Risks and challenges for agriculture in Europe. KBBE Towards 2020 Conference, Brussels, Belgium, September 14.

Gruissem, W., 2010: Biofortification of rice and cassava for human health. 14th International Biotechnology Symposium, Rimini, Italy, September 14–18.

Gruissem, W., 2010: Setting science and technology priorities for green growth. OECD Workshop, Rimini, Italy, September 16.

Gruissem, W., 2010: The battle against plant viruses. 6th World Conference on Future of Science, Venice, Italy, September 19–21.

Gruissem, W., 2010: Rice iron biofortification – Synergistic action of genes to increase endosperm iron content. Genetics of Plant Mineral Nutrition, Hanover, Germany, September 30–October 2.

Günther, I., Schipper, Y., 2010: Effectiveness of water infrastructure at source and at point of use. Impact Evaluation Conference (ISS/AIID), Amsterdam, Netherlands, October 4–7.

Günther, I., 2010: What we know and what we do not know about sanitation interventions: An economic perspective. Water and Development: Taking Lessons from Evaluations (World Bank/KfW), Berlin, Germany, August 31 – September 1.

Günther, I., Linnemayr, S., Bloom, D., Canning, D., 2010: Mortality, fertility and social interactions in developing countries. Swiss Society of Economics and Statistics (SSES), Fribourg, Switzerland, June 24–25.

Günther, I., Linnemayr, S., Bloom, D., Canning, D., 2010: Mortality, fertility and social interactions in developing countries. Annual Meeting of the Austrian Economic Association (NOeG 2010), Vienna, Austria, May 14–15.

Günther, I., 2010: Impact of water infrastructure programs on rural populations. Ingenieure ohne Grenzen, Zurich, Switzerland, April 29.

Günther, I., Fink, G., 2010: Water, sanitation and child health – Evidence from 172 DHS surveys. Population Association of America, Dallas, USA, April 15–17.

- Günther, I., Schipper, Y., 2010: Impact of water infrastructure programs on rural populations. Network of Networks on Impact Evaluation (NONIE), Bonn, Germany, March 29–30.
- Günther, I., Schipper, Y., 2010: Impact of water infrastructure programs on rural populations. Federal Ministry for Economic Cooperation and Development (BMZ), Bonn, Germany, February.
- Hering, J., 2010: Integrated Water Resources Management (IWRM): A science and engineering perspective with application to Switzerland. Latsis Symposium, EPF Lausanne, Switzerland, October 18–20.
- Hering, J., 2010: Contamination of water resources by inorganic pollution. 3rd Kaplan Workshop on Challenges of the Global Water Shortage, Maagan – Sea of Galilee, Israel, April 11–13.
- Hering, J., 2010: Role of coupled redox transformations in the mobilization and sequestration of arsenic. 239th ACS National Meeting and Exposition, San Francisco, USA, March 21–25.
- Hering, J., 2010: Environment. Swiss-Polish Science and Technology Collaboration Days, Warsaw, Poland, January 14–15.
- Hetényi, G., 2010: Earthquake hazard mapping in Bhutan. Department of Geology and Mines, Thimphu, Bhutan, November 5.
- Hurrell, R., 2010: Iron and malaria: Absorption, efficacy and safety. Bioavailability 2010, Asilomar Conference Grounds, Pacific Grove CA, USA, September 26–30.
- Kappel, R., 2010: Stärken und Schwächen von Fair Trade. Konferenz der Kommission für Entwicklungsfragen, ETH Zurich, Switzerland, March 26.
- Kappel, R., 2010: Water policies for sustainable agriculture in the Yanqi Basin, China. International Conference on Water and Agriculture, Urumqi, China, August 9.
- Kos, A., 2010: Monitoring landslides with a portable ground-based radar interferometer. Workshop on Tsunami Modelling and Landslides, DST-NGI India-Norway Institutional Cooperation project, Oslo, Norway, August 13–16.
- Kos, A., 2010: Spatial deformation monitoring of landslides. 2nd Regional Meeting, Discussion and Promotion of Early Warning Mechanisms for Landslides in the Asian Region, Dhaka, Bangladesh, December 1–3.
- Kreuzer, M., 2010: Diversification in feeding: In the tropics and with feeds from the tropics. Sitzung der beratenden Kommission des Instituts für Pflanzen-, Tier- und Agrarökosystem-Wissenschaften, ETH Zurich, Switzerland, September 24.
- Lehmann, B., 2010: Decision making patterns of smallholder farming systems. Trees sustaining smallholder hill country farming systems – Research and outreach experience, Kandy, Sri Lanka, January 22–23.
- Lehmann, B., Kreuzer, M., 2010: Zukunft der Nahrungsmittelversorgung – eine Herausforderung für die ETH Zürich und die Schweiz – und die Zukunft der Nutztierwissenschaften. Sitzung zu ausgewählten Themen der Agrarpolitik der Fachkommission Landwirtschaft der SVP, Bern, Switzerland, March 9.
- Meile, L., 2010: Microbial biodiversity of camel milk and fermented camel milk products: Technology, hygiene and safety. International Camel Symposium, Garissa, Kenya, June 7–11.
- Michaelowa, K., 2010: The impact of World Bank and IMF programs on democratization in developing countries. Swiss Political Science Association (SVPW), Geneva, Switzerland, January 7–8.
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List of acronyms and abbreviations

All units of the ETH Zurich are in italics.

ADAPT African Dams Project	EPFL Swiss Federal Institute of Technology Lausanne	µg Microgramme
ADPC Asian Disaster Preparedness Center	ESA European Space Agency	µM µmol/L = Micromoles per litre
AfNet African Network for Tropical Soil Biology and Fertility	ESSA École Supérieure des Sciences Agronomiques	mm Millimetre
AGRA Alliance for a Green Revolution in Africa	FAO Food and Agriculture Organization of the United Nations	MO Microorganism
AGRIDEA Swiss Association for the Development of Agriculture and Rural Areas	FARA Forum for Agricultural Research in Africa	MoU Memorandum of Understanding
AIM Association Intercooperation Madagascar	FAU Faculdade de Arquitetura e Urbanismo	MSc Master of Science
AIT Asian Institute of Technology	FDI Foreign Direct Investment	N / N₂ Nitrogen
ALP Agroscope Liebefeld-Posieux Research Station	FOFIFA Centre National de Recherche Appliquée au Développement Rural	NADEL <i>Postgraduate Studies for Developing Countries</i>
ANS Agar Nutrient Solution	FS Food Security	NCCR North-South National Centre of Competence in Research North-South
ART Agroscope Reckenholz-Tänikon Research Station As Arsenic	g Gramme	NEED Network of Entrepreneurship and Economic Development
ASAL Arid and Semi-Arid Land	GDP Gross Domestic Product	NEPAD New Partnership for Africa's Development
ASTI Agricultural Science and Technology Indicators	GFAR Global Forum on Agricultural Research	NERICA New Rice for Africa
ATV Anti-Tick Vaccines	GIS Geographic Information System	NGI Norwegian Geotechnical Institute
AVRDC Asian Vegetable Research and Development Center (The World Vegetable Center)	GMO Genetically Modified Organism	NGO Non-Governmental Organisation
AWARD African Women in Agricultural Research and Development	GPS Global Positioning System	NRM Natural Resource Management
BAU Bangladesh Agricultural University	GTZ German Technical Cooperation	OECD Organisation for Economic Co-operation and Development
BSc Bachelor of Science	ha Hectare	P Phosphorus
BUET Bangladesh University of Engineering and Technology	IAASTD International Assessment of Agricultural Knowledge, Science and Technology for Development	PA Phytate
CAADP Comprehensive Africa Agriculture Development Programme	IAEA International Atomic Energy Agency	PO₄ Phosphate
CBSD Cassava Brown Streak Disease	ICARDA International Center for Agricultural Research in the Dry Areas	PRS Poverty Reduction Strategy
CBSV Cassava Brown Streak Virus	ICE Institution of Civil Engineers	R&D Research and Development
CDM Clean Development Mechanism	ICLAM Institute for the Conservation of Lake Maracaibo	REDD Reducing Emissions from Deforestation and Forest Degradation
CENA Nuclear Energy Center for Agriculture	ICM Integrated Crop Management	ReSAKSS Regional Strategic Analysis and Knowledge Support System
CGIAR Consultative Group on International Agricultural Research	ICT Information and Communication Technology	RFPP Research Fellow Partnership Programme for Agriculture, Forestry and Natural Resources
CIAT International Center for Tropical Agriculture	IED <i>Institute for Environmental Decisions</i>	S-ENETH <i>former School Domain of Earth, Environment and Natural Resources, ETH Zurich</i>
CIFOR Center for International Forestry Research	IFAD International Fund for Agricultural Development	Sandec Department of Water and Sanitation in Developing Countries, Eawag
CIGEM China Institute of Geological Environmental Monitoring	IFDC International Fertilizer Development Center	SDC Swiss Agency for Development and Cooperation
CIP International Potato Center	IFPRI International Food Policy Research Institute	SFIAR Swiss Forum for International Agricultural Research
ClimPol Climate Policy Making for Enhanced Technological and Institutional Innovations	IIA <i>International Institutional Affairs</i>	SHL Swiss College of Agriculture
cm Centimetre	IITA International Institute of Tropical Agriculture	SO₂ Sulfur dioxide
CO₂ Carbon dioxide	ILRI International Livestock Research Institute	spp. Species
CSAE Centre for the Study of African Economies	INCAN Instituto Nacional de Cancerologia	SRDU Sustainable Rural Dwelling Unit
CSRS Centre Suisse de Recherches Scientifiques en Côte d'Ivoire	INERA Institut de l'Environnement et Recherches Agricoles	SSA Sub-Saharan Africa
D-AGRL <i>Department of Agricultural and Food Sciences</i>	INRA French National Institute for Agricultural Research	STRI Smithsonian Tropical Research Institute
D-ARCH <i>Department of Architecture</i>	INTA Nicaraguan Institute of Agricultural Technology	SUA Sokoine University of Agriculture
D-BAUG <i>Department of Civil, Environmental and Geomatic Engineering</i>	IPAM Amazon Environmental Research Institute	SUDU Sustainable Urban Dwelling Unit
D-BIOL <i>Department of Biology</i>	IREDU Institute of Research in Education	Swiss TPH Swiss Tropical and Public Health Institute
D-ERDW <i>Department of Earth Sciences</i>	IRIAP Indonesian Research Institute for Animal Production	SWR Sustainable Water Resources
D-GESS <i>Department of Humanities, Social and Political Sciences</i>	IRRI International Rice Research Institute	TBD Tick-Borne Diseases
D-HEST <i>Department of Health Sciences and Technology</i>	ISP Bukavu Institut Supérieur Pédagogique de Bukavu	TI Technology and Infrastructure
D-INFK <i>Department of Computer Science</i>	ISRA Senegalese Institute of Agricultural Research	TISS Tata Institute of Social Sciences
D-ITET <i>Department of Information Technology and Electrical Engineering</i>	ITM Infection and Treatment Method	t Tonne
D-MTEC <i>Department of Management, Technology and Economics</i>	IUT Isfahan University of Technology	UAS Bangalore University of Agricultural Sciences Bangalore
D-USYS <i>Department of Environmental Systems Science</i>	JNNURM Jawaharlal Nehru National Urban Renewal Mission	UC Berkeley University of California, Berkeley
D-UWIS <i>Department of Environmental Sciences</i>	KARI Kenya Agricultural Research Institute	UK United Kingdom of Great Britain and Northern Ireland
DP Diffuse Punishment	KFPE Swiss Commission for Research Partnerships with Developing Countries	UNEP United Nations Environment Programme
DR Congo Democratic Republic of the Congo	KfW KfW Entwicklungsbank	UNESCO United Nations Educational, Scientific and Cultural Organization
DST Department of Science and Technology	kg Kilogramme	UNFCCC United Nations Framework Convention on Climate Change
Eawag Swiss Federal Institute of Aquatic Science and Technology	KIST Kigali Institute of Science and Technology	UPB Université polytechnique de Bobo-Dioulasso
ECF East Coast Fever	km Kilometre	URT Urban and Rural Transformation
ECM Energy Corrected Milk	L Litre	USD United States Dollar
EHES École des Hautes Études en Sciences Sociales	LAB Lactic Acid Bacteria	WBGU German Advisory Council on Global Change
EIABC Ethiopian Institute of Architecture, Building Construction and City Development	LCA Life Cycle Assessment	WWF World Wide Fund for Nature
Empa Swiss Federal Laboratories for Materials Science and Technology	LIPI Indonesian Institute of Sciences	ZALF Leibniz Centre for Agricultural Landscape Research
	LP Leader Punishment	ZEF Center for Development Research
	LSE London School of Economics and Political Science	Zn Zinc
	m / m² / m³ Metre / Square metre / Cubic metre	ZnSO₄ Zinc sulphate
	MAS Master of Advanced Studies	

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