ORGANIC AGRICULTURE: AFRICAN EXPERIENCES IN RESILIENCE AND SUSTAINABILITY

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PREFACE

This publication, *Organic Agriculture: African Experiences in Resilience and Sustainability*, demonstrates that organic management can benefit people, the economy and ecosystems and that this can be achieved in Africa, where hunger and degradation stubbornly persist, despite decades of development efforts.

The work presented in this volume stems from the conference on *Mainstreaming Organic Agriculture in the African Development Agenda*, held in Lusaka, Zambia, from 2 to 4 May 2012. Participants of this Conference shared research results confirming that organic agricultural practices "increase yields, improve livelihoods and food security, conserve indigenous knowledge, plant varieties and animal breeds, as well as sociocultural development, and provide much greater resilience in times of climate extremes, such as drought and heavy rains."

This publication expands on selected research presented during the Lusaka Conference. The different chapters document sustainability experiences, including: mainstreaming organic agriculture into African development approaches; community-based livestock systems combining holistic range management; indigenous ethno-veterinary practices and new understanding of customary systems of resource management; ecofunctional intensification through management of legumes, systems of rice intensification and integrated farming; and smallholders' knowledge harnessed through family farmers learning groups and customized information and communication technologies.

The studies from different Sub-Saharan countries demonstrate that successful organic farming is about whole farm management, where feeding the soil feeds the plant, where optimal nutrient cycling is achieved through plant and animals management in time (i.e. rotations) and space (i.e. associations) and where quality production goes hand-in-hand with market linkages. Sound agronomy is a recipe that needs to be owned by farmers who have specific cultures and by pastoralists who have specific environments: traditional knowledge and flexible management strategies are therefore key for successful outcomes.

The experiences featured in this publication show that the complexity of plant and animal interactions with the environment can be managed for improved productivity and resilience, and that farming requires enhancing natural processes, rather than substituting them with external inputs. Managing rangelands and croplands through controlled use of local resources starts with social capital, that is by building on traditional community knowledge. Furthermore, the most efficient productivity "tools" for pastoralists and farmers are local deep-rooted perennial grasses and adapted indigenous livestock and diverse crop varieties, as these are readily available, time-tested and suitable to socio-economic realities and environmental conditions.

More often than not, smallholders' capacity to utilize natural resources appropriately is limited, especially in settings where knowledge sharing is challenged by modern lifestyles. By building trust and social relations, organic farms extend beyond the land boundary, both socially and environmentally. So far, people's interest and enthusiasm have developed organic agriculture through trial and error. Especially in poorly endowed areas, organic management has proved its potential to deliver social, economic and environmental sustainability.

Despite continued success stories, organic agriculture has still not entered into formal curricula and extension services. It is hoped that the experiences featured here will encourage government institutions to support organic agriculture, as knowledge is a crucial factor for empowering resource-poor farmers and pastoralists.

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ACRONYMS

AfroNet	African Organic Network
AGRA	Alliance for a Green Revolution in Africa
CBRLM	Community Based Rangeland and Livestock Management
CEC	Cation Exchange Capacity
DAP (DCP)	Di-Ammonium (Di-Calcium) Phosphate
EPOPA	Export Promotion of Organic Products from Africa
FAO	Food and Agriculture Organization of the United Nations
FFGL	Farmer Family Learning Groups
FSR/E	Farming Systems Research and Extension
GMO	Genetically Modified Organism
IAASTD	International Assessment of Agricultural knowledge, Science and Technology for Development
ICT	Information and Communication Technology
IFOAM	International Federation of Organic Agriculture Movements
IRDNC	Integrated Rural Development and Nature Conservation
KLWG	Kenyan Livestock Working Group
MDG	Millennium Development Goals
MVP	Millennium Villages Project
NOA	Namibian Organic Association
NOGAMU	National Organic Agricultural Movement of Uganda
OPPAZ	Organic Producers and Promoters Association of Zambia
PGS	Participatory Guarantee System (local organic certification system)
pH (H_2O)	Soil acidity (power of Hydrogen) tested in water
SANOD	Southern African Network for Organic Development
Sida	Swedish International Development Cooperation Agency
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
USDA	United States Department of Agriculture
WAS	Weeks After Sowing

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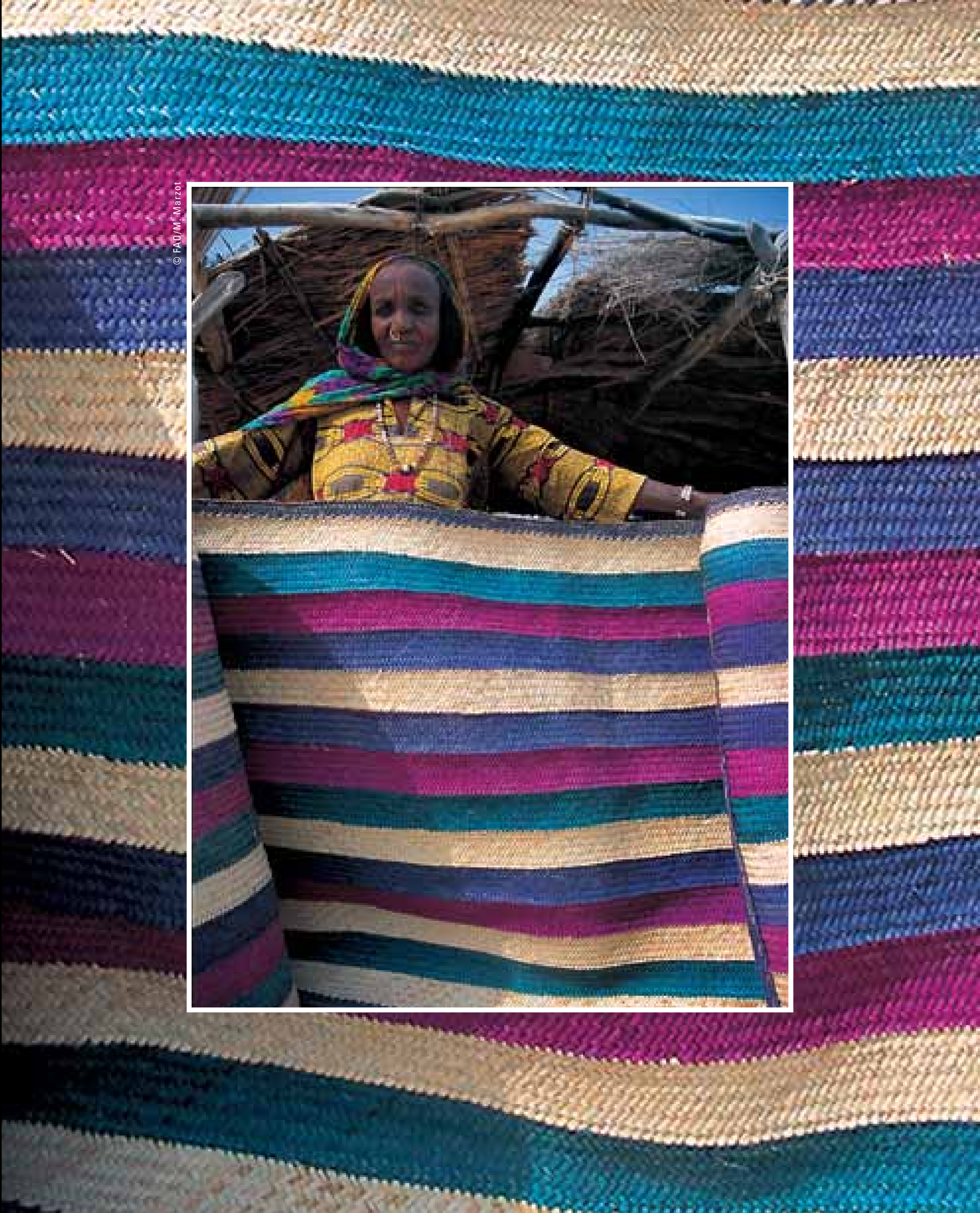
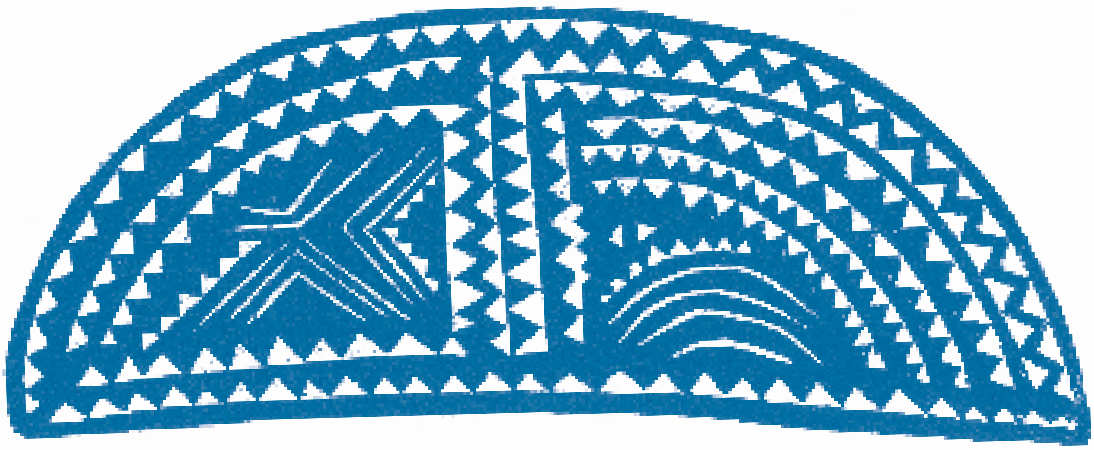


MAINSTREAMING ORGANIC AGRICULTURE INTO THE AFRICAN DEVELOPMENT AGENDA

Second African Organic Conference in May 2012 and the Lusaka Declaration

Transforming African agriculture: organics and AGRA

SECOND AFRICAN ORGANIC CONFERENCE IN MAY 2012 AND THE LUSAKA DECLARATION



"Organic agriculture is one of the best practices in ensuring environmental sustainability. It sustains the fertility of soils, ecosystems and sustains the health of people. It relies on locally adapted improved ecological processes and cycles, and natural biodiversity rather than the use of synthetic inputs and genetically modified materials. It is therefore, important that our farmers are encouraged to practice organic farming [...]. *I have no doubt that organic agriculture has potential to contribute to food security, increased incomes and generation of employment for our people."*

Those were some of the words by which the Honourable Emmanuel T. Chenda, MP, Minister of Agriculture and Livestock of Zambia, launched the Second African Organic Conference, entitled "Mainstreaming Organic Agriculture in the African Development Agenda". It was held from 2 to 4 May 2012 at the Mulungushi International Conference Centre Lusaka, Zambia. The Conference was organized by the Organic Producers and Processors Association of Zambia (OPPAZ), Grow Organic Africa, the Ministry of Agriculture and Livestock of Zambia, IFOAM, FAO and UNCTAD.

The Conference followed upon the first African Organic Conference in Uganda and the Conference on Ecological Agriculture held in Ethiopia both in 2008, organized by the African Union (AU), FAO and the Ministry of Agriculture and Rural Development of Ethiopia. Those two events as well as consistent work by organic networks and development partners stimulated the African Union Decision on Organic Farming in January 2011 (see box). This, in turn provided a solid policy foundation for further developments, including the organization of the Second African Organic Conference.

An impressive number of scientific papers (80) and case studies were finally approved for the conference, as well as 30 posters. The programme had five plenary sessions and 12 parallel sessions. Almost 300 participants, among them representatives of the AU, FAO, UNCTAD, the European Union and national organic movements participated. The Conference saw the formation of African Organic Network (AfroNet) as an umbrella organization for the African organic movement. The Conference also saw the development of the Organic Agriculture Plan of Action for Africa under the auspices of the AU. The Southern Africa Network for Organic Development (SANOD) a regional organic network for Southern Africa was also formed on this occasion.

The Conference represents a real milestone towards mainstreaming organic agriculture in Africa. The Lusaka Declaration (see below), provides a valuable platform for future continental cooperation on organic agriculture. The conference is a stepping stone for intensified cooperation among stakeholders in Africa and development partners, towards the full integration of organic agriculture in African policies. The 3rd African Organic Conference is planned for 2015 in Nigeria.

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THE AFRICAN UNION
HEADS OF STATE AND GOVERNMENT DECISION ON
ORGANIC FARMING

The Executive Council,

1. **TAKES NOTE** of the Report of the Conference of Ministers of Agriculture held in Lilongwe, Malawi on 28 and 29 October 2010 on Organic Farming, and **ENDORSES** the Resolution contained therein;

2. **EXPRESSES** concern over the current practice of exploitation of the organic farmers in Africa;

3. **REQUESTS** the Commission and its New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency (NPCA) to:
   - initiate and provide guidance for an African Union (AU)-led coalition of international partners on the establishment of an African organic farming platform based on available best practices; and
   - provide guidance in support of the development of sustainable organic farming systems and improve seed quality;

4. **CALLS UPON** development partners to provide the necessary technical and financial support for the implementation of this Decision;

5. **REQUESTS** the Commission to report regularly on the implementation of this Decision.

Source: Decision.Doc. EX.CL/631 (XVIII)

LUSAKA DECLARATION ON MAINSTREAMING ORGANIC AGRICULTURE INTO THE AFRICAN DEVELOPMENT AGENDA

We, the 300 participants from 35 countries, gathered at the Second African Organic Conference (AOC2) held in Lusaka, Zambia, 2-4 May 2012, on the theme "Mainstreaming Organic Agriculture in the African Development Agenda".

We agree that organic agriculture[1] plays a key role in sustainable development, food security, poverty reduction, environmental security, climate change adaptation, human health, preservation of indigenous knowledge, plant varieties and animal breeds as well as socio-cultural development. We shared international research results confirming that the adoption of organic agriculture practices significantly increases yields and improves livelihoods and food security in Africa. Based on locally available renewable resources instead of purchased chemical inputs (over 90 percent of which are imported in sub-Saharan Africa), organic producers are less vulnerable to international input price volatility. Moreover, organic agriculture is climate-smart agriculture, as it produces lower emissions and also provides much greater resilience in times of climate extremes such as drought and heavy rains.

We applaud the great efforts made by all national, regional and international organizations to support the development of organic agriculture in Africa.

We welcome the institutionalization of AfroNet (African Organic Network), the umbrella organization uniting and representing African ecological/organic stakeholders. We encourage all stakeholders to engage in and support AfroNet. We also welcome the strengthened networking within African sub-regions, as well as the Network for Organic Agriculture Research in Africa (NOARA).

We call for the implementation of the African Union (AU) Heads of State and Government Decision on Organic Farming (Doc. EX.CL/631 (XVIII). The Summit

1 In Africa, organic agriculture is also referred to as "ecological organic agriculture" and "ecological/organic agriculture."

decision requests the African Union Commission (AUC) and the New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency (NPCA) to initiate and provide guidance for an AU-led coalition of international partners on the establishment of an African organic farming platform based on available best practices, and to provide guidance in support of the development of sustainable organic farming systems.

We call upon the AU to mainstream organic agriculture into all areas of its work, including the Comprehensive African Agriculture Development Programme (CAADP) and to take the lead in implementation of the African Organic Action Plan (and its associated Pillars), in close collaboration with AfroNet and other partners.

We highlight the importance of the six pillars of the African Organic Action Plan:

1. Research, training and extension: to conduct participatory, interdisciplinary, multi-cultural research that informs stakeholder training and offers appropriate knowledge and skills and innovative solutions to the community.
2. Information and communication: to develop information and communication strategies to sensitize the stakeholders and the general public on the value and practices of ecological organic agriculture.
3. Value chain and market development: to increase trade in organic products from Africa on domestic, regional and export markets.
4. Networking and partnership: to strengthen synergies among stakeholders and beneficiaries to support ecological organic agriculture through networks and partnerships.
5. Supportive policies and programmes: to support the development and implementation of enabling policies and programmes.
6. Institutional capacity development: to establish, develop and support ecological organic agriculture institutions in Africa.

We appreciate all support received to date. We note that the coordination and implementation of the African Organic Action Plan will require strengthening the capacities of AfroNet, the AU Commission and other institutions.

We call upon all African stakeholders and development partners to support the implementation of the African Organic Action Plan from technical, financial and institutional perspectives. These partners include but are not limited to the Food and Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD), United Nations Conference on Trade and Development (UNCTAD), United Nations Environment Programme (UNEP), International Trade Centre (ITC), World Bank, the International Federation of Organic Agriculture Movements (IFOAM), the European Union (EU), the Swedish Society for Nature Conservation, Swedish Society for Nature Conservation (Sida), HIVOS, Grow Organic Africa, Norwegian Agency for Development Cooperation (Norad), Swiss Development Cooperation and the Government of Austria.

We request continued funding of existing initiatives falling under the framework of the Action Plan, including the Ecological Organic Agriculture Initiative. We further encourage the design and implementation of more initiatives at every level, from continental to grassroots communities.

We call upon the Regional Economic Communities to mainstream organic agriculture into existing Regional Agricultural Frameworks and Initiatives including the Regional Compacts, research for development, advocacy, outreach and communication, publications, capacity building, technical cooperation and intergovernmental meetings.

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We applaud the efforts made by the increasing number of African member States that have embraced the concept of organic agriculture and in developing policies and programmes to support the organic agriculture sector.

We urge all African Governments to include organic agriculture in their policies and agricultural development agenda, including their Comprehensive Africa Agriculture Development Programme (CAADP) Country Compacts and Investment Plans, in consultation with the organic agriculture stakeholders in their countries. The UNCTAD-UNEP "Best Practices for Organic Policy"[2] can provide useful guidance.

We urge African stakeholders developing national or regional organic standards/ regulations to use the principles of harmonization and equivalency to facilitate the flow of organic products in Africa in order to support the growth of the African ecological organic sector.

We request the EU, other global trade partners and international organizations to take all possible steps to facilitate the participation of Africa in global organic markets in particular by applying equivalency. This includes a request to recognize as equivalent the East African Organic Products Standard (EAOPS), which was developed through a consultative regional public-private partnership and adopted as the official East African Community organic standard in 2007. We also request that all possible steps be taken to ensure that equivalency agreements among regulators of major organic markets directly improve the market access of organic products from Africa and other developing countries.

We express interest in exploring and harnessing the potential of possible synergies with other related initiatives, programmes and projects in Africa, while remaining true to our core values.

2 UNEP-UNCTAD. 2008. Best Practices for Organic Policy. What developing country Governments can do to promote the organic agriculture sector (available at: www.unep.ch/etb/publications/UNCTAD_DITC_TED_2007_3.pdf).

We thank the organizers of this conference, including the AU Commission, Organic Producers and Processors Association of Zambia (OPPAZ), Zambian Ministry of Agriculture and Livestock, UNCTAD, IFOAM, FAO and those who provided financial and technical support.

We express our sincere appreciation of the support and attendance of Kenneth David Kaunda, OPPAZ Patron and First Republican President of Zambia.

We look forward to continuing our work together as one open, united and ever-growing African Organic Team.

APPENDIX

The definition of organic agriculture

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

The principles of organic agriculture (based on IFOAM)

- Principle of health: Organic agriculture sustains and enhances the health of soil, plant, animal, human and planet as one and indivisible.
- Principle of ecology: Organic agriculture is based on living ecological systems and cycles; it works with, emulates and helps sustain them.
- Principle of fairness: Organic agriculture builds on relationships that ensure fairness with regard to the common environment and life opportunities.
- Principle of care: Organic agriculture is managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

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TRANSFORMING AFRICAN AGRICULTURE: ORGANICS AND AGRA

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BACKGROUND

Increasing Africa's food production can be done technically through a range of interventions, from high external input chemical systems to systems which use locally available resources and build on indigenous technical knowledge. African agricultural production has been beset by three major problems: lack of infrastructure, poor market development and lack of skills (Sachs, 2005). There is land, aplenty, willing and capable people (and notably African women – see Nierenberg, 2012), and a range of soils and climates that can produce almost any crop, but improving food security requires systems which use available resources sustainably while developing management capacity (Scialabba, 2007). Lack of infrastructure includes bad roads, lack of coherent government support and poorly developed farmer institutions. Market development is hampered by the lack of these essential support factors, but also by general poverty and inefficiency. Skills development worldwide has received a good deal of attention from donors over the past 40 years, but there has been little emphasis on integrating skills training with institution building and development of market linkages (Carney, 1998), and agricultural research has focused on technical solutions (Ravnborg, 1992; Altieri et al., 1998). Given the realities of climate change in Africa, sustainability and resilience become increasingly important for the survival of vulnerable family farmers.

Two recent initiatives attempting to address these issues are the Millennium Villages Project (MVP), part of the Alliance for a Green Revolution in Africa (AGRA), and the Export Programme for Organic Products from Africa (EPOPA). The MVP is a multi-million dollar project started by Kofi Annan (former United Nations Secretary-General) and Professor Jeffrey Sachs (Director of the Earth Institute at Columbia University) in order to develop "a uniquely African green revolution" (Annan, 2004). In contrast, EPOPA was a relatively low budget Swedish-funded programme which worked in East Africa (mainly Uganda) to assist small-scale farmers with training, institution-building and strengthening linkages to the market (EPOPA, 2008). Although the two programmes took very different approaches, they both aim to support sustainable agricultural development in Africa, and both have succeeded in raising yield levels and improving food security.

This paper examines some strong and weak points of each of these African initiatives and compares them with the results of applied South African farming systems research into maize production (Auerbach, 1990; 1993) and work on water use efficiency and rainwater harvesting (Auerbach, 2011). Effective support mechanisms are then proposed for sustainable agriculture in the context of sustainable development in these times of climate change. The MVP and much of recent international agricultural research, takes production technology as its point of departure. In comparing this technological focus to a more systems-based approach, other researchers argue for emphasis on sustainability, market linkages and low external input systems (Carney, 1998; Scialabba, 2007; Auerbach, 2010; Nierenberg, 2012). The EPOPA approach worked with the National Organic Agricultural Movement of Uganda (NOGAMU), provided farmers with training and linked them to the markets by assisting entrepreneurs (EPOPA, 2008). Both approaches agree that building colloidal humus reserves in the soil contributes dramatically to improved water and nutrient holding capacity.

The strong points of a systems approach that uses training in an institution-building context to link farmers to markets in a way which fosters sustainable development are highlighted, but the technological lessons from the MVP should

be incorporated into any agro-ecological approach. If the goal is sustainable and resilient agriculture, a long-term approach to building soil fertility should be emphasized, building up colloidal humus in the soil and increasing agro-biodiversity, as proposed by the recent International Assessment of Agricultural knowledge, Science and Technology for Development (IAASTD). This also requires economic planning and assessment based not only on short-term profits, but also on evaluations that include impacts on social, environmental and economic considerations.

The African Union Commission decided at its Conference of Ministers of Agriculture held in Malawi in 2010 (see p. 7) that organic farming systems should be researched and given more support, and this resolution was taken seriously at the Second African Organic Conference held in Zambia in 2012 (see the Lusaka Declaration, p.8). The Millennium Villages Project took a more input-intensive approach to agricultural development.

THE MILLENNIUM VILLAGES PROJECT

MVP was initiated in 2005 after Kofi Annan and Jeffrey Sachs had found major support for developing a programme to show how African agriculture could progress (Nziguheba *et al.*, 2010). Initially, MVP has been implemented on 14 sites to show some practical approaches which could help Africa in achieving the Millennium Development Goals, especially reducing poverty and hunger. Farmers were assisted with seeds, fertilizers and training to 52 000 farming households, with initial subsidy rates varying from 50-100 percent; and maize crop yields increased from one to three tonnes per hectare. Maize grain storage was provided in the 14 village clusters (located mainly in West and East Africa) serving 80 villages and savings accounts were opened for the farmers. Most households produced enough maize to meet basic caloric requirements; their contracts also specified that they should contribute 100–300 kg of maize grain per household to local school feeding programmes. Finding buyers for crops grown in remote areas was a major challenge, and fertilizer prices increased sharply in the 2008 season,

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with the most expensive phosphate fertilizer, DAP, more than doubling in price in most villages (Nziguheba *et al.*, 2010).

Although recommendations include diversifying crops and enterprises, supporting an efficient extension service and introducing organic inputs and soil management practices, the emphasis in MVP has been on hybrid seed and chemical fertilizers, the MVP team comments that getting organics into these degraded farmlands is a challenge, as both the quality and the quantities available are insufficient and often have multiple uses (livestock, feed, fuel for cooking, fencing materials). With increased production, there are more crop residues available, though availability of animal manure remains limited. However, they do agree that farming which relies solely on mineral fertilizers is unsustainable, and therefore nitrogen fixing trees, leguminous fallows and nutrient recycling strategies are being introduced. Although the best farmers persevere with these practices and thrive, many abandon them after initial adoption (Nziguheba *et al.*, 2010).

In discussion with the director of MVP, Pedro Sanchez (Sanchez, 2011), he commented that there had been no support thus far for organic soil amendments because farmers were asking for more free fertilizer and seed, but that subsidies would be introduced for organic fertilizers in the near future in order to improve the water and nutrient holding capacity of the soil. The MVP team concurs, stating that "organic inputs are important for building soil organic matter and improving physical and biochemical properties of soil" (Nziguheba *et al.*, 2010). Sanchez agrees that scaling-up the programme (which has five highly trained staff members at each village cluster - four M.Sc. and one Ph.D), will be difficult and will require considerable resources (Sanchez, 2011). While Sanchez summarizes the achievements of the MVP as "tripling crop yields in tropical Africa", he also cautions that organic fertilizers are essential as they add carbon, feed soil microbes and help to retain soil moisture. He points out that "decades of farming without adequate fertiliser and manure have stripped the soils of the vital nutrients needed to support plant growth" (Sanchez, 2010).

The MVP team emphasizes the need "to support agricultural diversity to include nutritious crops, such as the many African leafy green vegetables, which have been disappearing from farms and diets" (Nziguheba *et al.*, 2010). This corresponds to the findings of an EU-funded study on agro-biodiversity (the African Indigenous Vegetable Production), which was carried out in twelve African countries from 2003 to 2008, investigating the nutritive value, extent of cultivation, seed production techniques and sustainable production practices (Shackleton *et al.*, 2009). The authors found that most African indigenous vegetables are organically produced but that availability of quality seed is a major constraint to increasing production. Kenyan researchers on this project reported that, with a little positive radio and television publicity, the Kenya Museum was able to set-up an informal organic certification system and was able to persuade supermarket owners in Nairobi to stock these items, which are moderately priced. There is a ready market for many of them and this proved to be a successful model, contributing significantly to improved nutrition, even for resource-poor consumers. The drought tolerance of African indigenous vegetables was also confirmed over a range of production conditions (Shackleton *et al.*, 2009).

Water scarcity and the implications of climate change are a major factor: unlike the Green Revolution in Asia that focused on irrigated crops, the African Green Revolution must deal with the challenges of rain fed irrigation to be successful. The MVP team points out that they were not able to achieve the same dramatic increases for millet and groundnut yields (as they did for maize) in the semi-arid zones of West Africa, where water proved too severely limiting. Touching on health and nutrition, the team concluded that health played a major role in helping communities to move out of poverty, and that it was vital for robust agricultural production and for developing market-based economies, but that these required education, the removal of sector barriers and easing of multiple constraints (Nziguheba *et al.*, 2010).

RESEARCH IN KWAZULU-NATAL, SWITZERLAND AND THE UNITED KINGDOM

Farming systems research on maize production in southern KwaZulu-Natal (South Africa) more than two decades ago (Auerbach, 1990) confirmed that in poorly farmed semi-arid areas, yields had already dropped to as low as 0.4 tonne per hectare. Research examined three hypotheses from a farming systems' perspective which had been developed over two years of consultation with Zulu farmers (Auerbach, 1993):

- **Hypothesis 1:** Increasing maize production of KwaZulu farmers will depend more upon easing constraints than upon providing technical information;
- **Hypothesis 2:** Technical information will be effective if the extension message is matched with the socio-economic situation of the client smallholder farmer, and incorporates strategies to ease the accompanying constraints;
- **Hypothesis 3:** The costs of additional purchased inputs will only be justified if matched by incremental inputs of effective management.

These hypotheses were tested through three formal on-station research trials over four seasons, and verified with seven on-farm trials carried out over three seasons. Economics of production (both on-station and on-farm) and farmers' attitudes to the research were also evaluated. The yield results were similar to those quoted by MVP (Sanchez, 2010; Nziguheba *et al.*, 2010). Maize yields were tripled relative to the system prevalent in the area (characterized by one weeding, no pest control, open pollinated seed and no fertilization with mean yields of 1.1 tonnes per hectare). By controlling stalk borer and cutworm, weeding three times, using a well-adapted hybrid seed and fertilizing with 1 tonne per hectare of poor quality cow manure, the mean yield was increased to 3.2 tonnes per hectare (Auerbach, 1993).

The cow manure was found to be an exceptionally poor source of nitrogen, as it is commonly left out in the sun and rain for many months. Pot trials showed that lack of nitrogen rapidly limited plant growth of maize plants; nevertheless,

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with simple weed and pest control, yields were tripled. Weed control was at least as important as fertilizer in this process, strongly supporting hypothesis three. Participatory rural appraisal techniques were applied to finding out what local farmers thought about the research results and the extension pamphlet guidelines produced (Auerbach and Lea, 1994). Results showed that early ploughing, hybrid seed, fertilizer and cow manure were the four top priorities cited by semi-commercial and commercial farmers. However in practice, early ploughing and weed control were more closely linked to yield increases, supporting hypotheses 1 and 2. Farmers were interviewed to find-out how they felt about the research findings; with regards to the importance of technology in improving maize production, the conclusion was reached that "tempting as it might be to concentrate on a host of technical factors, the reality of the rural situation in KwaZulu-Natal requires a process of local capacity-building based upon the best local practice"(Auerbach, 1995).

However, in order to raise yields above the 3 tonnes per hectare level, compound fertilizers were by far the most effective in monoculture maize. Raising maize yields above 3.4 tonnes per hectare using organic methods could only be done with major inputs of manure (20 tonnes per hectare of manure), and/or composting and mixed cropping systems which would also improve agro-biodiversity. However, it is striking that, while the MVP research in western and eastern Africa used significant levels of fertilizer inputs, the South African research showed that yields can be raised to the three tonnes per hectare level without particularly high levels of external inputs (Auerbach, 1993), provided that there is some input of organic matter, a well-adapted hybrid cultivar and reasonable pest and weed control. Nevertheless, it supports the findings of the MVP team that increasing soil organic matter is vital for sustainable crop production in Africa. Globally, the world's soil organic matter contains two to three times as much carbon as is found in all the world's vegetation and poor ploughing coupled with deforestation deplete soil carbon by about 2 Pg (billion tonnes) per year and contribute significantly to global warming (Brady and Weil, 2008). Well-managed organic farming and conservation forestry could reverse this depletion, sequestering 2 Pg of carbon per year more than is removed, thus helping agriculture to mitigate climate change.

Long-term experiments in Switzerland (Maeder *et al.*, 2006) illustrate this possibility: comparative trials of organic, bio-dynamic and conventional production systems confirmed that soil carbon in the conventional systems decreased to about 85 percent of the original levels, while there was no decrease in the biodynamic production system and only a small decrease in the organic system. Conventional agriculture uses ploughing coupled with chemical fertilizers such as urea, which often acidifies soils as well as decreases soil carbon, and in these trials, soil pH increased from 6.3 to 6.6 in the biodynamic system, remained stable in the organic system and decreased to 5.8 in the conventional system. The same has been shown in the United Kingdom, where long-term trials at the Rothamsted Research Station showed that while yields (and soil carbon levels) for plots treated with farmyard manure rose steadily from 1850 to 1950 and then flattened out, soils with no farmyard manure added declined slowly but steadily. Plots that received manure from 1852 to 1871 and did not receive any sort of fertilizer thereafter also declined slowly but steadily. Yet 100 years later, the beneficial effects of the 19 years of farmyard manure were still apparent, with soil carbon levels nearly twice those of the plots which had never had farmyard manure (Jenkinson and Johnson, 1977).

There are major opportunities for exchange of research findings between MVP and the organic research and development projects underway in southern and eastern Africa. Transforming agriculture into a carbon positive sector would mean that it becomes part of the solution to climate change, rather than remains part of the problem. Apart from the impacts on soil organic matter quoted above, the farming systems work done by the organic movement in eastern Africa has had dramatic practical and economic results, largely through export market development (EPOPA, 2008). The South African Government recently launched its Organic Farming Policy in recognition of these changes.

ORGANIC MARKET LINKAGES: A VEHICLE FOR SUSTAINABLE DEVELOPMENT

EPOPA in Uganda was funded by the Swedish International Development Aid organization (Sida). The scale of the impact of this market-linked, bottom-up, low-cost project has much to teach high external input technology-based initiatives in terms of scaling-up pilot projects and in terms of impacts per invested dollar. In putting an East African Organic Standard into place, regional cooperation between the United Nations Conference on Trade and Development (UNCTAD) and the United Nations Environmental Programme (UNEP) also played a major role in the development of the organic sector in the region (IFOAM, 2008).

As mentioned in the introduction, the EPOPA project supported organic agriculture in Uganda from 1997 until the end of the project cycle in 2008. The project also helped to develop the National Organic Agriculture Movement of Uganda (NOGAMU), and to set up UgoCert as a certification body. Through the project, the number of certified organic producers in Uganda increased to well over 200 000, with an average farm size of 1.5 ha and a total export trade (coffee, cotton, pineapples, bananas, cashews, vanilla and shea butter) of more than US$22 million for 2008 (EPOPA, 2008; Muwanga, 2009). According to the Chief Executive Officer of NOGAMU, the value of export production has since risen to US$35 million in 2010 (Muwanga, 2011).

The total cost of the Sida assistance to Uganda over the five year period (2003-2007) was about US$8.5 million, or US$1.7 million per year, and the programme has assisted over 200 000 Ugandan households (affecting over a million people) to produce commercial exports of US$20 to 25 million per year; the investment per person affected was thus less than US$2 per person per year.

The projects are not directly comparable, as AGRA MVP is also involved with health and education, but according to its Web site, it invests US$120 per person per year involving about 90 000 farming households (or 450 000 people) in the

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14 village clusters. The total investment in the programme to date is not apparent, but the following gives an indication (AGRA, 2007):

"In ten years, we believe that a total of 15 000 000 households could be successfully reached to purchase fertilizer and adopt soil management practices at a total program cost to the public and private sectors of US$2.5-3.0 billion of which the Bill and Melinda Gates Foundation cumulative contribution may total US$500 million".

The Web site further states that the short term focus is to use US$198 million of investment to increase the yields of 4.1 million smallholder farms; US$74 million will go to "fertilizer supply chain investments".

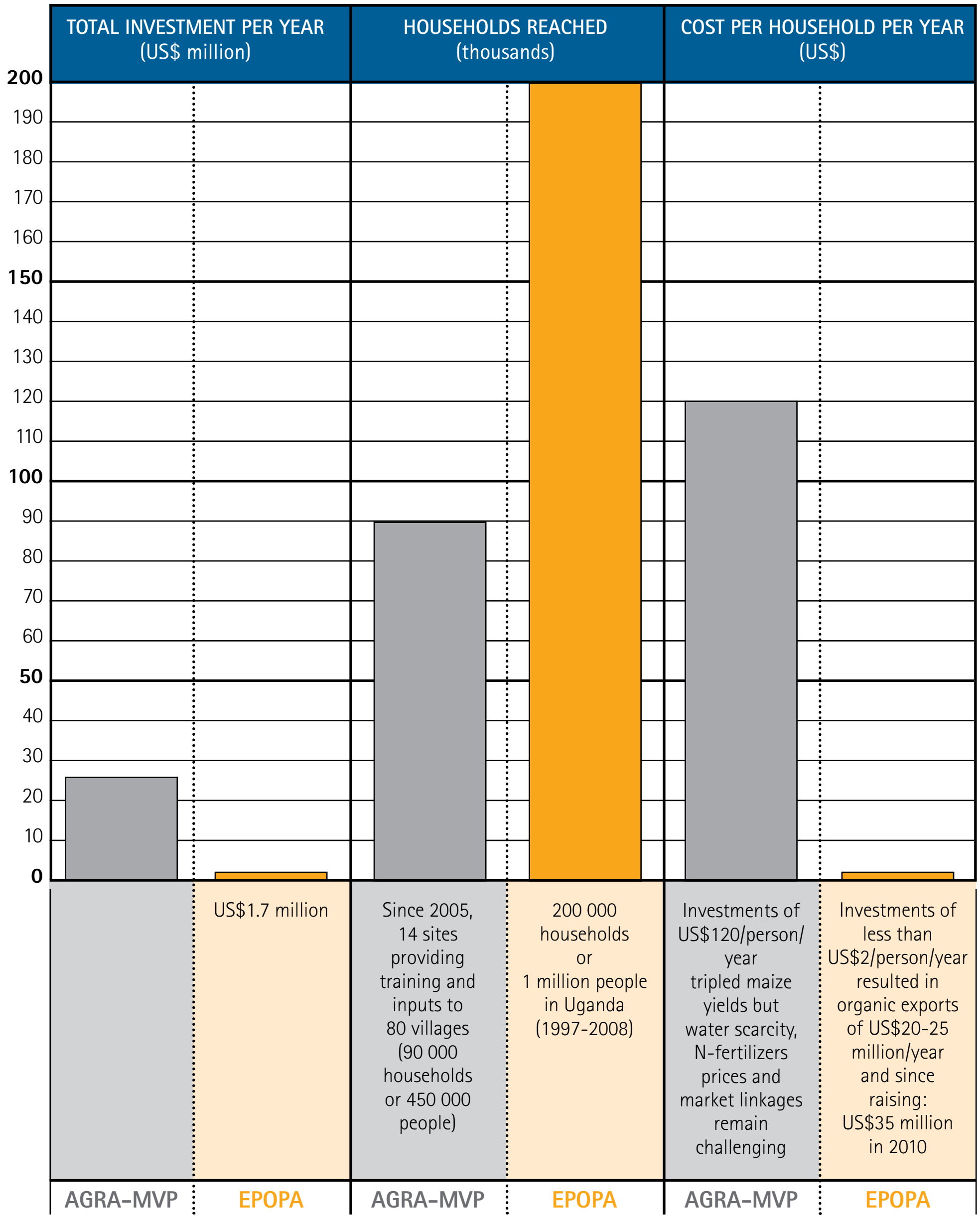
The strong point of the EPOPA development is that the linkages with the market were supported and that farmer institutions were strengthened, at a remarkably low cost, and with surprisingly efficient results.

The EPOPA project report summarizes the project logic as follows: "Lack of market access is a major limiting factor for agricultural development. There is a market demand for organic products. African smallholders are close to organic because they can't afford expensive inputs. Access to international organic markets can provide income and be an incentive to increase production and productivity. There is a need to get the commercial sector involved to make this happen." EPOPA concludes that this commercial sector involvement has been a major factor in the success of the project.

Two more recent South African initiatives confirm the effectiveness of linking small-scale producers to the market: the Bryanston Organic Market links small farmer groups to its market in northern Johannesburg through a participatory guarantee system (PGS), where consumers, sellers and producers participate in assessing the quality of this produce. Similarly, at the Siyavuna Development Co-operative on the KwaZulu-Natal South coast, simply by providing a regular market for small-scale farmers at Nositha Village, Wim Troosters was able to help boost vegetable production from R24 825 in 2008 to R46 679 in 2009; sustaining growth has, however, proved more difficult. The PGS approach has been widely adopted in recent years as a strategy to help small-scale farmers gain access to local markets. These two PGS initiatives and the EPOPA report agree that quality management is vitally important in helping small scale farmers to break into high-end markets.

TABLE 1

Comparison of Alliance for a Green Revolution in Agriculture Millennium Villages Project (AGRA-MVP) with the Export Programme for Organic Products from Africa (EPOPA)



RAINWATER HARVESTING AND CROP ROTATION REDUCE THE RISK OF CROP FAILURE

Rainfed production in dry areas responds well to a combination of organic soil management, which increases water and nutrient holding capacity of soils, and rainwater harvesting techniques, which reduce the risk of crop failure due to erratic rainfall. South African research, conducted between 1993 and 2005, showed how rainwater harvesting techniques contributed to reducing the risk of crop failure by increasing infiltration of plant available water in steep areas of KwaZulu-Natal with level swales (contour bunds), reducing the irrigation needs by as much as 50 percent and reducing evaporation (using Vetiver grass mulches) by nearly 40 percent (Auerbach, 2005; 2011). Research by Botha and colleagues in the drier, flatter Free State province confirmed the importance of in-field rainwater harvesting in reducing crop failures in semi-arid areas (Botha *et al.*, 2005).

Combining rainwater harvesting with organic farming methods gives resource poor farmers a strategy to improve soil fertility through raising soil colloidal humus levels, while sequestering carbon, increasing agro-biodiversity and raising nutrient and water holding capacity and also providing the means for entering high-end markets, domestically and internationally (Auerbach, 2010).

DISCUSSION AND CONCLUSIONS

The MVP experience in West and East Africa, as well as South African maize research results support the conclusion that raising maize yields on poorly farmed soils can be done in the short-term using mineral fertilizers, but that for sustainable production, inputs of organic matter and improved soil and crop management are needed. More efficient carbon sequestration and improved agro-biodiversity will only occur with the introduction of crop rotations, mulches and other conservation practices. Social and economic sustainability also requires development of market

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linkages and local managerial capacity, together with quality management systems. While it is widely agreed that agricultural development requires major investments in infrastructure, the focus on fertilizer and fertilizer supply chain investments is an expensive way to boost agriculture in Africa. Furthermore, it has already been difficult for AGRA to find markets for the maize which it has helped farmers to produce (Nziguheba *et al.*, 2010).

The EPOPA programme, together with the experience of the Bryanston Organic Market and the Siyavuna Development Co-operative show the effectiveness of market linkages in practice and show that they are essential for long-term changes in the situation of small-scale producers, and in improving their terms of trade. Participatory Guarantee Systems can facilitate access to local markets for small-scale farmers, if they are reasonably well organized, thus reducing the need for expensive third party certification processes. The formation of the African Organic Network (AfroNet) at the Second African Organic Conference in Lusaka in 2012 is a step towards a regional access network for African organic farmers.

In heading towards robust farming systems to help resource-poor farmers to emerge as commercial producers, it will be important to link them to markets while providing training that reduces the risk of crop failure and helps them to manage quality. National organic agriculture movements in East Africa have done this effectively with some international assistance. Southern Africa could learn from this regional co-operation experience, especially with more established high-end domestic markets. A combination of science with social and environmental activism is needed if African agriculture is to move into an era of prosperity, based on increased resilience and sustainability.

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COMMUNITY-BASED LIVESTOCK SYSTEMS

Managing community-based rangelands in Namibia

Holistic management of livestock in Namibia

Indigenous Nigerian ethno-veterinary practices

Adding value to Maasai beef


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MANAGING COMMUNITY-BASED RANGELANDS IN NAMIBIA

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Born and grown in Namibia in a family who had been livestock farming for two generations, Wiebke Volkmann works as a free-lance certified educator and facilitator for Holistic Management. She currently coordinates the training activities of the GOPA Community Based Rangeland and Livestock Management (CBRLM), writes training materials, serves on the management board of the Namibia Centre for Holistic Management and collaborates with various national capacity-building programmes to promote and support sustainable agricultural production and resource management.

BACKGROUND

Livestock production in Namibia takes place on freehold land, as well as open access land (commonly referred to as communal land), which is owned by the state and governed by local and regional authorities and traditional leaders. Rainfall patterns and soil conditions vary greatly over these communal lands and much of the subsistence farming relies on mixed agricultural practices with a strong reliance on running cattle, goats and sheep on natural rangeland because dry land crop harvests often fail in poor rainfall years. Both subsistence and commercial farmers experience a decline in carrying capacity and crop yields. Bush encroachment is on the increase and water tables are sinking (De Klerk, 1999; MAWF, 2009).

Livestock is kept to provide meat, milk, animal draught power and serves as a form of wealth and status. In many instances cattle are still part of spiritual and cultural practices, yet more and more farmers are selling animals to earn cash income. Because of these multiple production goals, any intervention to address farming practices requires a flexible and holistic approach.

FACILITATING A PROCESS OF CHANGE

The Namibian NGO, Integrated Rural Development and Nature Conservation (IRDNC) pioneered the Community-Based Natural Resource Management (CBNRM) in Namibia. It facilitates ecological literacy and raises awareness among traditional leaders, local authorities and communities about the value of being organized and taking collective responsibility for their resource base. IRDNC was instrumental in developing a legal framework and joint ventures which now return material, financial and grazing management benefits to rural communities from tourism and wildlife enterprises. Building on this success, the organization went on to explore ways to reduce the degradation due to overgrazing, and of limited income streams by enhancing the traditional livestock practices of rural communities.

Previous agricultural extension from government, academic and NGO institutions had tried to curb overgrazing and loss of top soil and perennial grasses by encouraging farmers to reduce their stock numbers. Besides being socially unacceptable, this strategy has also not had the desired result of reversing land degradation (De Klerk, 1999; MAWF, 2009).

In contrast, Holistic Management (see Box below) helps farmers to observe and manage the movement and behaviour of domestic animals and their impact on growing conditions, especially for perennial grasses. Some farmers on free hold land in Southern Africa had experimented with moving their livestock from one fenced paddock to another according to a grazing plan which takes into account all management factors and needs of plants, soil, animals and people (Howell, 2008).

HOLISTIC MANAGEMENT

Allan Savory, a wildlife biologist from Zimbabwe observed that rangelands and water sources declined despite massive culling and de-stocking of wildlife and domestic livestock. Where there used to be perennial grassland, mostly encroacher bushes and annual grasses survived on land that had lost its topsoil due to water and wind erosion. He realized the importance of the symbiotic relationship between soil health, plants and animals. When large herds of herbivores are allowed to move freely in areas where there are predators which hunt in packs, they stay in tight groups most of the time and trample the soil with their hooves; they also deposit dung and urine, and prune the leaves and stalks of perennial grass tufts, allowing sunlight to stimulate growth. These herds are then moved to fresh pasture and water, and do not return until sufficient time had passed for grass plants to grow out again and replenish reserves of energy stored in the roots and crown. This management promotes deep- rooted grasses.

Savory recognized that healthy grazing, animal impact and the herd effect are catalysts, especially in seasonal rainfall environments. The managed actions of large herds of livestock improve the main aspects of the ecological process: water and nutrient cycling, solar energy flow, biodiversity and community dynamics. Based on reports from certified educators and their own projects Holistic Management International estimates that in 2012 over 16 million hectares of land worldwide are managed according to the principles and processes of holistic planned grazing.

The greatest power of the holistic management process however lies in the decision makers choosing the right strategies at the right time for the purpose and the holistic context they have set themselves. This includes a statement about the quality of life they desire, a description of what needs to be in place and produced for this quality of life and a description of the resource base that must be maintained or improved far into the future to make this quality of life possible.

The following decision testing questions are asked, after various options and strategies have been considered to solve a problem or when planning an action:

- Sustainability: if we take this action, will it lead towards or away from the future resource base described in our holistic context?
- Cause and effect: does this action address the root cause of the problem?

- Social weak link: has confusion, anger or opposition from people whose support we need in the near or distant future been considered?
- Biological weak link: does this action address the weakest point in the life cycle of this organism?
- Financial weak link: does this action strengthen the weakest link in the chain of production?
- Energy/ money source: is energy and money to be used in this action derived from the most appropriate source in terms of our holistic context?
- Energy and money use: will the way in which the energy and money is to be used lead towards our holistic context?
- Feelings: after considering all the previous questions and considering our holistic context how do we feel about this action now?
- Marginal analysis: comparing several actions, which action provides the greatest return in terms of our holistic context, for the time and money spent?
- Gross profit: comparing several enterprises, which enterprises contribute most to covering the overheads of the business?
- Early warning signal: which sign will we look out for that shows us first that the action is leading to our holistic context (or away from it)?

These questions are integrated into the Holistic Management Grazing Planning, Financial Planning and Land (infrastructure) Planning procedures in order to facilitate a triple-bottom-line growth and stability (attending to economic, environmental and social sustainability). An early warning monitoring process for rangelands and for croplands was designed to enhance the feedback loop. It is based on scientific procedures, but simplified for practical farmers to carry out themselves frequently enough to change their plan before they are far off the general direction of their overall goal.[1]

1 Additional information is available on the following Web sites: www.holisticmanagement.org; www.managingwholes.com; www.achmonline.org.

IRDNC was further inspired by the pioneering work done by the Africa Centre for Holistic Management on Dimbangombe ranch in Zimbabwe, where a large herd of cattle and goats is being herded to a new place in the landscape, according to a grazing plan. From 2003, IRDNC facilitated exposure visits for representative groups of farmers from the Kunene District in northern Namibia, traditional authorities, local leaders and agricultural extension officers both to commercial farmers in South Africa and to Dimbangombe to witness the procedures of planned grazing with paddocks and with herding, and to provide for a farmer-to-farmer exchange. On their return, the Kunene farmers decided that for them herding was the most appropriate way to achieve planned grazing and to increase stock density, also because fencing is illegal on Namibia's communal land.

Farmers started to combine the animals from all the homestead kraals that are sharing a water point into one large herd which, after watering, is herded by 4 to 5 herders (depending on the number of animals) to an agreed place in the landscape. At sunset, the animals return to their homestead kraals.

The planned moves and the nightly kraaling prevent animals from returning to plants which they have recently grazed. The herders only come back to a grazed area when the perennial grasses are fully recovered. Recovery includes re-growth of roots which die off to provide starter energy for new leaves until their leaf area is big enough for photosynthesis.

Traditionally, animals of different owners were 'sent' into different directions every day and then left to their own choice of grazing. Now between 250 and 1 200 animals are moved all to the same place before they start grazing. By mid-2012, 75 so-called 'grazing areas' are mobilized in eight regions, affecting the management of about 400 000 hectares. Of these grazing areas, 45 have an operational grazing plan and daily herding takes place throughout the year. Baseline data has been collected at these sites for monitoring. Additional information is available on the following Web sites: www.holisticmanagement.org; www.managingwholes.com; www.achmonline.org.

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The highly nutritious and palatable *Brachiaria Negropedata* colonizing the Kalahari sand landscapes of farm Oasis near Ghanzi, Botswana, after the Barnes family started to combine their cattle into herds of up to 2 000 animals and to plan the moves of the herd to provide sufficient recovery time for perennial grasses

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Herding 1 200 cattle in a bunch across the landscape provides the animal impact and healthy grazing that restores soil health in the communal areas of North Western Namibia

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Raising the status of herders is essential to the sustained success of Community Based Rangeland and Livestock Management. As keepers of enormous wealth in the form of livestock and of ecological services they hold the future of Africa's communal rangelands

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Compared with traditional fertilizing practices where dry dung is hauled by farmers to their crop fields, the overnight kraaling of livestock in mobile kraals (boma) helps to not only break the soil crust and integrate organic matter into the soil surface but also adds nitrogen rich fresh dung and urine, hair and saliva. The kraal (boma) is moved after five to seven days to prevent over-fertilization and compaction

Each grazing area group negotiates with its neighbours to establish grazing area boundaries to prevent 'visiting animals' entering the managed grazing area in an uncontrolled way. Over time, the neighbours see the success of controlling the movement of livestock and despite initial reservations, many neighbouring areas are starting to herd their animals too. Besides growing more grass and therefore more meat per hectare, farmers realize the many additional benefits of herding, such as:

- reduced losses to predation and stock theft;
- reduced losses due to abandonment of calves, calving difficulties, disease, etc. as herders spot difficulties and can respond immediately with treatment;
- increased pregnancy rates because bulls are shared and reach females on heat easily;
- lengthened lactation periods and therefore more milk over an extended period;
- absentee livestock owners have easier access to their animals when they come to visit their cattle posts;
- the practice of overnight kraaling of livestock in crop fields and herding animals during the day in the growing season increases crop yields, while reducing labour for field preparation; and
- Increased yields of mixed farming (crops and livestock) contribute to food security.

While the described strategy of herding according to a grazing plan does not directly stem from a desire to produce and market organic produce, it satisfies most of the criteria of organic production:

- it requires few or no external inputs for raising healthy animals;
- it lowers the risk and improves the money earning capacity of pastoralists;
- it turns out to be an excellent pro-active adaptation and mitigation strategy to deal with climate change and changes in market dynamics;
- It helps to enhance habitat for bio-diversity and to increase replenishment of underground and above-ground clean water sources.

TABLE 1

Framework for holistic management

Whole Under Management	Decision Makers; Resource Base; Money
Holistic context	Forms of Production Statement of Purpose Quality of Life Future Resource Base
Ecosystem Processes	Community Dynamics — Water Cycle — Mineral Cycle — Energy Flow
Conventional Decision Making	Objectives; Goals; Vision; Mission
Tools	Human Creativity; [Technology; Fire; Rest; Grazing; Animal Impact; Living Organisms]; Money & Labor
One or More Factors	Past Experience; Expert Opinion; Research Results; Expediency; Compromise; Cultural Norms; Cost, Etc.
Testing Questions Objectives & Actions	Cause & Effect; Weak Link • Social • Biological • Financial; Marginal Reaction; Gross Profit Analysis; Energy/Money Source Pattern of Use; Sustainability; Society & Culture
Management Guidelines	Learning & Practice; Organization & Leadership; Marketing; Time; Stock Density & Herd Effect; Cropping; Burning; Population Management
Planning Procedures (Unique to Holistic Management)	Holistic Financial Planning; Holistic Land Livestock Planning; Holistic Planned Grazing
Feedback loop	Plan → Monitor → Control → Replan → Plan (Assume Wrong with Environment)

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Depicted in green are components of conventional decision making still integrated into the holistic framework

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RESULTS AND CONCLUSIONS

Bringing back deep rooted perennial grasses where previously there were mostly annual and pioneer species on Namibia's communal areas can significantly reduce the use of external inputs for meat and milk production such as mineral supplements from industrial and chemical processes. Improving the growing conditions for these perennial grasses by using a readily available resource (livestock) not only improves the forage base for animals, but also enhances a number of ecological services, such as mineral cycling and binding carbon into the soil. Because indigenous livestock is more adapted to the low levels of some minerals in most of the soils in Namibia, such as phosphate, these animals are ideally suited to lead the way towards organic production. However, in order to satisfy the modern market demands, the quality of meat and milk can be improved through a balanced combination and steady availability of nutritional components. High animal density and planned grazing provides a more even level of nutrition and higher production of animals (Savory and Butterfield, 1999; Howell, 2008; Isele and Külbs, 2010; Volkmann, 2011).

The economic advantages from herding come through reduced losses (to predators, abandonment, stock theft and neglect of disease or injury), as well as through improved animal nutrition leading to better animal condition and production (milk, birth rates, slaughter weights and grading). Some of the social benefits that have come from herding and planned grazing are job opportunities and improved livelihoods in rural areas, reduced conflict over resource use and water infrastructure maintenance, reduced and shared labour (especially for HIV/AIDS affected households) and the social cohesion through a joint purpose.

FROM RESILIENT PRACTICE TO RESILIENT POLICY

The convincing results that farmers on both freehold and communal land have had were shared in various ways, mostly in farmer-to-farmer exchanges. Presentations were given at the Namibia Rangeland Forum, an annual gathering of scientists, agricultural extension agents, farmers and other stakeholders. The agricultural curriculum of Polytechnic of Namibia includes lectures on Holistic Management planned grazing. The farmers' unions and Livestock Producers' Organization of Namibia are also now giving attention to rangeland management as a way of safeguarding the sustainability of livestock production.

In 2008, the Namibian Government called for the participation of the private sector in drafting a National Policy and Strategy for Rangeland Management. Convened by the Livestock Producers' Organization, a multi-stakeholder working group with representation from both freehold and communal lands agriculture, the group achieved what none had thought possible a few years before: agreement was reached on the principles of sound rangeland management to be implemented in flexible management strategies, rather than prescribing stocking rates or rotation systems or specific land reclamation techniques to farmers. The principles focus on creating optimal growing conditions for perennial grasses, high diversity of plants and other organisms and keeping the soil surface covered for optimal water conservation. Timely adaptation of animal numbers is one of the principles for reducing the risks of livestock losses and denuding of the soil surface in times of low rainfall or drought.

Given the active participation in these national fora of people working with pastoralists, the Namibian Government grew confident enough to upscale the adoption of the principles that had guided the Holistic Rangeland Management of IRDNC. In 2010, the Community Based Rangeland and Livestock Management (CBRLM) programme was initiated with funding from the Millennium Challenge account. It is implemented in partnership with the Ministry of Agriculture, Water and Forestry by project managers GOPA-CBRLM with technical support from IRDNC (Namibian Rangeland Forum, 2010).

The rigorous monitoring accompanying the implementation of the CBRLM programme and envisaged scientific research in partnership with sites and institutions from Botswana, Zimbabwe, Namibia and Germany will soon make reliable research data available.

Some stakeholders still hold to the simplistic paradigm of “reducing livestock numbers to preserve rangeland” and have yet to adopt the facilitation strategies for managing complexity. However, the farmers who have experimented practically see and value the fruits of their efforts and are likely to persevere. Their willingness and proven ability to consider and manage natural complexity, rather than reacting against the dynamics of nature, now informs national policy and the Namibian example is being copied by producer organizations and government institutions in neighbouring countries.

Until recently, the challenges of setting-up controlled scientific trials that adequately capture the complexity of farmers’ decision-making have prevented conclusive large-scale research on Holistic Management. The increasing field successes have motivated two major comparative on-farm research programmes planned or partly initiated already in Southern Africa. While a collaboration between Texas A and M University and the South African Department of Agriculture, Forestry and Fisheries will compare mainly bio-physical indicators on Farms in South Africa (under the leadership of Dr Richard Teague), a consortium of partners from Germany, Namibia, Botswana and Zimbabwe are planning a five year trans-disciplinary research project called "Sustainable increase of food production on natural grasslands in Africa" (coordinated by the Johann Heinrich von Tuenen Institute, Germany). Both projects will monitor bio-physical, economic and social indicators on holistically managed private farms and communal grazing areas in Namibia, Botswana and Zimbabwe and their direct neighbouring land which is not managed according to Holistic Management principles. The data collection and analysis will be according to requirements of scientific peer-reviewed research and publication.

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HOLISTIC MANAGEMENT OF LIVESTOCK IN NAMIBIA

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Judith Isele is an agricultural engineer working for the Namibian Organic Association and Namibia Centre for Holistic Management. Ekkehard Külbs was an agricultural engineer who farmed on Springbockvley from 1989 till 2012. In addition to the farming business, the couple is intensely involved in various projects, associations and trainings in the agricultural sector of Namibia, supporting and promoting sustainable and organic farming. Sustainable agriculture, livestock production and rangeland management are more than a profession but a way of life. Since January 2012, Judith keeps on living this life by spirit and in memory of her beloved husband, as Ekkehard passed away when he fell from a windmill. His life, passion and successes are reflected in this chapter.

BACKGROUND

The organic livestock sector in Namibia is still in its nascent stages: thus far, only two cattle farms and no small stock farms are certified by the Namibian Organic Association (NOA). Natural circumstances favour extensive livestock farming on the basis of free range grazing on indigenous pasture. The majority of the agricultural land in the semi-arid country receives an average yearly rainfall of 150–500 mm supporting only marginal savannahs. An area of 8-30 hectares is needed to supply year-round fodder for one large livestock unit (equivalent to a mature cow). Even when conventionally managed, these free range conditions naturally allow animal husbandry that is closer to organic ideals than most European farming systems ever achieve.

In such a marginal environment, the adaptability of livestock to their specific circumstances is of utmost importance (Idel, 2006). On Namibia's extensively managed commercial farms (farms are usually between 3 000 and 20 000 hectares) the natural environment differs greatly, even between two neighbouring farms (Barrow, Binding and Smith, 2010). This emphasizes the importance of location-adapted animals.

When it comes to organic livestock production, in such rangeland-based systems it is not about animal husbandry only. Being uniquely able to convert high cellulose plant material into animal produce, ruminants are simultaneously "gardeners of their own food". Animals, the plants they eat and the soil in which these grow, are irrevocably linked and interdependent. None of them can be in a healthy state without the other one flourishing just as well. Therefore sound management of rangelands (soils included) needs as much attention as the well-being of the animals (Idel, 2011; Volkmann, 2011).

The example of the farm Springbockvley is used to showcase typical Namibian livestock farming on the one hand and to distinguish between those and more sustainably managed farms on the other hand. In addition, the challenges and constraints of converting to more resilient, sustainable organic farming systems are demonstrated. The farm is located in the southern-central part of Namibia, 180 km southeast of the capital Windhoek, at the Western border of the typical Kalahari dune landscape but in almost completely flat countryside; it is 9 500 ha in extent.

With an average yearly rainfall of 260 mm, Springbockvley is situated in an area of average production capacity which supplies appropriate fodder for cattle and sheep alike. Since 1990 the farm has been managed according to the Holistic Management decision making framework (Savory and Butterfield, 1999). This generally includes a high level of awareness of sustainable use of resources and improvement of biodiversity, while simultaneously managing towards profitability and the well-being of people involved. Therefore, farms run according to Holistic Management principles and procedures "present themselves well for the conversion to organic production" (Barrow, Binding and Smith, 2010). With its highly efficient, low input approach and well-adapted indigenous animals that require almost no external inputs, the farm is ideally set up for organic production.

Nguni cows and Damara sheep next to the water trough on Springbockvley during the growing season in March 2011

METHODS AND MATERIALS

The experiences and knowledge gathered during more than 20 years of sustainable farming on Springbockvley provide interesting production data. Since 1994, regularly recorded rainfall figures, livestock numbers, expenses and income statistics, as well as stocking rates and meat production figures are processed, with meat production being expressed as kg live weight produced per year (cattle and sheep combined) and including increase and/or decrease in livestock numbers (Isele, Külbs and Volkmann, 2010; Isele and Külbs, 2011).

RESULTS AND CONCLUSIONS

Well-adapted small frame cattle and sheep are run in several combined herds of up to 300 head of cattle and 2 000 sheep.

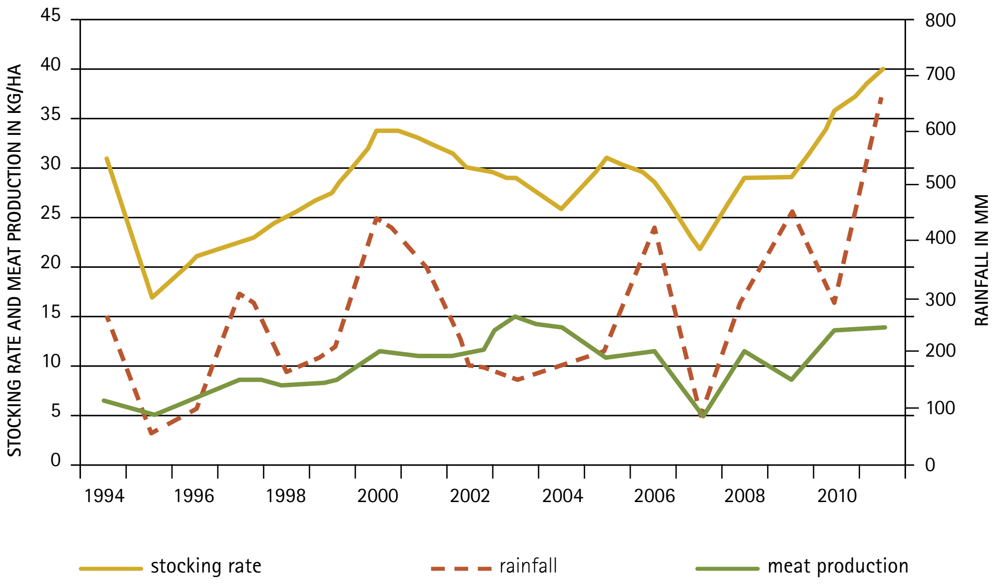
With the practice of Holistic Management planned grazing on Springbockvley, it was possible to increase stocking rates over the years (see also Barrow, Binding and Smith, 2010). This has been achieved in spite of inconsistent rainfall which, since 1989 varied between a minimum of 60 mm (in 1995) and a maximum of 680 mm (in 2011). Stocking rates also varied: from a minimum of only 17 kg live animal mass per hectare being stocked during the severe drought in 1995, better rainfall allowed increased stocking rates more recently culminating in more than 40 kg live animal mass per hectare stocked by the end of 2011, which (according to oral statements from neighbouring farmers) is noticeably higher than on most farms in the region. Although stocking rates tend to follow the ups and downs of the rainfall curve, it can be noted in Figure 1 that the latter is much more erratic (Isele, Külbs and Volkmann, 2010; Isele and Külbs, 2011). As long as high stocking rates go along with healthy rangeland condition, this trend in the curve of stocking rates over the years indicates sustainable rangeland management practices; through proper soil preparation and plant treatment, more stable forage production can be provided even in years of lower rainfall.

Simultaneously, since 1995 a remarkable off-take of meat production per hectare of more than one third of the stocking rate has happened and it has been maintained, comparing well with areas of higher production capacities. Since the year 2000, meat production averaged 11.6 kg meat per hectare with highest annual production levels of more than 14 kg per hectare in 2003, 2010 and 2011.

These results could be realized with animal numbers having started off with 550 head of cattle some 15 years ago, and the sheep flock fluctuating between 4 000 and 5 000 head during those years. Over the past 15 years, average animal numbers have been at 540 cattle and 4 300 sheep. In 2012, animal numbers on the farm have increased to 800 Nguni cattle and 4 500 Damara sheep, a total

FIGURE 1

Stocking rate, meat production and rainfall on Springbockvley 1994–2011



Source: Isele and Külbs, 2011

stocking rate which was never achieved before. This stocking rate reflects sheep numbers which are not at their highest ever; the Damara sheep are browsers with 60 percent of their diet coming from browsed bushes, and over the years it has been found that because the habitat on Springbockvley consists of a limited number of bushes and contains much open grassland, a number of 4 500 to 5 000 sheep currently seems to be the upper limit to be supplied with sufficient amounts of suitable natural browsing fodder. Cattle numbers have increased significantly over the past five years, as can be seen in Figure 1.

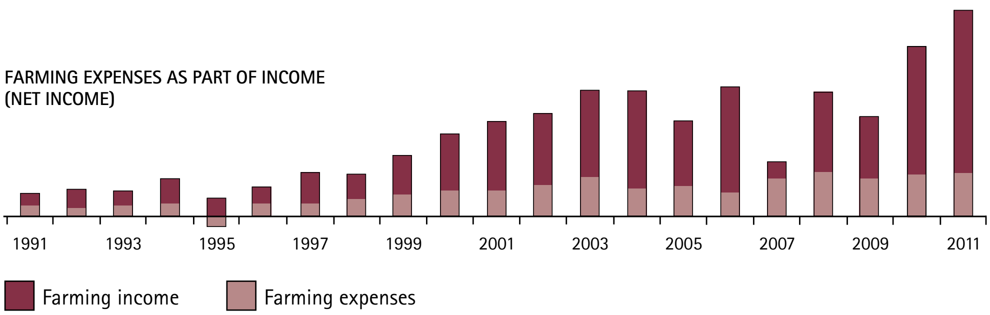
Treated with low stress livestock handling techniques, these adapted and indigenous animals in combination with Holistic Management financial planning tools and the approach of "controlling costs while maintaining income, produces profit" provide for high efficiency of production. Since 1997, farming income improved steadily maintaining farming expenses at about one third of the income. Both farming income and expenses more than tripled since 1997. Such results can only be achieved with strict and disciplined financial management practices, as human beings tend to spend money more easily as soon as income increases. On Springbockvley though over the last 15 years farming expenses remained on average 34 percent of farming income with even 25 percent or less in four years namely 2004, 2006, 2010 and 2011. Resulting net incomes (profits) average N$65 per hectare since 1997 with a maximum of N$146 per hectare achieved in 2011.

Contrary to the trend in conventional and industrial agriculture, these outcomes support an approach that focuses on combined herd performance, i.e. overall animal production per hectare. High individual animal performance techniques are not an alternative because they are often accompanied by high energy off-farm inputs and increased susceptibility to diseases (Idel, 2006).

In tackling the challenges of organic livestock production, the adoption of Holistic Management procedures readily provides tools for sustainable management. Besides financial planning procedures which focus on triple-bottom-line approaches

FIGURE 2

Farming expenses as part of farming income on Springbockvley 1991–2011



Source: Isele and Külbs, 2011

(taking social and environmental as well as economic factors into account), sound rangeland management promotes healthy soils, plants and animals.

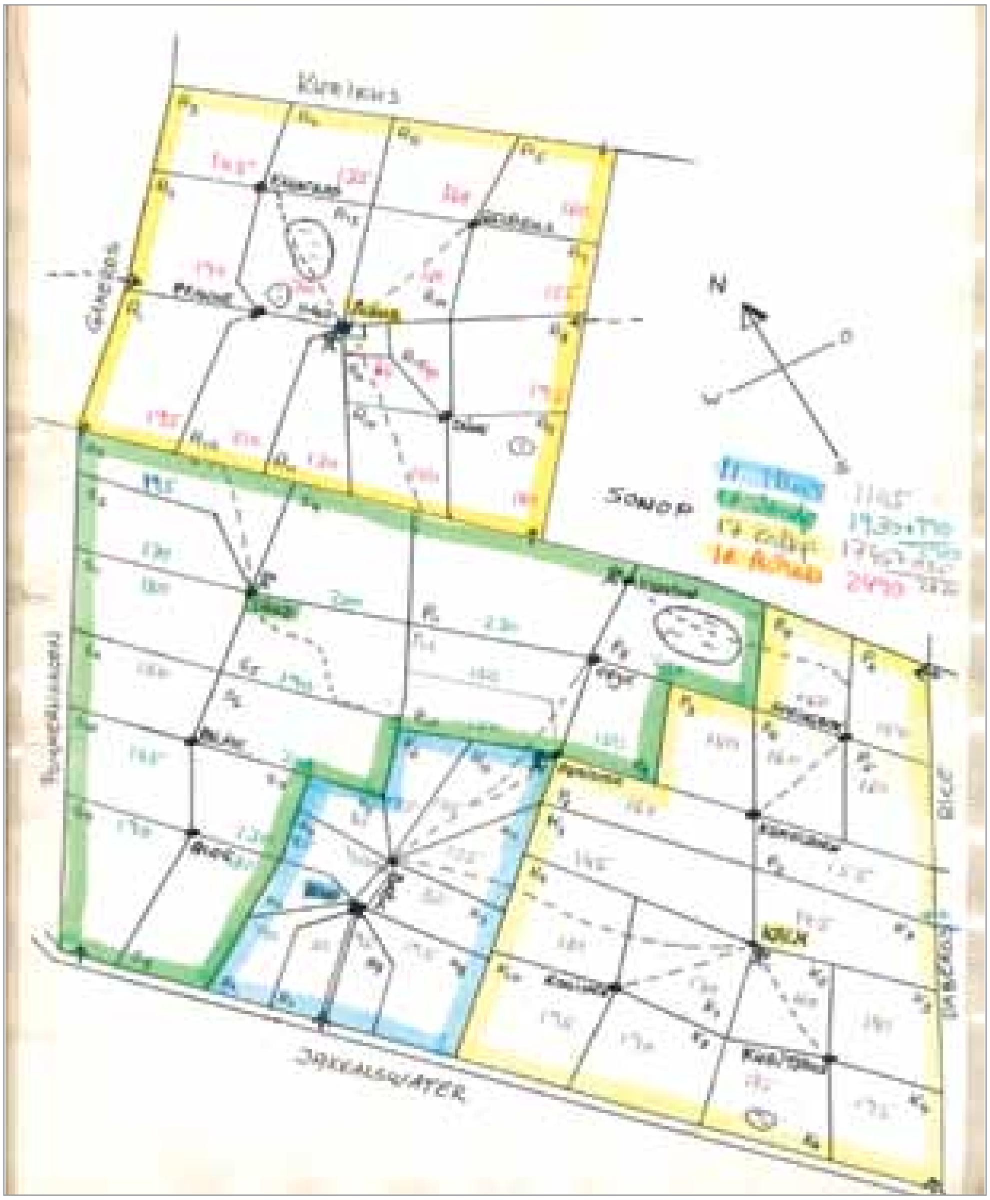
Springbockvley is subdivided into 60 more or less rectangular camps (paddocks), most being about 160 hectares in size with extremes of 45 and 330 hectares. These camps are managed as four cells: three large cells of 16 to 17 camps each, which contain up to 2 000 sheep and 300 cattle and one small cell around the farmyard containing 11 camps which are at the disposal of a herd with around 500 sheep and 100 cattle. The four herds are moved according to a grazing plan that includes not only the differences in size and quality of fodder in each camp but also factors such as different soil conditions, breeding seasons, compulsory vaccinations, weaning, marketing, special treatment of specific areas and problem species. The nutritional needs of the animals at different times of the year are considered in the planning to optimize animal condition and production. The resulting average grazing period in the growing season is between four and six days per camp,

© V. Külbs

Owner-managers of Springbockvley, Judith Isele and Ekkehard Külbs together with some of their animals – Nguni oxen and Damara ewes with lambs – during the non-growing season (end of winter) in August 2010

FIGURE 3

Farm map of Springbockvley
(total area of farm: 9 500 hectares; the four cells are shown in different colours)



provided fast growth is observed. During this time the main objective is to grow as much forage as possible. To assure adequate recovery time the needs of perennial grass plants are given special consideration while not ignoring the needs of animals and people. For each non-growing season, a new schedule of animal moves is drawn up. Generally, grazing periods of seven to twelve days are planned to again combine the needs of animals and soil life (portioning out the available forage to their maximum benefit) with the need to prune grass tufts and work the soil surface to prepare both for the coming rainy season.

Parasite problems are minimized by breaking the lifecycle of external and internal parasites through the above-mentioned well-planned moves of animals across the landscape. Some animal health issues still need additional attention, as there is a lack of research and experience under similar climatic circumstances, such as the treatment of diseases transmitted by one-host ticks, prevention of fly-borne diseases, etc. Fence line studies between holistically managed farms and their conventional neighbours could provide further insight into outcomes and emphasize efficiency of such management.

© E. Külbs

Nguni cows with calves on Springbockvley during the non-growing season in June 2011

CREATIVE CHALLENGES TO SATISFY THE MARKET

There are other hurdles to compliance with organic animal husbandry practices in Namibia: Barrow, Binding and Smith (2010) mention the common practice of supplying urea during the dry season as an affordable non-protein nitrogen supplement to increase the productivity of cattle that are destined to compete in the export market. In order to fetch the best price per kg and carcass, most farmers aim to sell their slaughter animals below the age of 36 months at minimum slaughter weights of 215 to 230 kg. To achieve this, most farmers feed a urea lick mix during the dry season. The use of urea and other synthetic nitrogen compounds is prohibited in organic production. Sound grazing planning allows for the optimal supply of all nutrients for the animals' needs. This reduces the need for nitrogen supplementation and substitutes for urea can be found, though presently this is an additional cost factor.

Namibian farmers are watching with great interest the developments on the farm Oasis just across the border with Botswana in the Ghanzi area. Here the Barnes family have also been practicing Holistic Management planned grazing for over ten years, running very large herds of cattle (up to 2 000 cows in one herd). Although the soil (Kalahari sandveld) is similar to Springbockvley, the average rainfall is higher and the vegetation composition is different. On Oasis, a higher animal density is achieved by combining 2 000 large stock units in camps of around 300 hectares and therefore, an average density of 6.6 animals per hectare when they are grazing in a camp. This higher animal density and herd size effect may well have led to improved growing conditions, and with that the remarkable spread of *Brachiaria negropedata*, arguably the most nutritious and palatable perennial grass found in Southern Africa. *Brachiaria* tufts, if managed well, produce green shoots nearly the whole year round on Oasis. Together with the diversity of browse from nitrogen rich shrub leaves, livestock have access to a carbohydrate–protein balanced diet and can grow muscle and produce more milk even during the dry months. This led to the Barnes' decision to stop supplementing their animals with urea three years after starting with Holistic Management planned grazing.

Nevertheless on Springbockvley with lower rainfall in many years during the dry season, optimal digestion of the "standing hay" is difficult to achieve because

Rangeland on Springbockvley during the growing season in February 2011

of high fibre content and low nutritional density. In the absence of organically produced protein feeds, GMO-free oil cakes from non-organic sources may well be used but are still expensive and not widely accessible. Given that most parts of the dry country are unsuitable for crop production (such as soybeans), further (market) research on alternative protein sources might be crucial to sustain healthy and well-fed organic animals (Barrow, Binding and Smith, 2010). In 2011, Judith Isele and Ekkehard Külbs decided to replace urea with locally collected milled *Acacia erioloba* pods which are mixed with the mineral lick.

At present, the limiting factor for progress on Springbockvley still relates to the ability of the animals to perform exclusively on the resources present on the farm. Another factor for limited animal condition on Springbockvley is the very low species diversity of the grasses: 90 percent of the grass composition consists of only two relatively narrow leaved species: the perennial *Stipagrostis uniplumis* and the annual *Schmidtia kalahariensis*. With all the emphasis on grazing management over so many years, there is still no readily discernible increase in diversity. In conjunction with a planned research project funded through the German institute for organic farming, a portion of the farm will be subdivided into smaller paddocks to increase the animal density, in the expectation of this leading to a change in plant composition, similar to that on Oasis.

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Flock of Damara ewes with lambs on Springbockvley during the non-growing season in June 2011

INDIGENOUS NIGERIAN ETHNO-VETERINARY PRACTICES

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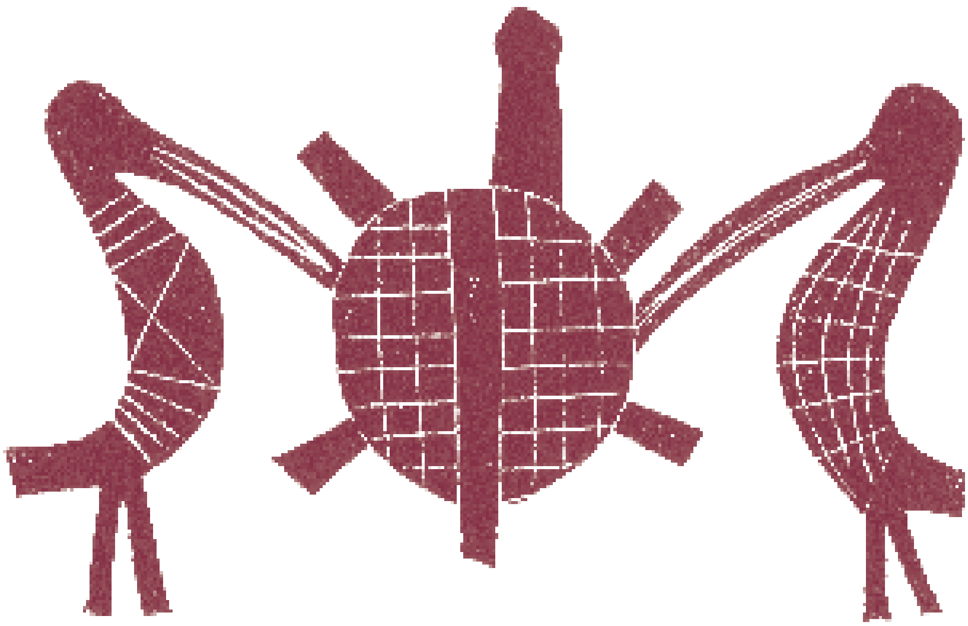

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Oladapo A. Fasae is currently a Researcher and Lecturer in the Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria. He holds a Ph.D in Ruminant Animal Production. He has research interest in farming systems' development of all year round feed for ruminants and organic ruminant production. He is a project partner on dual purpose goat development in Sierra Leone (DelPHE Project 577). Fasae is a registered animal scientist with the Nigerian Institute of Animal Science and member of the Nigerian Society for Animal Production and Organic Agriculture Programme for Tertiary Institutions in Nigeria. He has over 20 journal publications in reputable local and international journals.

BACKGROUND

In Nigeria, ethno-veterinary practices are used extensively in village sheep and goat production, and quite effectively for primary health care treatment and maintaining animals' health. Ethno-veterinary practices cover people's knowledge, skills, methods, practices and beliefs about the care of their animals. It is the knowledge developed by local livestock healers in contrast to the allopathic veterinary medicines which have to be purchased from outside the community. For most of these livestock owners, modern veterinary inputs and services are not readily available and are relatively expensive. Traditional remedies are locally available and cheaper and the knowledge is passed on verbally from generation to generation (Alawa *et al.,* 2001). Moreover, these practices have produced results of proven effectiveness compared with conventional modern medicine (Chopra *et al.,* 1956). In recent times, herbal medicines have become more popular and are forming an integral part of the primary health care system for sheep and goats in many villages in Nigeria.

Ethno-veterinary practices in southwest Nigeria are underdeveloped in spite of their extensive usage for primary health care treatment and maintaining ruminants' productivity. Some of these medicinal plants are also threatened as a result of population pressure, agricultural expansion and deforestation. The present study investigated the ethno-veterinary methods practiced by the owners of sheep and goats in Odeda local government area, Ogun State, Nigeria. This is 86 km north of Lagos, between Abeokuta and Ibadan. A total of 77 respondents were selected from six communities and information concerning the ethno-veterinary practices for the treatment of common diseases and skin problems was collected through interviews, and healing plants were gathered. Sixteen medicinal plant species were identified with scientific names, vernacular names in Yoruba and ethno-veterinary uses. This study has sought to describe the characteristics of the farmers who practice ethno-veterinary medicine in sheep and goat production systems and to identify some plants used as indigenous cures for diseases in the villages of Odeda Local Government area, in the Nigerian Ogun State.

MATERIALS AND METHODS

The study was conducted in six villages namely Apakila, Ogboja, Ogidan, Malaka, Kofesu and Alabata in Odeda. The vegetation represents an inter-phase between the rain forest and savannah. The area experiences approximately seven months (April to October) of usually bimodal rainfall. The inhabitants are mostly involved in crop-livestock systems which they chiefly depend upon to earn their livelihood. Disease affects animal production and most people depend upon traditional methods in the treatment of their animals.

A comprehensive structured questionnaire was designed to collect reliable information from the respondents involved in sheep and goat production through weekly farm visits. All together, a total of 77 respondents were selected and interviewed from six communities ensuring fair representation of the farmers rearing sheep and goats. Data collected in the questionnaires were verified through person-to-person contact in order to identify the plants, mode of preparation and administration of each plant and information concerning the socio-economic characteristics of the respondents. Many respondents were uneducated, and could only communicate through their dialect. Plants were identified using their local names and samples or pictures collected for identification and confirmation (Odugbemi and Akinsulire, 2006).

RESULTS AND DISCUSSION

The distribution of respondents by socio–economic characteristics is shown in Table 1. About 7.8 percent of the respondents were below 30 years of age while older respondents above 50 years of age dominated the management of these animals. This suggests that ethno-veterinary practices are concentrated among older people and this may hinder transfer from the elderly to the younger generation.

Medicinal plant knowledge and transfer of knowledge to the young generation have been affected by modernization and environmental change (Hillenbrand, 2006). About 32.5 percent of the respondents had formal education and most of the respondents had lived for over 40 years in the communities (59.7 percent). This could suggest that these villagers have adapted themselves to the tradition of animal health care practices.

The majority of the respondents (70.1 percent) keep less than 10 animals, a basic feature characteristic of small-holder sheep and goat farmers in the rural areas of South-West Nigeria (Fasae *et al.*, 2012).

The medical aid for disease treatment employed by the respondents in the selected villages followed the same trend. In most of the cases, the respondents' first choice for treating their animals is through traditional herbal medicine. On average, most respondents (83.8 percent) use ethno-veterinary methods in the treatment of their animals. About 90 percent of the respondents preferred ethno-veterinary medicine because of easy accessibility, 83.3 percent found it economical, 79.5 percent used it for its effectiveness and simplicity and 53.3 percent for its traditional nature.

TABLE 1

Distribution of respondents by socio-economic characteristics (n=77)

AGE/GENDER	<30 YR	31-40 YR	41-50 YR	51-60 YR	>60 YR	MALE	FEMALE
Of 77 respondents:	6 (8%)	13 (17%)	15 (19%)	24 (31%)	19 (25%)	31 (40%)	46 (60%)
EDUCATION AND RESIDENCE	FORMALLY EDUCATED	NON-FORMAL	RESIDENT < 20 YR	RESIDENT 20-40 YR	RESIDENT > 40 YR		
Of 77 respondents:	25 (32%)	52 (68%)	4 (5%)	27 (35%)	46 (60%)		
NO. ANIMALS KEPT	< 5	5-10	10-15	>15			
Of 77 respondents:	13 (17%)	41 (52%)	17 (22%)	6 (8%)			

DESCRIPTION OF COMMON ETHNO-VETERINARY PLANTS AND INDIGENOUS APPLICATION METHODS

© Avadhanam Lalithamba

Azadirachta indica

COMMON NAME: Neem
LOCAL NAME: Dogonrayo

Used for the treatment of fever, anorexia, skin diseases and wounds.

The leaves are boiled and given to animal to drink. For skin treatment, two portions of leaves plus one portion of Ocimum *leaves and oil are ground together and applied to skin.*

© P. Latham

Vernonia amygdalina

COMMON NAME: Bitter leaf
LOCAL NAME: Ewuro

Used for the treatment of ringworm, constipation and bleeding.

The juice from leaves is mixed with palm oil and ground pepper and applied to affected parts. To stop bleeding leaves are mashed and applied to wounds.

© P. Ballings

Elaeis guineensis

COMMON NAME: Palm Tree
LOCAL NAME: Airan Ope

Used for the treatment lice and mange.

Burn tree inflorescence in animal shed which gives a pungent odour that repels lice. To treat animals, scrub skin lesions with ground fibrous palm kernel fruit waste with lime juice, salt and palm oil and apply to affected parts.

© http://bioweb.uwlax.edu

Carica papaya

COMMON NAME: Pawpaw
LOCAL NAME: Ibepe

Used as an anthelmintic.

Dry and grind seeds and mix with animal feed.

© Marco Schmidt

Spondias mombin

COMMON NAME: Hog plum
LOCAL NAME: Iyeye

Used for the treatment of endoparasites, cancer, swellings and diarrhoea.

Apply the mashed leaves to the affected parts.

© Forest & Kim Starr

Chenopodium ambrosioides

COMMON NAME: Worm wood
LOCAL NAME: Arunpale ewenla

Used for the treatment of fractures and swellings.

To treat the affected parts, place crushed leaves on fractured part, bound with stick and rope.

© Bapu Gosavi

Tridax procumbens

COMMON NAME: Coat buttons
LOCAL NAME: Mbuli

Used for the treatment of cuts and wounds.

Apply juice extracted from leaves to the affected parts.

© Ashasathees

Chromolaena odorata

COMMON NAME: Siam weed
LOCAL NAME: Ewe akintola

Used for the treatment of wounds.

Apply juice extracted from leaves on wounds.

© Markus Hagenlocher

Nicotiana tabacum

COMMON NAME: Tobacco
LOCAL NAME: Taba

Used for the treatment of mange.

Rub mashed tobacco leaves plus coconut oil on the affected parts.

© Lan Nghiem-Phu

Cocos nucifera

COMMON NAME: Coconut
LOCAL NAME: Agbon

Used for the treatment of conjunctivitis.

Apply by dropping unripe coconut water int the affected eyes.

© H.J. Ndangalasi

Ficus exasperata

COMMON NAME: Sand paper
LOCAL NAME: Eepin

Used for the treatment of ectoparasites.

Put in the animals resting place branches of plant stem and leaves.
Replace regularly.

© P. Eatham

Newbouldia laevis

COMMON NAME: Boundary plant, African Border Tree
LOCAL NAME: Akoko

Used as an anthelmintic and to treat dystocia.

Use leaves as animals feed.

© Forest & Kim Starr

Ocimum gratissimum

COMMON NAME: Tea bush, African basil
LOCAL NAME: Efinrin

Used for the treatment of diarrhoea and bloat.

Apply by mixing squeezed leaves in animal's drinking water. For bloat, add juice from leaves to lime in animals drinking water.

© Eric Hunt

Capsicum annuum

COMMON NAME: Bell pepper, sweet pepper
LOCAL NAME: Ata

Used for the treatment of cold and anorexia.

Apply by pounding fruit plus seeds and mix with animal feed or drinking water.

© Xander van der Burgt/
Royal Botanic Gardens, Kew

Afzelia bella

COMMON NAME: Mahogany
LOCAL NAME: Apa

Used as anthelmintic and treatment of constipation.

Use leaves as animals feed.

© Surajit Koley

Dioscorea cayenensis

COMMON NAME: Yellow yam
LOCAL NAME: Apepe

Used for the treatment of ecto and endoparasites.

To apply, add cooked leaves to gypsum and salt and give animal to drink.

In the study areas, 16 medicinal plants were identified to be in common use by most of the villagers for the treatment of common diseases. Plant leaves were most commonly used relative to the other plant parts. Thirteen plant parts were identified to be used alone in the treatment of various diseases without the application of other ingredients. This shows that plants indigenous to the area possess significant medicinal properties for disease cure. The indigenous name is a reflection of the culture where the plants are mostly found and the meaning of the name was sometimes indicative of the appearance of, or use of, the plants.

Moreover, given that ethno-veterinary plants is a cheaper alternative means of treating livestock animal diseases, it is important that strategies that can enhance sustainable means of producing these plants either through cultivation or preservation of existing habitat be developed and supported with the active participation and cooperation of all stakeholders. Especially important is the participation of rural dwellers, in order to improve the livelihoods of the local community and the conservation of medicinal plants for livestock production within the community.

CONCLUSIONS

Ethno-veterinary practices are important in sheep and goat production, particularly with increasing problems of chemical residues in foods. They are cheap, safe, time tested and based on local resources. Over time, they have been adapted to the culture and socio-economic realities of resource-poor farmers. It is therefore recommended that medicinal plants should be systematically protected and preserved. Plants claimed to be effective in ethno-veterinary practices should be tested scientifically to assess efficacy and appropriate dosage rates. The government should encourage research programmes through grants, loans and subsidies to study clinical actions of the plant extracts, isolate and characterize the active principles. This will improve the existing indigenous knowledge systems.

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KEEKENYOKIE: ADDING VALUE TO MAASAI BEEF

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Michael Kibue has worked in various disciplines and commercial enterprises, organizing and training rural communities in production, sales and marketing especially informal livestock sector enterprises and is technical advisor of Keekonyokie slaughterhouse in Kiserian District, Kenya. During the last 15 years, he has been involved in livestock (beef) value chain development and market price information systems for empowering pastoralists, farmers, processors and traders, to access and provide better market services including community learning and knowledge management for engagement in value chain development to increase returns to poor rural producers. He is the Secretary of Kenya Livestock Working Group and Facilitator of the FAO-SARD Livestock Farmer-Field-Schools.

BACKGROUND

The biggest humanitarian challenge facing sub-Saharan Africa is the recurring droughts due to climate change; impacts reached catastrophic levels in 2010. Kenya was hardest hit with at least 3.2 million people (mostly pastoralists) devastated while thousands of livestock died in most arid areas. The scale and magnitude of environmental decline in these dry lands is reaching alarming levels and this has been attributed to unsustainable livestock grazing systems. In response, the government and development agencies have intervened to sedentarize (settle nomadic populations), destock and develop water facilities to improve livestock productivity. This draws on the classical ranching models, along with formulation of policies aimed at substituting extensive pastoralism on communal rangelands with different production systems and livelihoods. However, these strategies have not improved the situation nor increased livestock productivity. The strategy has been seriously challenged by ever increasing evidence of positive conservation outcomes from pastoralism on communal rangelands (Western *et al.*, 2009) and new understanding of customary systems of resource management, where livestock is seen as an integral part of conservation and development for African drylands. Furthermore, transhumance (transfer of livestock from one grazing area to another) may even be a necessary precondition to sustainable development in arid lands (ILCA, 1988).

While economic improvement is both a moral imperative and is essential for livelihood sustainability, it must also maintain natural resource use systems. Pastoralism can be just such a system, since it is an adaptation to arid and semi-arid environments that is more compatible than many other land use systems. While drylands of Africa are under increasing threat of environmental degradation from climate change, pastoralism has a vital role to play in the future sustainability of these dryland ecosystems. Future policies must therefore enhance the dual roles of pastoralism as a conservation and economic activity for sustainable dryland livelihood strategy. This paper details this vision and documents successes achieved by pastoralists in Kenya.

PASTORALISM AS AN EFFECTIVE CONSERVATION PRACTICE IN AFRICA

As hunger spreads among more than 12 million people in the Horn of Africa, a study by the International Livestock Research Institute (ILRI, 2009) about the response to Kenya's last devastating drought, in 2008-2009, finds that investments aimed at increasing the mobility of livestock herders-a way of life often viewed as "backward"- despite being one of the most economical and productive uses of Kenya's drylands could be key to averting future food crises in arid lands.

As can be seen from the Table 1, there are more pastoralists in Kenya than in any of the other pastoral countries in Northeast Africa. According to the PENHA Network, there are over 25 million pastoralists in the Horn of Africa. Table 1 gives a country by country summary of the different pastoralist groups with population numbers and the Human Development Index (HDI) for each country. The HDI is a composite index based on the level of education, the health of the nation and the

Gross Domestic Product per head, taking account of local purchasing power. The rich mainly northern hemisphere countries (high income OECD) have an HDI average of 0.946 and the least developed countries average 0.464. According to Livingstone (2005), pastoralists make up 25 percent of Kenya's population, and control 75 percent of the Kenyan livestock population of 60 million.

TABLE 1

Overview of pastoralism in the Horn of Africa

COUNTRY	PASTORALIST GROUPS	NUMBER	% POPULATION	HDI
Djibouti	Afar, Somali	100 000	16	0.445
Eritrea	Tigre, Rashaida, Hidarib, Afar	1 000 000	28	0.421
Ethiopia	Somali, Boran, Afar plus 15 others	7 070 000	11	0.327
Kenya	Turkana, Pokot, Tugan, Maasai, Gabbra, Sakuye, Rendille, Sambura, Dassanetch, Boran, Oroma, Somali	7 500 000	25	0.513
Somalia	Somali	4 800 000	55	n.a.
Sudan	East: Beja, Beni Amer, Shukriyya, Rashaida; West: Kababish, Zaghawa, Rizeigat, Messiriya, Fallata; South: Dinka, Nuer, Mundari, Topposa. Plus many others	4 700 000	15	0.499
Uganda	Ateso, Nuer, Karimojong, Banyankore, Basongora	1 030 000	5	0.444

Source: adapted from PENHA and UNDP, 2006.

Annual variation in amount and distribution of rainfall, together with grazing, fire and human activities result in wide variation of grassland productivity (Walker, 1993). Rangelands ecosystems are very resilient and recover well when there is sufficient rainfall and controlled use of the resources. Range condition is dependent both on the grazing system (considered as timing and frequency of grazing) and on the grazing intensity, which is defined as the cumulative effects grazing animals have on rangelands during a particular period (Holechek *et al.,* 1998). Grazing intensity is closely associated with livestock productivity, trends in ecological conditions, forage production, catchment status and soil stability, as shown in the earlier chapters of this book (two Namibian studies). It is considered as a primary tool in range management, and flexibility of grazing intensity is critical to rangeland ecosystem health. Grazing intensity has a major impact on range condition (Sisay and Baars, 2002). In Serengeti and Maasai Mara, grazing was found to stimulate net primary productivity at most locations, with maximum stimulation at intermediate grazing intensities, declining at high levels of grazing. Stimulation was dependent upon soil moisture at the time of grazing (McNaughton, 1985).

Traditional management systems of African pastoralists recognized the need for controlled grazing access to conserve the biodiversity and allow the rangeland to recover. Traditional grazing systems are therefore more effective for sustainable resource use and maintenance of rangeland condition (Pratt and Gwynee, 1977). However, the traditional systems are under threat from increased livestock populations and decreased grazing lands, resulting in increased grazing pressure. This is already being recognized by Boran pastoralists in Ethiopia, who perceive that the condition of the rangelands is poor compared with 30 to 40 years ago (Angassa and Beyene, 2003) and consider that the rangelands are degraded and their livestock production is declining.

LINKING RANGELAND CONSERVATION TO LIVESTOCK MARKETS (CONSERVATION MEAT ENTERPRISE)

As reported in a recent study of Kenyan pastoralism, “The alienation of pastoral lands threatens the long-term viability of the pastoralist way of life and is a major factor in the serious conflicts between pastoral groups” (Livingstone, 2005). The urgency of challenges facing pastoral rangelands requires bringing in both environmental and economic renewed forces synergistically, in order to mitigate the impending climatic risks facing Africa. Greening of pastoralist livestock market chains to link to rangeland conservation may provide a wide range of opportunities to redeem the adverse environmental impacts facing African rangelands.

Addressing global climate change and its potential dramatic social, economic, and environmental impacts requires an integrated approach (Nassef *et al.*, 2009). A green economy has the potential to become the basis for new development initiatives, depending on how its benefits are perceived and how the burden of transition is shared. More balanced growth can lead to truly sustainable development by helping to 'internalize' environmental costs in the market chain, making trade an instrument for sustainable development. Although competitiveness and environmental standards are often considered enemies, trade policy and environmental policy can support sustainable development. Trade and environmental strategies can innovate in the present to conserve and capture markets in the future. This concept of conservation meat enterprises has been practiced by Kenyan pastoralists for decades, and provides an opportunity for new thinking and praxis.

SUCCESS STORY OF MAASAI PASTORALISTS IN KAJIADO, KENYA

(KEEKONYOKIE CONSERVATION MEAT ENTERPRISE)

The Keekonyokie livestock market and slaughter-house, located in Kiserian, in Kenya's Rift Valley province, is a pastoralist owned and managed business established in 1981 without external support or funding. The abattoir slaughters livestock from Maasai pastoralists and sells meat to Nairobi. It offers a direct and sympathetic channel of market access to communities of Maasai pastoralists from south Kenya and parts of north Tanzania, covering over 200 000 pastoralist households and their family networks.

The business has built on local innovation and learning in a pastoralist owned and managed livestock enterprise, developing its focus on both a viable livestock business and rangeland sustainability. The vision is to be an active partner in the pastoralist livestock business and assist in the transformation of the pastoralist livestock value chain in East Africa, serving the pastoralist livestock keepers, while delivering high quality sustainably-produced meat to urban markets.

The slaughterhouse itself has grown from processing 30 cattle per day in 2005 to an average of 180 cattle per day at present, while being able to offer pastoralists a 30 percent better price on their livestock compared with competing markets. It is the most vibrant pastoralist owned livestock enterprise in Kenya, trading more than 250 cattle and 600 sheep and goats per day.


Livestock are sold directly to this pastoralist-owned business

A TRIPLE BOTTOM-LINE APPROACH TO BUSINESS

Sustainable development needs to attend to what has been described as the ‘triple bottom line’, including the social, economic and environmental aspects. All three of these aspects have been part of Keekonyakie’s development, as will be illustrated in the following three sections:

Social business enterprise

- The Keekonyokie slaughterhouse livestock business was designed to function as a social enterprise:
- Contributions to health/education/funeral expenses for members and their family (there are maximum amounts agreed, in specific cases these are topped up with individual voluntary contributions). No loans or other financial services are provided.
- Special contributions to members particularly affected by droughts in terms of organizational structure: Keekonyokie has a complex and well thought membership-based management system. Individual members can agree to contribute extra funds to other members in difficulties.
- The board of directors includes seven officials and nine rotating members. The seven officials include the spokesperson, secretary, treasurer and four other members, who are elected annually by members based on the year’s performance (indicators: income generated and volume of business). Additional members in the board of directors rotate substantially during the year, depending on availability and movement of the pastoralists.
- The association adopted a written constitution in 1992, as it was a requirement for being registered as a company. This did not however alter the rules of the association. Members meet once a month and share the revenue generated among themselves, minus the social contributions (for medical, health and funeral expenses).
- Main costs met by the association are: electricity, water, salaries, insurance, printing, bullets, income tax, auditor’s fees, registration fee licenses, maintenance and repairs.

ECONOMIC ACHIEVEMENTS OF KEEKONYOKIE MEAT BUSINESS

The slaughterhouse has become the central ‘pull’ factor for the economic life of Kiserian Market and the Maasai pastoralists in general. There are 1 240 beneficiaries and the key achievements of the slaughterhouse include a six-fold growth from processing 30 cattle per day to 180 per day over the last five years, making it the biggest pastoralist terminal market in Kenya. The business has a daily turnover of between Kshs. 60 000-100 000 in slaughter fees, and this makes the slaughterhouse a vibrant business with clear returns to shareholders.

It has created direct and indirect employment opportunities: 172 people are employed directly by the slaughterhouse. Several hundred others are employed in associated service businesses (meat trade: 150 men and 80 women; offal trade: 15 men and 88 women; 143 young men involved in livestock trading, 93 men working as flayers and meat processors and 42 women involved in providing hygiene services).

A major achievement of Keekonyokie is the establishment of a “guaranteed” market for livestock, therefore greatly reducing the risk associated with the sale of livestock. The management of the slaughterhouse has embraced a learning culture, which has transformed knowledge into innovation that has contributed to the rapid growth of the business. As a result, Keekonyokie has become a showcase of a successful community-owned and managed livestock enterprise, with a strong and transparent business management structure including annual elections of officials, based on performance, and an equitable system of sharing returns from the livestock trade.

CONSERVATION MEAT INNOVATIONS
(KEEKONYOKIE BIOGAS PLANT)

In 2005, the slaughterhouse decided to construct and operate a biogas plant to convert slaughterhouse waste into energy and bio-fertilizer. This was part of an effort to fulfil requirements for slaughterhouses to stop discharges causing environmental degradation. The methane produced by the biogas plant has several end-use applications. It is used to generate electrical power for the meat storage cold room, meat processing equipment and hot water for sterilizing and washing the abattoir. Excess biogas is supplied to the local communities as cheap cooking gas to replace charcoal, reducing the cutting of trees in the rangelands. The liquid organic slurry replaces the expensive chemical fertilizer and increases food self-sufficiency of local communities.

The biogas plant at Keekonyokie turns waste into energy

Biogas is converted into electricity

MAASAI COWS TO KILOWATTS INNOVATION

Continuing with the policy of environmental innovation, waste from the cow is transformed into energy for processing the meat. The picture above/left shows how the slaughterhouse cold room facility is powered by the electricity from the biogas plant.

Meat-processing equipment also uses cheap power from biogas to produce a variety of products for sale to urban markets. To make this happen Keekonyokie slaughterhouse had to invest substantial resources in renovating and upgrading both the slaughterhouse and the processing facilities to acceptable hygiene standards.

A biogas storage tank of 200 m^3 is piped to a generator set of 20 KVA capacity (as shown in the picture above/right), producing power for the slaughterhouse. The plant also produces 10 tonnes of liquid fertilizer together with its daily production of nearly 200 m^3 of biogas.

KEEKONYOKIE PASTORALIST FIELD-SCHOOL

Keekonyokie slaughterhouse pioneered and supported the establishment of a Pastoralist Field-School (PFS). The PFS was established to serve as a local training centre through which the pastoralists engage and learn various livestock production technologies and rangeland conservation approaches within their own value systems. It involves the use of visual illustrations through murals of various aspects of livestock production and marketing, natural resource management and policy analysis. It also has demonstration sites for pasture conservation and water harvesting. The PFS brokers knowledge on the various technologies for building resilience against drought especially through pasture management, holistic management and water harvesting. Through the partnership with other organizations, over 200 participants were trained through the school in the year 2011. The participants were drawn from the Kajiado district and also (for Training-of-Trainers) from West Pokot, Isiolo and Samburu. Through these activities, the slaughterhouse is engaged in reseeding of the rangelands and supporting the establishment of other pastoralist field schools in the wider Kajiado district.

A field school for pastoralists is supported by Keekonyokie

NEW THINKING FOR THE PASTORALIST LIVESTOCK MARKET CHAIN

During the last 20 years, many efforts have been made to address the challenges facing African pastoralist rangelands and the livestock value chains. Massive resources have been spent achieving very little success. Indeed, development of the pastoralist livestock industry has failed to link with formal extension and research, yet the industry has the potential to rescue millions of Kenyans from abject poverty and make a substantial contribution to the economy.

Experience and lessons learned through Keekonyokie livestock enterprise are that successful strategies to conserve African rangelands must include the creation of social capital. In practice, this means transferring knowledge from older, more experienced pastoralists to younger members of the community, and combining these pastoral skills with marketing and management skills, so that the whole value chain is understood by the pastoralists. The activities range from animal health through holistic rangeland management to buying and selling of livestock, the slaughtering process, meat manufacturing so that value is added to the products while still under the control of Keekonyokie, through to environmentally sound management of wastes and their conversion into useful products. All these aspects allow local people to find employment, so that the local economy is stimulated. This is what the economist Norman Reynolds describes as "Sustainable Community Investment Programmes"; the more the economic benefits derived from agricultural production are transformed locally into products and services, the more the local economy will grow and thrive (Reynolds, 1981).

However, to achieve this, the social capital invested by communities must be sustained through good management and innovation, linking economic and conservation concerns in a mutually beneficial way. While it is true that traditional grazing and marketing practices by pastoralists provide the much-needed social capital which can practically integrate economic, social and environmental sustainability, unfortunately this is now limited by external factors like climate change. Keekonyokie is a social and economic model that shows how conservation meat enterprises can link profitable trade and conservation in these challenging times of varying climatic conditions. Combining the flexibility of transhumance with the business skills of a settled and stable marketing system gives Kenyan pastoralists the best of both worlds. They can adapt to changing environmental demands for animal production while having a stable base where children can be schooled and assets can be invested.

The case study presented of Keekonyokie conservation meat enterprise clearly demonstrates that it is possible to achieve development that integrates economic, social and environmental sustainability, where all are mutually supportive. Traditional knowledge systems can be supported by science and good business practice to the benefit of rural people in many environments.

DISCUSSION AND CONCLUSIONS

Mobile pastoralism is not a backward means of livelihood—many laws, policies and procedures should be considered backward, because they do not recognize the ecological and economic value of mobile pastoralism.

Management of livestock mobility also requires multiple institutions working at multiple spatial scales, authorities and functions. To modify or create the institutional structure for a legitimate, locally controllable transhumance, the function not just the structure of new institutions must be addressed.

Trade can be an effective instrument for sustainable development and conservation. It can help steer (rather than create obstacles for) the transition to a green economy linking trade to environmental conservation. Sustainable trade is not only about trading green goods and services, but also about ensuring that trade contributes positively to conservation. It must share the domestic costs and gains of conservation, and contribute to sustainable development.

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ECOFUNCTIONAL INTENSIFICATION


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ORGANIC COTTON IN NIGERIA? USE AFRICAN BUSH TEA AND LEGUMES!

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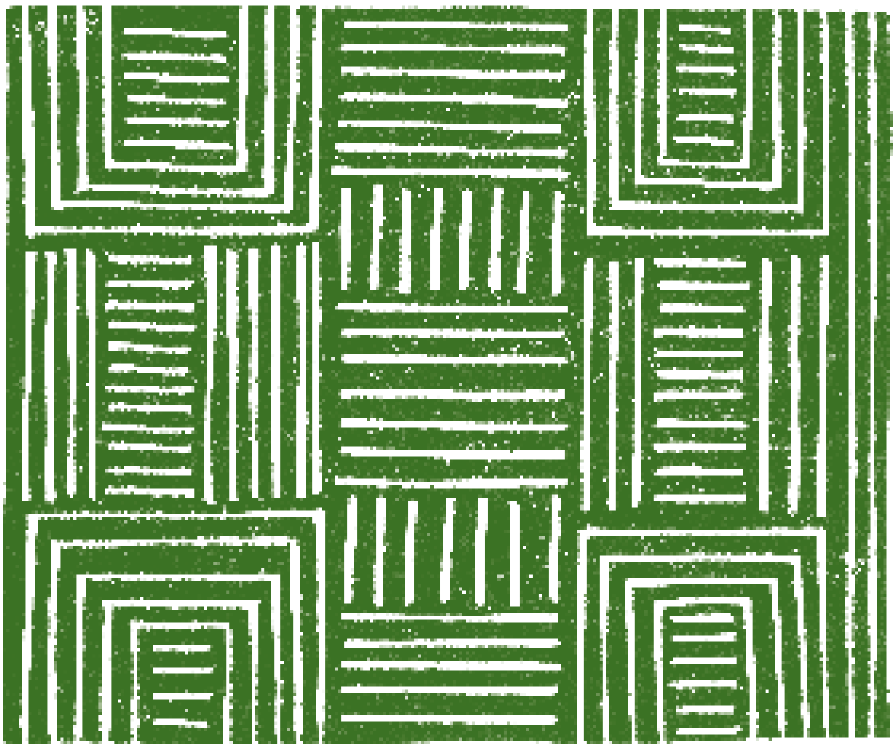

ABOUT THE AUTHORS

The authors are affiliated to farming/cropping systems research of the Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria. Odion works on improving the productivity of low-technology farmers through sustainable inputs and has worked with both Peter and Sambo on improved fallow systems and clipping/thinning management of crops for soil fertility improvement. Ogedegbe worked on the clipping management of lablab to improve crop/livestock systems, while Sharifai, Peter and Yaro are currently working to develop organic agriculture production procedures for various crop mixtures. Together they have undertaken preliminary studies on the use of Hyptis sauveolens (Poit.), African bush tea for the control of pests and diseases of field crops, as well as allelopathic properties of the plant. Using the soil fertility improvement methods together with protection from H. sauveolens, they have been successful in the production of the mixtures of cotton/cowpea, sorghum/cowpea and roselle/soybean. All the authors are staff members, students or former students of the Department of Agronomy of the Institute.

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BACKGROUND

Africa has a large population of small farmers who are largely dependent on the use of local resources, but who may make moderate use of external inputs. These farmers produce a large proportion of grains, almost all roots, tubers and plantain crops and much of legume crops. Following the food crisis in 2008, a new green revolution for Africa was proposed by the Alliance for a Green Revolution in Africa (AGRA) which aims to double or quadruple yields of smallholder farms. To achieve this, AGRA is funding the development of new seed varieties, improving soil fertility (through higher usage of chemical fertilizers) market access and farmer education among others. However, as noted by Altieri (2009), this approach appears destined to repeat the tragic record left by fertilizer dependent miracle seeds in Latin America and Asia by increasing dependence on foreign inputs and patent-protected plant varieties (which poor farmers cannot afford), and on foreign aid. In addition, the application of high rates of chemical fertilizers has been implicated in soil degradation processes and the pollution of the environment. For example, in the USA, Khan *et al.* (2007) reported that despite the use of forage legumes, soils in the Midwestern Corn Belt suffered serious decline in their content of nitrogen (N) and organic matter, except in cases involving regular manuring. In Asia, Mulvaney *et al.* (2009) showed that loss of organic N decreases soil productivity and the agronomic efficiency of fertilizer N and that this has been implicated in the widespread reports of yield stagnation, or even decline for grain production

in Asia. In Europe, nitrate leaching from conventional crop production has been shown to be higher than for organic farms (Olesen *et al.,* 2004).

It is estimated that global biological nitrogen fixation accounts for about 175 million tonnes of fixed N per year, compared with about 80 million tonnes of ammonia produced annually through the Haber-Bosch process, 75 percent of which is available for fertilizers (Elkan, 1992). Virtanen and Meitinen (1963) and Grahammer *et al.* (1991) have shown that the N content of a cowpea plant varies with the age of the plant, and is often highest at mid-fill pod stage, while Adjei and Gentry (1996) and Hena *et al.* (1990) also reported that the nutritive value of lablab varied with stage of maturity and reported that the best combination of nutritive qualities was obtained when the crop was harvested at 12–14 Weeks After Sowing (WAS).

This paper describes the development of strategies for profitable organic cotton production in Northern Nigeria. Before describing the cotton production research trials, the role of African bush tea and of the leguminous green manure crops cowpea and Dolichos Lab-lab are described, as these were incorporated into the approach to cotton growing; without countering cotton pests and improving soil fertility, organic cotton growing is not viable in Northern Nigeria.

SOIL FERTILITY IMPROVEMENT WITH AFRICAN BUSH TEA AND LEGUME GREEN MANURE CROPS

In the past two years when the trial was initiated, it was not possible to grow crops of either cotton or cowpea organically, as leaves were attacked from the onset and the plants did not flower at all. In 2010, in an attempt to save the crops, African bush tea, *Hyptis sauveolens* (Poit.) was sprayed for the first time on the crops towards the end of the season. It showed promise in reviving the crops, which then flowered; for this reason, the plant was used for pest control in the 2011 growing season. African bush tea is a weed that can be used in pest and disease control both with crops and animals. It has antimicrobial, insecticidal, acaricidal, larvicidal and antiinflammatory properties. It has been used successfully in the production of organic cotton, and has shown promise with tomatoes, roselle, cowpeas and groundnuts.

Thus the use of African bush tea has made organic cotton production in Nigeria feasible. Use of legumes to improve soil fertility has also been tried over the years in Nigeria; two legumes have proved to be important in organic agricultural production. When clipped regularly, the clippings have proven to be a good source of green manure. Cowpea (*Vigna unguiculata* (L.) Walp) sown at very high population densities produced between 7-15 tonnes per hectare of green fodder depending on the clipping time, which translated to about 140 kg N/ha, or about six bags of urea fertilizer, added to the soil in four seasons (Odion and Singh, 2005a; 2005b).

Also dolichos lablab (*Lablab purpureus* (L.) var. ILRI 147) produced cumulative fresh herbage of over 30 tonnes per hectare, of which more than 50 percent was at 12 WAS (Hena *et al.* 1990).

Among resource poor farmers, it is much more cost effective to improve biological nitrogen fixation, either through the intensification of leguminous cultivation, or by the expansion of areas devoted to the production of legume crops, or using both, rather than to provide more money to purchase chemical fertilizer. Biological nitrogen fixation could be more beneficial to the low external input farmer, as it could serve a dual purpose of crop/livestock integration and soil fertility improvement (Odion and Singh, 2005a). Sambo *et al.* (2009) reported that the incorporation of clipped cowpea to the soil improved soil organic carbon by 18.4 percent, soil organic matter by 19.6 percent and soil N by 52.9 percent, while the cation exchange capacity increased from 4.9 to 18.0. They also reported that it took cowpea leaves 18-24 days and the stems 27-35 days to decompose completely when placed on the soil surface and 32-40 days and 43-53 days, respectively, for the leaves and stems buried in the soil.

This method of fertility improvement has a significant role in agricultural production, not only because of current high costs of fertilizer and its unavailability to a high percentage of farmers when needed, but because agriculture is currently held responsible for soil and environmental degradation and global warming.

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Environmentally sustainable techniques must be developed to feed more people. Added to this is the high rate of fertilizer adulteration in Nigeria, by which farmers do not get the products they are paying for. Farmers are able to estimate the amount of biological nitrogen fixation by the size of land devoted to production and the type of legume planted. In addition to providing green manure for soil fertility improvement, clipping management also produces the same quantities of pods and grains as the unclipped plots (Odion and Singh, 2005b; Sambo and Odion, 2011), thereby increasing the economic value of the practice and making it a win-win situation. Discussing the relationship between increasing yields (and returns to labour) with poverty, Irz *et al.* (2001) estimated that for every 10 percent increase in farm yields, there was a 7 percent reduction in poverty in Africa, and more than a 5 percent poverty reduction effect for Asia. The World Bank (2010) reported increases in overall Gross Domestic Product (GDP) derived from agricultural labour productivity were on average 2.9 times more effective in raising the incomes of the poorest quintile in developing countries, than an equivalent increase in GDP derived from non-agricultural labour productivity. It follows therefore that any innovation to improve farm yields and productivity will have a positive effect on improving the lot of the farmer, and could have an additional multiplier effect (Delgado *et al.*, 1994).

The addition of large quantities of green organic plant material residues is primarily a biological method of soil fertility maintenance which can mobilize and make available significant quantities of N, when residues are placed on the soil surface and/or incorporated. This approach can be substituted with shifting cultivation and the bush fallow systems of soil rejuvenation.

Regenerative resources such as plants and their products for pest and pathogen management are essential if more farmers are to be involved in improved production practices. Concerns that large-scale use of plant-based fungicides and insecticides may lead to resistance among pathogens have not been substantiated. Unlike conventional pesticides based on a single active ingredient, the bioactive components in the natural plant products are made up of a complex array of chemicals which affect several physiological processes (Fawcett and Spencer, 1970). The age-old interaction and co-evolution between pathogens and plant hosts makes plants ideal sources of new products for use of indigenous strategies in the management and control of pests (Sharma, 1998). Such plant products are relatively bio-efficacious, economical and environmentally safe, and can be ideal for use as agrochemicals (Macias *et al.*, 1997; Cutler, 1999). Sharma *et al.* (2007) reported that volatile substances obtained from higher plants have proved useful in controlling bio-deterioration, as they form a vast cornucopia of defence chemicals, poisons and antimicrobial agents. *H. suaveolens* contains alkaloids, phenols, tannins, flavonoids and saponins (Edeoga *et al.*, 2006), which can be used to control pathogens (Singh and Sawhney, 1988) as well as in the manufacture of insecticides (Okwu, 2003). The plant may also be allelopathic, which could confer weed controlling properties on it. Working with natural products therefore should improve productivity, as well as reduce or avoid environmental pollution.

MATERIALS AND METHODS

A field trial was carried out in the 2011 growing season on the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, in the Northern Guinea Savanna agro-ecological region of Nigeria. Given the above research findings, cowpea was selected as the preferred green manure companion crop for cotton, and African bush tea was used as a standard treatment to ensure that both cotton and cowpea plants were not destroyed by pests.

The soil in the experimental area is sandy loam, low in organic carbon and total N and acidic in nature. Treatments included two cotton varieties (SAMCOT 7 and SAMCOT 9), intercropped with cowpea in five cropping patterns with the following arrangements of rows (cotton : cowpea) in the layout: 1:1, 2:2, 3:3 (replacement mixtures) and 1^2:2 and 1^3:3 (additive mixtures, thinned to two or three cotton plants per stand respectively (see Table 1 and explanation below); each replicated three times.

TABLE 1

Field layout for the three replications, and treatment codes

PURE COWPEA	V2P2	PURE COTTON	TREATMENT DETAILS: NO. OF ROWS	
V1P1	V2P5	V2P4	Cotton : Cowpea	Treatment Code
V2P5	V1P3	V1P5	1:1	P1=1:1
V2P1	V2P4	V2P3	2:2	P2=2:2
V1P4	V2P1	V1P3	3:3	P3=3:3
V1P2	V1P1	V2P2	1^2:2	P4=1^2:2
Pure cotton	V2P3	Pure cowpea	1^3:3	P5=1^3:3
V2P4	V1P5	V1P1	1^2 (thinned to 2/ stand)	
V1P5	V1P2	V2P5	1^3 (thinned to 3/ stand)	
V2P3	V1P4	V2P1	Cotton variety:	
V1P3	Pure cotton	V1P4	SAMCOT 7	V1
V2P2	Pure cowpea	V1P2	SAMCOT 10	V2

Gross plot = 12 ridges of 4 m length and 0.75 m apart = 36 m^2

The trial was planted on July 07, 2011, using the cropping patterns above after the application of cattle dung (at the rate of 2 tonnes per hectare) and rock phosphate (Phosphate + Magnisite: 21 percent P_2O_5, 5 percent Magnesium and 5 percent Calcium) at the rate of 50kg P_2O_5 per hectare, the land was ploughed and ridged (see field layout). The cotton was thinned to one plant per stand in the replacement mixtures and either two or three plants per stand in the additive mixture, depending on whether it was a 1^2 or 1^3 cotton proportion one week after sowing. Pest control measures were undertaken on the cotton crop with African bush tea, throughout the season using about 800 g of fresh leaves to 15 litres of water (because the first flowers were noticed until bolls started to open). A solution of the African bush tea is made by squeezing leaves of the plant in a bucket of water and allowing this to settle overnight and then filtering out the solids. The filtrate is then mixed with water in a 15-litre sprayer and sprayed on the crops. The cowpea crop was clipped in September and the organic material incorporated into the cotton rows. The cotton was picked in February 2012.

RESULTS AND DISCUSSION

The results show that the varieties used were not significantly different in yield (Table 2). The cropping patterns were also not significantly different in yield; though yields in the replacement mixtures (notable the 1:1 mixture) were better than in the additive mixtures. This may have been due to the higher number of plants per stand in the additive mixtures, resulting in higher competition among cotton plants. Thus, intra-specific competition was higher in additive mixtures than in replacement mixtures, and the added advantage of organic manure did not help the plants to overcome its effects.

Cotton in the trial remained green for a longer time than in other trials (Pictures 3 and 4), indicating that either soil moisture retention capacity was higher in this trial, or better crop growth resulted from added manure, as manured soils are

TABLE 2

*Yield of cotton (*Gossypium spp L.*) varieties intercropped cowpea (*Vigna unguiculata*) at different cropping patterns in 2011 cropping season at Samaru.*

TREATMENT VARIETY (V)	YIELD IN KG HA^{-1}
SAMCOT 7	556.30
SAMCOT 9	530.93
SE±	62.729
Planting Pattern (P)	
1:1	693.4
2:2	511.1
3:3	536.2
1^2:2	486.9
1^3:3	491.5
SE±	99.18
Interaction	
VxP	NS

NS = Not significant

more fertile and supportive of higher crop productivity (Lal *et al.*, 1979; Keller, 1982; Meyer, 1982; Singh *et al.*, 1999).

The novelty in this trial is the successful production of cotton under organic agriculture management. In addition, the African bush tea was also used to control pests in cowpea, the companion crop in this mixture; though the clipped cowpea in this trial eventually failed as it was overtaken by weeds, it was incorporated into the soil in the cotton rows, and contributed to the success of the main crop. However, given that nitrogen was not measured, it is uncertain whether the incorporation of cowpea had an effect. For the low-technology farmer, the growth of cowpea could be prolonged by controlling weeds on the farm, thus producing both cowpeas (Odion and Singh, 2005a; 2005b) and cotton using the experimentally developed production practices.

Integrating crops and livestock is a core activity among most low technology farmers. Maintenance of animals, particularly during the dry season when fodder is limited, is a major bottleneck for improved productivity and impacts negatively on these farmers. Odion and Singh (2005a) and Hena *et al*. (1990) have reported how cowpea cut at about 6-8 WAS and lablab at 12 WAS were high in nutritive values, making such fodder valuable for animal production; in this way the green manure crops could also be used as fodder crops.

Cotton lint

Cowpea seed

Treated plants in January before harvest

Control plants in January before harvest

CONCLUSIONS

The clipping management of legumes should be exploited for low-technology farmers as a strategy for the improvement of soil fertility, at the same time providing high protein animal fodder. The practice, if adopted, will not be affected by global economic downturns, as farmers could be self-sufficient or rely very little on external inputs. This is very different from the present situation where conventional farmers rely on subsidies or loans to purchase inputs needed on their farms.

More work with African bush tea is however still required to determine its efficacy and potential in crop production practices and storage of products, as well as its usefulness in weed control. In this trial, the plant was effective as a preventive measure but it is thought that it could also be curative, as it was able to revive plants that were completely defoliated in 2010.

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ORGANIC PRODUCTION OF PINK RICE IN MADAGASCAR

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Andry Randrianarivelo completed his graduate studies and worked in Europe for several years. In 2004, he became the Coordinator of the Secretariat of the Groupement SRI de Madagascar and is Managing Director of the consulting group, Groupe Conseil Développement, based in Antananarivo, Madagascar. The group aims: i) to promote the exchange and sharing of information as well as the coordination of SRI activities at the national level and progressively at decentralized levels; ii) to establish an improved system of communication for SRI in Madagascar through the establishment of a system for the collection of SRI information and the development of a Web site for SRI; and iii) to network with other groups and actors.

Rames Abhukara is a Country Representative of Jim Carrey's Better U Foundation in Madagascar. In that role, he co-manages the planning and coordination of the Foundation's work in support of the dissemination of SRI with partners across the country. From 1981 to 2012, he worked with the Canadian International Development Agency both at its headquarters in Ottawa and overseas. From 2005 to 2007, he worked at the International Labour Organization as Chief Technical Advisor for the International Program to Eliminate Child Labour in Madagascar. Since the end of this assignment, he has worked with the Foundation on the promotion of SRI. He holds a graduate diploma in international development studies from the Institute of International Cooperation at the University of Ottawa.

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Corinne Pargee served as a Peace Corps Volunteer in Madagascar in 2010, where she worked directly with the leadership of the Koloharena Ivolamiarina to manage the production, packaging and export of pink rice. Her primary role was to train the farmers and cooperative staff in organic production compliance and operations management. She currently works as Associate Program Manager at Millennium Promise, and holds an MPA in Development Practice (MPA-DP) from Columbia University's School of International and Public Affairs.

Olivia Vent is the former Director of Communications at the Cornell International Institute for Food, Agriculture and Development. She took an early interest in the potential for linking SRI farmers to markets as a way to improve their incomes, preserve rice biodiversity and create long-term demand for more sustainably grown rice. She identified Lotus Foods as a likely private sector partner and used a small grant from the SEED initiative to enable the owners of Lotus Foods to visit Madagascar to assess the feasibility of a partnership with SRI farmers. She is now retained part-time by Lotus Foods as their SRI Liaison. Lotus Foods has developed supply chains with SRI farmers as well in Cambodia and Indonesia, and sells the rice in grocery stores and natural food stores across the US. The company has an active consumer outreach program about SRI, which they refer to as More Crop Per Drop™.

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BACKGROUND

Madagascar has enormous agricultural potential, yet a majority of its 20 million people struggle to get enough to eat. Two-thirds are subsistence farmers, with most living on less than $1 a day, and 38 percent of the population undernourished. Rice is both the main crop and the staple food for the Malagasy population, with an annual per capita consumption of more than 120 kg (CIRAD, 2012). However, low agricultural productivity limits food availability for consumption or income generation. Poverty and a lack of rural infrastructure – such as adequate irrigation systems, road networks, intermediary markets and storage facilities – limit access to food and income opportunities. Natural disasters such as cyclones, flooding, and drought intensify challenges for already vulnerable populations. These factors have been the impetus for research, as well as local, national and international efforts to identify and promote methods to raise agricultural productivity. Indeed, the need to increase yields from land currently under cultivation has become critical.

The desire to preserve the environment and the changing needs of the international market have encouraged the practice of organic farming in rice using the System of Rice Intensification (SRI) practices (see Box below). This case study highlights the benefits of combining innovation-intensive and organic agriculture in a market-oriented production system in Madagascar. Madagascar was previously a net exporter of rice. Today, the country relies on imports from the world market and consumers are vulnerable to strong price fluctuations driven by external factors. As this study shows, with appropriate policies and farmer-focused incentives, Madagascar could again meet local demand and even become a net-exporter of rice, thereby reducing local consumers' exposure to price volatility and enhancing their food security. Indeed, as the UN Special Rapporteur on the Right to Food noted at the conclusion of his visit to the country in July 2011, "Madagascar has a unique potential for ecological agriculture. We know that the system of intensive rice cultivation [SRI], a pure Malagasy invention, allows to double, triple or even quadruple yields. A national strategy to support this type of ecological production could make the large island self-sufficient in rice in three years, whereas it is currently importing annually 100 000 to 150 000 tonnes of rice. But for this to happen, the authorities must decide to act." (UN, 2011).

The successful export of organic pink rice (also known as *Dista* rice) to the USA is the result of a deliberative process and intensive informal collaboration among many individuals and institutions in Madagascar and the USA (AFD, 2011). The pink rice export is nested in a larger effort to provide market incentives for small-scale farmers using SRI methods. Beginning in 2004, Cornell University's International Institute for Food, Agriculture and Development (CIIFAD), which promotes research and understanding of SRI around the world, moved into marketing as a natural extension of their mission to improve farmers' livelihoods. This was notably the case in Cambodia and Madagascar but also in Sri Lanka, Nepal, and Indonesia.

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Most SRI rice in Madagascar had been grown organically but was not certified as organic, as there was no local market for higher-priced organic rice and farmers had no experience in certification and export processes. Many SRI farmers were also planting locally-evolved or traditional varieties, with beneficial nutritional properties. Creating domestic markets for organic rice and connecting SRI farmers to export markets for heirloom and organic rice presented an important and novel opportunity to have significant economic and environmental impact on smallholder rice communities.

THE SYSTEM OF RICE INTENSIFICATION(SRI)

SRI is a set of alternative crop management practices, developed in Madagascar in the 1980s, to benefit farmers with small landholdings (Africare, Oxfam and WWF, 2010). It:

- increases the productivity of resources used in rice cultivation;
- helps households be more productive, secure and self-reliant;
- has been adopted by farmers in more than 50 countries.

SRI has six recommended practices:

1. Age of seedlings. young seedlings are transplanted at 8-12 days old ("2 leaves");
2. Number of seedlings: 1-2 seedlings per hill are transplanted with shallow depth into soils that are not flooded;
3. Spacing of plants: seedlings are planted in a grid pattern, 20-30 cm apart to facilitate weeding and to expose plants to sunlight;
4. Water management: fields are non-flooded, with intermittent irrigation (alternate wetting and drying during the growth period);
5. Soil fertilization: use of organic matter is recommended (manure, compost);
6. Weed and pest control: weeding is done, often with a rotary pushed weeder, to remove weeds and aerate the soil.

The benefits of adopting SRI include:

- less seeds are required with SRI, therefore better quality seeds can be used;
- easier to maintain 'purity' of rice produced with SRI;
- stronger plants and better resistance to climate conditions, pests and diseases;
- higher yields per hectare with better quality (fuller) grains;
- reduced water usage because fields are not continuously flooded;
- less pressure to convert remaining forests and natural landscapes to agriculture;
- reductions in greenhouse gas emissions, especially methane.

In Madagascar, very small-scale farmers who cultivate on tiny plots have started to dedicate more of their rice fields to the practice of SRI and have been able to increase their yields, thereby reducing their vulnerability, especially during the 'lean season'. Adopting SRI, a natural, eco-friendly approach that encourages the use of organic fertilizers and requires fewer purchased inputs, also means no debt, no poisons, and no pollution, and contributes to an improved quality of life.

"Before, we used the traditional method of transplanting seedlings randomly, in a scattered fashion. Yields were not very high. Since we have been using SRI, planting seedlings in a grid-system, we can control weeds effectively. We now have a stable income and live in better conditions. We have enough money to educate our families and to pay for health services. This method, as well as planting in the off season, has brought us a happy life. Some have built modern houses; others have bought phones or bicycles", explained Madame Berthine, a farmer in Ambositra.

Experience shows the need to provide follow up support and accompaniment to farmers for a few years after the initial training in order to reinforce the learning and give them more confidence because farmers may be attached to their traditional ways, may be risk-averse and may face technical difficulties.

The System of Rice Intensification (SRI) supports rural livelihoods through sustainable development in a way that respects the environment, helps farmers to adapt to climate change, trains them in organic production and thus improves household food security while generating increased income.

Food markets in the USA and Europe are highly competitive and heavily regulated. Launching a new product into established markets can take five to ten years and requires large up-front investments. The failure rate is high. SRI farmers in Madagascar, their partners and advocates lacked the funds and expertise needed to enter these markets. In 2005, Cornell approached Lotus Foods, a small California-based company that had introduced to the USA market heirloom rice varieties grown on small family farms in Bhutan, Bangladesh and China. In 2006-2007, Lotus Foods conducted due diligence visits to Madagascar and Cambodia, thus beginning the process towards what became the first-ever launch of SRI-grown rice from Cambodia, Madagascar and Indonesia into the USA market in mid-2009. The rice varieties include:

- the pink rice or Dista rice produced with SRI methods by members of the cooperative Koloharena Ivolamiarina in Amparafaravola of the Alaotra Mangoro Region of Madagascar;
- a Cambodian jasmine variety grown on small rain-fed plots by SRI farmers in Takeo Province; and
- a blend of traditional brown and red rice grown by SRI farmers in West Java, Indonesia.

All three of these rice varieties are certified organic. The Cambodian and Indonesian rice are also certified Fair Trade. The rice from Indonesia is the only rice that has been successful in qualifying for IMO certification as “Fair for Life”.

Lotus Foods products can be found in 4 000 stores and thousands of foodservice venues in North America, and from Lotus Foods’ Web site. The SRI-produced rice are marketed under the tagline “More Crop Per Drop”.

THE KOLOHARENA NETWORK AND SRI

The Conféderation Nationale Koloharena Sahavanona (CNKH) is the national representative body of 29 farmer cooperatives known as Koloharena. The Confederation encompasses 950 village-based associations and 29 000 members committed to increasing small-farm income using environmentally sound farming methods. The cooperatives are concentrated along the threatened humid forest zone in eastern Madagascar.

From 1999 to 2008, the USAID-funded Landscape Development Initiative (LDI), followed by the Eco-Regional Initiative (ERI) and the Business and Market Expansion (BAMEX) projects encouraged the development of the Koloharena and SRI rice production, working closely with the Association Tefy Saina, the local association from whom LDI staff first learned about SRI.

With higher yields, many SRI farmers found that they had surplus rice after meeting household food needs. In 2004, Slow Food recognized the Association Tefy Saina with the Award for the Defence of Biodiversity for its work with the Koloharenas to produce varies mena, traditional Malagasy red rice. Several Koloharena farmers and leaders participated in Slow Food's international food fair, the Salone del Gusto, in Turin, Italy, in October 2004. There, they sold bags of vary mena for US$6/kg – more than 20 times the local market price in Madagascar. Slow Food made an in-kind equipment grant to the Hanitriala Koloharena cooperative to help improve rice packaging and quality control.

By 2005, the Koloharena was growing red rice using SRI methods, as well as spices, essential oils, fresh fruits and vegetables, and had a full-time coordinator for marketing these products. This effort was backstopped by BAMEX, which assisted in the commercialization of products produced by Koloharena members. With their positive experience with Slow Food and because there is a limited domestic market for organic rice, the Confederation decided to focus on the export market. As agrochemical use is limited in Madagascar and as the government in office at the time was supporting eco-friendly agricultural strategies as part of the Madagascar Naturellement initiative in order to differentiate Malagasy products in global markets, these efforts coincided very well with national policy.

WHY PINK RICE

In November 2006, Lotus Foods visited Madagascar and tasted red rice, visited farmers' fields and milling facilities, negotiated with a shipping company and met with government officials and scientists at Madagascar's national agricultural research institute.

Pink rice was served at a luncheon in Amparafaravola hosted by Mr Sosoa Andriamanantseheno, then president of the Koloharena Ivolamiarina, in the Commune of Amparafaravola in the Alaotra Mangoro Region. This area is known as the "granary of Madagascar" due to its ability to produce surplus rice for national markets. A few days later, in a blind taste-test of nine different rice organized in Fianarantsoa, the Lotus Foods owners selected the pink rice as their clear favourite.

At the time, the only *Koloharena* producing pink rice was the *Koloharena Ivolamiarina*. The cooperative consisted of about 50 active members, mostly rice farmers, pursuing principles of natural resource conservation in their farming practices, including SRI. As there were two potential mills in the area and there was a good relationship between the *Koloharena Ivolamiarina*, BAMEX and the Confederation, Lotus Foods proceeded to contract with the cooperative in 2007 for one container (about 18 tonnes) of pink rice for the 2007-2008 growing season.

Prior to Lotus Foods identifying the pink rice variety as their favourite and best-suited for the USA market, the rice had been steadily gaining popularity in the region. In the 1990s, a producer named Jean Baptiste, known as 'Dista', happened to notice two different-looking grains in a bag of rice. He planted them in his garden and was surprised when the variety gave a higher yield compared with other varieties grown locally. The pink rice – now also known as *Dista* rice – has several positive attributes including: it is a long grain rice with an attractive pink colour and good flavour; it has a longer growing cycle compared with other varieties (one week longer); it needs little water and responds well to organic fertilizers; it is resistant to diseases and stands up to heavy rains; it is not prone to lodging[1]; it has an average of 30–60 tillers and yields 4–8 tonnes per hectare with SRI; and it has a milling rate of 68–70

1 Lodging is when the rice falls over just before harvest due to weight. It is typical with traditional varieties which tend to be tall.

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percent and less than 15 percent breakage if drying conditions are good. Because of the rice's quality, the variety was popularized throughout the Alaotra Mangoro Region, which includes the rural area of Amparafaravola.

THE FIRST CYCLE

For the 2007-2008 growing season, 16 farmers participated and the production was just short of 26 tonnes of paddy rice of suitable quality. After careful selection and milling, about 16 tonnes of pink rice was exported. Staff members and elected leaders of the *Koloharena Ivolamiarina*, with strong backstopping from local development projects, handled the rice collection and coordinated the procedures necessary to export.

The first pink rice export cycle was seriously affected by the global economic crisis and the spike in food prices towards the end of 2008. Many countries imposed bans on the export of rice, including Madagascar. This increased the length of time the paddy remained in storage after being harvested and collected in June 2008. It also delayed the scheduled disbursement of payments to farmers and the milling of the pink rice paddy. Moreover, the mill that was to process the rice became unavailable unexpectedly and an alternative mill had to be identified. In January 2009, seven months after the paddy was harvested, the first container of pink rice was shipped to Lotus Foods in California.

ORGANIC CERTIFICATION

Given the many start-up challenges, Lotus Foods accepted that the first container of rice would not be certified organic but requested that the second container be certified. This was necessary for the markets they serve in the USA. The *Koloharena* members were in agreement with this request as their philosophy supported the protection of the environment and non-use of chemical products. They recognized that organic certification was important for export and that organic inputs for farmers were cheaper than chemical fertilizers and helped improve soil quality. The quality and taste of rice was also better. Therefore, in 2009, the *Koloharena* managers approached the international organic certification organization EcoCert, which maintains an office in the capital city of Antananarivo, to determine the process for organic certification for their *Dista* rice.

The stages for EcoCert certification included a preliminary field visit and evaluation by EcoCert staff, a presentation of compliance requirements to the *Koloharena* managers, follow-up and advice for the preparation of rice fields for export, a field visit by an EcoCert certifying agent, interviews with farmers on their fields, presentation of compliance documentation, verification of 'traceability', certification of storage and processing facilities, random sampling of milled rice (samples were sent to a French laboratory for evaluation) and then final organic certification for the pink rice.

Each plot under production was visited and registered with a unique identification number. In addition to these visits, testimonies from adjacent farmers and/or landowners were required to verify cultivation methods in each plot during the

past three years. The international non-governmental organization *Agronomes et Vétérinaires Sans Frontières* (AVSF or Agronomists and Veterinarians Without Borders) supported the *Koloharena* throughout this process and used Geographic Information Systems software to map the location of each plot under production.

In cases where the *Koloharena Ivolamiarina* was not in compliance with standards for certification, corrective actions had to be taken by farmers and then documented and confirmed by the *Koloharena*.

A Peace Corps Response Volunteer worked in collaboration with AVSF to design a training curriculum for all cooperative members, and trained board members and staff in documentation procedures for organic production. An organic production manual detailing the procedures required to maintain certification was also prepared. After training, the *Koloharena* board and staff members, with support from the Peace Corps Volunteer, set up and documented the organic certification process.

Each of the institutions involved in the production of the rice must be certified, including the cooperative itself, each individual farmer's plot, and the milling, packaging and storage facilities. Finally, EcoCert issues a certification of non-fumigation of the product once it is loaded into the container for export.

Tables 1 and 2 below compare the cultivation methods and profitability of traditional cultivation versus 'SRI-BIO' or organic cultivation.

TABLE 1

Economic returns

RESULTS	TRADITIONAL RICE CULTIVATION	SYSTEM OF RICE INTENSIFICATION (ORGANIC)
Costs of production	Costs similar 150 kg seeds Herbicide cheaper than labour for weed control. Significant costs for pesticides.	Costs similar 10 kg seeds More expensive labour for planting and weeding but costs offset by higher yields gained through aeration of soil. Biological controls available at lower costs.
Yields	3-5 tonnes per hectare	5-8 tonnes per hectare (up to 11 with biodegradable transplanting pots)
Target Market	Local	Local and export
Price of paddy	400 000-600 000 Ariary per tonne (US$180–270) at harvest time (varies according to period)	700 000 Ariary (US$320) per tonne

TABLE 2

Production techniques and inputs

TECHNIQUE/ INPUT	TRADITIONAL RICE CULTIVATION	SYSTEM OF RICE INTENSIFICATION (ORGANIC)
Nursery	Form: located in rice field Area: 200 to 400 m² per ha Seeds: 150 kg of ungraded grain from the previous harvest Pre-germination: soak in water for 12-24 hours, then leave for a day in the sun, and wait for germination Method of planting: plant directly into moist (irrigated) soil without prior fertilization or seed treatment. 20-40 days top-dress, 5 kg urea; at 40 days: pull or strip.	Flat strips or biodegradable pots Area: 15 m² per ha Seeds: 6 to10 kg only selected grains (including some exchanged with other farmers) to improve performance Pre-germination identical with application of a little salt as a seed treatment Method of planting: plant into a bed of farmyard manure, at least 3 cm deep and level. Cover with a thin layer of manure and straw. Spread out the seedlings exactly 8 days later.
Soil preparation	An animal-drawn tractor is used, as well as a hand-operated tiller and sometimes some fertilizer. Muddy conditions using animal traction and water flooding.	An animal drawn tractor is used, as well as a hand-operated tiller and Zebu manure at a rate of 2 tonnes per hectare.. Muddy conditions are controlled by wetting soil to just 2 cm above ground level to prevent anaerobic conditions. Drainage furrows are constructed; 500 kg of poultry manure is added to soil before transplanting of seedlings.
Trans-planting	December - January (40 days after sowing) 4-11 seedlings per hill	December - January (eight days after sowing) Single seedlings planted in line, spaced 20-20 cm apart
Aftercare	Manual weeding one to two months after transplanting, or many use herbicides. Manual hoeing follows herbicide use, to remove dead weeds. Chemical insecticides follow.	Mechanical weeding one week after transplanting and then two weeks later. Hand weeding after 15 days. One week after emergence of ear, treatment with natural pesticide.
Harvest	Set to dry in a heap for one week : to be on the safe side, this may be done for a month to ensure that the grain is ready for milling. Threshed by trampling (Zebu) or using a mechanical thresher. Winnowed. Bagged. Stored in loft, or sold directly. Hulled manually or mechanically.	Identical treatment, but only natural products used. Product is labeled. Majority use a harvester for threshing. No winnowing. Bagged at a weight of 80 kg. Transported directly to Ivolamarina Co-operative, stored in warehouse for at least three months, for best seed quality, humidity should be 11-14 percent. De-hulling at the factory, and storage in warehouse until shipped for export.
Packaging and storage	Set to dry in a heap for one week : to be on the safe side, this may be done for a month to ensure that the grain is ready for milling. Threshed by trampling (Zebu) or using a mechanical thresher. Winnowed. Bagged. Stored in loft, or sold directly. Hulled manually or mechanically.	Identical treatment, but only natural products used. Product is labeled. Majority use a harvester for threshing. No winnowing. Bagged at a weight of 80 kg. Transported directly to Ivolamarina Co-operative, stored in warehouse for at least three months, for best seed quality, humidity should be 11-14 percent. De-hulling at the factory, and storage in warehouse until shipped for export.

RESULTS AND PROGRESS

- With SRI, yields of 4-8 tonnes per hectare, even up to 11 tonnes per hectare, if biodegradable transplanting pots are used.
- Four export shipments to USA to-date; shipment to Italy expected in 2012.
- Guaranteed price for farmers; negotiated at beginning of season; 30-50 percent higher than local market prices.
- Higher incomes and an improved quality of life for farmers, as well as the possibility for them to invest more in their agricultural activities.
- Only surplus beyond household need is exported, therefore reduced vulnerability and enhanced local food security.

CHALLENGES ENCOUNTERED SPECIFIC TO ORGANIC CERTIFICATION

The *Koloharena* has faced several challenges during the different phases of organic certification.

Production

- The training of *Koloharena* extension agents and farmers on organic production compliance required significant time and resources from partner organizations.
- Most *Koloharena* farmers' plots border plots owned by non-*Koloharena* members who produce multiple varieties of rice using conventional, or traditional rice cultivation methods. Organic certification requires that a five-meter barrier separate organic from conventional paddy rice and therefore only paddy harvested within the barrier zone can be certified organic. The rice produced in the barrier zone itself must be harvested and stored separately, and cannot be certified organic due to concerns of spillover contamination from certain pesticides, herbicides, and fertilizers used in adjacent plots. Depending on the shape of each plot and the dimensions of the barrier zone, farmers could experience a reduction of the quantity of certified organic rice produced in a particular plot, thereby reducing the additional income earned from the sale of certified organic pink rice.
- Certified organic fertilizer purchased in Madagascar typically costs between 15-25 percent more than conventional fertilizers, which are prohibited under organic regulations. Most *Koloharena* farmers apply compost to their fields, but at a rate below what local agronomists suggest is needed to support strong production and soil quality maintenance. Producing adequate amounts of compost to fertilize an average *Koloharena* farmer's size plot is unrealistic and therefore farmers turn to commercial organic fertilizer.
- EcoCert compliance standards require farmers to document the following phases fully: seed selection, field preparation, transplanting and periodic weeding, as well as local transportation, harvesting, milling, packaging, and shipping. Agricultural extension agents employed by the cooperative, in addition to *Koloharena* board members, work closely with farmers to oversee, verify and assist in the completion of all compliance documentation. Technical assistance covering all of these stages has been provided by several different organizations.

Harvest and storage

Each 80 kg bag of paddy rice leaving a particular field following harvest must be individually tagged and identified. The identification information includes the farmer's name, the plot number and location code as well as the date of harvesOrganic paddy must be threshed and transported using machinery free of any contaminants, including traces of conventional paddy. Storage of organic paddy prior to milling must be done in an uncontaminated location.

Processing

Securing a rice mill in the Lac Aloatra region that is technologically advanced enough to produce export quality products is a major challenge. Prior to milling organic paddy rice, the facility must be thoroughly cleaned to remove all foreign matter and traces of conventional paddy rice. Once all organic paddy is milled, the paddy from the barrier zone along with rice from 'in conversion' fields can be milled (paddy must be produced in fields that can be shown to be free of pesticides, herbicides and conventional fertilizer for three years prior to being eligible for organic certification; in the meantime, such fields are described as "in conversion").

Organic requirements prohibit the transport of the organic pink rice with other non-organic food products or potential contaminants. Normally food products are fumigated before export but organic standards prohibit this practice.

Lotus Foods suggested that the *Koloharena* should develop wholesale packaging options, using 5 kg vacuum-sealed bags, which would add as much value as possible to the product locally and remove the need for fumigation prior to shipping. The BVLAC Project[2] provided a vacuum-sealing machine for this purpose, but the *Koloharena* experienced repeated setbacks in securing appropriate vacuum seal bags, and to date, the vast majority of pink rice has been exported to California inside one tonne bags, which are loaded into temperature controlled shipping containers.

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2 The BVLAC Project, or the Bassin Versant Lac Alaotra Project ("Lake Alaotra Catchment Area" Project), is funded by the Agence Française de Développement and implemented by CIRAD.

ADDITIONAL CHALLENGES

- Limited availability of experienced transplanters.
- Difficulty in finding milling facilities that fulfil international organic standards.
- Professionalizing and upgrading farmers' practices and skills.
- Need for annual authorizations to export far (due to the export ban imposed by the Government of Madagascar because of the global food crisis).
- Building local capacity to manage organic production compliance and to coordinate the international export process in order to ensure the sustainability of activities, especially if external support from donors and international NGOs ceases.

KEY PARTNERSHIPS

The *Koloharena* has benefitted from the technical and financial support of a number of important partners, without whom the pink rice export initiative could not have succeeded.

The export plan was initially supported by USAID, through the LDI, ERI and BAMEX projects, in order to develop markets and assist with export procedures. Jim Carrey's Better U Foundation also provided grants to the Lions Club of Ambatondrazaka to help farmers get additional technical assistance and have access to key inputs and equipment such as certified organic fertilizer, weeders and hand hoes. Since 2009, the BVLAC Project, which focuses on agricultural development and ecosystem conservation in the Lake Alaotra and Ambatondrazaka zones, has

MFR (Maisons Familiales Rurales) Youth with BUF weeders played a critical backstopping role in all aspects of the value chain. This includes providing financial support, overseeing the organic certification procedures and liaising with Lotus Foods to bridge the language and communication barriers. The Peace Corps made available four highly-qualified volunteers for three successive six-month periods to live in Amparafaravola and directly assist the *Koloharena* to meet the demanding criteria for export and organic certification. As noted earlier, AVSF worked closely with the cooperative on compliance issues related to organic production and provided additional training for farmers related to SRI methods. Lastly, the Lotus Foods co-owners have been directly involved in every aspect of the operations, providing the vision, oversight and investment essential for success. Their continued commitment despite many serious challenges has been a key driver.

CONCLUSIONS

The organic and SRI activities of the *Koloharena Ivolamiarina* are a model for a strategy that can contribute to Madagascar's achieving self-sufficiency and producing export quality rice. There is evidence that with improved professionalism and greater attention to quality and standards there could be strong demand for Malagasy *vary mena* and *Dista* rice in Europe and North America. The experience and vision of the *Koloharena Ivolamiarina* can be an example to other producers, and members can, in the future, provide training to other farmers on what they have learned. The pink rice initiative should be sustained and scaled-up through more support to overcome the current challenges, including:

- maintaining and developing the international market;
- increasing the production of pink rice for export (depending on availability of human, financial and technical resources as well as land);
- sharing the experiences of the Koloharena in Amparafaravola with groups in other regions of Madagascar.

The activities of the Cooperative Ivolamiarina are important for Madagascar in terms of self-sufficiency and foreign exchange earnings through the export of high quality rice. Farmers attest to substantial benefits, both through improved nutrition and higher incomes. The success of the Cooperative Ivolamiarina is an example to small scale producers, demonstrating how attention to quality and standards as well as a more professional approach to rice production can yield benefits to farmers, to their communities and to the whole country.

For more information about the *Koloharena*, about the pink rice initiative and about SRI in Madagascar and in other countries, the following Web sites can be consulted:

- www.groupementsrimada.org
- www.sri.ciifad.cornell.edu or www.sririce.org
- www.lotusfoods.com
- www.betterufoundation.org

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ORGANIC FARMING SYSTEMS IN ZAMBIA

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Daniel Kalala is a research coordinator at Kasisi Agricultural Training Centre in Lusaka, Zambia. Daniel also lectured at the Natural Resources Development College where he developed teaching modules in soil and crop science. He also worked as part-time tutor at the University of Zambia from 2008 to 2010. He holds Bachelors and Masters Degrees in Agronomy from the University of Zambia. Daniel is happily married and blessed with a daughter.

BACKGROUND

About 70 percent of Zambia's working population is engaged in agriculture, largely subsistence farming. The agricultural sector accounts for 20 percent of the country's gross domestic product (FAO, 2006). This sector however, faces numerous challenges ranging from declining soil fertility, lack of high quality germplasm, inadequate rural infrastructure, extreme weather conditions and unsupportive policies (Keil *et al.*, 2004). Declining soil fertility is one of the greatest of these constraints to increasing and sustaining agricultural productivity, especially among smallholder farmers (Vanlauwe and Giller, 2006). This is primarily caused by three interlinked factors: a breakdown of the traditional fallow system as a result of an increasing population and decreasing per capita land availability (Kwesiga *et al.*, 2003); inadequate adoption of sustainable soil fertility management options; and sub-optimal use of mineral fertilizers by the majority of smallholder farmers due to high cost and supply difficulties (Howard and Mungoma, 1996). With this background it is clear that the standard mineral fertilizer-seeds subsidy alone will not sustainably increase agricultural productivity especially among smallholder farmers in Zambia.

Long-term improvement in soil fertility has become a very important issue in the research and development agenda (Scoones and Toulmin, 1999) because of the strong linkage between soil fertility and food insecurity and the implications to the economic well-being of the country (Ajayi *et al.*, 2007).

AN INTEGRATED ORGANIC FARM IN ZAMBIA

Charles Zulu, Robson Nyirenda, Dr Henrietta Kalinda and Edwin Matambo

The integration of livestock and crops in an organic farm, as in the case of Mr Charles Zulu of Kasenga B Resettlement Scheme, which is about 30 km from Chongwe town, has shown positive results. Mr Zulu's innovations include improved housing for his livestock that are mainly birds (guinea fowls, chickens, turkeys, quails) and goats, and water harvesting and management systems for his garden. The management system for his birds is based on both indigenous and scientific knowledge. The guinea fowl eggs are incubated by chickens. He grows garden crops such as turmeric, garlic, onion, tomatoes, maize and pumpkins using organic methods. The seed used plays an important role in the control of diseases and pests; other practices include composting, crop rotation, companion planting and use of botanical pesticides. Charles Zulu attended a course in sustainable agriculture at the nearby Kasisi Agricultural Training Centre (KATC), though some of his farming practices were learned from his father. The integration of livestock and crops ensures that there is little or no waste of farm by-products, as animal manure is used to feed crops and crops are used to feed animals. This creates an almost closed loop, where the enterprises are able to support each other, making this a balanced farm organism. The nearby bushes are used for beekeeping where a number of hives hang.

To prevent some of the diseases from attacking the birds, Aloe Vera is administered through the drinking water. The plant is cut in pieces and soaked in the water, which is then put into the drinkers. Aloe Vera is known to prevent a number of diseases and also to help in building of the immune system.

Turkeys are free-ranging and they do well if they are left to lay eggs in the surrounding bushes. Turkey brooding takes longer than guinea fowl. The turkey is left to sit on its eggs in the nearby bushes and later brought to a suitable house, enclosed for three to four days. The turkey can hatch up to 18 eggs. Guinea fowls are rather wild birds, they are semi–domesticated and usually lay their eggs in the bushes; these eggs are observed and removed when possible. Chickens are used for incubation. Chickens become accustomed to incubating guinea fowl eggs. These are substituted for chicken eggs after the hen has started sitting on her eggs. Guinea fowl eggs take 30 days to hatch. Chicken eggs can be replaced in the second week. This practice is able to achieve about 80 percent hatching of the eggs. Once eggs hatch, the guinea-fowl chicks are fed each morning.

Turkey chicks are susceptible to cold and therefore small houses are constructed (about $1\ m^2$) to restrict movement so that the hen can provide warmth to the chicks. Turkeys are kept in these houses for about four to six weeks after hatching, after which the housing is enlarged.

Crop cultivation includes the growing of vegetables and cereals, and manure from cattle, donkeys goats and poultry is used in the growing of plants. The manure is usually composted and applied to the crops at planting. Additionally, manure is used in the making of manure extracts, which are applied to the crop as a top dressing. The crops that are currently grown in the garden include green maize, ginger, garlic, tomatoes and other vegetables.

There are three approaches to marketing the farm livestock: the first one is where chickens, turkeys and guinea fowls are sold live, the second one is where they are slaughtered and dressed. Thirdly, chickens are dressed and smoked, which adds more value to the product and creates a specialist niche market. There is a steady market growth for smoked chickens locally.

The organic integrated farm provides a basis for increased production and income, as the enterprises support each other. Livestock integrates well with crops, especially in an organic farming arrangement. This ensures almost zero external input, as the farm is almost self-sufficient. The main challenge has been the marketing of field and garden crops, especially on a contractual basis when more than one farmer is involved, as other farmers sometimes fail to honour the contract.

Sustainable organic agriculture, which is a farming system that emphasizes environmental health, economic profitability, and social and economic equity (Smit and Smithers, 1994), presents a potential farming alternative that could address most of the above-mentioned problems.

This case study is based on the Promotion of Rural Food Security Programme (PRFSP) implemented by a consortium consisting of Kasisi Agricultural Training Centre (KATC), the Jesuit Centre for Theological Reflection (JCTR), Caritas Livingstone, and Catholic Relief Services (CRS), funded by the Scottish Catholic International Aid Fund (SCIAF) and the Scottish Government. The programme was implemented in Chongwe, Kazungula, Sesheke, Shangombo and Mongu districts. The overall objective of the programme was to improve food security, household incomes, and resilience to climate change of rural communities through more widespread adoption of organic and sustainable farming practices. Refer to the example of the farming system of Charles Zulu.

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METHODS AND MATERIALS

The study site consisted of the five districts in which the PRFSP was implemented: Chongwe, Kazungula, Sesheke, Shang'ombo and Mongu in the Lusaka, Southern and Western Provinces of Zambia. Data was collected from 18 communities across the five districts covered by the PRFSP.

The sampling was purposive. At community level, the selection included remote communities and those nearer to urban areas. Both communities where the intervention had been more challenging or problematic and more successful ones were included. At individual level, data were collected from programme participants.

The primary data were collected through the revision of key programme documentation. The survey was conducted using a questionnaire with a structured interview format. Respondents were PRFSP participants. Focus group discussions (FGDs) were conducted using guiding questions. The survey sample consisted of 218 participating farmers (103 women, 115 men) and included 23 FGDs. Respondents were aged between 19 and 89, with an average age of 46.

RESULTS AND DISCUSSION

Considering that the PRFSP only covered two complete planting seasons, it is inappropriate to speak of "adoption of new farming techniques" after only two years of the intervention, therefore, adoption in this paper refers to a longer-term adoption, i.e. the use for three consecutive seasons of at least three organic agriculture (OA) practices, one from each of the three principles of soil fertility, soil protection and biological pest and disease control.

Adoption of sustainable organic practices

At the end of the programme, there was an increase in the number of households that had adopted organic agriculture (OA) practices from 17.5 to 43 percent. The most commonly adopted techniques included minimum tillage, composting and application of manure; no burning and non-usage of inorganic fertilizer. It was however noted that even where OA had not been broadly adopted, most were practicing one or two OA techniques. The main reasons for not practicing the techniques learned included: lack of tools; shortage of labour with the perception that organic farming is labour intensive; the difficulty of making rainwater harvesting basins in sandy soil, as the prepared basins or furrows tend to collapse before planting is done (Picture 1), inadequate sources of manure and the long distance between the fields and the manure source.

Area under cultivation using organic practices

There was an increase in the proportion of land under cultivation using OA techniques from the baseline value of 8.4 percent to 13.1 percent. The average area of land cultivated using OA practices also increased from 0.5 to 1.3 hectares (total 290 hectares). It should be noted however, that the majority of farmers practicing organic agriculture techniques had allocated only a portion of their land to the new techniques, and so were practising organic alongside conventional farming. Less than five percent cultivate their whole farm purely organically.

Average yield of maize

The survey revealed that farmers reported highest yields for maize from organic agriculture (with an average output of 2 408 kg/hectare). The average maize output from conventional agriculture was 1 175 kg/hectare. There was evidence of increased yields even among those who were practising just one or two organic farming techniques. The number of farmers who reported an increase in production as a result of using organic practices for two years or more increased from 2.3 percent to 75 percent giving a total number of 163.

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Crop diversification

Fifty-one percent of the respondents were found to be growing drought-tolerant varieties of one or more of the following crops: sorghum, millet (pale pearl), local maize, cassava and cowpeas. This reflects an overall increase from the baseline value of 40.5 percent. There was an increase in the number of households reporting increased yield for three consecutive seasons through drought-resistant crops from 0 to 60 percent. The number of respondents practicing maize monocroping reduced from 78 to 6 percent. These figures suggest that PRFSP has been highly successful in promoting crop diversification. However, the fact that 49 percent of respondents were not growing any drought-tolerant crop varieties shows that there is still much work to be done to persuade farmers to diversify using traditional drought-tolerant varieties.

Food and income security

Over the 32 months period there was a general increase in household food security, with staple crops lasting up to 9.5 months of the year compared with 6.5 months indicated in the baseline. As a result of increased crop diversification, the average household dietary diversity score (determined by summing either the number of individual foods or food groups consumed over a reference period) was also seen to rise from the baseline value of 1.9 to 5.3. There was also an increase in the number of participating households with one or more surplus farm product for sale from 25.9 percent to 69 percent. Sixty-one percent of the households reported an increase in their income by 50 percent through sales of surplus farm produce. This is an increase from the baseline figure of 18.9 percent. Although there is as yet no domestic outlet for organic crops, there is an increasing interest in developing organic food markets.


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CONCLUSIONS AND RECOMMENDATIONS

Although the time period of 32 months was a short timeframe to demonstrate the impact of sustainable farming techniques, a number of positive results were recorded as a result of the programme. The increase in yields for farmers using OA techniques with little or no external inputs was seen to translate into increased household income with a high number of households having surplus crops for sale. The number of months in which households had staple food from their own production was also higher. These findings are in line with the findings of Kyalo et al. (2009) that organic farming has a positive effect on rural poverty reduction. In addition to the mentioned benefits, there were some indirect benefits as well which were not measured. These included sustained soil health and fertility build-up, as well as enhanced resilience to climate change effects. Based on these and many other benefits, we conclude that OA presents a very good alternative farming system to address the many challenges and constraints faced by rural resource constrained farmers. More widespread promotion of the system backed by government support would bring about even greater benefits at national level.

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OLD ORCHARD ORGANIC FARM IN ZAMBIA

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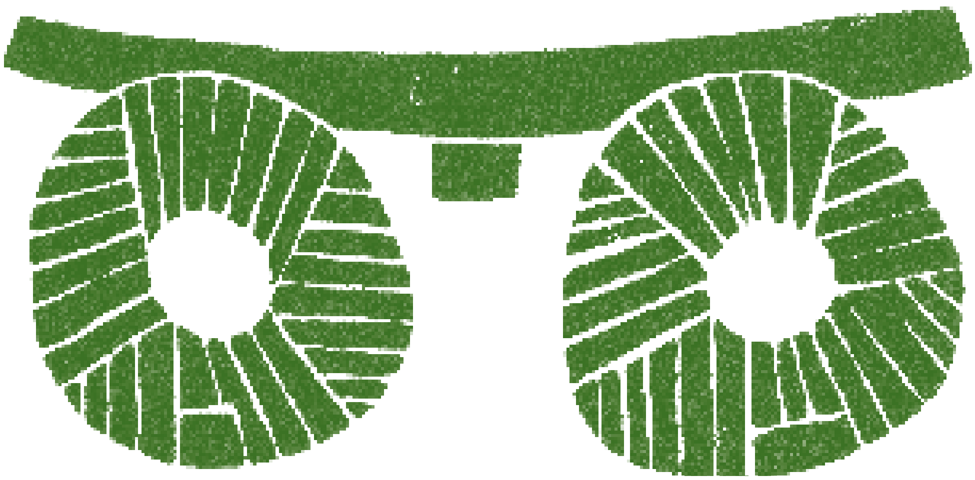

ABOUT THE AUTHOR

Born in 1978 in Kalulushi in the Copperbelt of Zambia, Sebastian Scott has had an interest in regenerative agriculture since the age of 16. He feels the inspiration for his work came from the observation that the conventional farming systems common in Zambia, based on fertilizer' use, were reducing soil fertility and driving farmers off the land in search of jobs and a way out of rural poverty. After working on organic farms in Australia and England, he started in 2001 his own farm in Kafue, Zambia, where he grows organic vegetables, field crops and livestock, with a view to developing viable models for regenerative farming for small scale agriculture in Zambia. The 3 hectares farm is worked by Sebastian and one other farmer and no machines are used. In the past two years, work has begun with rural communities in order to develop and share ideas with them for rural development.

BACKGROUND

Since its establishment in 2008, Old Orchard Organic Farm has grown every year in diversity and size. The farm is run by two people, including building, irrigation installation, crop production and marketing. The total area under production is currently about three hectares of crops and one hectare for free-range pigs. Production is diversified to reduce the risk and to spread the workload over the year. The farm has developed the following enterprises as profit making ventures: banana production (1 000 plants over 0.7 hectares), vegetables, eggs, broilers, pork, dry-land crops for animal feed production, macadamia nut production (trees not yet bearing nuts), and research on rainfed crop production.

The idea to start the farm came from a desire to help to develop rural Zambia and empower people through knowledge in natural resource management. The farm has become a farmer-managed 'research station' for small-scale farming systems that aim to reduce cost, increase profits and re-generate the natural resource base. As much as possible, farmers try to learn from nature to develop multi-species systems that have beneficial interactions.

THE CHICKEN BANANA SYSTEM

The banana/chicken production system works to benefit the bananas by eliminating the need for imported nutrients, as the chickens are constantly adding manure to the soil. The chickens' foraging habit also reduces weeds and insects in the banana plantation (picture below/left). The benefit to the chickens is the canopy made by the bananas which gives the chickens shade and protection from eagles – a predator to free range chickens. The feed consumption of the chickens is also reduced by up to 30 percent in the rainy season when grasses and insects are abundant. The layer hens are enclosed in the plantation by chicken wire (2.5 m high, 50 mm mesh). The chickens have a permanent house, where they lay eggs and roost at night (see picture below). The house has one 11-watt energy-saver bulb that allows

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The chicken/banana system

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The poultry layer house

the farmer to modify the laying cycle of the chickens so they lay all year round. The light is kept on until 8pm each night. The average laying percentage for this cycle of laying hens is in the range of 70-75 percent. All layer chicks are raised from day-old on the farm. The potential profit under good management and average price of ZMK900 per egg is about ZMK100 000 per bird per year.

PIGS DRY LANDS AGROFORESTRY

The pigs are on a rotational free range system; currently there are four paddocks, two of which are dry land fields for rain fed crops and the other two are used in the rainy season. In order to reduce the parasite burden, the aim is to have at least six months rest before the animals return to the paddock. The grass pasture is well wooded to provide shade for the pigs and the crop lands are planted with Pigeon Pea (*Cajanus cajan*) and *Sesbania sesban*, leguminous shrubs (Picture 3), and *Faidherbia albida* (musangu) a long-lived tree. These are grown in rows in the field. Pigs have access to a mud bath at all times to help control their temperature and as a means of allowing them to control external parasites.

The aim is to develop the system with two farrowings per year, one in mid to late March and one in late September, to avoid excessive rain when the pigs are still young. Pigs gain much food from pasture and remain healthy and lean. Less back fat means higher prices. The four sows and one boar have a potential of 80 piglets per year. Sales of *Berkshire* breeding stock to interested parties are planned as a means of improving free-range pig productivity. Originally from China, the *Berkshire* pig has a good maternal instinct, good disease resistance, good ability to convert forage to meat, black colour to avoid sunburn stress and has superior quality meat. These traits make this breed very interesting for free-range conditions in tropical/sub-tropical climates. The potential profit per sow under good management at a lean meat pork price of ZMK14 000 is about ZMK14 000 000 per year.

LIVESTOCK FEED

The aim is to grow as much animal feed on the farm as possible, but the balance of feed is currently brought in from local small-scale farmers and from livestock feed merchants. The main ingredients for our poultry are maize, soya cake or farm roasted soybeans, fishmeal, livestock lime, di-calcium phosphate (DCP), iodised salt and vitamin supplements. Currently organic standards restrict the use of non-organic feed stuffs to 35 percent of animal feed. As about 35 percent soy is used in layer, broiler and pig grower ration, and the farm does not grow enough soy to feed the animals for the whole year, maintaining an organic status for the birds and pigs is difficult; one strategy is to increase the area under rainfed crops. Feeding principles are simple and the same system is used for all the livestock:

- Restrict feed to once a day to encourage use of pasture. This principle is born of the idea that a full animal is a lazy animal. Feeding for all animals is at 4pm every day. The animals should finish eating before dark to reduce feed losses from pests, like rats.
- Give animals a choice in their feeding diet to maximize efficiency. This principle is based on the idea that animals know best what they need in their diet and it is not known what the animals are finding on range. Protein and minerals (soy, fishmeal (some stages only), salt, DCP and vitamins), whole maize kernels (mature animals), and limestone grits (layers only) are all given separately, so the animal can choose.

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Berkshire pigs grazing with rows of Sesbania sesban (left) and Pigeon Pea (Cajanus cajan – right)

IRRIGATED VEGETABLES

A wide variety (25 or so different types) of vegetables is grown for direct sale through a box scheme, farmers market and wholesale to retailers, in local and Lusaka markets. Trailers have been constructed on the farm for mountain bikes which can carry up to 175 kg on rough roads. The local farmers market is 5 km from the farm and opens twice a week. The box scheme operates by finding interested customers who buy high quality, fresh organic fruit and vegetables and subscribe to an internet/mobile phone mailing list. Text messages are sent to customers every week with a note on what will be in the box. What goes into the box depends on the season and what is available at the time; the customer has no choice over what goes into their box. The customer can order a small (ZMK40 000) or large (ZMK60 000) vegetable box; they collect their box from a central point on a set day. Growing organic vegetables is easy and if done well, can reduce the cost of production over conventional 'chemical' growing. The principles are few and simple:

- Prevention is always better than cure!
- Feed the soil to feed the plant. Vegetables grow very well in fully decomposed compost or stable organic matter from green manures and mulch. If fertilizer or raw manure is added, this will make the plants sick costing time and money. The vegetable will not need anything else but water to grow if the soil is adequately supplied with colloidal humus. Crops grown on soil without humus require repeated pesticide applications for their survival.
- Follow the season. Optimal plant growth is seasonal, and this can again save time and money. Growing out of season results in a need for crop protection by using organic sprays or climate modification (such as plastic tunnels or plastic mulch).
- Rotate away from disease and pests. Practice crop rotation.
- Minimum soil disturbance and reduced soil compaction by using raised beds or permanent paths to build soil health. Excessive soil disturbance is detrimental and creates unhealthy soil and unhealthy plants.
- Control weeds on time.

Main fertility builders for the vegetables are composted chicken litter and green manure crops such as velvet bean, sunnhemp and cowpea.

BROILER PRODUCTION

Free-range broilers are integrated into the vegetable or maize cropping system. The chickens spend the night in a moveable house that is rotated around the field. The birds gain benefit from the greens and insects on the pasture and they weed, fertilize and control insects, making the field ready for the next crop. Birds are harvested at 10-12 weeks to ensure a good taste and texture to the meat. All the birds are sold through direct sales and are sold by weight. Current price is ZMK14 000 per kg live weight and ZMK24 000 per kg cold dressed weight. The potential profit under good management is ZMK20 000–25 000 per bird.

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LOW INPUT MAIZE PRODUCTION

Trials for reducing inputs in maize production have been underway on the farm for four years and some low-input/high-output systems have been developed. The basic principle is to use the same field to produce a cash crop (maize) and a nitrogen-fixing crop (legume) that grows well with maize with minimal competition to the maize. Two crops have been identified that show potential to give commercial level yields with reduced or no added nutrients. In general, the green manure uses the end of the cropping cycle and uses residual moisture to grow on into the dry season. The following is a summary of the results for the 2011 season:

- Yields and costs were compared in side-by-side trials using open pollinated and hybrid maize varieties on a sandy clay loam. A typical cost and yield analysis for small-scale farmers in the region is included in the comparison.
- Within the trials two types of maize seed were used: a hybrid variety 'Seed Co ZS206', a yellow maize variety (referred to as 'Hybrid'), and an open pollinated local maize variety 'Gankata' (referred to as 'OP'). Both are late varieties, maturing approximately 150 days after planting.
- Drylands 1 and 2 were opened up in 2007 and have been managed using hand labour by the author and one other person with occasional seasonal labour of one extra person.
- Dryland 1: 1 800 m^2 in area, was self-seeded velvet bean from a previous crop of maize intercropped with velvet bean, in the season prior to planting the 'sprouted velvet bean' fertilized maize crop.
- Dryland 2: 700 m^2 in extent was soya beans which yielded 1.8 tonnes per hectare the season prior to planting the "composted chicken litter" fertilized maize.
- Dryland 1: Prior to planting maize, the residues of the velvet bean, including the mature seed that had remained in the field over the dry season were pulled into rows to allow for 90 cm row spacing for maize. This was done to facilitate digging holes for planting maize. The maize was planted out on November 21st after 25 mm of rain. Holes were dug approximately 40 cm apart and 5-8 cm deep and two maize seeds were planted per hole and covered with soil. Seventeen rows of Hybrid and five rows of OP were sown over a two-day period. The maize was weeded in the row with a hoe two weeks after maize emergence and the velvet beans were left to grow in between the rows of maize. The velvet beans were then slashed with a grass slasher at three weeks. No further management was required up until harvest.

- Dryland 2: Prior to planting maize this field was prepared during the dry season. Holes were dug at a row spacing of 90 cm, at 15 cm depth to allow for application of compost in the hole below the seed. Farm-made chicken litter compost[1] from free-range laying hens was applied at a rate of one hand full per hole (approximately 1.7 tonnes per hectare) and then covered with soil to avoid volatilization of nitrogen. Compost was applied three weeks before planting maize. After covering the compost, a 5-8 cm depression remained for planting maize. Seven rows of Hybrid and six rows of OP were planted on November 20th after 15 mm of rain. This field was under-sown with Dolichos lab-lab at three weeks during the first weeding. The maize also received an additional 1.7 tonnes per hectare of compost when the maize was knee high during the second and final weeding.

The results of the various treatments are summarized as follows:

- Dryland 1: 7 200 kg/ha where ZS206 Hybrid was used; 3 000 kg/ha where Gankata OP was used.
- Dryland 2: 6 500 kg/ha where ZS206 was used; 3 500 kg/ha where Gankata OP was used.

The use of the Hybrid more than doubled maize grain yields on both systems. Local small scale farmers obtained yields of approximately 1.5 tonnes per hectare with open pollinated maize crops and modest dressings of compost, and about 3 tonnes per hectare with hybrid seeds and modest dressings of (expensive) fertilizer. The extra fertilizer costs more or less balanced out the extra yields, giving a gross margin per hectare of about half a million ZMK. Fully mechanized commercial farmers in the area use much higher dressings of chemical fertilizer and although yields average around 10 tonnes per hectare, many commercial farmers report that they are barely breaking even at current high cost levels and relatively low maize grain prices.

1 Farm-made chicken litter compost was made from chicken litter from the night pen of the farms' small free-range organic layer flock. The litter consists of hard wood sawdust or hay chopped to 10 cm length and used to keep the litter dry. The compost is heaped, wet and piled into windrows no more than 1 m high and 1.2 m wide. The compost material is also covered with perforated plastic to avoid volatilization and leaching. The material is turned once and allowed to cool down.

The crops harvested above were sold as shelled maize grain at a price of 1 000 ZMK/kg, and the positive gross margins for the four treatments were:

Dryland 1 (compost)	1800 m^2	ZS206 Hybrid:	5.78 million ZMK
		Gankata OP:	2.49 million ZMK
Dryland 2 (velvet bean and dolichos)	700 m^2	ZS206 Hybrid:	5.05 million ZMK
		Gankata OP:	1.95 million ZMK

Although these were not replicated research trials, the yields do illustrate four facts:

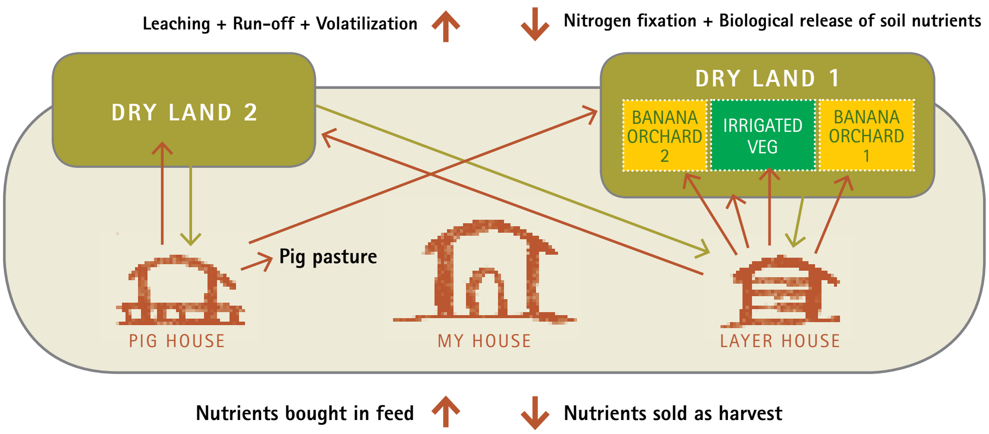
- well-adapted hybrid seeds give farmers a considerably higher yield under most conditions;
- both compost and legume amendments offer cost-effective and sustainable alternatives to expensive chemical fertilizers;
- these systems sequester large amounts of carbon in the soil; and finally
- adequate nitrogen can be provided for crops from local sources. This latter allows small-scale farmers to increase production levels without the difficulties first of sourcing and second of paying for expensive inputs, while also reducing the risks of nutrient loss and pollution through leaching and volatilization.

OLD ORCHARD FARMING SYSTEM

The sub-systems described above interact as an integrated farming system, as illustrated in Figure 1.

FIGURE 1

Nutrients around the farm



The farming system at Old Orchard Farm has developed through a practical process of trial and error, like most locally adapted farming systems. As time goes on, new successful elements are added to the system and through observation, optimal combinations and timing are refined. Over the years, some elements of previously popular systems fall away, but many old systems may come back into fashion as fertilizer prices increase and priorities change towards greater resilience and sustainability. As an example, dolichos lab-lab (velvet bean, *Mucuna pruriens*) was commonly grown as an intercrop with maize in Alabama in the USA, where Templeton *et al.* (1917) estimated that in that year, slightly over 1 million hectares of maize intercropped with velvet beans was grown[2].

Crops, vegetables and animals on Old Orchard Farm are selected to fit into an integrated system, where each element plays several roles and supports other elements in the production system.

2 Templeton, G., Ferguson, H. and Gibbens, E. 1887. 1 Velvet beans compared with cottonseed meal for fattening steers. 2 Velvet beans, cottonseed meal and corn as feeds for dairy cattle. 3 Velvet bean pasture compared with corn and dried blood, velvet bean meal compared with corn for fattening hogs. Alabama Agricultural Experiment Station Report.

SMALLHOLDERS KNOWLEDGE

Family farm learning groups in Uganda

Information technology and communication in organic agriculture

Information for better yields and new markets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FARMER FAMILY LEARNING GROUPS IN UGANDA

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Jane Nalunga is the agricultural training officer for the National Organic Agricultural Movement of Uganda (NOGAMU), where she has acquired hands-on experience in designing practical solutions to farmers' observed constraints. She sets-up organic internal control systems for farmers' groups dealing with organic production and export. She organizes and implements training of farmers, farmers' groups and extension personnel in production, soil fertility, pest management, harvesting and post-harvest handling, and designs training materials.

Mette Vaarst, Ph.D., is a senior scientist at the Institute of Animal Science at Aarhus University, Denmark. She also has a Master's degree in health anthropology and has experience in action research. She has worked in research and as a volunteer worker with participatory learning groups of farmers in Kenya, Uganda, India and Europe, especially in Denmark where she was a co-developer of the Danish Stable School Approach.

Inge Lis Dissing is a Danish teacher and organic farming consultant with experience in participatory training programmes and project management. She worked with two Ugandan companies on sun-dried organic fruits, including training of farmers, training of internal inspectors for organic fair trade projects and training processing staff. She is also involved in an organic project in Bolivia.

Aage Dissing, who holds a M.Sc. degree in agriculture, is an organic farming consultant. He has experience in participatory training programmes and project management. He worked with two Ugandan companies that developed a processing plant for sun-dried organic fruits, where he was involved in the training of farmers, management and processing staff and the board. He also trains farmer group facilitators in a project in Bolivia led by the Danish company Aurion.

BACKGROUND

A partnership between Organic Denmark (OD), National Organic Agriculture Movement of Uganda (NOGAMU) and the Sustainable Agriculture Trainers' Network (SATNET), established in 2009, has produced fruitful results among the smallholder organic farmers in the naturally endowed mountainous parts of Uganda.

The partnership worked on establishing an approach that would encourage farmers to own their development process. This approach, now called Farmer Family Learning Groups (FFLG), was being referred to as Farmer-Field-Schools during the pilot project.

While the conventional Farmer-Field-School often is based on establishing a central learning garden and learning involves the growth cycle of the enterprise in question, the FFLG approach considers each farm as being unique and as a special learning entity.

The approach therefore involves farmers rotating from one farm to another to learn and support the particular farm with respect to its uniqueness.

Part of the naturally richly endowed Rwenzori landscape

The approach also promotes whole household participation. The facilitator who basically guides the learning stirs farmers into developing confidence within and among themselves in the organic production processes, using agro-ecological farming methods and practices which are economically, environmentally, socially and institutionally sustainable.

The Rwenzori region, in which 100 Farmer Family Learning Groups (FFLG) have been established, is a part of Uganda that is endowed with a biodiverse environment in which farmers depend mostly on natural resources to sustain their agricultural activities. Smallholder farmers in this region are locked in a vicious cycle of poverty, partly due to limited capacity to utilize the available natural resources appropriately. In addition, the culture of interacting and sharing knowledge among smallholder farmers had been reported from farmer communities as dying out. To meet the multiple challenges in farmer communities, the partnership found it important to introduce a group-focused and practically-oriented approach, which could promote social relations amongst farmers. Social relations include a combination of social trust, exchange of ideas, norms, attitudes, beliefs, values, common learning and culture that people draw upon to solve common problems.

In 2009, SATNET, NOGAMU and OD piloted a FFLG approach to promote organic farming for family food security, improved incomes and advocacy. FFLG are groups of households or farmer families which – with the help of a facilitator – get together to support and help one another, market their produce together, solve their common problems together, and work, develop and learn together. Among the key challenges facing the farmers who took part in this project were: small land holding (often below half a hectare per household), declining soil fertility, female headed households abandoned by men, poor planting materials, pests and diseases, limited access to and unfavourable markets. Generally in Uganda, less than 20 percent of farmers gain access to extension services, and the same is the case in the Rwenzori region.

Each FFLG is facilitated by a Community Process Facilitator, who was an active member in one of SATNET's member organizations. Twenty five facilitators from 12 member organizations were taken through a course in May 2009, which basically transformed them from being trainers to becoming facilitators for organic farmer groups. Each FFLG consists of 15-30 households (whole families), who work together on one another's farms to solve problems and attain a common goal, and to discuss relevant and important issues in their farms and community. They meet at the host's farm (all FFLG members are hosts when it is their turn), analyse the situation together, and then design and implement recommendations which will improve the farm production through building resilience to shocks.

The impact of FFLG on the over 1 000 households of the Rwenzori region in Uganda is manifested in the form of improved food security, increased household income, increased resilience in the agricultural systems to mitigate and adapt to climate change, biodiversity, seed production, livestock integration in farms and group marketing. All this leads to poverty alleviation and contributes to Millennium Development Goals (MDGs).

SOCIAL CAPITAL AND TRUST WITHIN AND AMONG FFLGS

Building social capital has been the key attribute of all FFLGs as a result of continuous interaction among the farmers and their facilitator. To open-up their farm to the access, appreciation and constructive criticism of others is itself a manifestation of confidence in other group members. Many aspects of the FFLG approach were strongly supported and inspired by theories of social capital, for example, that developed by a team of psychologists led by John Munene (Munene, Schwartz and Kibanja, 2005), where social capital is defined as an individual's willingness to make short-term sacrifices for the long-term benefit of a local community, as well as the individual himself or herself, by setting common goals and interacting to meet these goals. When the FFLG members evaluated which changes had been most significant following the establishment of the groups, the strongest message was that the social capital was crucial and helped all the other

changes, which they had experienced, such as improved agro-ecological farming practices, increased income and better family food security.

FFLG members have worked together on communal water supply (springs), improving hygiene in communities, maintaining community roads, helping needy students and the elderly and influencing the elections of local leaders. It is the strength of numbers and the bonding of these farmer groups that have rendered them strongholds which are now attracting political attention. Over 70 percent of FFLGs have received government support from National Agricultural Advisory Services in the form of seed, livestock and finance due to their visible impact. Collective problem-solving by members has increased a sense of belonging and responsibility for the community by each individual member. This has seen issues such as theft vanish from some communities.

FOOD SECURITY

All FFLGs increased food crop production, with increases ranging from about 50 percent to about 85 percent, resulting from timely application of good farming practices and improved enterprise diversification, which helped to reduce risks and to provide a balanced diet. Most households can now have three meals a day compared with the start of the project when they had one meal a day. Household members worked together and this improved access to and control over food by women and children. This has positioned the female FFLG members to take decisions over what to cook and reduced the tendency of men to turn everything into cash.

Households have kitchen gardens established through working together as a group on one farm at a time and multiplying good seed at group gardens. The kitchen gardens are diverse in vegetables (*amaranthus* spp., tomatoes, cabbages, collards, eggplants), fruits (pineapples, avocadoes, mangoes, pawpaws and passion fruit), and staple food such as plantain, banana, cassava, beans, groundnuts, maize, soybeans, Irish and sweet potatoes. All products are produced organically, so on top of the food being available and nutritious, it is also healthy and safe.

CLIMATE CHANGE ADAPTATION AND MITIGATION

Each FFLG emphasized better understanding of the impact of chemical monocultures, and this has resulted in an effort to promote biodiversity and create more resilient agricultural systems with better soil fertility and water management. Mulching, composting and cover cropping have led to the abandoning of bush burning, which has resulted in less destroyed vegetation cover and smoke effects and more carbon sequestered in the soil.

Trees have been planted, especially fruit trees for food but also castor trees as wind breaks and for environmental recharge through evapotranspiration. Use of

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energy saving stoves, such as the home-constructed Lorena stoves reduces wood fuel consumption. Farmers jointly construct the Lorena stoves and in a single day have been able to make two or more Lorena stoves, otherwise, they collect money to purchase a Jiko Safi stove (both are fuel-efficient low-cost stoves). These newly introduced Jiko Safi stoves have promoted the use of Jatropha for cooking (*Jatropha curcas* is a support tree for vanilla and is used as a land boundary demarcation tree in Uganda; several species of the genus *Jatropha* are used in bio-diesel production in some countries). The Jatropha nuts have previously not been utilized in the Rwenzori region.

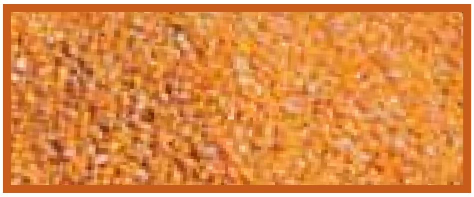
FARM PLANNING FOR IMPROVED BIODIVERSITY

FFLG members plan and improve their farms together, using mostly agro-ecological systems analysis for each farm of every member. This has led to recommendations from fellow farmers and thereby increased positive interactions between farms. On all farms, intercropping has been emphasized. Leguminous crops such as beans, groundnuts and soybeans, and trees such as *albizia, crotolaria* and *sesbania* are interplanted with heavy feeders.

Some FFLGs (e.g. Mutiba, Bairumba, and Ndongo) established central nurseries to multiply trees that are beneficial on farms, so that farmers can access them freely. Seed multiplication for crops which have become scarce in the area has been done (e.g. cocoyam, black bean, jack bean and herbal plants) to serve as food security and medicinal crops and to conserve biodiversity. Some of these crops such as cocoyam encourage the presence of several frog species that tunnel and improve the soil. The FFLG promotes self-reliant farms; monocropping is discouraged and the use of GMOs (genetically modified organisms) is strictly prohibited.

SEED PRODUCTION

Generally, FFLG farmers rely on home-saved seed. On-farm and off-farm seed multiplication and preservation have been carried out in some groups. Farmers grow and preserve their own seed (e.g. beans and maize) using techniques learned through group sharing of indigenous knowledge such as the use of cowdung, ash, *tephrosia* leaves, Mexican marigold, etc. At harvest of grain, the best seed is selected following critical observation of crop vigor during each cropping cycle.



LIVESTOCK

Animals are part of sustainable organic agriculture production systems and each farmer is supported to acquire some livestock, for example through group savings/ joint owned livestock that is passed on from one farmer to another. Apart from being kept for food and cash, animals are primarily kept to fertilize the soil and provide urine which is fermented and used as a pesticide. Among the popularly kept livestock are: goats, pigs, poultry and, cattle. In some households, rabbits and sheep are also kept. Animals are fed and treated using locally available, organically produced materials. Most poultry are kept as free range. Goats, cattle, pigs and sheep are kept in paddocks or animal sheds with access to exercise yards.

INCREASED INCOME

FFLG members work together and thereby reduce labour costs. They open more land than when working alone. Due to proper and timely management practices, productivity has increased. The selection of commercial enterprises based on group decisions helps planning for larger quantities to be marketed as a group. In addition to crops that double as both food and cash crops, the purely cash crops grown are coffee, cocoa, and cotton. All FFLGs have established savings and credit schemes. Most groups have increased their minimum total savings from a mere US$1 to around US$3 000. All this has been made possible by the social trust and interaction which enables farmers to access better markets through group marketing.

Increase in income has enabled farmers to improve their resource management further. In the words of one of the facilitators: “When poverty-stricken, farmers were destroying forests for charcoal to earn a living especially in Kibale forest, Mount Rwenzori National Park and Queen Elizabeth National Park”.

GROUP MARKETING

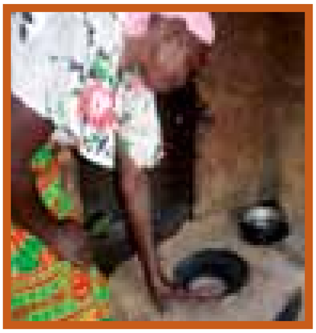
FFLGs have organized themselves around a common commercial enterprise. They produce large quantities compared with other enterprises, purposely for a surplus for the market. Most groups have a responsible person for market research. She/he collects production data and secures a collective market for the produce. Some groups have started to add value to their produce (e.g. wine processing from pineapples and banana, cakes from banana and wet coffee processing). Two maize mills have been purchased to mill grain into flour instead of selling it as grain.

POVERTY ALLEVIATION

Poverty alleviation is brought about by several interwoven factors which are characteristic of FFLGs such as: better prices through group marketing, increased production due to appropriate farm management practices and working in groups that result in increased labour productivity, better resource utilization and savings and credit groups. The popularly shared sentiment for the groups' power has been "moving out of poverty is not action, it is interaction" (*Pers. comm.*, Prof. Munene).

As marketing of produce is done by the group, each household is informed of how much goes to their share.

Several men from FFLGs reported having "quit booze" due to group advice and due to realized benefits of working on their farms and supporting the whole family, including children's schooling, instead of loitering from bar to bar. This behavioural change has contributed to a reduction in poverty, and the interaction has resulted in greater wealth, not only reflected in monetary terms, but also in access to information and knowledge.



Woman shows her energy saving stove constructed for her by FFLG members to reduce cutting down trees for fuel

Farm crop diversity among FFLG members

Children at a rural school serving porridge from corn contributed by parents in FFLG to the school

CONTRIBUTION TO REALIZATION OF MDGS

Directly, the project has contributed to reduction in poverty among participating households and their communities, increased food security (access, availability, stability and nutrition), increased education through availing school fees, pens and books for children and sufficient food for children, which enables them to stay in school. There is improved cooperation at household level that has resulted in less domestic violence especially on women as a result of women and their husbands working together in the same way. This spirit is carried home. Environmental conservation has also been supported as discussed earlier.

CONCLUSIONS

The learning from the FFLG project in the Rwenzori region is a manifestation of the role of social capital in organic agriculture especially amongst smallholder farmers. The experience in this organic project shows how practical application of organic agriculture using the FFLG approach can lead to a wide range of improvements. It is crucial to keep the approach flexible, and that the participants keep the ownership over their group and set their own goals and group life. In the Rwenzori region, over 60 FFLGs have been established with 1 000 households as direct beneficiaries.

Organic farms extend beyond the physical farm land boundary, both socially and environmentally. Therefore, as organic farming employs a holistic approach on the farm, an extra effort is made to ensure that the interaction of the farm in question with other systems is not impeded by the institutional aspects, social, political and market environments. All have to be given equal attention through social interaction.

Africa still suffers through disregarding her own technological innovations in agriculture and other development fields. In assessing the sustainability aspects of

FFLG, it was found to be strong in terms of ecological, economic and social sustainability while the institutional aspects were still weak. This calls for a great change in confidence and trust in Africa's social, natural and cultural values. The following Chinese proverb reminds one of universal principles of sustainable development:

Tell me and I will forget
Show me and I will remember
Involve me and I will understand
Step back and I will act.

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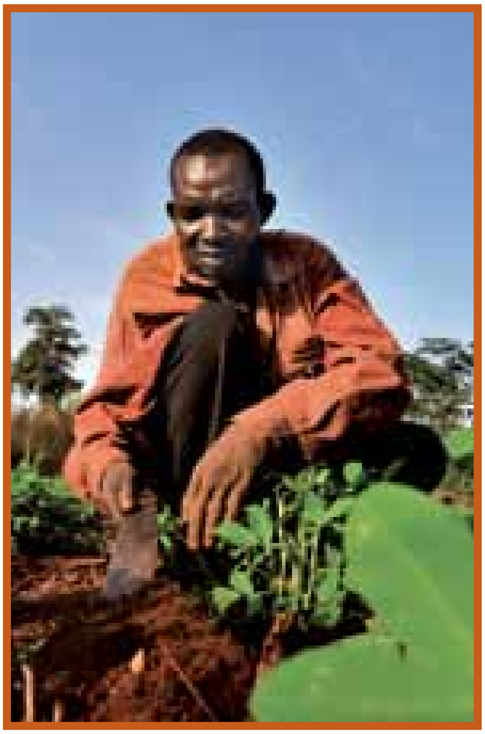

INFORMATION TECHNOLOGY AND COMMUNICATION IN ORGANIC AGRICULTURE

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ABOUT THE AUTHOR

Anne Bruntse grew-up on a Danish mixed farm and experimented with organic farming in her home vegetable garden. She graduated from the Royal Agriculture and Veterinary College in 1978 with a master's degree equivalent, and then worked in the Danish Extension system. FAO work followed, in Swaziland and Kenya on seed multiplication and fodder. She then farmed privately (and managed a business) in Kenya for 21 years, inter-spersed with consultancies on camel value chains. She joined Biovision Foundation for Ecological Development in 2006 and worked with the Biovision team and short-term consultants to build-up the farmer data base www.infonet-biovision.org. She was later in charge of the Infonet Outreach pilot project, seeking to find effective methods for the information to reach farmers.

BACKGROUND

The value of getting timely quality information to smallholder farmers should not be underestimated. The agricultural research and development community is trying to increase the farmers' knowledge base through an integrated approach including information and communication technologies (ICT), as noted by several researchers (Kesavan and Swaminathan, 2008; Ballantyne, 2009; Christoplos, 2010). With the challenges of poverty, food insecurity, decreasing agricultural productivity and climate change, creative approaches are needed to enhance access to information and make it useful to smallholder farmers. Such approaches should unlock farmers' capabilities to manage soils, water, biological resources, pests, disease vectors and genetic diversity innovatively and to conserve natural resources in a culturally appropriate manner.

Infonet-Biovision (IB), a project under the Biovision Farmer Communication Programme, has developed a farmer resource Web site (www.infonet-biovision.org) and has three years of experience with pilot outreach methodologies for organic and sustainable agriculture and environment conservation using applied ICT. This paper examines experiences and plans for partnering with local communities and research organizations in Kenya and East Africa to promote changes in agricultural practices and community organization.

The IB project was established after thorough consultation with farmers and listening to their needs. A joint team from Biovision Foundation (a Swiss-based NGO promoting the four health pillars of the International Centre of Insect Physiology and Ecology: plant health, animal health, environment health and human health) and the Company Avallain (ICT entrepreneurs) made extensive field visits around Kenya and collected notes on farmers' needs before submitting the project proposal to donors for funding. The farmers' identification of their greatest needs was surprisingly uniform across the survey with the greatest overall wish being a "one stop shop for good agricultural information". The partners then designed and developed a Web site (www.infonet-biovision.org) with information arranged according to the four health pillars. After building-up the major framework for plant health, and undertaking a usability study, the project was officially launched in 2007. The following year, a stakeholder workshop was held to identify suitable partners and collaborators and to plan the way forward (Steinlin et al., 2008). Two of the major workshop findings were that the Web site needed information about livestock and other health pillars as well and that farmers were not yet aware about it, nor how to access it. These needs and gaps became the focus of the second phase of the IB project, and the database was expanded to include livestock and other information and to create farmer awareness about how to access the information.

Two recent interesting developments are relevant to the changing conditions in agriculture in Kenya:

In Kinangop, Central Kenya, farmers together with Netherlands Development Organization (SNV) conducted a survey to identify farmers and found that 90 percent of farmers in that area were 40 years old or younger (G. Mungai, chairperson of Friends of Kinangop Plateau, personal communication). This is contrary to older statistics which identified an aging farmer population.

In 2011, the Rural Outreach Programme (Infonet partner in Mbale, Western Kenya) carried out a baseline study and tested the soil acidity of all 40 demonstration plots in their new project. The low average soil pH of 3.5 was unexpected (normally soil pH for crops would be around 5 or 6), several samples had a pH of 3.0. Only a few reached a pH level of 4.5 (D. Ajawa, *Pers. comm.*). Thus, better soil management practices are urgently needed if crops are to be produced successfully on these soils.

OUTREACH METHODOLOGIES AND TECHNOLOGIES

The use of a Web site requires a computer and internet connectivity, or an offline version of the Web site. The IB programme tested the use of basic laptop computers called *One laptop per child* (OLPC) for work in the field. These OLPCs can be charged directly by solar charging systems. The OLPCs worked well in two locations.

As adequately proven during the usability study (Steinlin, 2007), farmers access the Internet and use computers when they have a good reason to do so, but this requires some training. Outreach methodologies were designed to test various ways of communicating with farmers via ICT. Farmers were asked about their most urgent needs in terms of content upgrade and relevance of information. Following this, a review of the Infonet content on the platform was carried out and validated by subject matter experts. With the Web site usability accepted by initial farmers and confidence created, the IB project tested farmer organizational structures for speed of information spread. The following bottom-up approaches were tried with varying levels of success:

- Use of Community Information Workers (CIWs) based in their community: a CIW is typically either an interested farmer or a committed school leaver, provided with a field computer with a compact disk (CD) of uploaded Web site content, who disseminates information to farmers. The CIW contacts farmer groups in his/her location and attends their meetings when invited, sharing computer information with the groups. They study together and discuss the ventures farmers are interested in. CIWs were given an initial basic training in how to use the computers and the Infonet CDs. They have continued to work with more farmer groups with encouraging results.

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- Infonet-biovision is also working with the research organization KARI (Kenya Agriculture Research Institute) and a local Community-Based Organization (CBO) ”Katoloni Mission CBO” to establish a dynamic farmer resource centre. Under this arrangement, KARI provided an office with a computer and a photocopier and IB helps with remuneration of the centre manager (diplomate in agriculture) and four CIW’s. The CIWs help the CBO to improve organizational matters and enlist additional members as they visit groups to create awareness about organic farming. Access to knowledge can be a powerful service to attract individuals to a farmers’ association. In this case, the system was further strengthened by the CBO’s access to the local research station and the CIWs being able to consult with scientists on a range of issues, including technologies demanded by the communities.
- One CBO was supplied with a properly set-up field computer only and nothing else.
- Two farmer groups were issued an OLPC for direct learning.
- IB partnered with the Kenyan Ministry of Agriculture (MoA) in organic farming outreach in Kilifi.
- Partnering with other organizations to disseminate and give feedback (Kenya Network for Draught Animal Technology, Muranga Organic Training Centre, Lengo Agriculture Training Centre, Sustainable Food Development, Kenya National Federation of Agricultural Producers, Agriculture Information and Ressource Centre under MoA, Sustainet/ACT, etc.).
- Demonstrations during local agriculture shows and farmer field days, and distribution of CD’s with Web site content to farmers, schools and other interested parties including district extension officers. The CD was in 2011 declared one of the must haves in an essential information kit for extension officers by MoA. Other African countries are now also requesting CD’s.
- Advertisements and awareness about Infonet availability and use through ’The Organic Farmer’ magazine, which is distributed to farmers free of charge and other local media.

In evaluating the above methods, our experience shows that the most efficient outreach methodology via ICT is through serious CBO's where it is possible to have a dialogue about information needs of the organization's members. The availability of information at their offices is also a great membership booster and this creates a win-win situation. Good relationships and interactions with the research organizations are an added advantage. There has been an interest from SNV Netherlands to partner in up-scaling this model to dairy cooperatives supported by SNV in Kenya.

RESULTS

- **Productivity.** CIWs have been wonderfully committed to assist their communities with information. After an initial period of mainly studying, farmers in areas where CIWs were operating started implementing some of the technologies they had learnt, ranging from rainwater harvesting structures, to improved tomato growing, or increased numbers of indigenous chickens, to use of plant extracts to replace pesticides. Compost and manure use became widespread, with resulting yield increases and better food security (Vallauri, 2011). In many of the places where CIWs have been active, the next development has been a demand for an office where farmers can come to meet and to get information at their convenience.
- **Connectivity.** The tripartite collaboration involving KARI, Katoloni Mission CBO and IB has been particularly successful. The centre had its official opening in May 2010 when the CBO had 70 member groups. At the end of 2011, the CBO's membership had increased to 185 groups and other collaborating CBO's started to register. Following a training organized by IB on project planning and fund raising, the CBO was successful in securing funding for the first large environmental improvement project – to clothe the naked Kima Kimwe hill (home of about 45 groups). Farmers are not only going organic and starting tree nurseries but they have started organizing themselves according to interests, finding solutions to their most urgent problems by linking-up with all the service providers available in the area.

- **Sustainability.** The Sustainable Income Generating Initiative CBO in Busia (Western Kenya) was an organization which only received an OLPC laptop with uploaded content and when this later went missing, they still had a CD so they could still access the needed information. However they entered into partnership with a KARI station in Busia for a seed bulking scheme and earned enough money to buy their own computer. They increased their membership from 25 to 35 groups, including six youth groups. The youth particularly are keen to use new technologies and to come and study on their own to see how they may improve their farming practices. There are many success stories from this CBO, which has submitted a proposal to IB for upscaling services to their members. Both instances of supplying farmer groups with a computer directly failed due to internal group dynamics. The CD with Web site content has also been a success. More than 3 000 CDs were distributed in 2011 and many clients were eagerly awaiting the latest (April 2012) version. Students are allowed to copy the CDs and share these with their colleagues and AIRC is allowed to copy and distribute CDs to extension officers.

- **Awareness.** The collaboration with MoA in Kilifi has not yielded any measurable results apart from a greater awareness that organic farming is not necessarily a primitive practice from the past, but rather a series of well-documented modern technologies. Reportedly, farmers are now using more compost, manure and plant extracts as opposed to agrochemicals but no statistics have yet been collected. The MoA has greatly assisted in awareness creation through agricultural shows and trainings of extension officers. Over the last four years the attitude of agricultural extension officers towards organic agriculture has changed. It is no longer seen as the great enemy of progress which cannot possibly succeed. Many are now much more openly supportive of organic farming compared with perceptions in 2008. Demonstrations and shows during farmer-field days have been useful in raising awareness and interest in organic farming. In particular, women are concerned about all the negative changes to population health that have taken place in the last generation, and attribute many of them to current farming practices. Most Kenyan farmers only started using fertilizers and agrochemicals 30-40 years ago, and there is still some memory of older, more natural, farming systems. Collaboration with sister projects, The Organic Farmer magazine and the radio have been very beneficial, and media attention has raised awareness about organic and sustainable farming practices in Kenya and beyond.

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CONCLUSIONS

This is the right time to up-scale adoption of organic and sustainable farming practices, and ICT tools are already contributing towards this objective. Farmers are keen to learn new technologies and how to cope with the ever present declining soil fertility and climate changes, and they are also more educated than ever before, and able to use the new ICT tools with minimal training. Organic farming is receiving many positive press reviews, but has not yet been officially recognized by the extension system as a viable and sustainable option for serious farming. Organic farming curricula are also not available in most agricultural colleges, suggesting that it will still take some years before extension officers are able to advise effectively on organic systems unless they study individually. However with the general interest and enthusiasm among farmers, and the possibility of extensive dissemination of large amounts of information via ICT, it is still very possible through wide collaboration of concerned institutions to effect changes towards a healthier environment and overall improved human health in Africa, and hopefully this will also encourage extension departments to develop organic curricula and extension support for organic farmers.

Farmers agree that organic compost and animal manure greatly improve soil fertility, and many who have tried plant extracts in place of agrochemicals are convinced of their superiority. Also, tree planting is on the increase and local tree nurseries make good incomes from selling tree seedlings to other farmers and users.

However, one of the main challenges to increasing the market for organic produce in Kenya to the waiting consumers is the lack of consistent supply and serious shortages during dry spells. With better access to water harvesting and soil fertility management technologies, many more farmers would be able to join the organic market value chains. Given the trend of more young people choosing to stay on the farms, the importance of ICT in agriculture and good content being made available, the opportunities of accelerating organic agriculture and creating jobs in rural areas cannot be underrated, as most young people in Kenya today can use computers and cell phones.

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INFORMATION FOR BETTER YIELDS AND NEW MARKETS

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ABOUT THE AUTHORS

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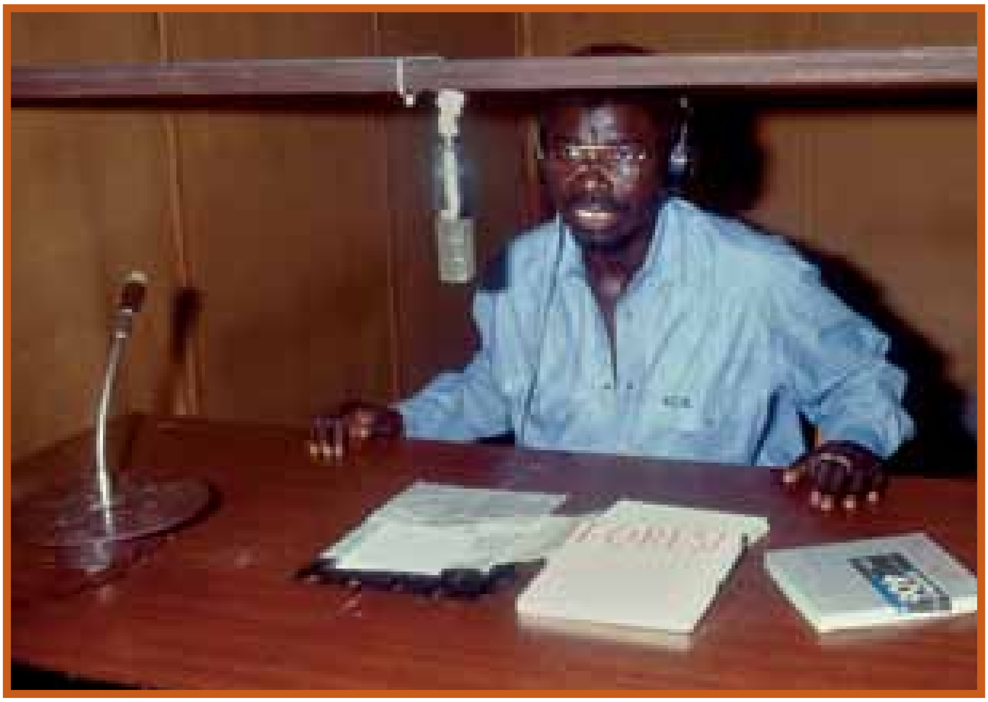
BACKGROUND

Videos, community radio, smart phones, Personal Digital Assistants (PDAs), notebooks, and SMS-messaging platforms are some of the many combinations of Information and Communication Technology (ICT) that can help key players in agriculture create, unearth and collect the information they need. This paper draws on the experiences of several farmer organizations in Africa that have first-hand experience of this. With help from ICT, they have successfully increased their yields, entered new markets, obtained organic certification and accessed market price information.

The International Institute for Communication and Development (IICD) has 15 years experience of working in this field with farmers' associations, farmer information centres, agricultural research institutes and other stakeholders. The projects have been working hand-in-hand with national farmer organizations to identify the information their members need. Subsequently, an innovative mix of ICT has been developed in order to package the information and deliver it to the farmers in the quickest, most efficient, cost-effective way and in their preferred language and format. IICD programmes in the Africa agriculture sector reach primarily farmers and herders from Burkina Faso, Ethiopia, Ghana, Kenya, Mali and Uganda.



EXAMPLES OF THE POSITIVE BENEFITS THAT ICT CAN BRING TO FARMERS

Agricultural research and support institutes can use community radio, the internet or mobile telephones to quickly and easily share existing information, particularly their research findings, with farmers and farmer information centres. Two Zambian organizations, the Zambia Agricultural Research Institute (ZARI) and the National Agricultural Information Services (NAIS) show how this can be done. Until very recently, if a Zambian farmer had a question, he or she would either have to wait for a visit from their extension officer or post their question to a team of agricultural information officers at NAIS Headquarters. Response could take months. In November 2011, NAIS launched an SMS-messaging platform to speed-up this process. It now takes a farmer two minutes to send a 180-character question to the number 3009 in one of Zambia's seven main languages and 24 hours for a NAIS agricultural information officer to reply in the language selected by the farmer. In the first half of 2012, questions were sent about crop protection, weather, types of seeds, soil management and market prices. NAIS's radio broadcasters also use the farmers' frequently asked questions to determine the themes of their twice-weekly agricultural radio programmes in seven different languages and to identify regional or content patterns to the questions.

USING SIMPLE PHOTO STREAMS IN BURKINA FASO TO GIVE FARMERS NEW SKILLS

Whether you are a farmer, teacher or health worker, discussing your experiences and knowledge with your counterparts is an effective way to share knowledge. A local farmers' organization in Burkina Faso, FEPPASI (Fédération Provinciale des Producteurs Agricoles de la Sissili) is doing just this: within only three years it has used video, photos and digital presentations to train around 2 500 farmers in specific skills; e.g. innovative production, food-processing methods, marketing skills, the production of organic fertilizers and techniques for the sustainable management of natural resources. FEPPASI uses a simple photo stream to explain the step-by-step process of how to turn yams into flour[1].

USING BASIC COMPUTER COURSES IN GHANA TO IMPROVE FARMERSBUSINESS AND MARKETING SKILLS

Through a programme called PEPS-C in Northern Ghana, 1 000 lower-income small-scale farmers and livestock managers have now been trained in basic business and marketing skills using ICT. Over 90 percent of the people who participated in this training programme confirmed that the skills and knowledge they gained did indeed improve their business performance and profits.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USING EXCEL, WORD AND POWERPOINT IN ZAMBIA TO IMPROVE LESSONS FOR VOCATIONAL STUDENTS

In Zambia, two vocational training centres for young people, Chawama Youth in Lusaka and Ndola Youth Resource Centre in the Copperbelt, have integrated ICT into all their vocational training programmes. Examples of this include using programmes like Excel to learn about sustainable agriculture practices while learning how to set up spreadsheets, designing furniture for carpentry, preparing and sharing) recipes online for cooking classes while learning word processing, recording music, preparing business plans on the computer, and taking ICT as a 'pure' subject. Inspired by the success of the Chawama Youth Project, the Ministry of Youth and Sports has now adopted this approach and joined forces with IICD in order to integrate ICT in its vocational training programmes nationwide. As a result, participating training centres witnessed a 20 percent increase in subscriptions to their courses in 2011 and job opportunities for the vocational students have also increased[2].

2 See information available at www.akvo.org/rsr/project/418.

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USING MOBILE PHONES TO INCREASE FARMERS REVENUES IN GHANA

In most countries, farmers lack quick and easy access to market price information. This is reflected in the widely differing prices between commodities on sale at the local markets. ICT can play an important role in improving price allocation to specific commodities by providing farmers with frequent and reliable information about market prices using a combination of radio and mobile phone services. This is demonstrated by one of IICD's Ghanaian partner organizations, SEND. They use mobile phones to empower small-scale farmers to use market price information effectively, and to connect producers with buyers, using an online platform called the ESOCO platform, which is active in 16 countries. The important innovative element in the online platform is the development of voice-based responses. This technology allows illiterate farmers – particularly female-farmers who lack access to other media - to use the service to contact and negotiate with potential buyers. Over 85 percent of participants indicated that they had increased their revenues by participating in the programme[3].

USING PERSONAL DIGITAL ASSISTANTS TO ACCELERATE ORGANIC CERTIFICATION IN ZAMBIA

In the past, collecting data about farms to help them to apply for and obtain organic certification had to be done by hand in Zambia, a time-consuming and lengthy process. Today, extension officers from the Organic Producers and Processors Association of Zambia (OPPAZ) use smart phones with an Android operating system to collect data from farmers who wish to become organically certified. The data is collected, analysed, prepared and fed into a central open source database at OPPAZ Headquarters in Lusaka. The system also acts as an internal control system (ICS), providing detailed information about the plot, soil composition, crop type and yield of each farm. By mid-2012, data from about 700 farmers in Chongwe, Mongu and Mpongwe had been collected. From 2012 onwards, the system will also serve as a marketing tool, linking organic farmers and producers with regional and international wholesalers via the OPPAZ Web site.

3 See www.iicd.org/projects/ghana-ecamic.

USING MOBILE DEVICES AND DATABASES TO STRENGTHEN THE MANAGEMENT OF NATURAL RESOURCES

Transcending the level of the individual producers, natural resource management can also benefit from ICT. Databases and mobile devices can be used to track soil quality, fertilizers and pesticides, water quality, deforestation and other relevant data. With the use of web applications and geographic information systems, this information is increasingly easy to distribute and share with relevant stakeholders.

THE KEY TO SUCCESS FOR MOST OF IICD's ICT INITIATIVES

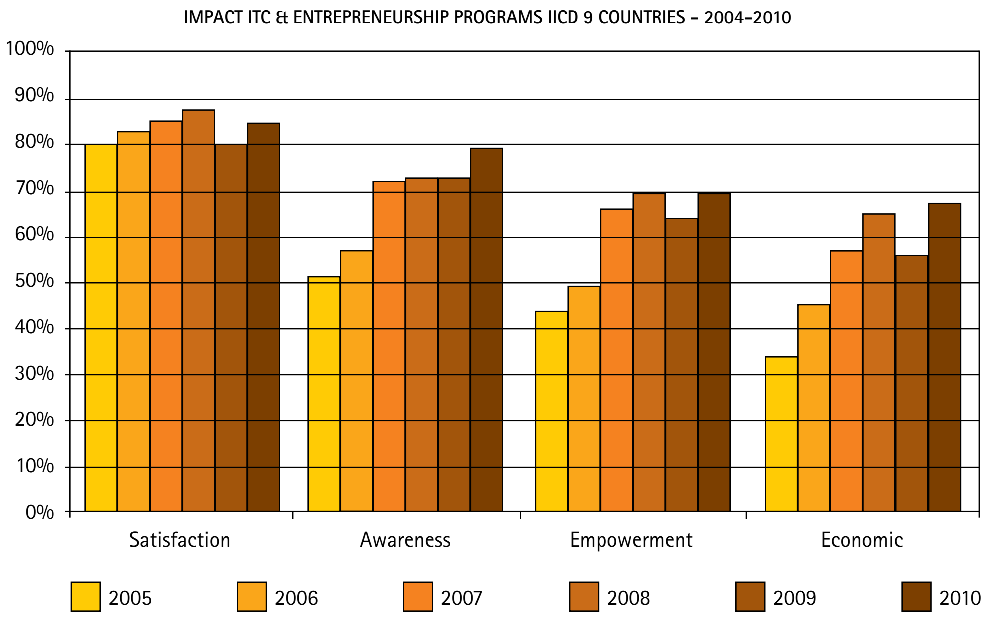
As mentioned earlier, the key to success for most of the ICT initiatives supported by IICD lies in the participatory approach used. This is further strengthened by an advanced evaluation system, which IICD uses continuously to monitor and assess the impact of the initiatives on the different target groups. This Monitoring and Evaluation (MandE) system is based on online/offline questionnaires and frequent focus group meetings with the end-users of the ICT initiatives. An analysis of 35 000 questionnaires collected since 2005 indicated that women felt especially empowered by taking part in ICT activities in the agricultural and environment sectors. End-users are asked to rate a series of statements such as "through this project I now know more places where I can sell my produce" and "through this project I now have more customers" from "disagree" to "strongly agree".

The histogram below summarizes the level of impact of ICT through IICD's entrepreneurship programmes as perceived by end-users of the agricultural programmes supported in nine countries (primarily small-scale farmers, producers and processors), over a six-year period from 2004-2010. The questionnaires were filled in anonymously by the end-users, either online or offline. Four key indicators are measured:

- **Satisfaction**: in this part of the questionnaire, end-users indicate how, and how often, they use the project, and their satisfaction with the different services and materials provided to them through the project. When asked "what were your main reasons for participating in this project?", answers ranged from "I wanted to change my way of farming" and "I wanted to reduce poverty in my community by listening to radio agricultural programmes" to "I wanted to learn from others and teach my children how to go about farming".
- **Awareness**: this indicator shows whether or not end-users of the project see themselves as having become more aware of the benefits that ICT can bring to them. We have noticed that 'awareness' can decrease over time when the end-users become more used to ICT, or it can increase when the project begins working with new end-users or changes their focus.

FIGURE 1

Summary of ICT impact survey results in 9 countries (2004 – 2010)

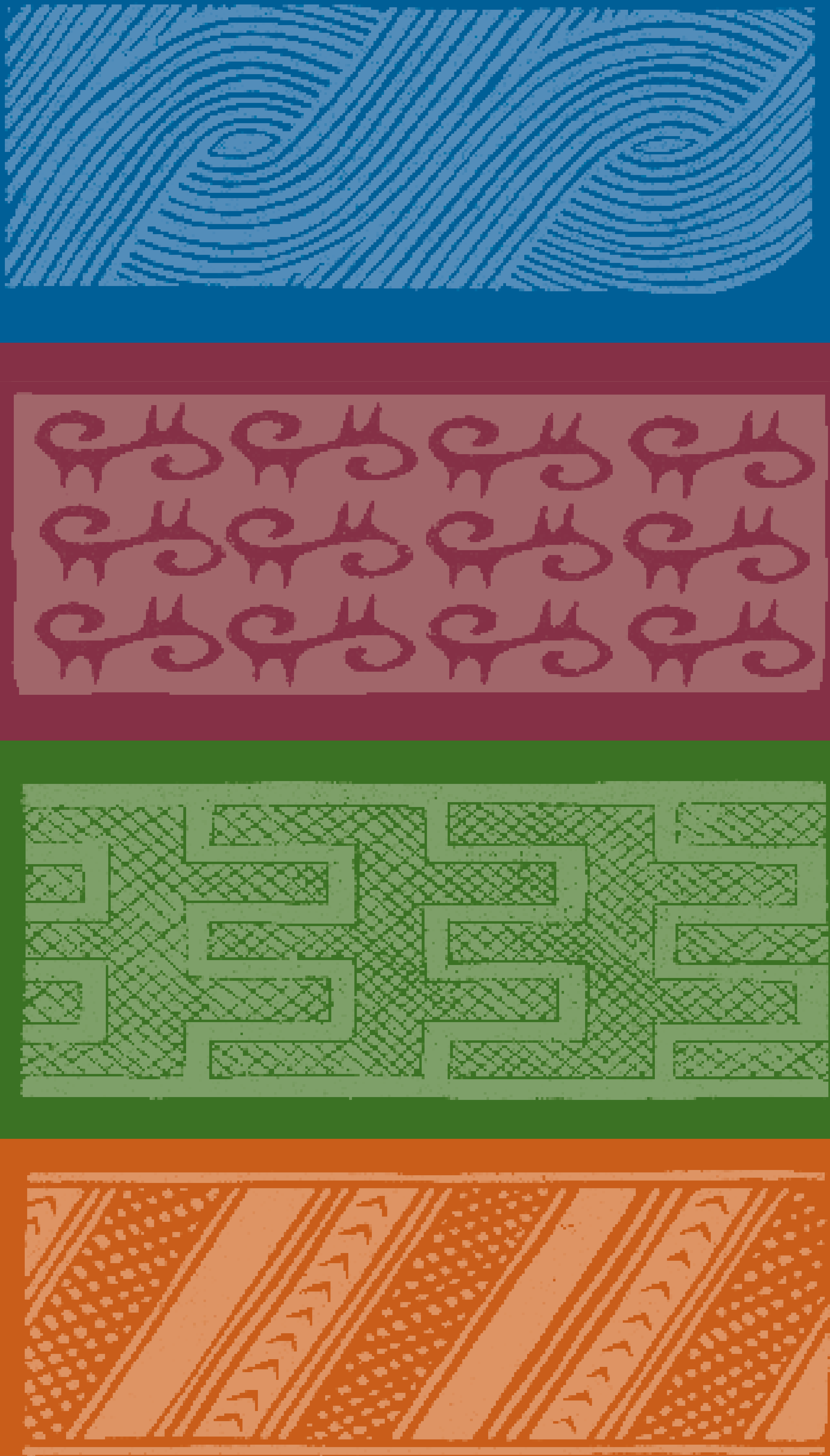


- **Empowerment:** do the end-users feel more empowered as a result of taking part in the project? For example, because they have acquired new knowledge or skills that enable them to improve their quality of life? In many cases, farmers indicated that as a result of taking part in the project they were in a better position to negotiate a fair price for their crops, or were better able to find the information they needed to improve their crop or increase their yield.
- **Economic impact:** it shows how the project has, or has not, improved the economic status of the end-users. Did they earn more money? Did they become more productive?

Other indicators are also measured through the questionnaire, e.g. the negative impact of using ICT. This shows if the end-users or their community experienced any unexpected, or undesirable, impact as a result of taking part in the project. For example "this project increases inequalities between men and women" or "given that some people do, and some do not have access to information, there is now false competition".

The monitoring and evaluation questionnaire is also used to compile a detailed profile about the end-users of the projects. It asks questions about the end-user's age, gender, position in the institution, level of education, household income level related to other people in the country, geographical location (city, rural area) and how often they use the project (daily, weekly, monthly).

In this way, IICD is able to monitor the impact of its projects on the ground continuously and adapt and amend them where required so that it is better able to respond to the needs of the local organizations in the countries where it operates.



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