

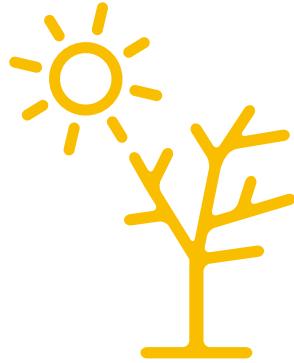


CLIMATE CHANGE MITIGATION AND ADAPTATION IN DRYLANDS

Actions by Drynet Members



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October 2015



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FOREWORD

Adapting agriculture to climate change is undoubtedly as old as agriculture itself. Since the establishment of agricultural practices 10,000 years ago, people have perpetually adjusted to changing conditions. Heat, cold, drought, severe weather, climate change, natural disasters, disease, land conflicts, war, persecution and migration: these circumstances have challenged people to adapt to and adopt new ways of producing food, sustaining their livelihoods and taking care of their ecosystems.

Farmers and pastoralists have endured many constraints, yet they have been able to renew their practices again and again to produce rich harvests from their seeds. Let's remember that agriculture drove the development of systems of measurement and calculation, and calendars and clocks.

Therefore, it would be wrong to believe that 'modern' agriculture that strongly relies on external inputs like hybrid seeds, artificial fertilizer and chemical pesticides, is the only scientific form of agriculture. Generations of observations and the evolution of sustainable practices in a variety of environmental, social and economic contexts have made small-scale farmers and pastoralists experts in soil science, water management, conservation of seed varieties and animal breeds, and adaptation to climate change.

As a result, small-scale farmers and pastoralists are currently responsible for producing 75 per cent of the food consumed in the world: they are the major food producers to which we owe our food security.

From the heights of the Andes to the Mauritanian desert, from Central Asia to South Africa, projects implemented by Drynet members together with local communities demonstrate a range of sustainable land use strategies that are based on local adaptation to climate change, adoption of more sustainable practices, and innovation.

They demonstrate ways of producing food and improving incomes while safeguarding agricultural heritage, protecting (agro)biodiversity, conserving and restoring soils, and adapting to climate change.

Maintaining the oasis ecosystem through an agroecological approach in Morocco, improving soils by bio-remediation in Bolivia, fostering assisted natural regeneration of land in Niger, reinventing pastoral migrations in Indian Rajasthan: all of these actions show how local land users contribute to the resilience of local communities and sustainable management of natural resources.

With this compilation, we hope that practitioners, scientists and policy makers everywhere in the world will be inspired by these examples and create enabling environments for sustainable actions.

Patrice Burger

Chair of Drynet

Director of CARI-France

Member of the CSO panel to the UN Convention to Combat Desertification on behalf of the accredited CSOs from Western European and Others Group (WEOG)



SOUTH AFRICA

Written by Noel Oettle

ADAPTATION TO CLIMATE CHANGE IN THE SUID BOKKEVELD COMMUNITY ENVIRONMENTAL MONITORING GROUP (EMG)

INTRODUCTION

On the arid sandstone plateaus of the Suid Bokkeveld, in the remote Northern Cape Province of South Africa, lives a community of small-scale farmers who grow indigenous rooibos tea and raise sheep and goats. This is a landscape that is deeply incised by ravines, and the farms are widely dispersed. It is an arid area that receives 150 to 300 mm of rain per year, mostly in the winter. It is a tough place to make a living, but this is a community that is descended from the first people of South Africa, the Khoisan, and its members are as resilient as the landscape they live in.

The acidic soils are well suited to cultivation of rooibos tea (*Aspalathus linearis*), which is a drought-resistant indigenous crop that is uniquely adapted to the area's low soil fertility and long summer droughts. Unlike their white neighbours, whose extensive commercial farms are in higher rainfall zones and include adequate reserves to ride out droughts, the farming enterprises of these small-scale farmers are highly vulnerable to climatic extremes. The community has been shaped by a long history

of dispossession, discrimination and marginalisation at the hands of the colonial and Apartheid regimes. When members of the community came together in 1999 to initiate a development process, they aimed to address the poverties that they had been enduring for generations and to transform their community into a more equitable one. Two years later they had formed the Heiveld Co-operative to process and market their rooibos tea, and since then they have been selling their products at local and international markets.

ENGAGING WITH CLIMATE VARIABILITY AND ADAPTATION

The failure of the winter rains in 2003 (which was followed by three years of drought) placed severe strain on livelihoods and threatened the very existence of the community. It was well known that periodic droughts in this area had in the past had a devastating impact on agriculture and communities dependent on the land for their incomes. This led to the initiation of a joint learning process between the farmers' own organisation, the Heiveld Co-operative Limited, and two local NGOs, Environmental Monitoring Group (EMG) and Indigo development & change, to enhance the capacities of the farmers to adapt to climatic variability and change.

At the time no initiative existed in South Africa to support small-scale farmers to adapt to climatic variability and change. Temperatures were on the rise, and long-term climate predictions for this part of South Africa indicated that changes in rainfall patterns were likely. Subsequent climate modelling indicates the likely later onset of the rainy season, earlier cessation and an overall reduction in the winter rains upon which the local ecology is primarily dependent. MacKellar et al. (2007)¹ predict the pole-ward retreat of rain-bearing mid-latitude cyclones (with reasonable agreement across the models) by the late twenty-first century.

In particular, this retreat of mid-latitude cyclones and reduction in rainfall is most consistently projected for early winter, with indications of reduced rainfall later in the winter season. Together, these projected changes suggest a shift in the timing of seasonal rainfall, with late summer rainfall heavier than present and extending to later months, and reduced winter rainfall arriving later (Archer et al. 2008).²

CREATING A LEARNING PLATFORM: QUARTERLY CLIMATE CHANGE PREPAREDNESS WORKSHOPS

The approach taken by the NGOs was informed by an understanding that effective adaptation is a vital aspect of sustainable development. Successful adaptation would contribute to development, and also reduce the risks to which people are exposed and minimise the damages and losses that they may suffer in the future as a result of climatic impacts.

EMG and Indigo initiated a series of quarterly climate change preparedness workshops designed to enable community members to share their experiences and records of the weather and reflect on its impacts and their responses, and also to provide and discuss the implications of the latest long-term weather forecasts, focusing on the next three months. In addition the workshops were intended to create a platform for learning and discussion of issues of common interest and facilitate the planning of individual and collective interventions that might assist people to adapt to current or anticipated climatic impacts and contribute to sustainable development. These workshops were hosted in collaboration with the Heiveld Co-operative.

Since 2004, the collaborating organisations have hosted climate change preparedness workshops every three months with the support of a succession of donors, including the European Union and SDC via Drynet. The workshops were conceptualised and designed as a safe space in which participants would be able to meet multiple human needs in the course of a multi-faceted, participatory learning process.³

Over time, the workshops evolved into a valued platform where community members could share insights, generate new ideas, and plan collective actions on a regular basis. The workshops came to encompass and address far more than adaptation, creating space for reflection and providing an important point of focus for a collective development process. They also provided a platform for the development and accountability of multiple small projects in the community, addressing aspects such as alternative energy provision, water resource monitoring, soil erosion control, livestock monitoring and propagation of wild rooibos. These projects were facilitated using a Participatory Action Research approach.⁴

The workshops also came to serve as a point of sharing and accountability for processes such as knowledge exchanges to other communities, and for sharing knowledge about topics that were not related to adaptation or livelihoods. Over time participants gained more confidence and were able to surface diverse problems, and to address these through peer learning and other forms of knowledge sharing. Farmers started collecting weather data and reporting more accurately on weather impacts and patterns.⁵

SUSTAINABLE DEVELOPMENT IN THE SUID BOKKEVELD

In parallel with the facilitation of adaptation processes by EMG and Indigo via the workshops and associated field activities, Heiveld gradually expanded its role in contributing to the sustainable development of its members. It responded to the drought by providing its members with rooibos plant material to replace fatalities. By doing so each planting season while the drought endured, Heiveld was able to ensure that its members were able to continue producing and earning incomes, and could retain its place in the market. With the appointment of two Mentor Farmers to advise its members on sustainable production, Heiveld was able to promote knowledge sharing and solution-seeking amongst its members.

At an early stage of project implementation, associated research showed that the sub-species of rooibos endemic to the area, which had traditionally been harvested in the wild but not cultivated, were far more resilient during drought conditions. As opposed to production in cultivated fields, which inevitably lead to loss of soil carbon, husbanding wild rooibos retains soil carbon and biomass of indigenous shrub cover. Traditionally, this so-called “wild rooibos” had been mixed with the cultivated tea. The Heiveld created a market for wild rooibos tea, enabling consumers to exercise their preference for “biodiversity-friendly and climate friendly” rooibos, and enabling producers to benefit directly from sustainable harvesting practices and the associated conservation of the environment in which the plant occurs.

Since it was founded in 2001, the Heiveld Co-operative has steadily grown in terms of its capital base and impact within the community. This impact has been a result of paying its members the highest price in the industry for their rooibos tea, ensuring that its members pay employees at a rate higher than the legal requirement or the local norm, and investing in the social development of the community. In 2004 Heiveld secured organic and Fairtrade certification and began exporting its products directly to

trading partners in South Africa and abroad. Over the years its membership broadened and included more women. From an initial 14 per cent of membership, by 2012 women accounted for 40 per cent of membership.⁶ Two of the five members of the Board of Directors are women, as are all three permanent members of staff. Participants in one of the quarterly workshops, reflecting on what strategies might make a farm more resilient in the face of climate change, floods and natural disasters, commented: **“We have progressed a long way because women are also involved in many activities and much is still possible”.**

ADAPTATION AND LIVELIHOODS: FAIRTRADE AND ORGANIC CERTIFICATION

Heiveld has established an international reputation as a producer of sustainably and fairly produced rooibos tea, and in 2014 it won the United Nations Equator Prize, receiving international acclaim for its local actions with global impact. The Co-operative has demonstrated the importance of effective local institutions by consistently playing a role in supporting its members to adapt their farming practices to greater experienced and anticipated climatic variability, and its partnership with NGOs and links both to the scientific community and members of the international community have played a significant part in enhancing its ability to do so. An important aspect of these partnerships is that they provided what Herriger (2006) describes as resources for self-determination and independence, which have supported people’s efforts to organise and direct their own lives, thus contributing to their individual and collective empowerment.

The interwoven processes of development and adaptation in the Suid Bokkeveld have been characterised by a steady expansion of the options and actions available to members of the community to sustain their lives and enterprises. The empowering nature associated with these processes have encouraged people to discover their own strengths and to enhance self-determination and autonomy.⁷

The adaptation process in the Suid Bokkeveld can thus be understood as what Nelson et al. (2007) describe as “a process of deliberate change in anticipation of, or in reaction to, external stimuli and stress”.⁸ Following the initial shock and reactive response to loss of production during the drought of 2003-2006, the responses of the community have increasingly been anticipatory, that is they have taken place before the impacts caused by the stressor actually occur.⁹



CONCLUSIONS AND LESSONS LEARNED

Facilitate adaptation at community level: Adaptation in rural communities where people are managing land-based resources is a process that occurs when people decide to take action and change the ways in which they usually do things. This can include agricultural practices, more environmentally sustainable management of other natural resources, self-organisation, business strategies and investment decisions, and knowledge acquisition and sharing. It is a complex process that takes place at the level of individuals and local communities. Facilitation of adaptation processes should thus focus on the level of local communities that share sufficient common social, economic and environmental interests to collaborate and develop and pursue a shared vision of development.

Create strong local ownership: A crucial aspect of the on-going engagement of members of the Suid Bokkeveld community in the adaptation process is that they perceive it as “their” process, and express high levels of ownership for it. The Heiveld Co-operative, to which most families in the area are affiliated, has been a key player in sustaining the process. Coupled with this is the steady increase in the agency that members of the community have demonstrated, taking action to adapt in pro-active ways, and not merely waiting for negative climate impacts before responding. Real ownership of processes and institutions is an essential element of successful adaptation, and will contribute to individuals and communities being able to exercise greater agency in creating anticipatory responses to climate-related challenges.

Foster a learning approach: At the root of changing the ways that things are done is learning how to do them better. At a community level this implies providing access to accurate current information (e.g. climate trends and predictions, and information about sustainable agriculture) and facilitating learning processes in which new knowledge can be generated by participatory research or knowledge from other sources can be integrated. Reflection on what has been done and its impacts (both positive and negative) is an important occasion for learning and improvement, and integrating regular reflection into community workshops and other processes is an invaluable way of facilitating this.



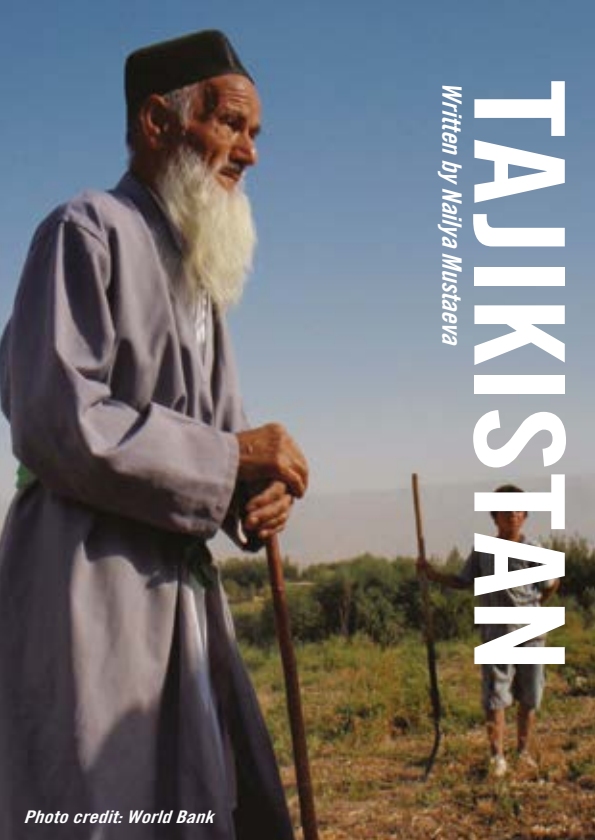


Photo credit: World Bank

TAJIKISTAN

Written by Nailya Mustaeva

CHALLENGES AND OPPORTUNITIES FOR AGRICULTURAL DEVELOPMENT IN LIGHT OF CLIMATE CHANGE IN ARID ZONES OF CENTRAL ASIA: TAJIKISTAN CASE STUDY

REGIONAL ENVIRONMENTAL CENTRE FOR CENTRAL ASIA (CAREC)

INTRODUCTION

All five countries¹⁰ of Central Asia are considered most vulnerable to climate change and face common challenges in socio-economic and environmental development. The fourth IPCC assessment report states that Central Asia will warm rapidly. Average temperature in the region will increase by up to 3.7 degrees Celsius by the end of the 21st century.¹² Agriculture and water resources are recognised as the most vulnerable sectors in all Central Asian countries, and vulnerability is intensified by the region's aridity.¹¹

Tajikistan has the misfortune of being the country in Europe and Central Asia that is most vulnerable to climate change (Fig. 1.). This is explained by its high susceptibility to climate risks and its extremely low coping capacity.¹⁵ An increase in mean annual temperature by 0.2-0.4 degrees Celsius is expected in most areas of the country by 2030, which correlates with observations over the last 15-20 years.¹⁴

Climate related risks are highly threatening for Tajikistan’s key socio-economic sectors. The country experiences about 500 natural disasters every year, which results in annual loss and damage to the value of USD 20-100 million. The proportion of the population that is affected by climate-related disasters is the second largest of the 28 countries in Europe and Central Asia.¹⁵

Fig.1. Location of Tajikistan in Central Asian region Source: Adapted from TNC 2014



CLIMATE CHANGE AND ITS IMPACTS ON AGRICULTURE IN TAJIKISTAN

In Tajikistan, agriculture is a strategically important sector, accountable for one fifth of the country’s GDP. The sector has high exposure to climate change risks.¹⁶ Rapid rise in air temperature and intensive melting of snow and glaciers triggers flash floods and mudflows. In 2005 and 2010 this was the main cause of damage to infrastructure and agriculture, costing USD 50-100 million. Heavy rains also result in floods and mudflows, washing away crops, reducing crop yields, and decreasing productivity. For example, the drought of 2001-2002 caused a critical 30-40 per cent drop in crop yields in most dry farming areas.¹⁷ The drought of 2008, which was followed

by a compound crisis, resulted in a productivity drop of 40 per cent.¹⁸ Other issues that negatively affect crop productivity and quality include weak water and agriculture policies, poor farming practices, obsolete infrastructure, and lack of capacity.

With the onset of climate change, it is irrigated agriculture that will be most threatened. Reduced water runoff is expected to place a significant stress on Tajikistan's land resources. Crop yields in some regions of the country will fall by 30 per cent by 2100, causing changes in crop and forage quality, and the spread of pests and diseases.¹⁹ Coupled with other barriers, such as lack of finance, technical capacities, and obsolete infrastructure, climate change will dramatically challenge food security and sustainable economic development.

LINKAGES TO WATER AND ENERGY

Irrigated agriculture is completely dependent on water availability, which will experience a substantial deficit in the long-term. Projections for the next 20 years indicate that the flow of main rivers such as Amudarya and Syrdarya will decrease by 20-30 per cent, resulting in economic decline across the whole of the Central Asian region.²⁰ Hence, the agricultural sector and food security should not be considered in isolation, but rather in combination with the water and energy sectors, which are inter-dependent. At present, agriculture uses 91 per cent of the country's available water, and the industrial sector, 5 per cent ²¹. Energy consumption for irrigation is now more than 11 per cent of the country's total usage.²²

A NEXUS APPROACH FOR ADAPTION AND MITIGATION SOLUTIONS

The ongoing Agrarian Reform in Tajikistan is very complex and multi faceted, involving other crosscutting sectors (water, environment) and envisaging a number of changes in respective policies, legislation and regulatory measures. The preparatory stage of the reform, involving agreement on priority areas, has already proven to be challenging for both the Tajik Government and its development partners. Despite three years of intensive work, it is not completed. Nevertheless, the Government has committed itself and is willing to implement the agenda. This creates a favourable environment for incorporating some of the recommendations listed below, taking into account increasing climate change related risks in agriculture and water, as well as CAREC's experience in the region.

Introduction of the nexus approach into respective national policies: Climate change will result in a further increase in demand for water and energy to maintain the agricultural sector. It is therefore considered smart to adopt an integrated approach for solutions throughout the Water-Energy-Food nexus. A combined solution should be developed, with correlations in policy and instruments across the different sectors. At the same time, Tajikistan should continue agricultural reform, which nowadays includes the irrigation and water sectors. There is also a need to reform the energy sector and take into account its relationship with agriculture and water (e.g. pumping, construction, and maintenance of irrigation infrastructure).

Diversification of the agricultural sector: Sustainability of agricultural production and food security is critically important for the country's development and resilience to climate risks. There is a need to climate-proof food production. Integral aspects of the nexus approach include diversification of agricultural crops towards drought resistant varieties, change in farming practices to accommodate water saving technologies in irrigation, best practices on land and pasture management, and soil cultivation in combination with incentives for local farmers.

Energy efficiency and low carbon development: In addition to agriculture and water policies, it is important to implement energy efficient practices and promote the use of renewable energy sources, other than hydropower which is predominant in Tajikistan. Practices in other countries might be replicated. For example, the introduction of energy efficient pumps in Kazakhstan helped to reduce energy usage by 16 per cent in recent years.

Integrated Water Resource Management (IWRM): Since 2010, Tajikistan actively promotes IWRM principles. This links institutional reforms in the agriculture, land and water sectors with the public sector. There is, however, still a need to technically coordinate the reform efforts, taking into account horizontal (national/central => sector-based institutions and policies) and vertical (national/central => oblast (province) => community) cooperative results and further planning.

Capacity building, awareness raising and networking: Capacity building and awareness raising about the integrated nexus approach should result in changes in all sector-based development and within the ongoing agriculture reform. Many targeted awareness projects have similar objectives of raising levels of education and knowledge in different target groups, strengthening

human capital to cope with risks, and accelerating socio-economic development, yet run parallel to each other. Such activities should rather be planned in tandem with similar initiatives related to climate change.

Networking with international partners within the region and worldwide can also add extra value to capacity building and information exchange. For example, the Drynet platform brings together a variety of international experts who address desertification, climate change and food security. Sharing such experiences can result in elevating regional practices to the global arena. Integrated policies for the nexus approach and inter-agency coordination, coupled with new water saving technologies, the introduction of climate-resistant crops, and smart irrigation solutions, are critical for adaptation and resilience of the sector. Advanced farming and sustainable land management techniques will increase the capacity of the land as natural carbon dioxide sinks.

However, it needs to be understood that the Water-Energy-Food nexus is a relatively new approach, which CAREC strives to integrate at the regional level. It requires time, resources and inter-sectoral coordination. Fortunately, because Tajikistan in its active phase of agricultural reforms, there is an enabling environment to support integration of the approach.

BOX 1. LINKING WATER AND AGRICULTURE IN A TROUNSBOUNDARY CONTEXT

The Isfara river is a transboundary river that runs in northern Tajikistan and south western Kyrgyzstan. More than 70 per cent of the population in these areas are involved in agriculture. One of the main limitations for sustainable agriculture is the lack of water for irrigation, a result of ineffective management of water infrastructure. Silted and polluted irrigation and drainage canals need regular maintenance in order to prevent water losses and ensure sustainable irrigation. This is one of the activities of CAREC's project on transboundary water management. It is expected that 160 km of irrigation canals will be regularly monitored and cleared. This will result in increased productivity of agricultural crops and pastures. More than 20,000 Tajik and Kyrgyz farmers are expected to benefit directly and indirectly, along with the approximately 300,000 people living in the Isfara river basin.



MAURITANIA

IMPROVING FOOD SECURITY AND ACCESS TO BASIC SERVICES THROUGH ADAPTATION AND MITIGATION MEASURES **TENMIYA**

Ensuring food security and access to basic services is a major challenge in the fight to reduce poverty, particularly on the eve of 2015, the deadline that countries have committed to for achieving the MDG (Millennium Development Goals). Tenmiya projects address this dual challenge of enabling people to have access to basic services and food security through actions that promote adaptation and mitigation to climate change. Renewable energy (solar) is promoted to ensure access to safe drinking water, lighting, and new information and communication technologies. Food security is improved through protection and management of natural resources in the management of building infrastructure, use of appropriate technologies, and reforestation.

In Mauritania, the Guidimakha region is the country's most important rainwater catchment, yet at the same time its people experience chronic food insecurity. It is situated in the lower altitude areas of highland Assaba, and its foundations are the hard volcanic and metamorphic rocks of Mount Wawa. Guidimakha receives an average rainfall of 500 mm per year, as well as run off from the higher altitude areas of the Assaba plateau. Although

the water is a blessing, the lack of rainwater storage ponds and increased strength of flow in the wadis are causing heavy erosion, which reduces farmland.

In the village of Waret Hmoimid, located in the municipality of Tachott northwest of the region, people have adapted to climatic conditions to protect their farmlands against erosion. The village's 520 residents were surviving on food grown on less than 10 hectares of farmland. They used only the banks of wadis and small depressions in the land to grow food crops during winter. Rain-fed crops have very uncertain success, and uncertain and irregular rainfall results in very low yields. This meant that Tachott's residents were living in conditions of persistent food insecurity.

To adapt to uncertain climatic conditions and land degradation caused by water-driven erosion, Tachott's people used a number of different techniques on their plots, which are scattered along the wadis. Crop varieties with short cycles were used, as well as various techniques to conserve water in the soil, such as zai, or earthen bunds. It should be noted that farmers worked individually on their own lands to reduce erosion.

Tenmiya introduced a programme to support people in restoring their lands. Within a natural resource management framework and using a watershed approach, the entire Waret Hmoimid community mobilised to restore their land. The mobilisation involved awareness raising, capacity building and supervision thereof, recovery of materials, and local expertise.

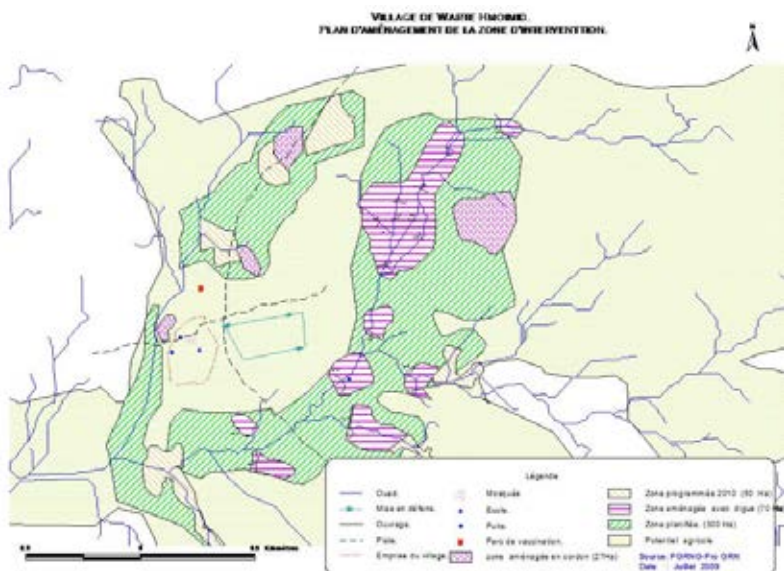
With the support of the program, Tachott' people produced seven books covering filtering dikes, levees and thresholds in gabions. In addition, 3.6 km kilometers of stone bunds were built. All this work has required the mobilisation of labor of 15,000 person days. These books have helped people to reduce erosion and recover nearly 100 hectares of farmland.

The most spectacular achievement is the recovery of Uplands in The Armor, which were never cultivated before. These are highlands with a very hard volcanic rock base. Recovery was made possible through successful mobilisation and the availability of labour. Previously farmers had considered them to be poor land and unsuitable for local investment. However, the restoration work has not only reduced erosion, but also improved deposition of silt, which is of high importance in local traditional agriculture during times of rain.

Currently, the community has developed and cultivated 97 hectares of land. In 2009, local production of millet increased considerably, from 12 tons to over 135 tons.

In addition to this increase in production, water storage structures now extend the time that water is able to remain in the landscape, which allows for rapid regeneration of vegetation and the return of certain species that had disappeared.

Development plan for Waret Hmoimid



Restoration of vegetation cover



Highlands, recovered and now cultivated





SENEGAL

Written by Emmanuel Seck

IMPROVING FOOD SECURITY AND COMBATting DESERTIFICATION WITH SUSTAINABLE AGRICULTURAL PRODUCTION SYSTEMS IN THE NIAYES ENVIRONMENTAL DEVELOPMENT ACTION IN

The Niayes area stretches over northwest Senegal. It consists of very fertile dune slacks, stretching from Dakar to Saint-Louis, and including the coastal strip and its immediate hinterland. This is the country's main market garden area.

The Niayes presents an extraordinary landscape made up of a lattice of depressions and dunes spread out over a shallow water table. Its hydrographic composition includes many lakes and waterholes, and this is what allowed the development of lush vegetation in Sahelian latitudes. Rainfall is scarce now, but the area has a particular microclimate, and the region has particular physical conditions (climate, soil, and hydrogeology) that are favorable for a range of agricultural activities.

The 180 km long and 20 km wide coastline produces more than 80 per cent of Senegal's market garden crops, as well as fruits and vegetables for export. It also includes most of the country's dairy industry and almost all its poultry industry. The Sébikotane area, which is the focus of our study, falls within this large agricultural area (Map 2).

Production here is focused on horticultural export crops.

Following recurrent droughts in the 1970s and 1980s in Senegal and across the Sahel, people have come to accept that the climate has undoubtedly changed. This changed many parameters related to management of the natural resources on which people base their existence, especially in rural areas. In the search for new alternatives, ENDA, in partnership with farmers of Sébikotane, developed a strategy for adaptation to climate variability for rain-fed agriculture. This involved sustainable agricultural production systems based on irrigation, and the use of windbreaks.

In Sébikotane's production systems, windbreaks play crucial roles in providing mechanical protection of plants against wind and limiting evapotranspiration, while ensuring a sustained injection of organic material to improve soil fertility. These systems are based on environmental, technical, economic and social factors that impact significantly on food security.

AN OPTION FOR FOOD SECURITY

At the technical level: With a production of about one ton per hectare per year, the Sahelian farmer in general and the Senegalese farmer in particular, will take 100 years to produce 100 tons/hectare, that is if he cannot multiply a hundred-fold the hectare cultivated in new clearings. This is a very long production time. Moreover, irrigation, fertilization, and crop protection, must become part of the vocabulary and daily practices of Sahelian farmers for them to be able to adapt to climate variability. In the agroforestry systems of Sébikotane, performance factors are precisely based on appropriate production techniques. Apart from the hedgerows that give some configuration to the farms, the practice of terracing also creates a microclimate conducive for production. All farms are irrigated with a particular focus on drip irrigation, which is very water efficient and labour-saving, and can also be used to administer fertilizers during irrigation.

At the environmental level: The environment has been described and perceived in every sense: it is protected, preserved, threatened and degraded. But little thought has been given to producing from it. Since it is possible to identify and define the environment, it also becomes conceivable to produce from it if one understands the components.

When the environment is degraded, it is important to ask what it is that is really degraded? In the context of natural resources in Sébikotane, it is the forest canopy and the entire ecosystem it encompasses that is degraded. From an adaptation perspective, the natural environment can be considered the first factor for consideration in agricultural production through actions such as recreating vegetation cover so that it simulates the role of natural forests in providing protection against wind, neutralising water and wind erosion, and ultimately creating the microclimate that supports plant growth.

The overall mechanism: The capacity of these systems to produce food while “producing the environment” is enabled through the functional configuration of windbreaks, and the nature and species of plants used.

At the socio-economic level: Production, composed mainly of vegetables and fruits, is market-oriented. Depending on the customers targeted, the product is packaged (parcel or punnet) for external markets, or sold in bulk at local and sub-regional markets. Farmers who practice these systems of market gardening and fruit production get average yields of 20 tons per hectare, and sometimes 50 tons per hectare for crops as tomato. This provides them with an income per hectare that is 20 times higher than rain-fed production systems (first generation) or irrigation without windbreaks (Syspro, 2004).

The return of young people into agricultural production helped to raise technical expertise levels on farms. Along with this generation of young male farmers, there is also an associated generation of young female farmers who not only invest in production as owners, but also occupy positions typically assigned to men.

SUPPORT FOR ADAPTATION AND MITIGATION TO CLIMATE CHANGE

Due to the introduction of windbreaks, Sébikotane agricultural production systems additionally produce an average of 19 tons of wood per hectare. This wood comes mainly from periodic logging to reduce competition with crops. Therefore, these production systems, while focused on producing food, also produce surplus wood that is used for cooking. Carbon stock measurements made by the ENDA Syspro team in June 2003 show that agroforestry systems in Sébikotane can sequester an average of 15 tons per hectare of carbon every five years. These figures take into account both the carbon sequestered in the epigeal (above ground) part of the windbreak (*Leucaena leucocephala*), and carbon stored in roots. In addition, organic matter stocks in the soil amount to 6 per cent, which is far greater than quantities found in traditional production systems in the Sahel (2- 3 per cent).



LESSONS LEARNED

In the Sahel, and particularly in Senegal, the adaptation of agriculture to climate change necessarily involves a complementary substitution of rain-fed agriculture with irrigated agriculture, which is not only less susceptible to the vagaries of climate but can also be practiced throughout the year. In addition, beyond protection, conservation or restoration, the environment can be “produced” and perceived as a factor of production such as seeds, inputs or production techniques. Therefore it follows that land degradation and even desertification are not irreversible.

In the region, irrigation is a response to ensure food security as well as an adaptation to rainfall deficit, especially because the Sahel has a large water network involving resources such as the Senegal River (1,700 km), the Niger River (4,200 km), and Lake Chad (25,000 km²).

Perennial windbreaks planted in a linear way help to delimit blocks of crops and define the outlines of roads and farms. These trees create a microclimate favorable to production and control of wind and water erosion. These windbreaks also contribute to improving organic soil content and produce wood, while farmers produce fruit and vegetables for export. This model of adaptation combines production with natural resource management, and agricultural development with carbon sequestration. It makes headway in combatting desertification and reducing poverty, and is a replicable model of sustainable development, particularly in Sahelian countries with similar micro-climates.



ETHIOPIA

Written by Elise Guzda, Dr. Kiros Meles

ENHANCING ADAPTATION TO CLIMATE CHANGE THROUGH CONSERVATION FARMING IN ETHIOPIA DRYLAND COORDINATION GROUP (DCG)

CONSERVATION FARMING TO ENHANCE RURAL FARMERS' ADAPTIVE CAPACITY

The Drylands Coordination Group (DCG), in partnership with Tigray Agricultural Research Institute (TARI), Amhara Regional Agricultural Research Institute (ARARI), and Hawassa University (HU), are working to strengthen rural farmers' adaptive capacity to the effects of climate change in three regions of Ethiopia: Tigray, Amhara, and the Southern Nations, Nationalities, and People's Region (SNNPR). This is achieved by testing the effects of various conservation farming (CF) techniques on finger millet, maize, sorghum, and teff production.

RATIONALE

Agriculture is the foundation of the Ethiopian economy, responsible for over 40 per cent of the country's GDP and over 80 per cent of both its export revenue and total employment. Nevertheless, agricultural productivity remains low and food insecurity is a very real problem for many dryland farmers and their families.

The issue of food insecurity and declining agricultural productivity in the drylands in Ethiopia can be linked to a combination of factors, including significant climatic variability, water scarcity, and degradation of land resources as well as ecosystem and biological diversity, all of which are affected by recent trends in climate change.

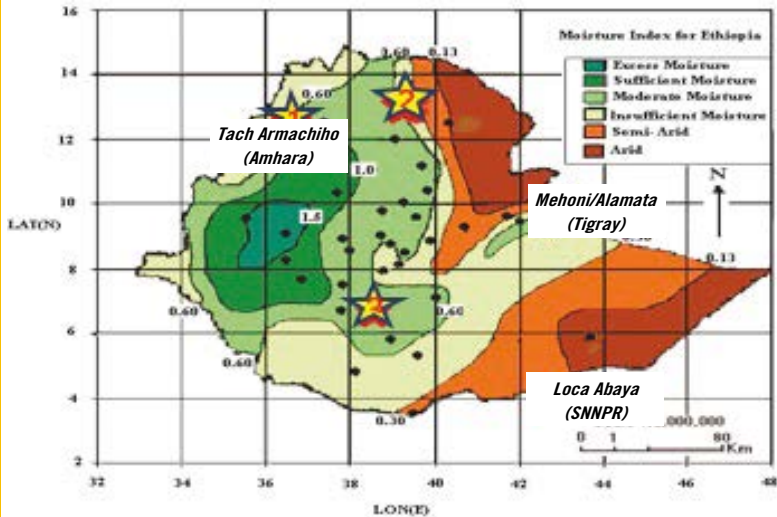
The precarious situation of declining land productivity in the drylands is further exacerbated by traditional land preparation practices, which include among other things, repeated ploughing of the soil and the complete removal of crop residue after harvest. Over time these techniques cause deterioration in the quality of the soil which lead to a marked decline in soil moisture conservation, fertility, and overall productivity. Without the introduction of sustainable land resource management measures that enhance the productivity of dryland soils, Ethiopian dryland farmers will not be able to cope with the impacts of climate change.

In contrast, CF practices, which are based on minimum disturbance of the soil, inclusion of legumes in rotation with other crops, maximum use of available water resources through early and timely planting, and use of mulching, can enhance soil fertility and structure, conserve soil moisture and organic matter, improve the soil's overall biological health, and contribute to sustainable management of land resources. Further, these practices can both improve agricultural production and productivity, as well as provide rural farmers in the drylands of Ethiopia with adaptive mechanisms to grapple with the effects of climate change.

IMPLEMENTATION

DCG, TARI, ARARI, and HU carried out participatory action research to test the effects of various combinations of CF techniques at three study sites in Tigray, Amhara, and SNNPR (see Figure 1) over three consecutive seasons (2012-2014), with the active participation of both local farmers and stakeholders.²⁵ The tested techniques varied from site to site, depending on the type of crop and variety grown, rainfall conditions, and farming practices. During the first year of the trial, four to five different sets of CF treatment combinations were tested and compared with each other, and also with traditional practices. From among the CF combinations tested during this first season, one or two of the best performing treatments were selected for testing by additional farmers in the subsequent two seasons. The trials were jointly monitored and evaluated by the researchers, farmers, and agricultural extension staff.

Figure 1 Project Sites



TESTED TECHNIQUES

The combination of the CF treatments tested include: soil preparation methods (e.g. ripping and wing ploughing), moisture conservation methods (e.g. tied- ridging and basin pits), and both the application and non-application of site adjusted fertilizer (See Tables 1a-d for a full overview of the tested techniques). The tested treatments varied across the sites, depending on the farming systems of the respective areas. In the Mehoni/Alamata area of Tigray, moisture is the most critical limiting factor, thus the CF treatments selected for testing centered on moisture conservation, such as tie-ridging and basin planting. In Loca Abaya in SNNPR, where moisture conservation is also an issue, tie-ridging was also tested, in addition to other treatments. In the Tach Armachiho area of Amhara, where the soil is characterised by black vertisols, the treatments focused mainly on reducing the effect of water logging and striga infestation.



Table 1a. Sets of treatment combinations tested using maize in Borecha/Loca Abaya (SNNPR)

	SET'A	SET B
1	Conventional ² with no fertilizer	Ripping + Fertilizer
2	Conventional + Fertilizer	Ripping + Tied ridging + Fertilizer
3	Ripping ³ + Fertilizer	Conventional + Fertilizer
4	Ripping + Tied ridging + Fertilizer	
5	Ripping + Tied ridging + haricot bean inter-cropping	
6	Ripping + Tied ridging + haricot bean intercropping +Fertilizer	

Table 1b. Sets of treatment combinations tested using sorghum in Tach Armachiho (Amhara region)

	Set A	Set B
1	Conventional with no fertilizer	Ripping + soy Bean Intercropping + Fertilizer
2	Conventional + Fertilizer	Ripping + Fertilizer
3	Ripping + Fertilizer	Conventional with no Fertilizer
4	Ripping + Soybean Intercropping	
5	Ripping + Soybean intercropping + Fertilizer	

Table 1c. Sets of treatment combinations tested using finger millet in Tach Armachiho (Amhara region)

	Set A1	Set B
1	Conventional with no fertilizer ²	Ripping+ Wing plow + Fertilizer
2	Conventional + Fertilizer	Ripping+ Fertilizer
3	Ripping ³ + Fertilizer	Conventional with no Fertilizer
4	Ripping + Wing plow + Fertilizer	
5	Ripping + soybean intercropping	
6	Ripping+ soy bean intercropping + Fertilizer	

Table 1d. Sets of treatment combinations tested using Sorghum and Tef in Mehoni/Alamata (Tigray region)

	SORGHUM				TEF
	Set A ¹	Set B	Set C	Set D	
1	Conventional with no fertilizer ²	Basin + Fertilize	Transplanted on Basin + Fertilizer	Ripping + Tied Ridging + Intercropping + Fertilizer	Conventional with no fertilizer
2	Conventional + Fertilizer	Conventional + Fertilizer	Transplanted with Ripping + Tied Ridging + Fertilizer	Ripping + Tied Ridging + Fertilizer	Conventional + Fertilizer
3	Ripping ³ + Tied Ridging + Fertilizer		Conventional + Fertilizer	Conventional + Fertilizer	Ripping + Tied Ridging + Fertilizer
4	Ripping + Sub-Soiling + Fertilizer				Ripping + Wing plow + Fertilizer
5	Ripping + Tied Ridging + Green Gram Inter-cropping				
6	Ripping + Tied Ridging + Green Gram Inter-cropping + Fertilizer				

NB.

¹: set refers to a group of treatments planted on an individual farmer's plot

²: Conventional refers to repeated (3 or more times) plowing using a traditional plow (*maresha*)

³: ripping refers to opening a planting line using a ripper

RESULTS

The results from the study have not yet been finalised, however, a review of the data collected in 2012 and 2013, along with an initial review of the data from 2014, points to clear benefits for adopting certain CF treatments. Some of the most impressive results reveal: enhanced utilisation of rain water in areas receiving low and erratic rainfall; significantly improved grain and biomass yields; improved drainage in water-logged soils; reduced levels of striga infestation; improved drainage in water-logged soils; reduced levels of soil disturbance and erosion; reduced dependence on oxen for land preparation; and reduced input and labour costs. The complete set of results will be available in a full report scheduled for publication in 2016.

NEXT STEPS

The tested CF techniques have generated much interest from farmers, local authorities, and NGOs. The project has now been extended for an additional two years, during which time the project team will lay the necessary groundwork to facilitate effective upscaling of the most promising results. The project team will work with local farmers and authorities to formally integrate the results into regional extension packages in Tigray, Amhara, and SNNPR.

LESSONS LEARNED

With the majority of farmers dependent on their crops for their livelihoods, many are rightly reluctant to test new techniques. The project team was aware of this challenge, but was similarly aware that without buy-in from the local farmers the tested techniques, irrespective of their effectiveness, would be of little relevance. Thus, in an attempt to overcome this challenge, the project team sought the help of district-level agricultural experts and workers to identify more progressive (less risk-adverse) farmers who would be willing to participate in the project. By the end of the first agricultural season, it became clear that several of the CF techniques being tested were out-performing the traditional methods. It was at this point that many farmers expressed interest and volunteered to take part and test the techniques the following season.

Farmers witnessing the effects of the CF techniques on other farmers' plots resulted in a ripple effect that enabled the project to grow and gain a solid foundation within the communities that the research focused on. Based on this experience, the project team has understood that a similar process will be necessary if any attempts to upscale the results are to be effective.



MOROCCO

*Written by Jean-Baptiste Cheneval and Patrice Burger
Contribution to translation by Lynn Erselius*

ADAPTATION OF OASIS ECOSYSTEMS IN MAGHREB TO CLIMATE CHANGE: HOW TRAINING AND ON FARM DISSEMINATION OF AGROECOLOGICAL PRACTICES CAN HELP CENTRE D' ACTIONS ET DE RÉALISATIONS INTERNATIONALES (CARI)

THE CHALLENGE OF CLIMATE CHANGE IN THE OASES OF MAGHREB²⁴

Oasis areas situated in arid zones will suffer from a significant decline in their water resources as a result of climate change. In 2060, a decrease in rainfall of up to 50 per cent is forecast for these areas. At the same time, the occurrence of extreme events such as prolonged droughts, heat waves or recurrent heavy flooding will become more frequent, with various consequences such as increased scarcity of water resources, degradation of soil quality mainly due to erosion, reduction of moisture and salinisation, and decline in agricultural yields.

The degradation of natural resources and the diminution of agricultural yields will mean that the supply of cereals, the staple food of North Africa, will plummet between now and 2050. Estimations of the decrease range from 25 to 50 per cent in some areas.

The challenge faced in the region is to ensure continued production of sufficient quantities, but with increasingly scarce resources. Oasis ecosystems are directly impacted by climate change, and their existence ultimately threatened.

The vast semi-desert plain of Tafilalet in Morocco is an arid area characterised by multi-year droughts, with 60 mm/year of rainfall against evaporation of up to 3,000 mm/year. In this region several combined factors are responsible for the decline of the oases : water crisis, date palm crisis, land crisis, and social crisis. The steady degradation of conditions that make it possible to farm has resulted in a drop in income and impoverishment for the majority of oasis societies.

BUILDING AGROECOLOGY ON A TRADITIONAL FARM²⁵

With the support of the private foundation Itancia²⁶, the aims of the project in the oasis of Jorf, were to support the implementation of a demonstration farm that could disseminate agroecological practices in order to support the promotion of the sustainable use of the natural resources of the oasis. In a typical family farm unit, about 6 hectares of land feeds a family of 15 people. It is organised around different types of production: arboriculture, crops, vegetable growing, date palm and beekeeping.

The work carried out between September 2012 and September 2014 was organised along two pillars.

Pillar I: Transformation of existing farmland into an agro-ecological farming system.

Apply the principles of ecological agriculture on a standard family farm in the oases with special emphasis on economic profitability, in line with its function of a production unit. The technical support focused on soil fertility management and setting foundations for the agroecological approach, and included vegetable gardening practices, disease control, arboriculture, finance, and structural investment. All investments were made by the farmer apart from the investment in solar pumping which required the support of the project.

Support was given for a range of farming activities:

- The focus was initially on vegetable gardening, in order to support the farmer in setting up new activities and help him produce earlier in the season.
- This vegetable gardening offered opportunity to discuss techniques

related to soil fertility management (e.g. composting, crop rotation, and inter-cropping)

- The farmer participated in training and was supported in improving his knowledge on olive tree cultivation, disease management, draft animals and local seed production.
- A number of investments were also made. In addition to small equipment, support through the project allowed the farmer to install a solar pump and drip irrigation systems, which enabled him to save money, time and labour. This allowed him to invest in construction of a second well.
- New and innovative tools have been introduced on the farm: a palm leaf grinder, a “kassine”²⁷ to work with draft animals, a seeder, and a drill.

Within a very short time of two years, it is possible to see that key changes were made in farming practice, and that there is a positive impact on the economic efficiency of the farm, time saving and new financial benefits.

Pillar II: Dissemination of information on practices

The project has fully achieved its role in sharing information about the new practices: the farm received several hundred visitors over the two years, from both the immediate neighborhood and across the country.

Three target areas for dissemination of information on practices:

- Dissemination of information about the new practices near the demonstration farm has focused on various farmers, and resulted in convincing at least four farmers to adopt an agroecological approach. They will relay what they have learnt : “we agree with the things we learnt and we wish to move away from chemicals to preserve our health.”
- The largest information dissemination event in the oasis mobilised a number of different oasis associations during a popular workshop on draft animals and tools.
- Regional events were also very successful, with ten specific training sessions being held. Different types of audience were mobilised: farmers, teachers, researchers, students, general public.

THE IMPACT OF THE WORK CARRIED OUT DURING THE TWO YEARS²⁸

Supporting the farmer in his agroecological approach

The project addressed all aspects of agroecology and provided the tools and basis to enable the farmer to continue to improve the agroecological approach.

In addition, the farmer increased production and reduced water costs.

In terms of climate change adaptation, many benefits can be noted:

- The extension of the production period by starting vegetable growing

earlier, which reduces susceptibility to early hot weather conditions

- Water saving thanks to the drip irrigation system and new agricultural techniques, with an obvious impact on the availability of the resource. There is also avoided greenhouse gas emissions because of the use of solar pumping.
- Labor and time saving on the irrigation tasks, allowing greater involvement with other activities
- The re-evaluation of a changing climate and locally adapted varieties, and initiation of selection and multiplication of seeds.

Build the capacity of the local partner to improve his economic situation.

The farmer's economic situation has been improved, enabling sufficient savings to be made for medium-term projects to be considered. The farmer is no longer obliged to sell his sheep in order to finance some of his projects. We find that the farm has entered into a virtuous cycle.

- The vegetable production has enabled the farmer to develop a new economic activity and increase his turnover by 5 per cent.
- The installation of a solar pump is not only environment friendly but has also allowed a number of costs savings (fuel, oil, repairs), which was equivalent to the loan taken for its installation. Vegetable production also enabled investment in drilling a new well.
- Installing a drip system has saved labor (about 50 per cent) and water.
- With regards to the development of new tools for draft animals, the farmer estimates that 50 percent of the labor related to tillage can be saved.

CREATING A LOCAL GROUP DYNAMIC BASED ON AGROECOLOGICAL INNOVATIONS

At least 15 farmers have been fully trained. The majority of these farmers were already using draft animals or produced their own seeds based on traditional knowledge. The support of CARI has allowed farmers to build on their own knowledge and to significantly improve at least one of these practices. Of these 15 farmers, five are noticeably sensitive to the issues addressed by agroecology. When the project started, only a single farmer was motivated; now the group has expanded. These farmers are already implementing some of the techniques they learnt in the workshops, including production of compost and natural treatments.

DEMONSTRATING AGROECOLOGY BY PRACTICING IN REAL CONDITIONS

The main pedagogic interest of this farm is that it is a family farming unit in an oasis ecosystem. Because it functions with the same constraints as any other family farm in the area, it is more valuable as a demonstration site than an experimental or training centre could have been.

The farm has welcomed more than 400 people over the past two years at training and awareness workshops. This includes private individuals and international multidisciplinary groups of farmers and interested members of civil society.

WHAT WE LEARNT FROM THE EXPERIENCE

The innovative personal character of the farmer was a key element in the success of the project. His very pro-active behaviour enhanced the numerous interventions by bringing to the fore not only the constraints, but also the knowledge and the solutions he already had. He also put into practice and adapted the new techniques that were introduced. The work conducted has a visible influence on the preservation of natural resources over the long term, as well as resulting in improvement in the economy of the farm. Saving water, time and money are key elements for the farmer. This was achieved by intensifying the ecological aspects of farming and thus also contributing to climate change adaptation and mitigation. Development and use of ecological agriculture techniques is therefore demonstrated to be a real solution for soil degradation.

The gradual appropriation of new techniques and technology by other farmers indicates their interest when local conditions are taken into account and the experiment is conducted in replicable conditions. However, the success of this relatively small scale project requires individualised support to respond to the specific problems of different people. The local technical public services need to be involved in order to reach a wider audience and ensure long term viability.

Sometimes technological improvements require that farmers have the capacity to invest financially. The project was able to provide this support in the form of an interest-free loan. Some financial mechanisms do exist, but unfortunately they are not always accessible to family farmers. Certain administrative procedures must be adjusted to support farmers in accessing loans for farm improvement.

Agroecology constitutes a real opportunity for greatly improved resistance to the impacts of climate change. However, it requires a change of vision in the current agricultural development approach. Farmers' conceptualisations and local constraints need to be introduced into the reflection and implementation. Without that dimension, the dissemination of agroecological information and practices will fail.



INDIA

Written by Hanwant Singh Rathore

DOCUMENTATION OF NATURALLY CLIMATE RESILIENT MIGRATORY SHEEP PASTORALISM IN SOUTHERN RAJASTHAN WELFARE ORGANISATION FOR LIVESTOCK KEEPERS (LPPS)

“Nomadic herding was an adaptive response to climate induced resource depletion and availability. In large and small measures, this factor is working even today, and the magical contribution of groups like the Raikas of Rajasthan, India to food production, out of degraded and depleting Commons, continues; yet unsung and unheralded. With adaptation methods honed over centuries, their practice is likely to best withstand future periods and adverse effects of climatic stress.”

G.B. Mukherji, Retired Civil Servant, social observer and photographer.

INTRODUCTION

Pastoralists have been developing climate resilient livestock for centuries and even millennia, and can produce food, fibre, and fertilizer under the most trying circumstances and in the most challenging climates. Pastoralists and their livestock have adaptability and resilience written into their DNA. While the enormous economic contribution of African pastoralists has been well documented and is increasingly acknowledged, this is still not the case for India where the official government vision of livestock development revolves around exotic high yielding breeds that are patently not adapted to cope with any kind of climate stress.

In order to challenge and rectify the prevailing perception, LPPS set out to document, measure and make visible the output of the nomadic shepherding system of the Raika, a community, or rather Caste of traditional livestock keepers, in Rajasthan. The Raika practice mobile shepherding in both sedentary and nomadic systems. It is the nomadic Raika that have larger herds and more productive animals, but they are “here today and gone tomorrow”, so maintaining contact with them or collecting data used to be quite difficult. The arrival of the mobile phone has simplified matters.

Having previously worked with Raika camel breeders and sedentary shepherds, LPPS decided to work with the nomadic Raika shepherds after it was approached by them for help with preventing the night-time theft of sheep by organised gangs and soliciting support for them from the police and other administrative agencies. LPPS hence embarked on a routine of regular visits to the shepherds on their migratory routes and documented the economic importance of the system.

THE RAIKA SHEPHERDING SYSTEM

The nomadic shepherds spend three months out of the year during the rainy season in their home villages. At the beginning of winter when the rains have ceded they organise in groups of 10-20 families and jointly migrate towards the south to graze their sheep on harvested fields. It is a highly organised operation led by an elected leader, the Patel who makes all the decisions and is responsible for negotiations with land owners. They have no tents, only charpoys or string beds on which they stack their belongings. At night these charpoys are surrounded by the sheep and other animals, which include camels and donkeys that transport all the belongings, as well as the young lambs born while on migration. Guards stay awake all night to try to prevent thefts, but often the Raika are helpless against the gangs.

The relationship with land owners is variable. Some land owners are very happy about the manure that accumulates on their fields, and pay money or grain or tea and sugar to the Raika. Other farmers may be hostile.

Due to the booming meat market, the demand for lambs is very high and traders follow the Raika encampments; there is no marketing problem at all. Milk from sheep is also an important product during parts of the year. The women process it into butter for consumption by the family (it is delicious!), and also to villagers who believe in its medicinal value. By contrast, wool is no longer a money-making option.

Figure 2: Milking a goat for breakfast tea



The amazing thing is that the Raika are happiest during the hot season when temperatures soar above 40 degrees Celsius, although they are out in the open day and night. They say that this is the time of year when there is good nutrition available for their sheep and no danger of them harming any crops. It is the season when conflict is lowest, and the animals are in good condition and healthy.

Figure 3: The raika use no tents and live entirely in the open



The amazing thing is that the Raika are happiest during the hot season when temperatures soar above 40 degrees Celsius, although they are out in the open day and night. They say that this is the time of year when there is good nutrition available for their sheep and no danger of them harming any crops. It is the season when conflict is lowest, and the animals are in good condition and healthy.

Figure 4: Raika posing with his prized breeding ram



An important aspect of the Raika – and other - pastoral nomadic system is that they continuously select their livestock for drought resistance while also trying to improve their performance. They invest significant amounts of money and time in searching for the best male animals for breeding. No research or government institution is in a position of performing such an exercise – livestock that is kept on government farms is not subjected to real life selection pressure. The Raika also indirectly aid the conservation of biodiversity. For instance, vultures which have otherwise become almost extinct in Rajasthan, can regularly be seen in the

RESULTS/ACHIEVEMENTS

As a result of its extended interaction, LPPS now has data to show the output in terms of meat from the system, as well as the enormous services to society in terms of food production (directly through the production of meat, but also indirectly through the production of organic fertilizer) and biodiversity conservation – all this in an extreme climate and with hardly any protection from the elements.

This information is widely shared and has been picked up by other organisations who work for sustainable livestock development in India, such as the Rainfed Livestock Network (RLN) and the South Asian Pro-Poor Livestock Policy Programme. It was presented at national level meetings about small ruminant production as well as at an interaction between shepherds and government officials held in February 2015 in Indore.

EFFECTS

The crucial point is that these climate resilient shepherding systems survive and thrive because their disappearance would significantly diminish food security, both in terms of meat and milk produced, as well as with respect to the organic fertilizer that is so important in the area to maintain soil fertility. By making them visible and providing proof of their output, LPPS has created the foundation for their recognition and for improved engagement with them on behalf of policy makers and Indian scientists.

LESSONS LEARNT AND RECOMMENDATIONS

For LPPS it has been an enormously rewarding experience in improving understanding of the existing climate resilient agro-ecological systems and their value for food security, livelihoods and biodiversity conservation. We can only recommend that such studies and documentations are expanded and multiplied all over India, or even in all countries where pastoralist systems are important. A framework for such studies is provided by the “Biocultural Protocols” or “Community Protocols” that are legal tools under the Nagoya Protocol on Access and Benefit-Sharing to the Convention on Biological Diversity (CBD). LPPS is currently coordinating a project to develop such protocols in different parts of India

“Climate smart” and “climate ready” are buzzwords in development circles these days and enormous amounts of investment are made by the biotech industry in making crops “climate ready”. The assets that pastoralists have developed over the centuries in the form of their livestock breeds are at least equally important.



TURKEY

Written by Erhan Akça (Adıyaman University), Özlem Katisöz (TEMA Foundation), Kume Takashi (Ehime University), Tetsu Sato (Research Institute for Humanity and Nature), Shizue Miura (Istanbul University), and Hikmet Bozaklı (Karapınar Agricultural Chamber)

TRANSLATING CHALLENGES AS OPPORTUNITIES: VISUALISING OPTIONS OF SUSTAINABLE AGRICULTURE IN KONYA KARAPINAR TURKISH FOUNDATION FOR COMBATING SOIL EROSION, FOR REFORESTATION AND FOR THE PROTECTION OF NATURAL HABITATS (TEMA)²⁹

INTRODUCTION

Governments, Institutions, NGOs and locals of any region aim to amalgamate or integrate the needs of society and scientific endeavours, which is a major challenge of 21st century. Public demands and pressure on natural resources were not acknowledged as threats to the natural environment and human health, and were even considered to be “development” prior to 21st century. However, many human activities, including agriculture, caused catastrophic results globally. Science then shifted from its “development oriented aim” to “sustainable oriented goals”. This paradigmatic shift of science created serious conflicts between society and science. In particular, agricultural activities that were based mostly on economic needs rather than environmental priorities demanded high input of agrochemicals and irrigation, along with tillage for cultivating cash crops. All these tools (such

as chemical fertilizers, pesticides, large capacity irrigation pumps, irrigation equipment, and tractors) are introduced by science. But, like irrigation, new techniques enabled semi-arid and arid land farmers to triple and even quadruple their agricultural production. The excessive use of agro-tools resulted in salination of soils, loss of plant nutrients from the soil profile, erosion, and ultimately desertification.

For example 6,000 cubic metres of groundwater is pumped for irrigation every second from 100,000 groundwater wells in the Konya Basin (C. Turkey) between April and late August to irrigate thirsty maize, sugar beet, alfalfa and potato crops. All stakeholders in the Konya Basin aware of this problem, but no common solution has been set due to varying expectations. Farmers do not want to lose their income, politicians do not want to lose public support, governmental officers do not want to lose their positions, and scientists do not accept alternative measures presented by other stakeholders. Moreover, farmers are generally reluctant to implement environmental protection measures without compensation.³⁰

Issues of 21st Century in Karapınar

In the 1970s, scientists initiated projects that ignored local demands and merely considered nature in isolation from humanity. Areas were contained within barbed wire for conserving nature. However, many humans did not support this approach and trespassed into these areas (Figure 1).

Figure 1: Erosion control area in Karapınar, C. Turkey invaded by shepherds



Recent approaches to integrate the human dimension with conservation by integrating local values, promises fruitful results.³¹ This type of approach first needs a paradigm shift in orthodox scientific beliefs, which may be achieved by incorporating the needs of the target society. Along with the value of nature, the value of culture and tradition should also be considered by the scientists. Project goals, such as reducing water usage without losing income, can be realised by modification of local and proven land use management measures, rather than theory based solutions. The challenge in Karapınar is to establish a land management system to reduce groundwater use, which induces formation of sinkholes (Figure 2).

Figure 2: Sinkhole formation in Seyit Hacı Village, Karapınar, C. Turkey



In Karapınar, 13.5 tons of maize can be produced per hectare with irrigation 10 to 12 times per year. In comparison, 15 tons per hectare of traditional melon for pickle making (Figure 3) can be produced with 2 to 3 irrigations per year. In 2014, the net income of maize was USD 3.030 per hectare, and for melon it was USD 20.300 per hectare. It may not be necessary for a scientist to inform a farmer that melon use less water than maize, but the more critical aspect is to inform the farmer that no economic loss will occur as a result of switching to melon, as farmers are driven by economic values. On the other hand, despite the fact that farmers are also aware of the higher income from melon, they prefer to avoid the high labour demand of melon production.

In addition, the entire 140,000 hectares of arable land cannot be converted to melon cultivation. Crop pattern planning such as sugar beet quotas might also not be a solution for the farmers as they can evade implementation of the

quota by purchasing from other farmers or registering idle land for sugar beet production but cultivating their preferred crops on productive lands. Animal husbandry was also proposed as an option for maintaining the high income of farmers, and Karapınar is famous in Turkey for its rich fodder flora. However, overgrazing in the 1960s almost converted Karapınar to desert. Following 30 years of mitigation studies, cultivation and sheep breeding became feasible again in the region because animal husbandry in the area depends on the carrying capacity of the natural grasslands, which host more than 40 fodder plants. Initially, grasslands should be seeded with natural plant species to increase the meat and dairy quality of sheep.

CONCLUSION

Stakeholders in Karapınar agreed that instead of repeating unsuccessful implementation approaches in Karapınar, traditional income tools, which have proven to be successful for society's economic activities for millennia, should be modified to accommodate stakeholders' views and demands. This may be achievable only with regular meetings and workshops, particularly as stakeholders are dissatisfied with the once-off interactions that are common for many projects and want to ensure sustained involvement. Regular meetings also enable better understanding by participants of different stakeholders' approaches and supports the amalgamation of these different approaches so that all members of the society are able to develop common understanding and be involved in designing the future of the society. This was addressed to some extent in the CROP-MAL Project funded by Mitsui Environment Fund and directed by TEMA Foundation Turkey, which ensured active participation of stakeholders in the region with the intention of producing solutions that are appropriate for all levels of the society.

Figure 3: Melon for pickle making





PAKISTAN

Written by Tanveer Arif

CLIMATE CHANGE ADAPTATION AND SUSTAINABLE LAND MANAGEMENT IN THARPARKAR SOCIETY FOR CONSERVATION & PROTECTION OF THE ENVIRONMENT (SCOPE)

Tharparkar is a 22,000 km² semi-arid region in the south east of Pakistan, with an average rainfall of less than 300 mm. The area is a fragile dryland ecosystem, with scrub vegetation characterised by herbs, shrubs and trees. Eighty per cent of the area is a rangeland with sand dunes, inter-dune valleys and flat plains. About one million people and four million cattle and other livestock dwell here. The area has been subjected to climate variation events such as prolonged droughts and flash floods, as well as severe desertification, due to soil erosion and over exploitation of natural resources.

SCOPE, which is associated with UN Convention to Combat Desertification (UNCCD), and is an active member of Drynet, has been implementing a sustainable land management (SLM) programme in the region since 2000, with the participation of local communities.

The main purpose of the programme is to develop resilience against climate change impacts and drought. Activities include: rangeland management through sustainable grazing and management of livestock; water management through building water harvesting ponds, tanks, and the introduction of bio sand filters; communal social forestry; off-farm income generating activities for women, including handicrafts making and marketing; and on-farm water management.

A component of “agro-pastoral farms”, was also introduced. These are two to three acre fenced farms where trees and vegetation are protected from browsing and grazing by livestock. A quarter of this area is used for cultivation of vegetables and fruit for nutritional use by families. These agro-pastoral farms are managed jointly groups of one to ten families. They serve as a backup mechanism during prolonged drought periods, and as an important instrument for developing resilience to climate change and prolonged droughts.

The Thari Women’s Project (TWP) is an extension of SCOPE’s programme. A description of a project being implemented at Nagarparkar, a sub-division of Tharparkar District, is given below.

THARI WOMEN’S PROJECT (TWP), A PAYMENT FOR ECOSYSTEM MANAGEMENT (PES) APPROACH FOR NATURAL RESOURCES MANAGEMENT

Nagarparkar is a fragile ecosystem, where natural forest is under threat because of illegal harvesting of Guggal (*Commiphora wightii*), a gum yielding shrub. SCOPE is engaged in protecting forest that is dominated by this shrub. Guggal gum is increasingly utilised in the pharmacological industry, and its leaves are consumed by livestock. Local people collect gum that is secreted by the plant, however some groups with vested interests use a chemical gum extraction method that drains the plants and ultimately kills them. Forests in Nagarparkar experience serious degradation due to this chemical exploitation of Guggal plants. In 2011-2012, SCOPE implemented a GEF small grants project in which local youth were trained as “green guards”. They not only planted trees, but also protected them from illegal exploitation.

A follow up project, centred around local Minority Caste women, was developed with the intention of strengthening the achievements made in the earlier project. The women were provided with incentives to plant Guggal trees in their villages and farms.

The Thari Women’s Project aims to improve access to water, food security and income for Scheduled Caste women and their families living in villages in the

Thar Desert, as an incentive to protect Guggal dominated forest. Schedule Castes are historically disadvantaged groups who are now given official recognition and protection. The project is funded by the Scottish Government's South Asia Development Programme. The Scottish charity organisation, Bioclimate, is the grantee and responsible for overall project management and partner coordination, design, development and monitoring of project activities, capacity building and technical input, and the dissemination of project lessons. SCOPE is the lead implementing partner in Pakistan and Christian Engineers in Development (CED) is providing technical advice on water infrastructure. The project cycle is 35 months, ending in March 2016.

The project is situated in the Thar Desert, in the Tharparkar District, Sindh Province, in the far south eastern corner of Pakistan. It directly involves about 2,000 women from 13 Scheduled Caste villages. The main focus is on building wells and underground tanks for storing rainwater. Women will be supported to develop kitchen gardens, organise themselves into village structures, and gain rights over communal land areas. They will earn performance-based payments for planting and managing endangered Guggal trees on these communal land areas. They will also earn income from the sale of Guggal gum extracted using non-chemical methods.

Village Women's Committees (VWCs) were established, and are operating effectively, in each of the 11 project villages, accumulating savings, and extending loans to women facing emergencies. The VWCs hold bank accounts with First Micro Finance Bank which enables them to manage their savings securely.

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Membership of the VWCs has increased by to 1,013 women over the year as participants have recognised the ability of the project to deliver tangible benefits. This means that 53 per cent of all women across the 11 project villages are involved in village decisions, savings and project activities. All project villages have at least 30 per cent women's representation on their elected water management committees, and have updated agreements on water infrastructure use and maintenance.

WATER MANAGEMENT

Nagar is a drought affected area, and with climate change, droughts are becoming prolonged and almost persistent. In order to develop resilience against drought, water storage capacity is developed in villages to store rainwater and water collected from wells. Twin chamber water storage tanks were built for 182 households. They give each household additional water storage capacity of 4,000 liters. In total, 1,301 people are benefiting.

SCOPE has also made and installed bio-sand water filters for 975 households, and trained people in maintenance of the filters. A total of 7,118 people are benefiting from access to cleaner water.

A water engineer from CED assisted in assessing water supply improvement options. Towards the end of 2015, an existing rainwater pond will be expanded, a new rainwater pond will be built, two existing pipeline networks will be repaired and a new deep well will be sunk, and six new hand pump wells will be built.

GUGGAL TREE PLANTATION

Some 800 women and 85 men have been trained and are being assisted to propagate and plant endangered Guggal trees, with the idea that the trees will offer them revenue earning potential in the future.

The recall rate from the training was measured at 89 per cent. Participants have planted and are caring for more than 37,000 Guggal trees, enabling them to earn the first tranche of conditional cash transfers worth GBP 10,350 in total. A total of 891 households are benefiting from the transfers, 756 (85 per cent) of which were classified as poor and ultra-poor in our participatory wellbeing survey in 2013. Over 6,000 people stand to benefit from the transfers: 1,077 women, 1,056 men, 1,856 girls and 2,127 boys. The transfers are being paid into the VWC bank accounts for management and disbursement to eligible members.

KITCHEN GARDENS

Kitchen gardens were established in 305 households, 225 (73 per cent) of which were classified as poor and ultra-poor in our participatory wellbeing survey in 2013. Women from the beneficiary households were trained in kitchen gardening methods. SCOPE measured the recall rate from the training at 73 per cent. Women are growing at least four different seasonal vegetables and four fruit trees in each garden. A total of 2,331 people stand to benefit directly from improved household food production and nutritional diversity: 377 women, 359 men, 785 girls, and 810 boys.

SCOPE undertook significant research, consultation and testing before it arrived at the kitchen garden model that is now in use. The gardens are built almost entirely from locally sourced materials. They offer protection from rodents and birds. Simple grass roofs provide shade and reduce evaporation. Simple grass roofs provide shade and reduce evaporation.

Kitchen garden



Women in search of water



Woman using bio sand filter





MALI

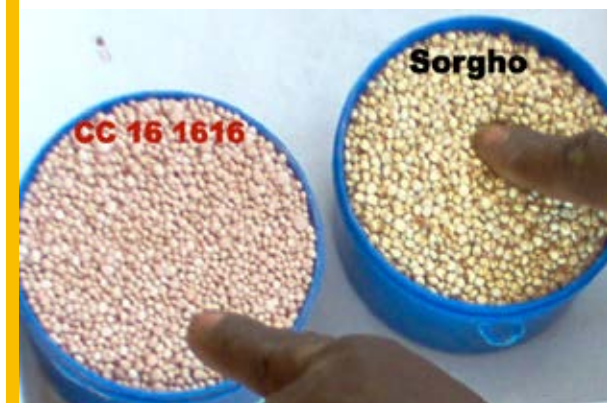
Written by A. Coulibaly, J. B. Aune, D. Sogodogo, H. Konaré et H. Yossi IER, Mali and NORAGRI with collaboration of GCOZA Mali and Norway

THE USE OF MICRODOSE FERTILISATION ON STAPLE CROPS IN MALI **GCOZA**

Grain farmers in the Sahelian and Sudano-Sahelian zones manually apply, by pinches, complex mineral fertilizers in microdoses, with or without seed, to remedy the decline in soil fertility. This practice initially did not fall within any formal recommendation scheme from researchers in the sub-region. According to the producers and development partners, such manual application of mineral fertilizers in microdoses requires enormous human effort and time in order to achieve production of 10,000 to 30,000 bunches per hectare.

To ease this work, some farmers use a seed planter called SMECMA, with slight modifications, to apply fertilizer and seed. The use of this planter has reduced the number of microdoses applied to some extent, however, there is still inaccuracy in the amounts of fertilizer and seed used.

Kitchen garden



The objectives of the research relate to the mechanisation of placing seed and applying fertilizer in micro-doses, taking into account the amount of fertilizer needed, product compatibility, economic efficiency and the perceptions of the producers. The research allowed for an upgrade of equipment that has eased manual input of microdoses of fertilizer and seed. This modification has significantly decreased the investment constraints for manual labor and agricultural inputs. A few different planter prototypes were used: ticotico (or jab planter), single row planter (type SMECMA), and multi row planter.

Mechanical placement of fertilizer microdoses



This equipment, with special disks or particular settings, places staple crop seeds and fertilizer microdoses simultaneously in the same planting holes if they are mixed, or in different planting holes if they are not mixed. This process helped small producers to use the fertilizers efficiently.

The multi-row planter prototype in use



In addition, these prototypes are inexpensive innovations in terms of access, and are intended for light mechanisation of small farms in Mali. Their real work performance (sowing and application of fertilizer micro doses) is on average one person day per hectare with donkey, beef or camel traction, compared to 12 person days per hectare if labour was entirely manual. This allows producers more time to implement traditional practices in early winter to address climate variability.

The technique enables:

- Placing microdoses of 0.2-2g per hole (5-50 kg/ha): making straighter seeding lines, facilitating mechanical crop maintenance; ensuring vigorous growth and adequate phenological development of plants through the starter effect of complex fertilizers in localized microdoses; improving the efficiency of fertilizer use (more than 25 kg of grain per kg of fertilizer);
- Reducing the working time (12.5 hours per hectare);
- Improving performance of dry food crops (a rise from 25 per cent to 50 per cent compared to the control group);
- Improving the income of the producers (one CFA franc invested has a return of over 20 CFA francs).

Sorghum plants 30 days after sowing with fertilizer input in microdoses.



Currently, the research is oriented to the development of prototypes of motorised seeders that are adapted to harsh climatic conditions, on the one hand, and on the other, to the mechanisation of sowing soaked seeds to improve the system of crops in the Sahelian and Sudano-Sahelian country.

The effects of mineral organic fertilization in micro doses on the yield of millet grain in a field test.



As part of the AGRA microdose project, the studies showed that intake of 33 kg/ha of ammonium phosphate (DAP) in microdoses at planting results in higher grain yields than the more commonly used dose of 100 kg/ha of DAP at planting and 50 kg/ha of urea at tillering on millet and sorghum. This can result in an increase in yield of more than 10 per cent compared to the popular dose, and 40 per cent compared to the control group. Furthermore, the technique significantly improves the productivity index, which is the ratio between the yield increase due to technology and total dose of fertilizer. This index is five times higher than the popular dose when the 33kg/ha of DAP is applied in microdoses.

Furthermore, the project has improved access to agricultural inputs by implementing procurement strategies and marketing agricultural products (warrantage shop, income generating activities, and capacity building of producers and extension agents)



BOLIVIA

Written by Rosa Virginia Suárez A. and Miguel Angel Crespo C.

BIOREMEDIATION OF SOILS IN ARID LAND FOR CULTIVATION OF CHÍA, SÉSAMO, SOYA AND QUINOA PROBIOMA

BACKGROUND

Bolivia is one of the eight richest countries in terms of biodiversity. However, this wealth has not been exploited for sustainable national development. Moreover, public policies have historically been mainly confined to the exploitation of non-renewable natural resources, condemning our country to be a producer of raw materials for the world market. This situation is reflected in the little or no government support for scientific research related to the sustainable use of genetic resources of high strategic value that exist in Bolivia.

At the current juncture, the planet is experiencing a series of crises resulting from development models that are not sustainable. These are reflected in environmental problems, food, energy issues, etc. Bolivia has little or weak industrial development,

yet a wealth of biodiversity, but paradoxically the State has not taken measures to use this as an opportunity to pursue policies that lead to a truly sustainable development based on biodiversity resources.

An important component of Bolivia's biodiversity resources is the microorganisms that are present in soil, insects, and plants. Very little research has been conducted on microorganisms, however in recent decades, private enterprises have initiated processes of research and technological innovation centred on microorganisms that have important roles in health, agriculture, food, decontamination of water, degradation of toxic waste, etc. In this context, the use of microorganisms contributes to the bioremediation of soil affected by desertification and/or contaminated by activities such as mining, and oil and gas extraction.

For 21 years, PROBIOMA, which is headquartered in the Santa Cruz Department of Bolivia, has engaged in research and technological innovations related to the use of genetic resources. This includes native microorganisms that can help in biological control of pests in agriculture, as an alternative to the use of agrochemicals.

This private initiative was developed in Santa Cruz Department, which is the largest of the nine constituent Departments in Bolivia. It accounts for 78 per cent of the country's biodiversity and also produces over 80 per cent of the food required to feed the country.

Biological control is a part of the laws of nature through which species' population growth is regulated by their natural enemies. In this sense, the process of research, innovation and application of biological controls does not affect biodiversity or human health. Furthermore, biological control does not generate pest resistance or producer dependence, because to the extent that environmental conditions permit, the relevant microorganisms are established and generated based on natural processes that will occur in the future.

Within this context, the research process conducted was directed firstly towards identifying beneficial microorganisms and/or particular pests in crops. These identified microorganisms were isolated and multiplied in the laboratory, and then reintroduced to the field. Validation tests were conducted in the field, and in parallel specific formulations were used to facilitate field application. Analysis was also conducted to establish formulations that support use of the microorganisms in the field in a way that is economically viable for the producer.

In this research process, a microorganism called *Trichoderma* spp. was identified. Its contribution is not only in terms of biological control of disease, but also in soil remediation. This was a very important recognition of the value of the genetic resources of microorganism biodiversity, and a demonstration of the importance of microorganisms in soil improvement programs and bioremediation.

The term 'bioremediation' was coined in the early 1980s. Scientists observed that it was possible to apply remedial strategies that were biological and based on the ability of microorganisms to address degradation processes.

Importance of microorganisms in forming and transforming soil dynamics

Microorganisms in the soil are of vital importance. They are the living part of soils and are responsible for the dynamics of transformation and development of soil structure. These microorganisms include: bacteria, actinomycetes, fungi, algae and protozoa. A fertile soil is one that contains an adequate supply of nutrients that is available to plants, or, in their absence, a microbial population that releases nutrients and makes them available to plants, thus enabling good plant development.

Description of *Trichoderma* spp.

According to CoiNBiol 2002, *Trichoderma* spp is a soil fungus that grows and develops on decaying organic substrates. It is easily isolated, and has been observed at different latitudes. It has antagonistic properties for several pathogenic fungi .

Within programs for bioremediation of soils *Trichoderma* spp. is shown to degrade organochlorines, chlorophenols, and other insecticides such as DDT, endosulfan, PCNB, aldrin, dieldrin, and the glyphosate herbicide tribluralin (Esposito and DaSilva,1998). It has enzymes such as cellulases, hemicellulases and xylanases that help initial degradation of plant material. It also has more specialised enzymes that contribute to break down of complex molecules such as biopesticides (Kaytama and Marsumara, 1993).

Trichoderma spp can facilitate improvement of chemical properties and soil structure through mineralisation of organic matter, which provides the essential elements needed to facilitate plant development. This process, being gradual and responsive to a potential interaction between plant concentration and soil, has a huge advantage over the use of chemical fertilizers which make nutrients available to the plant all at once, resulting in a sometimes negative interaction between elements (e.g. excessive nutrients can block absorption or vice versa). In addition to this, the excess or not yet absorbed fertilizer fractions are exposed to physical processes such as leaching, volatilisation, or fixation, which makes the nutrients inaccessible to plants.

Trichoderma spp is a natural antagonist of plant pathogens such as *Rizhoctonia solani*, *Fusarium oxysporum*, *Fusarium roseum*, *Botrytis sirenea*, *Esclerotium rolfssii*, *Sclerotinia spp*, *Phithium spp*, *Alternaria spp*, *Armillaria mellea*, *Roselinia spp*, among other species. PROBIOMA has been developing and transferring this biocontrol for disease control in seed and soil in an area of about 90,000 hectares.

The bio-stimulating effect of this fungus is evident in its ability to increase the rate of plant growth, strengthen plant development, and contribute to development of more robust and deeper roots. Its effectiveness has been demonstrated in gradually and progressively replacing the use of fungicides in the protection of seeds and transplantation.

This showed us the importance of validating these and other potential uses of Trichoderma spp in environments with a risk of soil degradation, in forming viable technical proposals for bioremediation of soils that are at risk of desertification.

Implementation of the proposal

Bioremediation of soils is financially agreeable compared to other restoration technologies, as illustrated by PROBIOMA in its activities of the past 20 years to demonstrate this effective alternative. In this sense, Trichoderma spp is providing an alternative to help combat land degradation. Facing the imminent possibility of depletion of soil resources in many regions, alternative sustainable production is necessary to reconcile humankind with nature. It does not only represent an immediate solution, but allows self sustained development within a production system that leverages the use of microorganisms in nature.

At present, most countries in the world, including Bolivia, experience strong desertification caused by development models that are based on the green revolution. This involved high use of agrochemicals, extractive processes reflected in mining, oil and gas activities, agribusiness and biofuels. These have been also accelerating the process of desertification in Bolivia where 40 per cent of the country is already affected.

Lack of policies regarding land management and rehabilitation in areas with low rainfall also affects the sustainability of ecosystems. There is high migration in some regions as a consequence of low crop yields. Within the framework of soil bioremediation, PROBIOMA has entered into cooperation with other regions to strengthen environmentally responsible agriculture, both in the highlands and the Chaco plains. This is mainly in the quinoa, vegetable and soy production areas where soils are under threat of rapid degradation.



The program had the following results:

- It has allowed validation of the potential of *Trichoderma spp* to counter desertification, mainly in the quinoa, chia, sesame and soy production areas, covering 89,873 hectares.
- Persistence and/or adaptation of *Trichoderma spp* was investigated in degraded soils in different ecosystems.
- The strategic value of *Trichoderma spp* in soil bioremediation and its socio- environmental benefits has been acknowledged in other regions that are in the process of desertification.
- Producers' knowledge of this microorganism enables mass transfer between producers of quinoa, potatoes, soy, corn, sunflower, vegetables and other crops.
- The final physical-chemical-biological analysis of soil after application of treatments allowed researchers to ascertain the ability of *Trichoderma spp* to recover soil physico-chemical features such as structure, organic content, and nutrient availability. It also allowed for understanding of the effect of *Trichoderma spp* on soil microbial populations.
- The persistence of *Trichoderma spp* was established through periodic surveys that were conducted at 30, 90, 180 and 360 days after transfer, and expressed in formed colony units per gram of soil .

CONCLUSION

We can conclude that microbial activities and organic matter in soils was boosted in areas where *Trichoderma spp* was introduced. It was also shown that the levels of phosphorus, potassium, carbon and nitrogen increased.

As mentioned above, *Trichoderma spp* aids the growth of roots through the phytohormone produced, and has the ability to enhance nodulation and facilitate mineralisation of organic matter, thus stimulating enzymatic activity in the soil.

This is reflected in the improvement of health and vigor of plants.

The microbiological diagnosis demonstrates the persistence of colonies of *Trichoderma spp* 360 days after the microorganism was applied in the soil.

One specific observation is that *Trichoderma spp* has a biostimulating effect on root formation in soybean cultivation. A 30 per cent increase of rooting area was observed. It was also verified that degradation processes of organic matter, were affected by the increased microbial activity.

The microbiological diagnosis showed a decrease in phytopathogenic colonies of *Fusarium spp* , *Alternaria*, *Pithium*, *Botrytis*, *Sclerotium*, *Rhizoctonia*, etc.

This leads us to conclude that biodiversity can contribute to bioremediation of land that is degraded by the intensive use of agrochemicals, extractive mining activity, oil exploitation, monocultures, etc. This will at the same time contribute to the food security and food sovereignty of Bolivia and the world.





NIGER

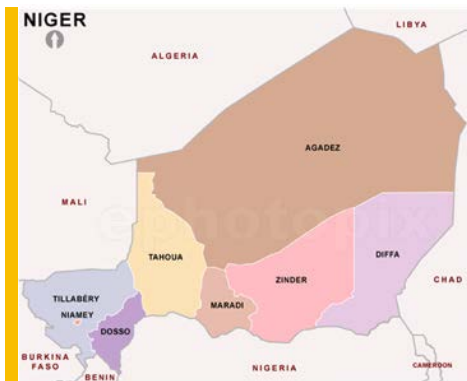
Written by Marie José van der Werff-ten Bosch

FARMER-MANAGED NATURAL REGENERATION IN NIGER BY CRESA (NIGER) AND Both ENDS (THE NETHERLANDS) Both ENDS

Today, 70 per cent of the land on earth is dryland, and 1.9 billion hectares and 2.6 billion people are affected by significant levels of land degradation.³² Such loss of productive and fertile land has direct consequences for the livelihoods of people. Substantial and lasting restoration of trees, shrubs and vegetation is central to achieving resilience.

All over the world, people are engaged in restoring their degraded lands and ecosystems. In Niger, one of the most drought-affected and food insecure countries in the Sahel, such restoration initiatives can also be found. In the provinces of Maradi and Zinder, farmers themselves have restored five million hectares of degraded and deforested land into a green park landscape over the last thirty years.

This Farmer Managed Natural Regeneration (FMNR)³³ is increasingly viewed as an indispensable element of ensuring local food security and ecological stability. It is a low-cost, low-labour intensive, and locally-developed approach with good results. Small-scale farmers restore the original tree vegetation, by nurturing and protecting spontaneous regrowth of tree seedlings and by using pruning techniques that promote faster growth in young trees. Methods of reforestation such as soil preparation (Demi-lunes, Zai method and other methods to reduce run off and impound water for longer periods of time to help infiltration into the soil), composting, planting and nursing are much more labour and knowledge intensive and thus more costly and difficult to use on a large scale. The regenerated trees have several functions, such as improving soil fertility by fixing nitrogen in the soil (*Faidherbia albida*), providing leaves and therefore mulch on the land which increases the water holding capacity of the soil (*Piliostigma reticulatum*), or simply as provider of shade, fruit or fodder. Non-wood forest products are critical for livelihoods and food security, and according to the UN Food and Agriculture Organisation, dependence on forest products generally increases when agricultural production is low, notably during droughts or other natural disasters.³⁴



These successes in the Maradi and Zinder regions are being spread to other regions and communities in Niger, such as Dosso which is a region where there is little (project) intervention, desertification is progressing rapidly, and levels of poverty are high. Similar initiatives can be found elsewhere in the Sahel, India and Brazil.

Since 2010, Both ENDS (The Netherlands) has been working with CRESA³⁵ (Niger) and local partners in Dosso to introduce, support and spread FMNR in four municipalities; Tébaram, Sanam, Dogonkiri and Soucoucoutane. The area is used by farmers settled in villages and pastoralists from the Touareg and Peulh tribes.

Regreening and resilience

Several areas in the Sahel and within Niger specifically are predicted to be highly affected by changes in climate.³⁶ Variations in rainfall amount, distribution and intensity, and in temperatures, droughts and unpredictable growing seasons, can lead to serious consequences for impoverished people who are disproportionately affected

by acute climate shocks and chronic stresses. Land degradation specifically affects vulnerable societies who have small reserves, whose household assets are diminished even more by climate change over time. For these rural societies to cope with such conditions, there is no 'one-size fits all solution'. However, it is possible to promote resilience thinking that provides a foundation for achieving sustainable patterns of resource use and improving livelihoods.³⁷ Resilience thinking needs solutions such as low-cost and low-technology practices for better access and management of natural resources, improved food production and inclusive land use planning. Along with this and in order for people to gain control over their land, lives and livelihoods, an enabling (policy) environment needs to be created. This prevents top-down land use planning and decisions that interfere with local practice, innovation and success.

In Niger we have experience, knowledge and evidence³⁸ showing that working with local people helps to reduce vulnerability, increases investment in natural resources and improves livelihoods.

Resilience barriers

Vulnerability and resilience have physical, social and economic aspects. There is no territory without potential, but innovation and collaboration is needed to address particularly the prevailing internal and external barriers that prevent people from taking control over their lands, lives and livelihoods. Examples of internal barriers are: a) the lack of information, knowledge and skills among local resource users; b) the limited source of income for farmers due to low yields caused by land degradation; c) the lack of access to finance (micro-credits for example) resulting in people's inability to invest in farm improvements; and d) the culturally determined gender norms that undermine women's participation in managing natural resources. Three examples of external barriers are: a) the complicated, non-adapted or even lacking legal frameworks, land tenure regimes and user rights agreements that fail to give people the confidence and security to make sustainable land use choices; b) the inappropriate and incoherent national and international development plans and policies that exacerbate unsustainable exploitation of natural resources; and c) trade and investment agreements that favour foreign and national large-scale companies and negatively impact efforts towards sustainable development in the Sahel.

The overall objective of the work in the four municipalities is to popularise farmer-led natural regeneration and re-vegetation (FMNR) to improve biodiversity and food security, self-sufficiency in firewood and timber supply, and incomes of the rural and poor producers in Dogondoutchi district who are exposed to rapid degradation of both their production and their lives. In the long term, the activities in the region aim to:

- Improve soil fertility, increase biodiversity of soil life and tree species, and support the return of small game and migratory birds;
- Increase people's access to basic needs: improved availability of water; better food crop harvests; food, fodder and medicinal products from trees and shrubs; self-sufficiency in firewood and timber as sources of income in times of need;
- Reduce competing claims on land and the risk of conflict between farmers and pastoralists, especially in the dry season;
- Better resilience against the harsh climatic conditions and potentially aggravating climate change events such as droughts: improved retention of soil moisture; reduced wind erosion; more favourable micro-climate in the farm fields and eventually in the villages.

Furthermore, it is crucial to set up a robust, independent social governance system through Village Committees, through which regeneration is protected and regreened landscapes are stimulated and maintained. This is essential especially in the first years when regrown trees and shrubs are most vulnerable, and in times of crisis when the pressure to cut down vegetation is highest.

Results achieved in Dosso, Niger

An impact study in the four municipalities completed in 2013/14 reveals several important achievements. We list a few below.

The total area where FMNR is now practised is 621,800 hectares. Eighty three villages are involved, reaching 6,968 households. In total, 140 farmers were trained. In the Municipality of Dogonkiria, 68 per cent of the villages adopted FMNR practices. In all villages, Village Committees were set up and are functional.

A significant increase in tree density resulted from the activities, with the estimated average tree density in the project area rising from 30 trees/ha in 2010 to 70-80 trees/ha in 2013. The vegetation density in the project area exceeds the vegetation density of more southern, wetter areas in Niger. With the introduction of FMNR and fertilizer trees, crop yields have increased significantly. Farmers reported harvests of 150 kg/ha of millet as a result of improved soil conditions. One bag of 50 kg can be sold for about USD 20. In addition to millet, cereal yields also increased. While in 2010 farmers harvested 300 kg/ha, in 2013 farmers reported yields of 500 kg/ha. The increase is modest, but it is expected to reach 700-800 kg/ha in the next 2-3 years. In addition to increased crop yields, farmers report that grain planting is 100 per cent

successful because the seedlings are protected against violent sandstorms. On bare fields these seedlings are often destroyed and farmers must sow several times.

FMNR has also had an important impact on the livestock system. It was previously a huge challenge to access enough fodder in the area of Dogonkoria, but with increased availability of wood pasture, there is now enough fodder during the nine month long dry season, and during unforeseen droughts. According to farmers, the health of livestock has improved and mortality and morbidity is lower than before. Animals face less stress as they don't need to travel long distances in search of fodder and they suffer less from the heat because the trees in the fields provide shade. The availability of sufficient fodder for livestock has reduced potential conflicts between nomadic pastoralists and farmers.

Under the greening project, pastoralists have signed a formal logging ban and have been sensitised through training sessions (organised by the Village Committees) on sustainable use of trees and fruits. A proportion of the fruit is not harvested so that wind, birds and insect pollinators can spread the seeds to contribute to the regeneration process.

A positive change in attitude of farmers regarding the role of trees in agricultural production can be noticed. Trees enrich the soil through recycling of nutrients, from foliage, flowers, fruits and twigs. Before applying FMNR techniques, much potential farmland was degraded and not suitable for agriculture. Now farmers note a change in the organic soil structure, especially when additional techniques such as Demi-lunes and Zai are used, which makes the land suitable for farming again. Many uncultivated areas have thus been recovered.

The Forest Services has always claimed naturally regenerated trees on farm land as belonging to the State. This discouraged farmers and pastoralists from restoring park landscapes in their region. Due to the advocacy activities of CRESA, there is now a growing understanding that this policy needs to change if anti-desertification and land restoration measures are to be successful.

Lessons learned

The greening is largely due to the local governance of trees through Village Committees that control their own achievements. Strong and organised Village Committees, preferably with legal status, are a crucial condition for the successful implementation, consolidation and expansion of FMNR practices,

now and in the future. The main challenge is the removal of trees by other land users. Due to awareness raising among the communities, the felling of trees has diminished. Besides raising awareness, it is of great importance to structure the committees in such a way that pastoralists are involved in the committees to create awareness among this group about the benefits of trees and the need to protect them.

All activities are conducted in partnership with government departments and local authorities. Having local authorities on board as promoters of FMNR will be a crucial element for the sustainability of FMNR in the future. From these partnerships, policies relating to the management of natural resources are being changed in favour of empowerment of the farmers and pastoralists themselves.

The management of communal lands is challenging and demands greater discipline from all stakeholders. Dialogue and agreement are needed between the farmers and the nomadic pastoralists regarding the management of these common resources.

Currently the government of Niger has committed to supporting municipalities in land rehabilitation and greening programmes on the ground. Furthermore the National Agroforestry development strategy is being developed and in the process of approval by the Ministry of Environment. The Ministry is also reviewing the Forest Code in which the FMNR is included and in which ownership and the right to prune and harvest one's own trees under FMNR is recognised. All these developments create opportunities for long term commitments and integration of FMNR in national development policies and programs, and will be the basis of providing support for further expansion of FMNR practices. It is therefore crucial that tangible proven examples are in place to stimulate and guide the implementation of these commitments. Drynet will be instrumental in sharing these experiences with other practitioners and providing a stronger basis and voice for integration of FMNR in country and regional policies and laws.



MADAGASCAR

Written by Thierry RABARIJAONA and Elisé ASINOME Information provided by the project 'Accès Eau' in Madagascar funded by IDRC, implemented by WWF, GRET, and CNEAGR.

Collecte d'eau
PHOTO: Elisé ASINOME

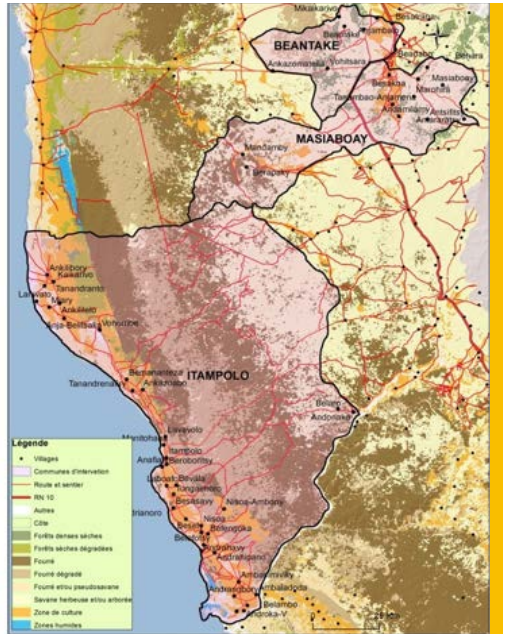
TECHNOLOGIES AND MANAGEMENT METHODS TO IMPROVE ACCESS TO WATER ON THE MAHAFALY PLATEAU PROFESSIONALS FOR FAIR DEVELOPMENT (GRET)

THREAT AND ACCESS TO WATER

Madagascar is one of the 25 biodiversity hotspots classified by Norman Myers since 2000. Endemicity of its flora and fauna is estimated at over 80 per cent. An illustration of that wealth is provided by a paleontological discovery by Malagasy and American scientists in 2015, when fossils of large-sized lemurs, tortoises, and fossas were found in a submerged cave of the Lake Tsimanampetsotsa. The country's exceptional biodiversity is displayed in the Mahafaly Plateau, the project area.

The area selected for intervention includes three communities: Masiaboay, Itampolo, Behantake. It is covered by xerophilous forests dominated by didieraceas over about 43 per cent of its area. The local community associations (COBAs) manage about 15 per cent of the area, according to a regulatory provision intended to raise awareness and empower local populations, and enable them to benefit from mainly non-timber revenue.

Climate change and human activities undermine the sustainability of this region. Resource degradation increases the vulnerability of the local people. The Southwest is the region most affected by poverty in the country.



Livelihoods dependent on natural resources increase pressure on these resources and create a dramatic cycle of deterioration that challenges the capacity of conservation and development actors to introduce coherent strategies. Addressing this cycle is the essence of a partnership project between WWF (conservation organisation), GRET (development organisation) and CNEAGR (National Centre focused on water issues), funded by IDRC (International Development Research Centre). These organisations have identified water accessibility as the central axis for resilience of communities to climate change.

1. Global warming and climate variability

The southern part of Madagascar is the area of the country most affected by global warming. Meteorological studies indicate that warming in the southern part of the island began in 1950. By 2055, the temperature is projected to rise by 1.6-2.6 degrees Celsius.

Annual precipitation is low, estimated at 350 mm, and spread over 30 days. Projections indicate an increase in annual average rainfall, however there will be a change in the timing of the rains which is likely to disrupt timing of crop planting.

The amount of rainfall in just a day or two can strongly influence the annual average.

The rainy season is usually from December to February, and during this time ponds are filled and there is water flow in rivers. There is no perennial river system. These factors combined make access to water problematic for many communities.

2. A low rate of access to water

Only 40 per cent of the country’s population has access to drinking water. This drops to 32 per cent in the Southwest because of a number of factors: the karst geological formation which facilitates infiltration; climate change to which the local population attributes the recurrent droughts since the 2000s; lack of storage infrastructure; lack of rainwater harvesting systems; integration of water management into clan systems.

The project ‘Accès Eau’ emphasises accessibility to water as a way of increasing resilience of the population to climate variability. This is an action-research project intended to reflect on the socio-economic conditions, anthropology and existing resources before proposing alternative appropriate technologies and effective management methods. In a clan-based cultural environment, the presence of technology does not guarantee sustainability of infrastructure.

METHODOLOGY

‘Accès Eau’ is a four year project. The communes selected are those where pressures on biodiversity are the most felt, as revealed through analyses of deforestation.

	Masiaboay	Beatanke	Itampolo
Population	12351	9618	41753
Area	485	320	2417
Threats	Coal mining	Coal mining	slash-and-burn agriculture
Hours allocated to the collect water during the dry season	Half a day	Half an hour to 2 hours	Half an hour to half a day

With regards to the action research project, initial studies conducted include inventories of surface water and groundwater resources, studies on climate

projections, quantitative and qualitative surveys. The results determine the technologies and water management methods adopted in the second half of the intervention. An impact analysis will assess the relevance of the options chosen to inform possible replication.

The project objected can be summarised into the following questions:

- How to reduce the impact of water stress on local communities along the Mahafaly Plateau?
- How to ensure the form in which access to water is improved?
- How to improve water management? And what is the impact of an improved water access and management?

In the context of this article, we will focus on results of the socio-economic and anthropological qualitative surveys conducted among resources persons, households and newsgroup. The objective was to understand the issues around access to water, including living environment, vulnerability, and water supply.

COMMUNITY RESILIENCE TO CLIMATE VARIABILITY

Surveys have shown that the impact of droughts is felt by local communities. Observations show a gradual lengthening of the duration of Asotry (dry season). Five to ten years ago, the rainy season was from October to March. Currently, it seems to be limited to two months. Knowing that farmers are agro-pastoralists, during this period, they engage in additional activities: kibaroa (daily work), cutting and selling wood, producing charcoal, making baskets, collection of medicinal plants. They also engage in picking tubers. While waiting for the resumption of agricultural activities, households who live in the areas bordering the forest are clearing for coal product or to sell wood. Some farmers are working for the mpanarivo (rich households in the village) in order to gain additional resources.

Temporary migrations motivated by droughts or soil degradation on the plots are also noted in a study of agrarian intervention in the region in 2010.

Livestock farming is an insurance during lean periods, to deal with emergencies or for traditional ceremonies. The owners organise a livestock transhumance of about ten kilometers from the grazing area, to watering points. The straying of livestock period lasts several months. In other localities, many zebu become sick and die because of a lack of water. To meet the water needs of the zebu, people use burnt cactus leaves. People adopt an adaptation strategy that maintains their attachment to the land of their ancestors despite a high level of vulnerability. The opinion of the farmers surveyed is that this vulnerability appears to be increasing over the years.

IMPROVED ACCESS TO WATER AND IDENTIFIED PATHS

According to the CNEAGR's work, 65 per cent of the water resources in the region is surface water, and 72 per cent of water used by the people in the region is not drinkable. Communities are exposed to diseases knowingly but have no possibilities for avoiding contaminated water.

Despite the efforts of several NGOs, major questions remain about the technology choices used (75 per cent estimated failure rate of drilling in the area), management of water services, and accompanying measures concerning work implemented. The infrastructure of only a third of the water supply systems identified is currently operating.

Following the research, a number of recommendations are proposed for inclusion in the operational phase of the project:

- The roles of all parties involved, whether beneficiaries or the support structures for water supply, must be clear to avoid misunderstanding.
- Community based management could be a solution in some small localities. However, this method of management requires a lot of effort on the part of the population, compared to internal organisation and compliance with internal regulations.
- It is essential to take into account social aspects in decision making regarding the installation of water supply facilities.
- Private management could be a solution for some localities where people agree to entrust the operation of water services to an individual from within or outside the village.
- Innovative technologies for the collection and efficient storage of rainwater are a vital need. Traditional water conservation systems at the family level should not be discredited, but it must be asked if they can be perfected?
- The lineages are the structures of solidarity or conflict, it is important to worry about the water sources management method proposed.





IRAN

Written by Nahid Naghizadeh

COPING WITH CLIMATE CHANGE AND DROUGHTS: HOW THE ABOLHASSANI TRIBAL CONFEDERACY REINVENTED THEIR NATURAL RESOURCE MANAGEMENT ON THEIR CUSTOMARY TERRITORY CENTRE FOR SUSTAINABLE DEVELOPMENT & ENVIRONMENT (GENESTA)

RATIONALE

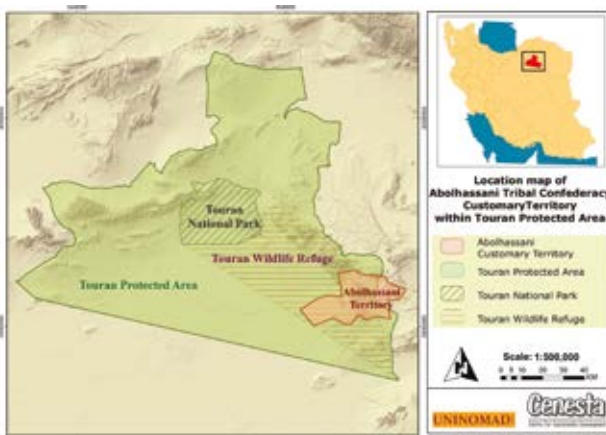
The Abolhassani Indigenous Tribal Confederacy have lived and migrated seasonally in the north-eastern margin of the central Iranian desert area known as Touran, one of the nine UNESCO Biosphere Reserves in Iran. The Reserve includes many types of protected areas, including wildlife refuge, national park, “protected zone” and rangelands, as well as Indigenous and Community Conserved Areas (ICCA)..

The Abolhassani ancestral domain - a nomadic tribal ICCA - covers about 74,000 hectares within the Reserve.

In recent years, the Abolhassani have witnessed and suffered from significant climate change, evident as increasing frequency and severity of droughts. This has caused many detrimental impacts, including decreased livestock and agricultural productions, water shortage, decreased fodder, moving sand dunes and loss of rangeland vegetation cover. There was even a time when drought was so severe that it caused mass migration out of the tribal territory. The great drought of 2000 inflicted such heavy loss in livestock that almost the entire tribal confederacy was forced out of the tribal territory. An estimated 70 per cent of livestock was lost or sold to intermediaries at a pittance, and the current livestock headcount is now at barely 40 per cent of the pre-2000 level.

However, the small Abolhassani tribal confederacy has learnt to deal with these disasters by implementing a number of adaptation strategies through customary laws and practices based on their traditional knowledge. Innovative responses include water storage, reducing the number of livestock, lengthening the migration path, renting farmland residues, and using agricultural by-products to feed their livestock. In addition they secured and implemented a project with the support of UNDP/GEF/SGP and facilitation of CENESTA/Drynet, that aimed at identification of the effects of drought in mobile pastoralist's territories, assessment and analysis of applied initiatives and indigenous knowledge in coping with drought, and expansion of local initiatives to other tribal members. The main successes in dealing with the effects of drought crises are presented in a strategy called "Coping with the Drought Cycle". The Abolhassani people have developed this cycle to cope with droughts, and integrated adaptation into their livelihood strategies to reduce their vulnerability to droughts.

The Abolhassani Territory-based ICCA anchored within Touran complex of protected areas



LOCAL INNOVATION AND ADAPTATION STRATEGY OF THE COMMUNITY

Because the Abolhassani community live in a particularly challenging dry and increasingly drought-prone environment, there is little they can do to mitigate the causes of climate change. Their efforts have therefore concentrated on community action for adaptation to climate change. Therefore, some of the tribal elders, particularly in the Saleh Clan, implemented an innovative idea to help them cope with the recurring droughts. The idea was simple: if they could learn to use their scarce sources of water to grow crops, they could improve their income and at the same time provide the leaves and branches of these crops as fodder for their livestock. In this way they could shorten or eliminate the intervals of famine for their animals.

In addition, the map of their territory shows that most of the area is still rangeland. A careful analysis has helped them enhance their pastoralist activities by carefully anticipating both fodder and grazing needs of their herds in each season, harvesting the feed from their reinvented agriculture at the right time, and saving part of the harvest for cases of extreme weather events. Thus, they began to experiment with crops such as pistachios, cotton, sunflower, watermelon, barley for fodder, and Saffron. They found to their delight that their innovative scheme help them reduce grazing pressure on the rangelands and added to their earnings and livelihood security. In fact, animals that are fed with cultivated fodder, especially barley, weigh about twice as much as those who are not, and in addition they have a greater chance of twin births and lower chance of pregnancy loss. Thus this initiative has resulted in an ingenious compilation of community innovations into a single logical strategy called “Coping with the Drought Cycle”. This is presented below, in a figure based on the community’s own hand-drawn charts and information.

In addition to the Strategy, the Sustainable Livelihood Council of Elders of Abolhassani Tribal Confederacy successfully lobbied government authorities at local and provincial levels, the agriculture organisation in particular, for support. As a result, the financial support that was provided, called “Drops for Life” (Qatrehaye Abadi), has enabled repair of qanats (irrigation tunnels) and building of water storage systems in various areas within the tribal territory.

Diagram of the Abolhassani innovative strategy "Coping with the Drought Cycle"



The restoration of a Qanat and its open storage tank (a "Drops for Life" Project)



RESULTS AND ACHIEVEMENTS

- **Establishment and registration of the Sustainable Livelihood Council of Elders of Abolhassani Tribal Confederacy**, consisting of trusted community elders. This is a mechanism for collective governance of tribal territory, organisation and expansion of local initiatives, and partnership and participation in decision and policy making processes with other organisations at local, provincial and national levels.
- **Conservation of natural resources** in the precarious desert environment. When livestock are fed with agricultural products and residues, this gives rangelands a much needed rest, which is particularly necessary at crucial times when rangelands are recovering and cover plants are flowering;
- **Conservation of biodiversity**, An estimated 800 plant species occur in the territory, more than 20 per cent of which are endemic and some species still not scientifically identified. There is also an exceptional diversity of wildlife, including the endangered Asiatic cheetah, Asiatic wild ass (onager), Iranian leopard, Houbara bustard, and gazelles. Abolhassani rarely hunt animals and respect the daily division of water resources between wildlife and livestock, which is facilitated by the improvement of the water supply and management system.
- **Application of tribal Indigenous knowledge** for developing and expanding local adaptation strategies in climate change and drought mitigation. This includes: seasonal migration; water storage systems; respect for customarily communal grazing decision systems by tribal elders with regards to quantity and type of livestock, and time allowed for grazing in each pasture land; renting farmland residues; and feeding agricultural by-products to livestock.
- **Knowledge sharing with other tribal communities** by organising tribal leaders' gatherings, and showings of documentary videos and photo-stories,

to promote and share information about the local innovation, “Coping with the Drought Cycle”, at various levels.

- **Improved livelihood and income** through increased cash crops and income from livestock with access to fodder from the new crops such as pistachios, cotton, watermelon, sunflower seeds, and barley in rainy years.

LINKAGES BETWEEN COMMUNITY INNOVATION AND CLIMATE CHANGE MITIGATION AND ADAPTATION

One of the most effective signs of the resilience and adaptability of this Indigenous nomadic tribe is that despite the worsened drought situation, their population has remained stable. This small tribal grouping is about 200 households (“tentholds”) amounting to some 800-850 individuals, organised into twelve tribes. First, since the depopulation phenomenon has not been witnessed in this community, the adaptability of the tribe is no longer to be proven. It was previously accomplished through a mix of traditional and innovative approaches. For example, the hanar³⁹ system works as an effective and important way to promote livestock adaptation to water shortage. Other enhanced traditional approaches include the strengthened customary grazing system, which is organised by the tribes’ elders, or the selection of migratory routes according to assessment of plant coverage. Innovative and contemporary approaches, which have resulted from Indigenous research and population consultation, have been enhanced. This includes reducing the sheep/goat ratio as goats benefit more from desert pastures, allowing appropriate grassland development before grazing, and respecting the traditional ‘borderless grazing’ by which herds can graze wherever they want, regardless of pasture ownership, from April to mid-May.

Moreover the diversification of crops has proved to be a good way to reduce reliance on any one solution and spread risks, for example in case a particular type of crop is endangered by pests. These practices also yield vital forage for the animals which reduces dependence on natural rangelands during critical times and allows more access to these resources by wildlife. Those who have poor access to irrigation for farming usually rent farmlands and follow similar patterns of supplementary farming, or use stubble and crop residues where available.

CONCLUSION

Although modern knowledge systems are gradually recognising the value of Indigenous knowledge systems, they have received inadequate attention in a wide range of spheres, including climate change. The territory of the Abolhassani Tribal Confederacy in the Khartouran region has a high ecological and biodiversity value, despite its location in a dry and drought prone area that experiences frequent and

long droughts that makes pastoralists' livelihoods increasingly difficult. However, the small Confederacy has evolved elaborate coping strategies and mechanisms, and has learnt to live with droughts by implementing a few adaptation strategies through customary laws and practices. They have adapted to climatic extremes and managed their ICCAs successfully, using Indigenous knowledge that is developed from thousands of years of experience. They must therefore have the right to govern their ancestral territory to ensure its survival into the future.

Indigenous nomadic tribes of Iran, throughout their history, have recognised the climate and ecological potential and limitations that exist within different regions. Because of their dependence on nature, they have tried to maximise their own compatibility with the environment by adapting their economic and social relations. They are stewards of drylands, with their precious Indigenous knowledge, customary laws and practices, and spiritual and material sense of ownership of their tribal territories. Therefore, there is a strong and immediate need to understand and promote recognition of the adaptation strategies and innovations that Indigenous and local communities have developed, and integrate them into climate change policies and decision making processes at all levels.





*Rest of glacier Toro 1 destroyed by mining activities
Asamblea por el Agua*

CHILE

THE DEFENSE OF AN ANDEAN GLACIER ECOSYSTEM BY HUASCO VALLEY COMMUNITIES IN THE SOUTHERN ATACAMA DESERT LATIN AMERICAN OBSERVATORY OF ENVIRONMENTAL CONFLICTS (OLCA)

Ten years ago the Huasco Valley communities held their first public demonstration against the establishment of a gold mining project on glaciers that are their main source of fresh water. At that time they stated that this was the first of a string of activities that they would engage in until they achieved closure of the project. The Huasco valley is located south of Chile's Atacama Desert and its inhabitants live mainly on small scale agriculture and livestock farming. As well as having a deep appreciation for the value of glaciers as water and landscape resources, local communities recognise their influence on climate and their importance as indicators of climate change.

Since that first demonstration, community and social organisations in the valley have succeeded in preventing the launch of the mining project. However, over the last five years, mining exploration activities and the building of roads and facilities have caused serious environmental damage to the glaciers and water systems in the area. Farmers have been reporting crop losses due to contamination of water by sediments from mining activities, which contributes to further land degradation and increases desertification processes in the region.

Affected farmers and communities took their case to environmental courts, where they demanded that the mining project be stopped because of the severe and irreversible impacts on a group of glaciers that feed the rivers and springs that sustain life and agricultural activities. Since the creation of environmental tribunals in 2012, this is the first lawsuit by affected communities. From the beginning of the conflict, OLCA has been collaborating with the communities of Huasco Valley in the defense of their livelihoods, which are seriously threatened by these types of projects. The development of this conflict is being followed with considerable interest by local and regional stakeholders, because similar situations are occurring in other valleys.

The Huasco Valley is located in northern Chile, in the Atacama region. It consists of four communities: Huasco, Freirina, Vallenar and Alto del Carmen, with a combined population of about 70,000. It is a transverse valley of the Norte Chico (Small North), which extends eastward across the country from the Andes mountains to the Pacific Ocean. It forms a linear oasis and constitutes a barrier against the advance of the driest desert in the world. Precipitation is almost non-existent, and the valley depends exclusively on the Andean glacier and hydrological systems, which are solely responsible for ensuring the permanent flow of the Huasco River and its tributaries, El Transito and El Carmen rivers.



Huasco Valley assembly members

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Historically, the Huasco Valley is characterised by agricultural livelihoods. Freirina and Huasco have large olive groves, the central part of the valley is dedicated to vegetables and fodder, and recently also to avocados, potatoes and artichokes, and the farming highlands are dedicated to intensive fruit cultivation, specifically table grapes for export as a result of the expansion of agribusiness in the 1990s. Over 80 per cent of farms are in the hands of small producers, each with less than five hectares cultivated, mostly with fruit crops. Throughout the valley, but especially in the highlands, there are family farms with subsistence crops. Another historically important economic activity is livestock, particularly goats, which are fundamental to the family economy in small rural places such as Freirina and Alto del Carmen. Local communities believe that all this can disappear because of the Pascua Lama mining project.

Pascua Lama is a gold mining project of the transnational, Barrick Gold Corporation. It is the first bi-national mining project in the world. It was established following the signing of a Mining Treaty between Argentina and Chile in 1977, which allows exploitation of the border area between the two countries, at the source of the waters.



The treaty created an area of operations in which both countries concede part of their land to mining. Chile concedes 25 per cent, and Argentina 6 per cent

The mine is located between 4,400 and 5,200 meters above sea level in the Andes. It is an open pit mining mega project that seeks to extract 17.6 million ounces of gold, 18.2 million ounces of silver, and 5,000 tons of copper concentrate over a period of 20 years. The project is located on a glacier ecosystem. In addition, part of the site is under three glaciers, Toro I, Toro II and Esperanza, which together constitute one of the largest contributor aquifers to the Huasco River basin and its tributaries. The initial cost of the project was estimated at USD 950 million in 2000, but increased to about USD 8,500 million in 2015.

This cost escalation is due largely to multiple delays at various stages of construction as a result of actions taken by the communities that have mobilised opposition to the project for the past 14 years. These actions include overseeing the activities of the company, and protesting all violations of environmental and labour laws.



To date, Barrick has accumulated nine penalties for violations of their environmental permit, which gives it the honour of being the company with most environmental fines in the history of Chile. In addition, due to the severity of its faults and failures to comply, the project was partially paralysed in October 2012 and completely paralysed in May 2013. The judicial process that determined these penalties is not yet finalised, and the future of Pascua Lama remains uncertain. There is a possibility that the case might end in a new sanction, and even that the Environmental Project Permit could be revoked.

In the last two years, the Assembly of the Communities has filed three complaints before the Brigade of Environmental Crime (Bidema), two regarding water pollution and one, the destruction of glaciers. They have also presented nine complaints to the Superintendent of the Environment regarding a number of failures by Barrick to comply with the Environmental Qualification Resolution (RCA). Affected communities are expecting that these charges will result in new sanctions against the company.

During the environmental assessment process, the community reported that the company had not included the threat to ice and rock glaciers among the impacts of the project on ecological systems. Despite this, the project was approved in 2001. To

comply with official requirements, Barrick prepared a Glaciers Management Plan, in which it proposed moving ice masses with backhoes. This was considered an insult by the local community and broad sectors of civil society at the national level.

Thus, the issue of glacier protection marked the beginning of the Pascua Lama conflict. The magnitude of the events was unprecedented in Chile, and rare even at a global level. The transfer of glaciers was challenged seriously at the scientific level and the intentions of the Canadian mining company became international news. Nevertheless, on 15 February 2006, a new expansion of the Pascua Lama project was approved, this time on the condition that there should be no impingement on or damage to the glaciers.

In 2005, the resistance against the Pascua Lama project reached one of its high points, both in the Huasco Valley and in the capital, Santiago. A powerful social movement was created, and it kept attracting more and more followers. Their constant, diverse and colourful actions gradually succeeded in focusing public attention on the conflict, and particularly on the care of glaciers. OLCA has been playing a support role as adviser to the community since the conflict began.

In October 2009, after undergoing many difficulties, project construction began. In March 2012, following a long process of active monitoring by farmers in the area, a report was released, showing that glaciers had been seriously affected, and some, including Toro 1 and Toro 2 glaciers, even destroyed as a result of the project. Following this, organisations and inhabitants of the valley began to consider the possibility of initiating legal action. This was a strategy that was supported by OLCA with a number of inputs, including legal counselling and active support of the struggle.

A legal demand to stop the irreparable environmental damage to the glaciers was filed on 27 June 2013, during the Second Environmental Court of Santiago, and subsequently endorsed by it. A strong body of evidence was presented to the tribunal, including reports from government institutions and international glaciologists, as well as reports produced over the years by Barrick itself that were carefully compiled by the affected communities. In January 2014, hearings of experts and witnesses began.

The closing arguments took place on 3 December 2014, and this time the representatives of the Assembly of Communities made a presentation in which they reminded the judiciary and the general public that the environmental authority had given approval for the project, conditional on the full protection of the glaciers,

and forbidding any interference with them, precisely because there could be no compensation for their deterioration or destruction. They therefore insisted to the Court that the only possible compensation for destruction of glaciers was to prevent further destruction, something that could be achieved only with the removal of the Pascua Lama project and dismantling of its facilities. Presently, affected communities and civil society around the country are awaiting the Court's final ruling.

Despite clear evidence of the negative impacts of the mining project on glaciers, as identified by regulatory agencies of the State, Barrick Gold has never been sanctioned directly for the destruction of glaciers. In addition, monitoring reports produced by the consulting firm hired by the mining company, Center for Scientific Studies of Santiago (CECs), conclude that the decline of the glaciers is a response to climate change and not due to human activity on site. This last conclusion seemingly ignores the two legal sanctions that were imposed on Barrick Gold due to breaches in its Glacier Management Plan.

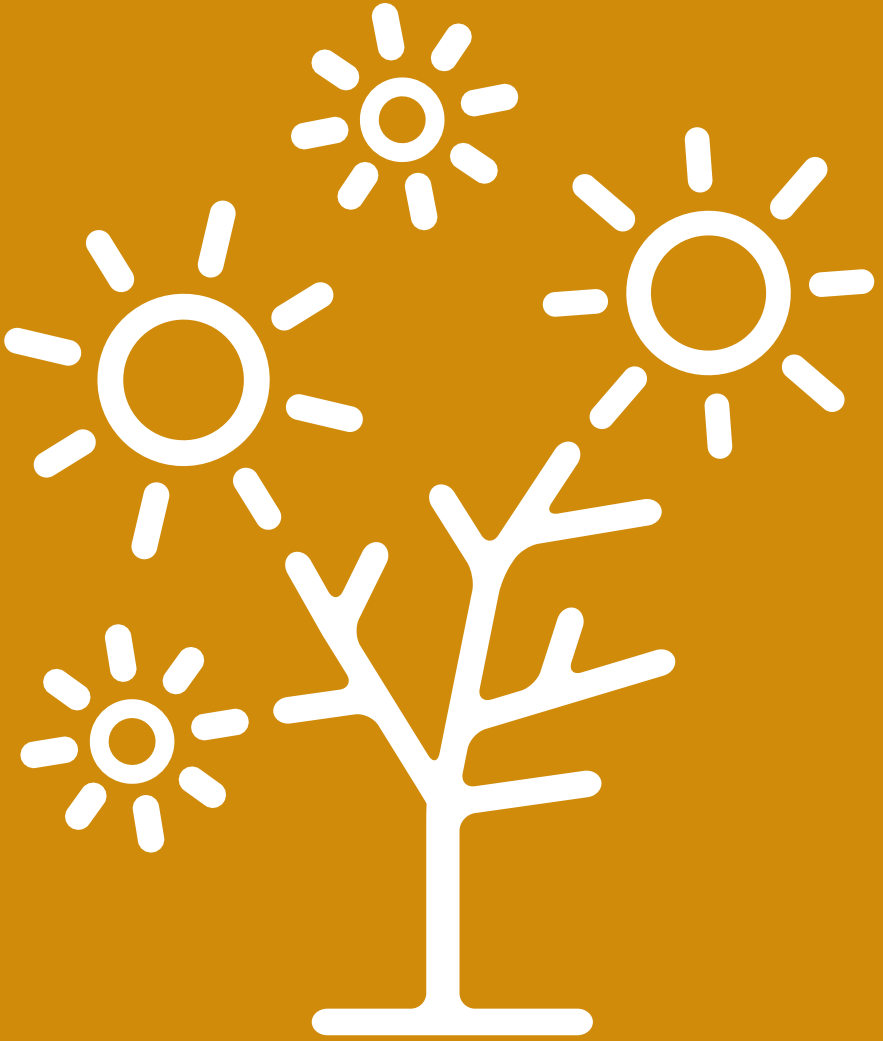
The impacts of direct human damage to the glaciers translate into a visible decline of surface and groundwater. The significant decrease in the flow of rivers has seriously affected agricultural production in the valley and particularly hurt small farmers.

Other impacts include a reduction of places suitable for swimming and recreation, which are holiday traditions. This affects the role of the river as a social space and a place to commune with nature. This particular impact lately became evident even in the city of Vallenar, which has seen a dramatic decrease of the waters of the Huasco river over the past three years.

One important effect of the reduced water availability has been the fracture of the community social fabric due to the increased competition for access to water between people who have been neighbours and friends for a lifetime. Another impact is that there is a growing distrust and even fear of the water from rivers because of the mining pollutants. Although historically the rivers have been used both in agriculture and daily life, even for drinking, there is now much uncertainty about the safety of river water, and this has resulted in a current dependence on water delivered by tankers, which in turn has created a series of changes at all levels.

Since they first became aware of the risk that their glaciers would be destroyed by mining activities, affected communities started to prepare themselves, with expert information and scientific documentation, to assume the role of protagonists for the defense of the glacier ecosystem threatened by the Pascua Lama project. The Huasco Valley community has taken over care for its glaciers and water, as a way to defend

its existence, protect fertility of the soil, and ensure a continuation of the conditions that have made it possible to conduct their traditional, productive and cultural activities for centuries. Their struggle, so far, has protected the delicate balance of this fragile yet resilient oasis ecosystem that stands guard on the southern border of the Atacama desert.



WORLD MAP





TEMA



LE GROUPE
DE COORDINATION
DES ZONES ARIDES



Canesta
Centre for Sustainable Livelihoods



Lokhit Pashu Palak
Sansthan

GRET

Professionals for
Fair Development



FOOTNOTE

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