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Better Water Use Efficiency for Increasing Yields and Food Security – from Watershed to Field

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List of contents

Introduction

The objective of the seminar "**Better Water Use Efficiency for Increasing Yields and Food Security - from Watershed to Field**" was to explore and share lessons-learnt from a range of experiences in water management and irrigation from Latin America (Bolivia and Ecuador) and West Africa (Burkina Faso) with a view to illustrate the multidimensional factors that influence efficient resource use in agriculture from a watershed, field and farm perspective. Additionally, the impact of improved water management and adapted irrigation on food security, poverty reduction and resilience to climate change was demonstrated.

The seminar has been co-organised by German Development Cooperation (Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH and KfW) on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) and the Swedish International Development Cooperation Agency (Sida), all representing institutions with extensive experience of water resources management and agriculture. Acknowledgements go to the preparatory team of the seminar, especially Jürgen Fechter, KfW, Elisabeth Folkunger, Sida and Elisabeth van den Akker, Dieter Nill and Jutta Schmitz, GIZ.

The interest for the topic of efficient resource use was demonstrated by the important number of 106 participants of the seminar coming from 29 countries . The topic has come timely at a moment when the water-energy-food nexus is gaining momentum. Adopting integrated approaches appears inevitable given the resource scarcity at hand. The design of the seminar, combining high-level key speakers and group work, as well as national policy aspects and concrete case-studies made the event interactive, dynamic and participatory. As a result, speakers and participants, with the able guidance of the moderator, actively shared good practices and lessons-learnt on successful approaches in improving resource efficiency, especially of water, towards increased food security.

The seminar was opened by Albert Engel, Head of Division Rural Development and Agriculture at GIZ. The welcome address was delivered by Mari Albihn, Head of Economic Development, Environment and Sustainable Development Unit at Sida. The first session related to setting the scene from the national policy perspective of Burkina Faso and Bolivia followed by a key note and presentation of four case studies from Bolivia, Ecuador and Burkina Faso. The second session hosted four lively group discussions, focusing on *Technological Shift, Self-administrated Irrigation, Water Harvesting and Resilience and Food Security*. Based on the interesting results, Stefan Schmitz, Head of Division Rural Development, Agriculture and Food Security, BMZ, indicated the way forward.

Photo: © GIZ/Ulrich Scholz

Improving Water Use Efficiency for Increasing Yields and Food Security – Main seminar results and way forward

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Context

Efficient use of natural resources is key to the resilience of livelihoods and ecosystems. Land and water management is closely interconnected, regardless of climate conditions or agricultural systems. As competition for land and water resources increases, there will be pressures to further increase efficiency in agricultural systems while managing effects from climate change, continued population growth, changing consumption patterns and increased competition from other production systems, such as bioenergy. The water-food security-climate change nexus makes efficient use of natural resources even more crucial to ensure food security and enhance the resilience of livelihoods and ecosystems.

The seminar presented relevant cases from Latin America and West Africa, highlighting both direct experiences related to water harvesting and irrigation systems but also more system-level issues related to sustainable land and water management and agriculture. The key-note presentation provided an overview of how water use efficiency and resource optimisation can be applied from a watershed, field and farming system perspective. The panel discussions highlighted specific example and experiences from watershed management and irrigation systems within the national strategies of Bolivia and Burkina Faso, followed by direct on-the ground experiences from German and Swedish development cooperation to illustrate the impact of improved water management, water harvesting and adapted irrigation on food security, poverty reduction and resilience to climate change.

Main results

Efficient water management within larger landscape units is a complex issue, which often creates conflicts of interests among different water users and sectors and potentially between rural and fast growing urban areas. Balancing between such different interests is partly a managerial issue, but eventually also an increasingly complicated political challenge (from the regional to the local level) as it has to consider and balance economic, environmental and social aspects. When considering local food security, poverty reduction, livelihood and equity aspects, it is clear that small scale systems in agriculture may be a more viable option than large scale solutions, which are often promoted from more straight forward efficiency and/or economic perspectives.

A range of (small scale) technologically viable irrigation, water conservation and water harvesting solutions that can generate more efficient water use in agriculture is already available. The examples from Bolivia and Ecuador showed that even small scale farmers can prioritize modern and more water efficient irrigation system and it is clear that their capacity to apply such modern technologies should not be underestimated. The examples presented also made it clear that irrigated areas in the Andin Region will face increasing water scarcity (due to competition and/or climate change), and there is basically no alternative to the shift from surface to sprinkler or drip irrigation.

However, it was also stressed that investment to increase water productivity only works if farmers experience direct and short-term benefit. This represents a challenge in some cases as efficiency gains may only be obvious and generate benefits in the more long term perspective. It is important, as was highlighted through the examples in Bolivia, to demonstrate how change in irrigation agriculture can support farmers to better cope with changing climate conditions and more near term poverty or food security aspects. The presentations demonstrated that with the right know-how, technical assistance, investments and incentives, it is possible to work through an integrated approach at the watershed level to protect the extensive grazing areas, the rain-fed fields and the highly productive valleys while at the same time increase income and reduce household vulnerability to climate change and price crises. Already small investments of only 80 to 150 € per ha could generate clear benefits, as was also described by the cases from Burkina Faso.

A recurring point was that large scale application of good practices is still lacking in some regions, and it takes a long time to implement and sustain real change in reality. This can be in rather sharp contrast to what was described as normal "project duration". This made it obvious that new financing mechanisms would be necessary to provide reliable long-term funding to what is clearly sometime a multi-generation task, stretching decades.

The seminar also stressed that a cross-sectoral approach is essential, which would also include the agriculture-water-technology interface and not only focusing on new agricultural production systems. Intensification of cultivation, new technologies and new seed varieties are clearly needed in order to strengthen the resilience of agricultural systems. It was underlined, however, that more technological investments also have to be accompanied by more and improved training, education and capacity development. Especially professional training schemes, focusing on young people in developing countries as change agents, and including other sectors than agriculture is strategic. Investments should also integrate more socio-cultural aspects. An example was the necessity to ensure equitable access to water from reservoir constructions and the development of the appropriate systems to ensure such rights through participatory management. Clarifying "chains of responsibility" is of paramount importance.

Way forward

Partners from Burkina Faso, Bolivia, Sida, BMZ, GIZ and KfW demonstrated that close collaboration among key actors related to agriculture and the entire food supply chain has strong positive effects and comparative advantages from a stricter sector-focus approach. There are already extensive experiences and approaches available and it is more a matter of applying well tested technologies and management approaches in an intelligent way, which will also build better resilience towards new challenges. A particularly important aspect for further consideration is to ensure capacity for more long term planning and implementation of measures. Improving natural resource management at the landscape level takes time due to the mere size of the task.

It is essential to develop approaches that ensure a more rapid return of investment in relation to efficient water management and the application of improved (resource efficient) technologies. However, efficient water management must also consider more long-term socio-cultural perspectives, which implies that water users and land managers must understand and accept how the system works and how it connects among various sectors, users and communities. Therefore, any new approach should start from the existing rules, institutions and values of local farming systems, while assuring political and traditional recognition of land and water rights.

Future and emerging challenges will require new partnerships and approaches. Efficient water management in times of climate change will not only require adaptation to changes in the water cycle, but also in relation to cropping patterns and farming systems. To this end, development cooperation needs even more to support the collaboration between research, farmers and the broader private sector.

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Water use efficiency at field and watershed levels: potential difficulties and contradictions

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The importance of water in improving livelihoods together with its scarcity in many parts of the world make it necessary to ensure 'the efficient use of natural resources' or 'resource optimization'. Words such as 'productivity', 'efficiency', 'optimization', or 'modernization' carry with them a nice flavor of technical improvements that are assumedly neutral, objective and desirable. More of these good things seems better than less of them. Development interventions associated with such concepts are therefore uncritically considered as interventions going in the 'right direction'.

If the concept of Integrated Water Resource Management (IWRM) is of any use, it should constantly remind us that the 'Efficiency' goal is to be considered in parallel with objectives of social Equity and Environmental sustainability. But if the first E is given priority and the other two are overlooked it is not because these are somehow forgotten; it reflects the fact that actors strongly endorsing the values and worldviews associated with each "E" tend to promote their "E" and to gloss over the other two. Economic efficiency is promoted by actors that favor market mechanisms, privatization, allocation of water to higher value uses, water markets, etc.; who implicitly put these values upfront and use them to guide policies. Social equity is the entry point of people and organizations favoring community management, strengthening livelihoods, or attention to gender issues. Environmental sustainability is the chief and overarching objective of environmental organizations who do not discard the other two "E's" but use an ecosystem approach to decide what is feasible and desirable, hence giving clear priority to the environment over other issues.

What is needed to have these three objectives fulfilled at the same time? The Global Water Partnership (GWP) definition of IWRM suggests that this could be achieved by way of a process of optimization. This process implies more efforts, participation, information and scientific results, and good will from all sides, if integrated management is to be possible. The problem lies, however, in the somewhat glossed-over evidence that these three 'E's' do not add on to each other and even are antagonistic most of the time (Molle, 2008).

One of the reasons for this hard-nosed reality is that water, as a finite resource that connects people and ecosystems across the hydrologic cycle, is allocated through processes that resemble zero-sum games. Interventions, be they in the name of efficiency, poverty alleviation, climate change mitigation, or otherwise, modify the pathways of water through the basin. This is not necessarily a problem, especially when water is plentiful. Frequently, however, this generates third-party impacts on other users or the environment when competition over and pressure on resources increase. The devil is in the details. Just like economically efficient or profitable activities are allowed to thrive because they ignore their social and environmental externalities, some natural conservation programs may forget the costs induced in terms of foregone economic opportunities or livelihoods. In other words, the name of the game is how costs are disregarded (or not) and pushed (or not) unto other constituencies, or internalized. This obviously takes us away from the technical realm well into that of politics, in its wider sense.

This presentation provides four examples of technical interventions – canal lining, water harvesting, drip irrigation, and grey water reuse – that are widely seen as desirable and frequently are the object of national policies or development projects. These examples show that caution and attention to cross-scale interactions are required if the three 'E's' of IWRM are to be given equal weight. They do not invalidate such interventions but illustrate that negative externalities should be addressed and that in some cases these may be larger than the purported benefits.

Canal lining has the potential to reduce 'losses' by seepage. This means that it may contribute to either increasing the water available at the end or on the side of the canal, or to reducing diversions into this canal, thereby opening up the 'savings' for other uses elsewhere (for example as environmental flows in the rivers). This sounds like a potentially attractive win-win situation. The example of the All-American canal, which diverts water from the Colorado river to the Imperial Valley district, illustrates how a 'good idea', much celebrated by the World Bank as a 'win-win deal', resulted in severe social and environmental impacts: the reallocation of 100 million m³ of 'saved water' to San Diego, without impairing the Imperial Valley, curtailed the main source of recharge of the aquifer, which, in the Mexicali valley that lies in Mexico just across the US-Mexico border, is intensively exploited by Mexican farmers. The lining of the canal resulted in a severe drop of the water table, degradation of water quality (and irrigated soils), and impacted on the delta ecosystem. There are countless examples (e.g. in India and China) of similar technical solutions having in fact reallocated water from groundwater users to surface water users (in most cases to urban populations to the detriment of farmers, next generations, or the environment).

Water harvesting has a flavor of indigenous knowledge implemented and controlled by communities for their own benefit. While these investments have merit they do just that: harvesting water that would otherwise flow downstream and, in some cases, be put to use by other distant folks. There have been many studies on how water can be retained upstream to the detriment of downstream users and ecosystems and on the negative impacts of large-scale water harvesting, India being the best documented case (*Batchelor et al., 2003*).

Drip-irrigation is the iconic, almost knee-jerk, policy response to water scarcity. It has all the ingredients of an ideal solution: technical, capital intensive, innovative, and perceived as the 'modern' way of irrigating high-value crops. Who could be against it? The first qualification is that micro-irrigation does not really decrease water consumption, understood as the amount of water transpired by the plant and evaporated from the soil. Although this varies a lot and depends on many factors (type of crops, type of soils, planting density, etc.), there are cases where water *consumption* is increased by micro-irrigation because of the more regular and better intake of water by the plant (this is of course positive in terms of yields) (*Burt et al.; 2001*). What can be substantially reduced is the return flow from irrigation. In the case of gravity irrigation (but that also depends on the locale), a large part of this return flow is a recharge to the aquifer. Promoting micro-irrigation with the objective of reducing allocation to irrigation (as a means, for example, to increase the share going to cities), can reduce groundwater resources and, therefore, the supply to those who are using (or overexploiting) it. Morocco is a good example of a country with a national policy promoting micro-irrigation on a large scale and many overexploited aquifers, whose situation will be compounded by this technological intervention.

Finally, wastewater treatment is, on environmental grounds, an uncontroversial and much-needed intervention. However, for good or bad, untreated wastewater is often appropriated and used by downstream farmers for peri-urban agriculture. If the now treated wastewater is reallocated to other users (a good illustration is Marrakesh, with treated wastewater being now allocated to golf courses), overlooking pre-existing uses, equity may be impaired.

Another possible shortcoming associated with an emphasis on physical or economic efficiencies is the 'silo vision' that comes with the priority given to one particular factor (e.g. the productivity of one particular production factor such as water). Farmers, but also water managers, operate in a constrained environment and the decisions they take reflect the consideration – if not 'optimization' – of many preferences and contextual limiting factors. This often creates situations where the interests and strategies of users, managers, and society at large are not aligned. Micro-irrigation, for example, might be interesting from the point of view of the farmer (most especially if it is subsidized or paid by the government), and from an economic point of view (if he now produces high-value crops), but not from the point of view of the aquifer manager.

There are also situations where the interests and strategies of farmers and managers may be at odds with those of aid workers and development banks. Many development projects, obsessed with the objective of supporting the production of high-value crops, gloss over the many constraints faced by subsistence or small-scale farmers, and may lead them or force them to face a high level of risks that they will not be able to deal with. This is, of course, a well-known – and recurrent - difficulty of development interventions.

Overall, both hydrological interconnectedness and social complexity warn us that interventions carried out or justified in the name of the common good, 'efficiency', or 'productivity', do have to be considered together with their wider social and environmental implications.

Bibliography

Batchelor, C.H.; Rama Mohan Rao, M.S. and Manohar Rao, S. 2003. Watershed development: A solution to water shortages in semi-arid India or part of the problem? Land Use and Water Resources Research 3(2003) 1-10.

Burt, C.M.; Howes, D.J. and Mutziger, A. 2001. Evaporation Estimates for Irrigated Agriculture in California. Paper be presented at the 2001 Irrigation Association Conference - San Antonio, Texas – November 4-6, 2001.

Molle, F. 2008. Nirvana concepts, narratives and policy models: Insights from the water sector. Water Alternatives 1(1): 131-156.

Improving water use efficiency in Andean small farmers' hill irrigation systems

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The setting

The Andean region is an area with mountainous watersheds and many scattered farmer-managed hill irrigation systems. Competition over the use of scarce water is a growing issue in the whole region. In many irrigation systems, the number of water users increases, which creates greater stress on limited water resources.

Former government investment strategies mainly aimed at increasing water availability within the irrigation systems, by means of putting river water at irrigators' disposal (river intakes, conveyance canals, distribution channels). Growing scarcity and competition now require initiatives in three mayor domains:

1. More available water for consumptive and productive use
2. Improved water use efficiency ("more crop per drop")
3. Promoting arrangements to (re)define water use rights within watershed settings

The need to improve water use efficiency on the plot

Main water losses in farmer-managed irrigation systems are due to low application efficiencies (less than 30 %). Thus, in the context of growing water scarcity, one of the issues at stake is to improve water use efficiency on the plot. Methods to do so are readily known:

- Labour intensive methods: mainly careful horizontal furrow layout, which raises application efficiency up to 70 %. Due to topographic reasons its applicability is limited and requires dedicated farmers' practices.
- Technology intensive methods: sprinkler and drip irrigation, with application efficiencies up to 75 % (sprinkler) and 90 % (drip). Technological proposals are mainly aimed at individual farm level and few proposals exist for collective systems.

The question is thus, how to apply available technology to improve water use efficiency in small farmers' collective hill irrigation systems?

In search of creative, sustainable and replicable answers to this question KfW promotes actions to improve water use efficiency in collective irrigation systems through a number of investment programmes:

- **PACT:** Programme on Water and Watersheds in Tungurahua, Ecuador.
- **PMI:** Plan on Irrigation Improvement, Cusco, Peru.
- **PGIMMA:** Project for Integrated management of the Mariño Abancay Watershed, Peru.
- **PACC:** Programme on Water and Climate Change (to start in 2013), Bolivia.

Consulting Engineers Salzgitter GmbH (CES) is engaged in the implementation of the first three programmes, assisting national institutions in developing sound proposals for irrigation modernization.

The perspective; facts from Andean agriculture

The experiences in existing irrigation systems demonstrate that improving water use efficiency through the installation of sprinkler and drip irrigation allows increasing irrigated crop production and reducing pressure on scarce

PACT: Programme on Water and Watersheds in Tungurahua, Ecuador.
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Sprinklers in action. Photo: © Gerben Gerbrandy

water sources. Thus, this technological shift is a feasible answer in all settings where more efficient water use does not affect downstream users.

Some proven gains in Andean settings are a reduced water use per hectare of > 35 %, which corresponds to > 50 % area gain. Productivity is increased by > 30 % because of more evenly spread water applications. Overall production increase for small farmers is therefore $1.5 * 1.3 \approx 100\,\%$. Optimizing irrigation efficiency increases resilience to climate variations and sprinkler and drip irrigation halt soil erosion.

The investment costs of sprinkler and drip irrigation depend on the complexity of the technological choice and the extent of collective installations needed, but the common investment parameters are 1,500 – 3,500 USD/ha for sprinkler irrigation and 2,500 – 5,000 USD/ha for drip irrigation.

Opportunities and pitfalls for introducing pressurized irrigation technology

In Andean hill irrigation systems there are a number of favourable characteristics to improve irrigation:

- Many systems provide sufficient gravitational energy for pressurizing water networks. In fact, most designs have to include pressure control measures to avoid over-pressure. Thus energy is free, reducing operational costs to a minimum.
- There is growing (government) awareness that water use efficiency has to be increased for sustainable growth of agricultural production.
- Small farmers, even those with limited income, show a growing interest to invest in on-farm equipment (movable sprinkler kits, drip installations).
- There is an increasing involvement of small farmers in high value crop chains, which allows them new investment choices.

However, improving water use efficiency in small farmers' hill irrigation systems is a not a simple business, mainly because the irrigation systems are collective endeavours, that require collective decision making and overall acceptance to introduce improved irrigation technology. Although any individual shift may be interesting, it usually cannot take advantage of free energy (on-plot height differences are not enough for pressurizing irrigation equipment) and the overall effect on water saving is limited.

The introduction of water saving techniques in collective systems has to take into account that the usual water distribution schedules in farmer managed systems are easily controllable but hardly compatible with sprinkler or drip irrigation (e.g. flows are too large, times are too short). Distribution schedules therefore have to be rearranged. However, it is noteworthy that farmers usually do not have problems with this, as long as new control mechanisms can be agreed upon. For instance, the former visible control of flow and time per user can be simply replaced by an evenly transparent control of number of sprinklers per user. In other cases, the decision was made to divide the systems into decentralised sectors, which are all provided with a fixed permanent (reduced) flow, distributed and controlled among neighbours. It also has to be considered that families have numerous small plots with odd shapes, which hinder common emitters' disposition patterns. To cope with this, in many systems farmers prefer using small sprinklers, even though these increase time investment in changing positions.

The overall conclusion is that design for pressurizing irrigation systems is a socio-technical process that requires farmers' commitment, involvement of trained specialists and a relatively long preparation period. As for now, the limiting factor is the notable lack of technicians able to understand the complexity of collective systems and transform these into coherently operable collective pressurized systems.

Green area with sprinklers. Photo: © Danilo Luza

Support for promoting water use efficiency in small farmers' hill irrigation systems

The change of irrigation methods to reach more efficient water use and higher production depends on the introduction of high quality solutions adjusted to the particularities of farmer managed hill irrigation systems. It is clear that such solutions exist, but that there are no blue print designs for it. Enhancing the promotion of water use efficient technology needs at least 3 themes in place:

1. Public investment and support

This needs strategies to promote water use efficiency and the prioritizing of pilot watersheds. Efforts to enhance water use efficiency (water and crop chains, universities, private enterprises, international cooperation) are needed and training programmes aimed at improving water use efficiency. Farmers need credit arrangements to fund on-farm equipment and guidelines for good preparatory studies and design are essential.

2. Training

Training has to be provided at three levels:

(i) training of farmers (e.g. application of new distribution schedules, use of irrigation equipment, soil-water-plant relationship);
(ii) training of technicians (conceptual design of pressurized collective irrigation systems, hydraulic design of closed pipe networks, design for easy and secure construction);
(iii) training of public administration (e.g. preparation of sound terms of reference, supervision and review of optimization studies).

3. Private investment and support

The supply chains need improvement (e.g. the availability of equipment, maintenance and replacement of technological components). Applied research on technical solutions for hill irrigation settings and collective pressurized systems is needed and demand and supply of irrigation technology need to be matched.

Farmers conecting tubes. Photo: © Carlos Rios

Small Farmer Self-Administrated Irrigation Systems

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The context

Poverty in Bolivia is mostly rural, where food security is highly dependent on agricultural productivity. The diverse climatic conditions make agriculture in the Andes more vulnerable to the effects of climate change. Weather conditions are strongly influenced by the extreme differences in altitude. Climatic conditions vary from tropical in the lowlands, to cold and dry in the upper parts of the Andes. Accordingly, the amount of rainfall likewise varies greatly from one region to another. These conditions make Andin agriculture vulnerable to the effects of climate change.

In order to satisfy the need for water, the indigenous population has built more than 5,000 rustic irrigation systems, tapping into almost all water sources available in the Bolivian Andes. Water users are organized in the rural, indigenous Quechua and Aymara communities who preserve culture and tradition

The project

Access to and availability of water for agricultural production in dry and semi-arid zones determine the basis of life and livelihoods of small farmers, who live in subsistence economies, with little food security and high vulnerability to climate change.

On the basis of the successful results of phase I (2005 – 2010), with valuable contributions to agriculture in dry rural areas of Bolivia, the Programa de Desarrollo Agropecuario Sustentable (PROAGRO) initiates Phase II (2011 – 2014) as a trilateral cooperation between the governments of Bolivia, Germany and Sweden, looking forward to continue the strive to reduce poverty by strengthening local capacity to advance sustainable agricultural development. Phase II incorporates a new thematic approach and new methodology to promote quality services in dry rural zones, considering the needs of adaptation to climate change, in order to contribute to food security and increased profitability of smallholder farming.

Thematic approach: Strategically, the program aims at familiarizing small farmers with the potential consequences of climate change in order to build resilience, improve the performance of their production and sustainable use of resources, with emphasis on water management. Based on successful experiences generated locally in the previous project phase, the identification of new promising adaptation measures, including systematic incorporation of ancestral knowledge, and with a bottom-up orientation is expected to expand knowledge management, political advocacy and replication impacts nationwide.

Methodological approach: The methodological approach is based on management models involving technical, social, economic, and environmental advantages for the sustainable use of natural resources. Management models provide spaces to generate knowledge and capacity among beneficiaries (“learning by doing”), and to generate local improvements that can be replicated. Capacity building among the project partners is a fundamental pillar with a view to ensuring the sustainability of the intervention.

Success factors

The model “Small Farmer Self Administrated Systems” begins with understanding the local water management and agriculture system, and according to it, the projects are designed with social participation that optimizes the collection and conveyance of water to the agricultural plots.

Based on the understanding of the local system, the model prioritizes traditional irrigation systems, because of the already existing water management capabilities. It promotes increased and more efficient use of water through the combination of infrastructural and social factors i.e. the peasant organization is considered as a key factor in the management of irrigation systems. Development institutions are used as service providers that accompany and facilitate the formulation and implementation of projects, by providing users with technical knowledge and alternatives.

Implementation of the model requires a process of negotiation and agreement between technicians and users to clarify responsibilities of each of the parties. This facili-

Photo: © PROAGRO

Photo: © PROAGRO

tates to define the scope of each project and to stay within the available natural resources and the institutional, financial and managerial capacity to manage the new irrigation systems and the social arrangements regarding the source of water in the basin. The model also applies an intercultural approach that values the importance of community organization to manage the irrigation systems and the expertise of engineers to determine the technical and financial feasibility in the project design.

The model has been developed in response to low efficiencies and water shortages in traditional irrigation systems. Most of them are characterized by the use of erosive flows, short application times and long periods between applications, causing low yields and increasing the vulnerability of small producers to climatic variations.

Challenges

The model is based on the principle of valuing indigenous culture and the sustainability of pre-existing farming systems. It encourages that investment decisions are made according to the needs and abilities of those who operate and maintain the irrigation system. To accomplish this, institutions need to develop capabilities to interact with communities. It is essential that technicians, who design, supervise or construct improved irrigation systems, have adequate training and be oriented towards intercultural respect.

Results

The program has enabled more than 12,000 families to access irrigation water for more than 20,000 hectares of irrigated land. Additionally, the safeguarding of food production has been improved and the irrigated area expanded. The water user organizations have been strengthened and their water rights clarified, which has reduced the conflicts over water. The average farm family's income has increased by about 130 %.

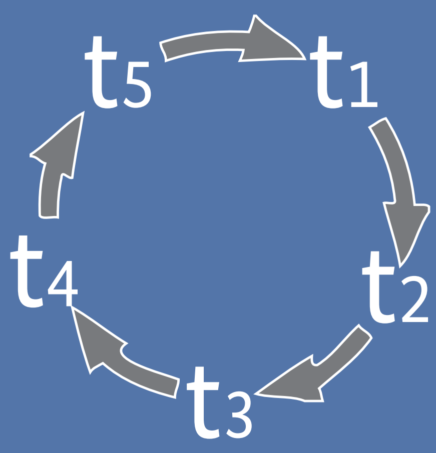
The Program has contributed to develop several instruments and tools such as the National Irrigation Program, guidelines for the planning irrigation projects and technical documents related to the design criteria. In addition, the Program has contributed in the preparation, evaluation and approval of irrigation projects of several national programs exceeding $US 100 million.

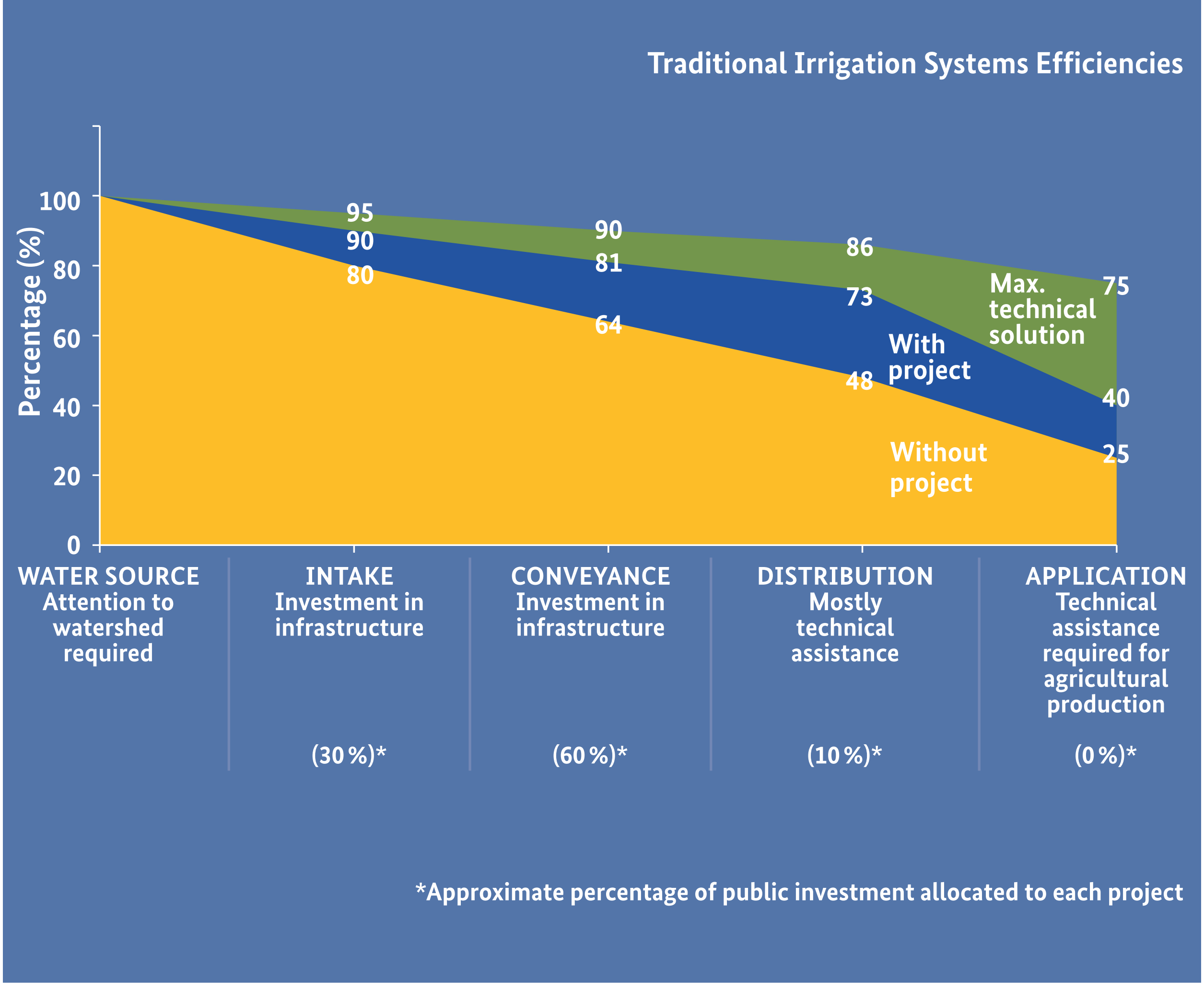
Policies and strategies

Pressurized irrigation offers the greatest potential for a more efficient use of water. For social reasons, the improvement of traditional systems has been prioritized for the following reasons:

- Water rights are defined on the basis of a single constant flow, which allows water delivery (full discharge) to users in terms of time. Each water right can literally be seen and measured in time (t) by any user of the system.
- Transparency of traditional irrigation systems is based on a *constant flow* (Q), which is distributed by time (t) in proper sequence to all water users to complete a turn. The collective knowledge of this type of right of access

Water rights are defined on the basis of a single constant flow, which allows water delivery (full discharge) to users in terms of time. Each water right can literally be seen and measured in time (t) by any user of the system.





to water, allows any member of the community to undertake the task of controlling the water delivery to its members.

- When water is piped in order to change from surface irrigation to pressurized irrigation, water is no longer visible. In this case, the flow (Q) can be variable on each individual water outlet and can be the time. The control parameter of water rights can no longer be time (t). The alternative is to measure volume (V) with calibrated devices. Otherwise, the transparency and social control of the irrigation system is lost.

Meanwhile, by means of improving traditional systems, irrigation efficiency can be raised as shown in the figure below. Raising total irrigation efficiency from an average of 25 % in traditional systems to a new 40 % or more in the improved systems, will contribute to additional water for farmers. This in turn increases resilience to climate change and provides increased income to overcome poverty. The model seeks – as an essential complement to infrastructure and technical development – to further human capacities at the individual and group levels by training, enhanced access to information, business and marketing.

Recommendations

- Harmonize irrigation ventures with national adaptation policies to fight poverty and climate change.
- Attend social demand and strengthen the local capacities for self-administration of irrigation systems.
- Link infrastructure investment programs with other production and marketing programs.

Photo: © PROAGRO

Water harvesting in the Sahel Zone of Burkina Faso: Increasing yields in low-potential areas

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The context

Funded by the Federal Ministry for Economic Cooperation and Development (BMZ), GIZ and KfW with the Ministry of Agriculture, Water and Fisheries (MAHRH) implemented a joint project in the Central Plateau of Burkina Faso between 1988 and 2006. Total project spending amounted to 25.6 million Euros.

The project (PATECORE/PLT)[1] has been carried out in the three provinces of Bam, Kourwéogo and Oubritenga of the Central Plateau, which is densely populated with 65 persons/km². Its landscape is characterized by low hills with lateritic plateaus and shallow soils. The foot hills below consist of sandy to sandy-loam soils, which are used for agriculture. The valley bottoms have clayey vertisols, which are partly used for dry-season horticulture.

The area receives between 400 and 700 mm of annual rainfall, which is often locally concentrated and erratic. The population mainly lives of subsistence agriculture with millet, sorghum and cowpea as staple foods. Livestock is kept by the Mossi farmers, which are the majority of the population, and Fulani livestock owners.

Over the last decades, climate change has led to decreasing rainfall and higher rainfall variability causing frequent droughts and, consequently, crop failures. Increasing population pressure has led to indiscriminate expansion of the cultivated area, overgrazing of communal pastures and deforestation. Consequently, soils have degraded due to water and wind erosion, the natural vegetation cover has regressed and ground water tables have dropped. Productivity of soils decreased from around 900 kg/ha in the first half of the 20th century to around 500 kg today. When the project started in 1988, the area was hunger-prone and people were forced to seasonally or permanently migrate to the cities.

[1] Projet d'Aménagement des Terroirs et Conservation des Ressources dans le Plateau central/Projet Logistique Transport

The approach

The objectives of the project were to increase agricultural production in the area and to stabilize food production and security through improved water and resource management.

Based on participatory rapid appraisals, the project started to organize the farmers in self-help groups and to carry out participatory land-use planning at the village and inter-village level. Areas for cultivation, grazing, protection and other uses were identified by the villagers.

The project's main focus was on technical interventions in the fields, where contour stone rows (cordons) and stone dykes (*diguettes*) were built in order to improve infiltration rates of surface runoff. Permeable rock dams (*digues filtrantes*) were used to rehabilitate gullies in the fields. For non-cultivated communal areas, local conventions were developed with a view to regulating how to use them more sustainably.

In addition to the aforementioned soil and water conservation (SWC) measures, soil fertility was improved through the introduction of mulching, composting and regeneration of trees in the fields.

In order to transfer know-how to the farmers, a cascading training system has been set up and 2,000 farmer trainers have been trained. Apart from training, tools and transportation have been provided by the project. All manual labor has been carried out as cost-free contribution by the beneficiaries.

Results

By 2006, the project had worked with more than 400 villages with a total population of 360,000 people. This equals roughly 90 % of the total population in the three provinces. Around 98,000 ha of cultivated land were treated with SWC measures, corresponding to 50 % of all fields, with an

average direct cost of only 150 €/ha. Throughout the main construction season around 10,000 people were working and investing in their land on a daily basis. A study showed that in 2005, 74 % of the structures were still of good quality. The rest was partially damaged and, therefore, operating with reduced effectiveness. The implemented measures had a complex variety of effects:

Production was increased by:

(i) Increasing yields: Sorghum yields in grain and straw increased by around 40 % corresponding to 150 kg/ha more grain and 720 kg/ha more straw per year.
(ii) Extending the cultivated area by around 10 % by rehabilitating degraded soils that had fallen out of production.

Surplus production allowed farmers gain additional income, which was largely re-invested in animals (small ruminants, poultry), health and education. In total, an estimated 16,000 t/yr of additional grain are now produced, plus 50,000 t/yr of straw serving as fodder. This has improved food security for 84,000 people[2] and provides fodder for 23,000 cattle or 180,000 sheep. The internal rate of return has been estimated at > 10 % at farm level and 3 – 4 % at project level.

The ground water table has risen in many villages, easing the work-load of women and helping the regeneration of the natural vegetation. In the treated fields an average of 30 trees and shrubs per hectare has re-established. Today, a large number of farmer-trainers are capable of providing further extension support and farmers are organized in self-help groups. Migration has reduced and the area has been better able to accommodate refugees during the recent exodus from neighboring Côte d'Ivoire.

Success factors

Two essential features of the project were the intensely participatory approach and the requirement on beneficiaries to contribute all manual labor as free in-kind contribution. Accompanying incentives for villages (wells etc.) were abandoned after the initial phase in favor of those villages exhibiting a genuine interest in SWC measures and their long-term benefits.

The organization of farmers into farmer groups and the intensive training of farmer-trainers within each group have built up a large knowledge base, which still serves as a source of information to other organizations working in the area.

After initial negative experiences with treating entire watersheds from top to bottom, activities were strictly targeted at fields only, which allowed farmers to quickly benefit from yield increases. The simplicity of the techniques used allowed for easy construction and maintenance.

Planning activities were carried out in a bottom-up fashion by the farmer groups, who communicated their requirements to the project. Several intervening NGOs were also integrated into a joint planning process, thereby, avoiding overlaps.

The long duration of the intervention of 18 years was necessary to continuously adjust concepts and cover a critical mass of people and agricultural lands to have impact at the landscape level.

Challenges

While food for an additional 84,000 people is now being produced annually, the population has increased by about the same number throughout the project's lifetime (increase 1989 to 2004 = 80,000 people).

The cost for the use of trucks is low (~80 €/ha) but nevertheless exceeds the readily available cash resources of farmers wanting to extend the SWC measures. There is no national institutional / financial mechanism to continue the activities despite further potential of another 500,000 ha. Only some NGOs continue with small-scale activities. SWC measures require long-term commitments, at odds with the short-term project approach of most donors.

Recommendations

National long-term funding mechanisms have to be developed, which allow for long-term implementation of SWC and water management activities (e.g. National Water Management Fund) and for follow up of activities by national extension services.

With high population growth, the potential for long-term food security improvements by means of SWC measures are limited. Efforts therefore have to be combined with interventions centered on family planning and reproductive health.

[2] 190 kg/yr per person

Reducing the vulnerability of small dams to climate change to improve food security in Burkina Faso

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The context

In Burkina Faso, catholic missionaries started building small dams already during the colonial period. Some 1001 dams, 556 artificial ponds, 227 natural ponds, and 10 natural lakes have been sensed in 2011 (Map below).

Heavy rains and flooding like in in 2009 caused damage to many of the dams and irrigation structures. As a response to the dams' degradation, the project "*Reducing the vulnerability of small dams to climate change in order to optimize their contribution to food security*" has been launched in June 2010. The project is implemented by the Ministry of Agriculture and Hydraulics of Burkina Faso in partnership with two public agencies AGETEER[3] and FEER[4]. These agencies are responsible for the infrastructure component of the project while the project coordinating unit takes care of the "soft" component. It is the first pilot project to deal with climate change adaptation of dams and irrigation systems in Burkina Faso. Sweden is providing the bulk of the project cost (103 million SEK), while the Government of Burkina Faso (GoBF) brings in necessary staff and facilities worth 10 % of the Swedish contribution.

[3] Agence de Travaux Eau et Equipement Rural
[4] Fonds de l'Eau et de l'Equipement Rural

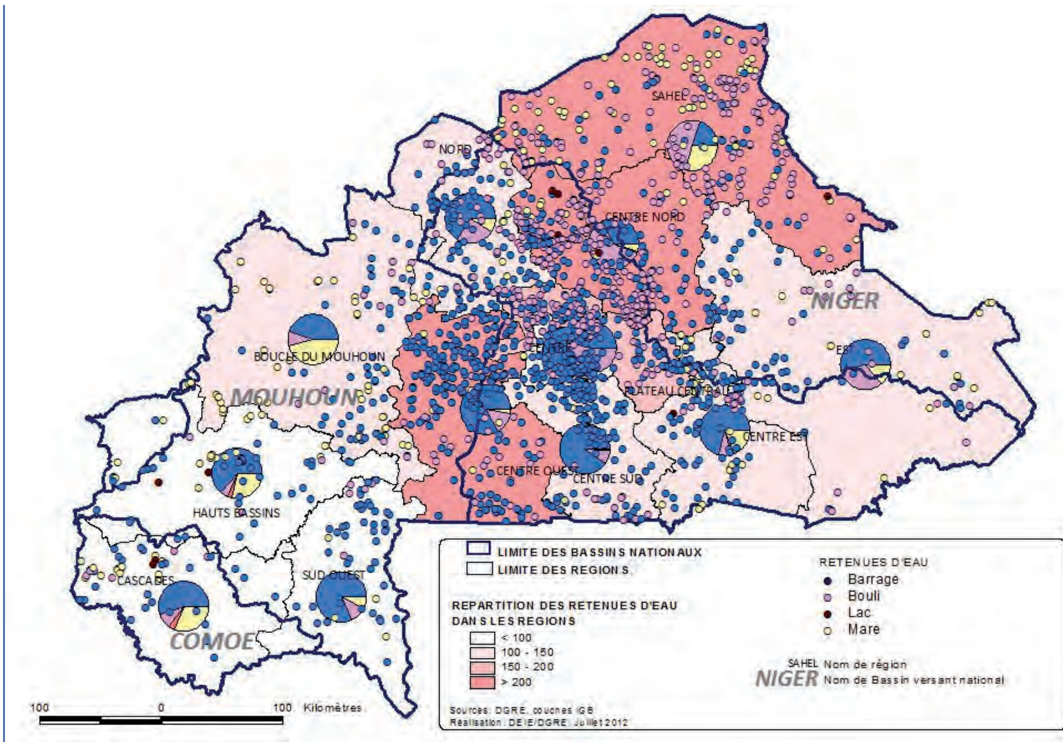
Project description

Outcome objective: To contribute to food security and poverty alleviation through harvesting and optimal use of water for agro-sylvo-pastoral production and fisheries, while integrating the dimension of climate change adaptation.

Intermediary/bridging objective: To create political, institutional and economic conditions for sustainability through the following activities:

a. establishing inclusive water users committees to manage the dams and irrigation structures;
b. training beneficiaries and giving them financial and material support to allow them producing food and fish;
c. raising awareness among communities surrounding the dams on control of water borne diseases and protection against HIV-AIDS;
d. developing a pilot early warning system for floods and drought management;
e. promoting innovations on efficient and affordable water transfer and small scale irrigation systems;
f. promoting the rights perspective in project implementation, with special regard to access to water for food production.

Output objectives: (i) to ensure the construction and rehabilitation of resilient dams and irrigation systems (carry out feasibility studies, effective control of works); (ii) to build fish ponds; (iii) to develop a national policy and strategy regarding dam construction, maintenance and rehabilitation.



Map from DGRE provisional report on dams' sensing, 2011

Successes

The project seems to have been very successful in implementing output objectives 1 and 2: Two new climate change resilient dams were built and are the pride of the project. Ten new hectares of land were prepared for irrigation along with 10 ha of fish ponds. Ten degraded old dams and 25 ha of irrigated land were partially rehabilitated. Success factors were: (i) availability of technical competence within the implementing agencies, (ii) appropriate funding and (iii) good quality feasibility studies.

Challenges

Some poor quality feasibility studies have failed to identify appropriate adaptation measures. Additional works are therefore still needed in order to increase resilience of dams and associated irrigation systems. Very little progress has been made towards achieving results related to the bridging objective (building economical and institutional sustainability), which appears to be the most difficult to implement. Intermediary firms and two specialized NGOs will be contracted by the project to give support to the Coordinating Unit to boost the implementation of the bridging objective 3 and output objective 4. The low performance has been due to the fact that:

- priority has so far been given to the infrastructure component of the project;
- the Project Management Unit had limited staff and lack of socio-economic competence.

The project has decided to carry out additional studies to complete the rehabilitation of most of the dams and irrigations systems.

Obstacles

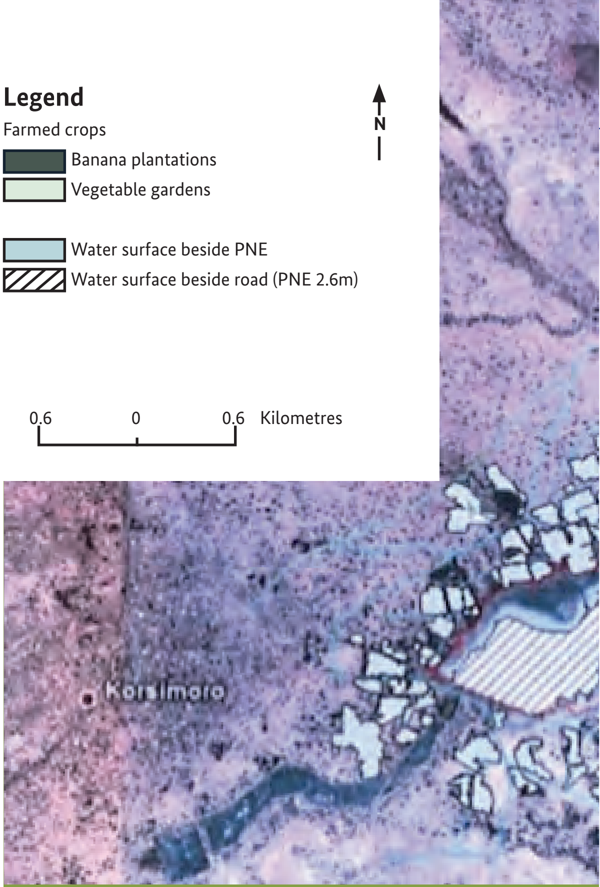
Rehabilitating old dams by integrating climate change adaptation has limits: it seems difficult to make something new from the old. Depending on the nature of the reparations, rehabilitation costs vary from 2 to 46 % of the initial cost of the dam. Population pressure relayed by the water administration, to get quick rehabilitation of the dams does not leave room for sound reflections to design appropriate adaptation measures. In addition, a high number of dams were selected but the project budget was not enough to cover the costs. Awareness of dam specialists is limited regarding adaptation to climate change. Often, adaptation is limited to the dam component neglecting the irrigation system and the social component. The project has carried one seminar on climate change adaptation and a lecture on the Rights' perspective has been given.

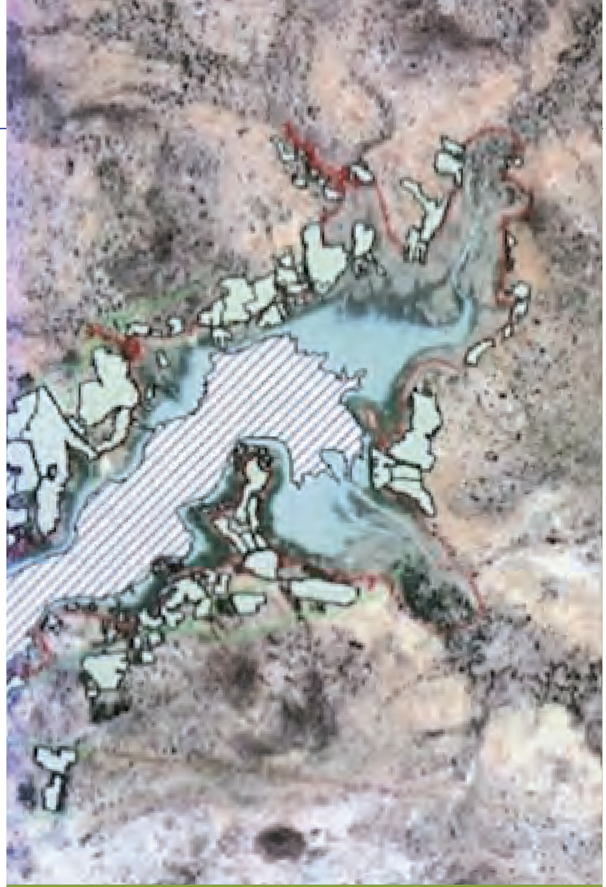
Opportunities

There is goodwill of the GoBF and the Swedish Government to pursue their cooperation. It is, however, necessary to get other donors on board to tackle this challenge. The Swedish funded pilot project has underlined the need for action research on cost efficient resilient small dams and irrigation systems. Mobilizing sufficient funds has so far proven difficult as donor support to dam development is currently weak.

Lessons learnt

Technically it is rather easy to improve the resilience of small dams to climate change. Even though no complete protection against climate change exists, risks can effectively be reduced. The additional costs due to the introduction of climate change adaptation technologies is estimated between 7 to 12 % for new dams and 2 to 42 % for upgrading of old dams. Surprisingly, introducing technologies for more efficient water use has resulted in cost savings up to 37 % and increased irrigation efficiencies from 60 % to 90 %. For scaling up, strong political support and sound feasibility studies will be needed along with long term and flexible funding. However, the current political and institutional framework for dam building, maintenance and rehabilitation is confusing, which reduces possibilities. Mainstreaming human rights, gender and the perspective of the poor in small dam irrigation





Spontaneous upstream irrigation. Photo: © IWMI Gerbrandy

systems remains a challenge. Usually, the poor have no access to irrigated plots around the dams.

The way forward

In order to further adapt small dams to climate change in the future, a number of aspects have to be considered. Secure funding has to be secured and ways needs to be found how to make the best use of stored water in an equitable, economical and sustainable way.

From a political and institutional point of view, it is surprising that even after 50 years of dam development in the country, no clear policy or strategy on dams does exist. The current institutional framework for dams is confusing and – as a consequence – 40 % of the dams in Burkina are degraded and need to be rehabilitated. Most of the dams have reached their life time and urgently need a detailed risk assessment in a context of climate change.

From a research perspective, this pilot project opens the way for a continued action research on cost-efficient resilient small dams and irrigation systems. The goodwill and commitment of the Governments of Burkina Faso and Sweden to pursue their cooperation is needed for that. At the same time, it is necessary to get other donors, actors and partners engaged.

From a conceptual perspective, there is a need to revise the current concept of small dam irrigation[5] but it is difficult to be put into practice without a mental revolution of dam and irrigation specialists. The following aspects need consideration: to revise the concept and operation of water transfer; to redesign upstream irrigation; to better assess and monitor water table recharge around the dams in order to make better value of the dams; to design new irrigation systems that promote human rights, gender and poverty reduction.

From a financial perspective, adapting small-scale dams and irrigation systems to climate change, and assuring future maintenance and re-investment is complex and needs long-term and flexible funding.

For the project, the immediate way forward is to further promote water transfer and upstream irrigation as a means to mainstreaming human rights, the poor and the gender perspective; to design participatory early warning systems for small-scale dams and to design a policy and strategy for small irrigation dams in the context of climate change.

[5] IWMI Burkina Faso, April 2012 : « Repenser les petits barrages dans un cadre inclusif: Quelles options de stockage de l'eau pour la sécurité alimentaire ? ». Jean-Philippe Venot Chercheur

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