WAHARA - Report Series

Report on options and enabling conditions to achieve spreading of Water Harvesting in Africa

Authors: Abraham Abhishek, Luwieke Bosma, and Francesco Sambalino

Date: 20-04-2016
Report number 37
Deliverable 6.1

Series: Scientific Reports

This report was written in the framework of the WAHARA project – www.wahara.eu

Deliverable 6.1: Report on options and enabling conditions to achieve spreading of Water Harvesting in Africa

Abraham Abhishek, Luwieke Bosma, and Francesco Sambalino

MetaMeta

Contents

1. Introduction

1.1. The WAHARA Project

Water harvesting (WH) presents highly adapted, flexible, easy to understand and implement, low-cost solutions to the productivity, climate adaptation and water security challenges, primarily by building water buffering capacity. WH technologies include centuries-old systems developed by local knowledge but also innovative new approaches. Together, these approaches hold great potential to boost economic development and sustain livelihoods in rainfed Africa. However, to unlock this potential, and despite the fact that WH has over the years received substantial interest from the research community, there is still considerable need for further advancement of knowledge.

The WAHARA (Water Harvesting in Rainfed Africa) project aims to contribute to a better understanding of the possibilities presented by Water Harvesting by identifying and field-testing promising technologies; assessing the potential of their biophysical, socio-economic and political uptake; and outlining a strategy to promote their scaling-up. While the research project's activities are located in four countries-- Tunisia, Ethiopia, Zambia and Burkina Faso-- the findings and deliverables are pertinent to the broader context of Africa. This has been ensured through the choice of research questions and design of the research methodology, especially where it pertains to the enabling conditions for the spread of water harvesting technologies (WHTs) which this report focuses on.

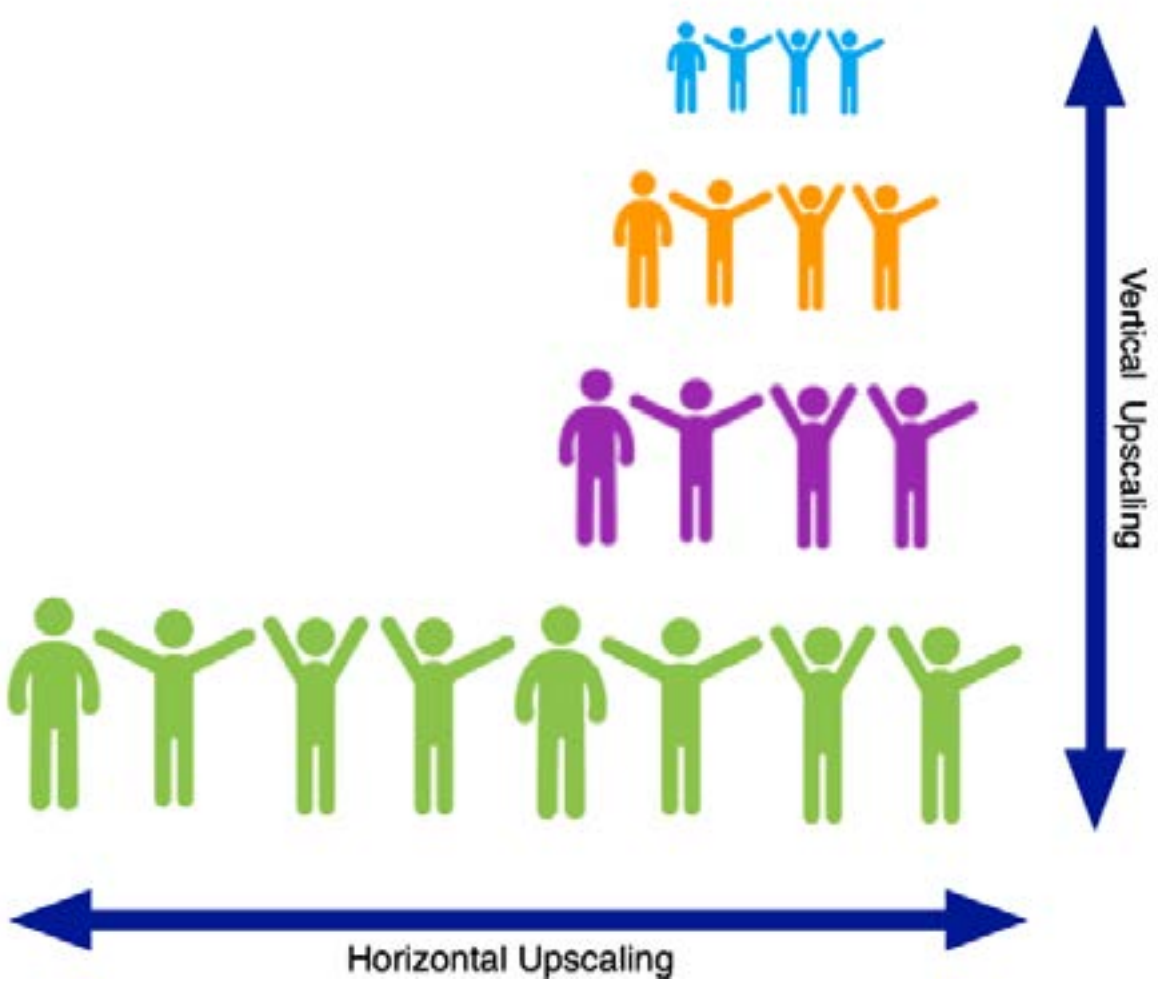
1.2. Analytical Framework

This report comprises of 4 country-specific sections that are based on literature review and fieldwork in Ethiopia, Burkina Faso, Tunisia, and Zambia. The fieldwork was carried out around the study-sites where the technologies were being field-tested. It includes interviews with key stakeholders-- farmers, extension workers, government officials, businesses-- that determine how enabling or discouraging the environment for the spread of WHTs is. It was prepared as part of Work Package 6, which focuses on the adoption, knowledge transfer and dissemination of WHT. The key questions it aims to answer are:

- Who are the key stakeholders in agriculture/ WH in the region/country?
- What are some of the most widely disseminated WHTs there?
- Under what conditions (policy, social, economic) and as a result of what efforts did the WHTs disseminate widely?
- Which of these enabling conditions and efforts can be replicated or built upon?
- What lessons can be drawn that are relevant to the spread and upscaling of WHTs in general?

As the questions suggest, this report focuses on socio-economic, governance, and policy conditions that enable the spread of knowledge related to WHTs and facilitate their adoption. This is in accordance with the purview of Work Package 6 of the project.
Enquiry along these lines presented a multitude of data and insights. A recurring idea among interviewees was that many of the variables-- farming systems, learning environments, socio-economic realities-- are context-specific and vary from country to country and at times even region to region. An analytical framework was adopted to analyse the various country-specific findings, identify common strands, and

draw general conclusions relevant to Africa and beyond. So this report identifies various strategies employed towards the dissemination of WHTs and analyses how they contribute towards horizontal scaling up (geographical spreading of innovative practices)[1] and/or vertical scaling up (spreading across various level of stakeholders). In the specific context of spreading of WHTs, horizontal scaling up would refer to spreading a technology among larger and larger number of farmers. Vertical scaling up would mean disseminating a technology across the various levels of stakeholders such as the farmer, the extension worker, bureaucrats, policymakers, businesses, NGOs etc.



For a WHT to truly spread, both horizontal and vertical scaling up are necessary. It is when a technology finds approval across the gamut of stakeholders (vertical scaling up) that comparative advantages are identified, value chains develop, and efforts harmonized. This facilitates uptake by a larger and larger number of farmers (horizontal scaling up).

1.3 About this report

Chapters 2-5 focus on the four WAHARA countries-- Ethiopia, Burkina Faso, Tunisia, and Zambia. They map out the stakeholders involved in agriculture and WHTs, and the environment they provide for the spread of WHTs. Each chapter also selects a particular WHT/ group of WHTs and traces the pathways through which they spread. An analysis is then made of the processes and initiatives that led to their spread, and what

[1] Linn, J., 2014. How to Reach Millions of Poor Farmers by Scaling Up Agricultural Technology**.** *Feed the Future*, [online] Available at: <https://feedthefuture.gov/printpdf/1758> [Accessed 22 December 2015].

conclusions can be drawn therefrom as to the enabling conditions and impediments. Chapter 6 draws on the analyses in the four country-specific chapters and reflects upon the question "What constitutes enabling conditions for the spread and upscale of WHTs?"

2. Ethiopia

Ethiopia is a very diverse country with a remarkable and distinctive history. In this chapter a short introduction with general country information specific to the agricultural context is provided at first. Consequently, the agricultural extension landscape is explained in order to grasp how this has developed over time and what systems are currently in place. Furthermore, the focus moves on WH technologies and how they are implemented through integrated and community-owned watershed management. Finally we conclude with key findings on options and enabling conditions for spread of WH.

2.1 Introduction

Home to 96 million people (2014), with sprawling diversity in terms of agro-ecosystems and livelihoods systems, Ethiopia is unique among African countries. From the afro-alpine mountain tops, through the temperate highland plateaus, until the ever dry lowlands, Ethiopians have adapted through different combinations of agrarian and pastoralism to these ever changing conditions. Historically, the ancient Ethiopian monarchy maintained its freedom from colonial rule with the exception of a short-lived Italian occupation from 1936-41 thus helping to preserve a strong cultural identity. In the 20th century there have been considerable political changes and unrest in Ethiopia. Transforming from a socialist state under the Derg regime (1972-1991), to a parliamentary state and within this time the country went through severe droughts and famines, refugee fluxes and uprisings. Currently Ethiopia's economy is growing under its state-led Growth and Transformation Plan (GTP). The GDP growth steadily score high in Ethiopia, although per capita income is among the lowest in the world. Ethiopia's economy is largely based on agriculture, it accounts for 47% of the GDP and 85% of the total population is active in agriculture. However, the agricultural sector suffers from poor cultivation practices and frequent drought. The Government of Ethiopia has put agricultural development high on the agenda, and recent joint efforts of the government and donors have strengthened Ethiopia's agricultural resilience.

In Ethiopia there is a long tradition and strong connection between landscape and culture, and a combination of WHT has for long been in place. After the 1973-1974 drought and famine interventions started with the food-for-work (FFW) programmes in order to create job opportunities for people affected by drought. This also included implementation of a number of WHT in Tigray and other areas in Ethiopia. During the Derg regime (1972-1991) that followed state ownership was promoted with top-down development planning including soil and water conservation planning. Since the new government took over in 1991, there has been a gradual shift towards more participatory community-driven development. In 1997 the National Environmental Policy of Ethiopia was adopted, in which attention was given to involve water resources users and to recharge groundwater and surface water resources. From here more attention was given to develop small scale irrigation and water harvesting schemes in Ethiopia. The focus in this chapter will be on Tigray where agriculture is the economic mainstay and several projects in WHT and SWC have been implemented over the last 40 years.[2]

Agricultural landscape in Tigray

Farming is the economic mainstay in the study area as is the case in most rural areas of Ethiopia's highlands. The rural households in Tigray depend heavily on agriculture to sustain themselves. More than 60% of the income is generated from agriculture, which is mainly rainfed. Land, together with amount and distribution of rainfall are two of the basic inputs that determine agricultural productivity. Land as well as all natural resources are under public ownership in Ethiopia. The Ethiopian Constitution (Article 40)

[2] Abebe, A. et al. Chapter 5, Ethiopia: opportunities for building on tradition – time for action. In Critchley, W. and Gowing, J. 2012, Water Harvesting in Sub-Saharan Africa.

provides land use rights but not ownership rights. Selling and mortgaging of land are prohibited, farmers can also not accumulate land, although user rights can be inherited, rented or sharecropped for some time. Land happens to be one of the three most important resources at the possession of rural households in Tigray; the others being labour and livestock. The conditions, combined with the small size of landholdings, deteriorating soil fertility and highly variable/erratic rainfall are a major challenge to the income of households and hence to their livelihood.

Therefore, the regional government has long time ago designed and implemented a conservation based agricultural strategy. Integrated watershed management (soil and water conservation, area closures, etc), coupled with water harvesting are the primary foci to boost agricultural production and productivity. Wide ranges of water harvesting techniques have been implemented in the Tigray region in general and in the study areas in particular.[3]

2.2 Agri-extension landscape

In this section a description is provided of the agricultural extension landscape. In order to gain more understanding of how this is taking place in Ethiopia, at first the government system is outlined as agricultural extension and spread of WHT has a strong governmental foundation. Furthermore, the agricultural policies are discussed and the role of NGOs and private sector in the development of Natural Resources Management (NRM).

2.2.1 In a nutshell - government and extension in Ethiopia

Ethiopia is a federal country that consists of five tiers of government: federal, regional, zonal and woreda. Following the 'constitutional' legal framework, the country is composed by nine regional states. Regional governments were established based on ethnicity and language. The regional states are subdivided into sixty six zones that are further sub-divided into 776 woreda's (each roughly consisting of 100.000 people). And under one woreda there are many Kebeles that are the lowest administrative unit.

At the federal level the Ministry of Water and Energy (MoWE), and the Ministry of Agriculture and Rural Development (MoARD) are responsible for preparing national water and agricultural policy, strategy and action plans. In addition to their regulatory role, the ministries also give technical advice. At the regional level the Bureau of Water Resources Development and the Bureau of Agriculture and Rural Development are responsible for the implementation of federal agricultural and water resources policies by adapting them to the specific conditions of the region. Regional bureaus also provide technical support to Woreda's, as they build capacity for agriculture and water management. At the Woreda level, Woreda Water Resources Development Bureaus are responsible for the planning, design and implementation of small-scale water resources development schemes. The Agricultural and Rural Development office is responsible of all the extension activities carried out at Kebele level where up to three Development Agents (DAs) are based and offer service to the community. All watershed plans are compiled by DAs, aggregated by Woredas and approved by Zonal Agriculture and rural development office. The Bureau of agriculture is also represented at Kebele level, whereas the bureau of water is not. This fact alone highlights the importance of the three DAs in reaching out to farmers when it comes to technologies and skills related to WH.

Distinctly the different levels require a certain interpretation and transformation of knowledge. In Ethiopia, a large demand and urgency exists for water harvesting solutions in many areas. Knowledge is transferred not only through the government but also through NGOs and the upcoming private sector.

[3] Nega, F. and Woldearegay, K. 2015, Farm household agro-socio-economic survey in Ethiopia – analysis report. WAHARA report series, report number 26. Series: Scientific Reports.

2.2.2 Putting water harvesting into practice - agricultural policy in Ethiopia

Extension service was introduced in Ethiopia more than 50 years ago and despite its long lasting establishment it suffered from discontinuity of approaches. Extension changed radically with the political and societal changes that occurred in Ethiopia. Alongside the move from Feudalism, to Marxism to a free market system also the extension services suffered major adjustments. At the moment extension is mainly provided by the public sector with the exception of few NGOs and private sector initiatives. For the most part extension focuses on three main areas: crop production, livestock production and natural resource management (NRM). The focus reflects the structures and availability of DAs at Kebele level (i.e. crop production, livestock production and NRM). It is within Natural resource management that the extension system is taking major steps in rehabilitating watersheds and introducing and scaling up Water Harvesting technologies.

In the national extension system the NRM DAs play a vital role in the introduction of Soil and Water Conservation (SWC) and Water Harvesting Technologies (WHT). The NRM DAs provide the expertise necessary for the introduction of such technologies in SWC and WHT, and play a key role in watershed planning.

Following the national Growth and Transformation Plan (GTP) framework, the GTP of the regional government of Tigray emphasizes integrated watershed management as a principal strategy of not only conserving the environment but also enhancing soil fertility and water availability so as to increase agricultural production and productivity.[4] Through the Community Based Participatory Watershed Development Guidelines all local government offices in Ethiopia have a theoretical framework to follow when planning water and land management on a watershed scale. The watershed rehabilitation efforts entail the adoption of a vast variety of measures that includes many soil and water conservation technologies and rainwater harvesting measures. Each community, Kebele and Woreda is bound to follow the guidelines as outlined in "Community Based Participatory Watershed Development guidelines" and create plans for their area of interest.[5]

Once the plans are approved at Woreda and Zone level the *implementation phase* can start. The government offices have a prominent role in the whole process, but the ultimate choice and approval of any measure must come from the community. The Woreda, the Zone and the region are supporting the community with technical backup, process coaching and in case of need with supporting schemes for the weakest members of the community. The community will participate in all implementing steps and beyond, and working groups are created. It is of key importance that the community finds an agreement on the kind and size of contribution each household will put forward to implement the Community watershed plan.

2.2.3 Role of NGOs, CSOs and private sector in WHT

Non-governmental Organisations form a key component of the civil society in Ethiopia. Their presence in the country dates back to the mid-1970s, when (mostly foreign) NGOs took up the task of famine relief that appeared to be well beyond the federal government and rebel groups locked in civil war. Since the end of the conflict in early 1990s, their numbers have only grown. This has also led to a proliferation in the number of domestic NGOs.[6] Together, the two have formed a 'non-government' sector that represents a substantial amount of financial resources, technical know-how and experience in implementing development programs. They are, therefore, natural stakeholders in any substantial intervention with regards to natural resource management. The interest and high importance given by the government to rainwater harvesting is apparent in a number of policies and initiatives:

[4] Nega, F. and Woldearegay, K. 2015, Farm household agro-socio-economic survey in Ethiopia – analysis report. WAHARA report series, report number 26. Series: Scientific Reports.

[5] Desta, L., Carucci, V., & Wendem-Agenehu, A. (2005). *Community based participatory watershed development: a guideline*. Ministry of Agriculture and Rural Development (MoARD).

[6] Markakis, John (2011) *Ethiopia: The Last Two Frontiers,* New York: Boydell & Brewer Ltd.

- The Sustainable Development Goals (SDG) 2015-2030 as part of the post 2015 development agenda developed and adopted by 193 countries. Water harvesting is explicitly mentioned under goal 6
- NAPA – National Adaptation Plan of Action – June 2007
- Small Scale Irrigation and RWH were central to Ethiopia's strategy on agriculture and rural development
- GTP – Growth and Transformation 5 years Plan for the Agriculture Sector (2010 – 2015) where irrigation is central – follow up after PASDEP (Plan for Accelerated and Sustained Development to End Poverty)
- Green Growth Plan of Ethiopia – until 2030.
- Food security strategy (for the chronically food insecure and less chronic) – PSNP (Productivity Safety Net Programme) – public works (PWs)
- The Water Bank Concept – at least one RWH structure per rural HH – related to other countries
- Community managed watersheds are promoted by many projects such as PSNP, SLMP, TBIWRDP,etc.

The government views the big NGOs as one of the important partners in implementing NRM and spreading know-how about related technologies. The NGOs view themselves as the dynamic agency at the forefront of knowledge transfer. There are two distinct points on which both agree:

1) In Ethiopia, NGOs—among a number of other agencies—are key to the process of natural resource management given the substantial resources, expertise and experience they possess.
2) Nevertheless, with all its resources and authority, it is the government which is best placed at scaling up technologies that work. So government uptake is key to whether new knowledge/solutions are able to realise their potential.

Cooperatives are increasingly playing a major role in many social and economic activities, including activities somehow related to Water Harvesting (Tesfamariam. K., 2015)[7]. Forestry, dairy and micro-irrigation cooperatives can in fact benefit from subsidized loans which can be used to implement small scale WH techniques to boost their production. In 2014 the overall number of cooperatives raised to 53,982 from 26,672 cooperatives as it was reported in 2009 (Tesfamariam. K., 2015).

With the advent of the el Niño in 2015, the government has mobilized 700 million birr to build water harvesting structures as countermeasure to face the expected droughts[8]. Likewise in Amhara mass mobilization in late 2015 focused on water harvesting. Between 0.75 millions of people and 1.5 million people participated in the mass mobilization for its implementation (see image below).

[7] Kifle Tesfamariam, 2015, Cooperative Movement in Ethiopia: Development, Challenges and Proposed Intervention. Journal of Economics and Sustainable Development

[8] Gashaw, G., 2015. Ethiopia: Preparedness to Address El Nino Impact. *The Ethiopian Herald,* [online] 14 August 2015. Available at: <http://allafrica.com/stories/201508140776.html> [Accessed 12 January 2016]

Women group involved in the community work to build contour trenches during the El Nino Campaign in 2015, Amhara region (Image Courtesy: Amhara Bureau of Agriculture)

In Tigray, as in most of Ethiopia, *the private sector* is small, and concentrated in the service sector. Besides, it is largely informal which means most enterprises are small, employing less than 5 employees.[9] This indicates a low capacity of the private sector to scale up, innovate and help establish the necessary supply chains when a technology is introduced in the region and demonstrated to be worth adopting. When check dams were introduced in the region and demonstrated to be effective, scaling up their use to treat gullies was much hindered by the lack of local entrepreneurs who could take up the manufacture of gabion meshes. At some point Relief Society of Tigray (REST), a local NGO, took it upon itself to set up a gabion factory (1991).[10] It now has several units in various parts of Tigray. However, they serve less as enterprises that respond to market demand, and more as producers of an input necessary to REST's (and the government's) ongoing work.

One area in which the role of private sector has increased in Ethiopia is technical training. This happens through designated Technical Vocational Education and Training (TVET) centres in Ethiopia. In the context of Natural Resource Management, TVET centres are important as they serve to train the youth into becoming mechanics, repairmen and DAs who become implementers and managers of water harvesting and soil conservation management interventions.[11]

In general it can be said that the adoption of water harvesting measures in Tigray is in all cases mediated by external intervention by government agencies or NGOs. Government in Ethiopia builds upon a strong

[9] The World Bank' (2009) Ethiopia Towards the Competitive Frontier: Strategies for Improving Ethiopia's Investment Climate

[10] Personal Interview with Teklewoini Assefa, Director, Relief Society of Tigray (2012)

[11] Krishnan, Pramila and Shaorshadze, Irina (2013) *Technical and Vocational Education and Training in Ethiopia,* Working Paper, International Growth Centre: London

system and enforce agricultural policies to lower levels. This has led to the uptake of a combination of NRM measures on a catchment scale with a mass mobilization of community members. However, spontaneous uptake by individual farmers or communities is patchy, not only in Tigray, but throughout the country.

2.3 Farmer-led innovation in WHT and SWC

This section goes in-depth on the practice of innovation and participatory technology development. This takes into account innovation values as perceived by the community and how they deal with local and external innovations. In addition a number of WHT often combined in Tigray are briefly discussed. Furthermore, a focus is on how knowledge is created through a participatory approach and examples of how this is taking place are provided. Finally an analysis is given of farmer-led innovation and it is discussed what lessons can be learned.

2.3.1 Innovation values

Innovation is a broad term, which captures both the invention of a completely different way of working and/or a modification of an existing technology. This broad perspective creates a challenge in distinguishing an innovative farmer. Because each farmer has to be an innovator to some degree. In addition there is a great variety in farms with respect to characteristics of the household, plot size and conditions and many physical structures. Two plots are not treated in the same way by one farmer, let alone by different farmers. What this explains is that a technology cannot be applied in an identical way in different plots, modifications per site will be necessary. Besides spatial variability, the time dimension also demands innovations. Although, the basic principles or functions of a technology remain the same.

Innovation in the community

Innovations and innovators are evaluated as integral part of the whole system. No innovation stands on its own, it is within the needs of the community that it gains appreciation and is being used. In Ethiopian rural communities, there is a traditional sharing of ideas and skills. This can be in terms of soil conservation measures, but also in sharing techniques and skills in the traditional exchange of labour. Besides, there is mutual support among farmers in times of drought. In those circumstances farmers can borrow different local seed varieties from farmer innovators who have already experimented with this. Additionally, due to population pressure and scarcity of land, some land on steeper slopes has to be used for cultivation. Usually, farmer innovators who were allocated land on the slopes experimented with various SWC techniques in their attempts to make the land productive. Other farmers learned from them through observation and adapted suitable measures to their own situations. This sharing of knowledge saves effort and time, and enables further fine-tuning of technologies in use.

In general local innovations are considered better by local farmers. Community members are proud of and more confident in the innovation by their community member. Any innovation that does not fit into community values is not easily accepted or integrated as a common practice and the innovator also has acceptance problems. With the introduction of Fanya Juu terraces in Tigray, farmers directly pointed out that the local solution of traditional ditches and level bunds was preferred. They showed a certain pride in their local solutions and were more confident of its effectiveness.

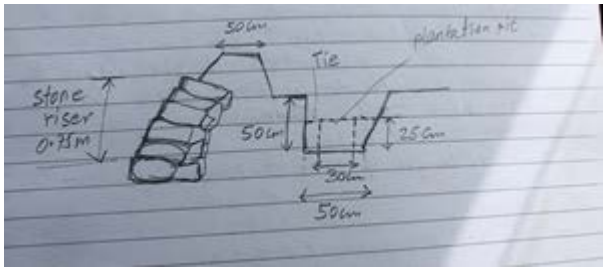
Farmers to farmers' extension is becoming a more common way of extension for Ethiopian communities. Nowadays, in some Woredas (e.g. Doba Woreda) farmers that are considered model farmers or farmer innovators travel from area to area occasionally to share their knowledge with other farmers that live in similar conditions.[12] Farmers are proud to be seen as innovators and see it as an honour to be in touch with other realities where their knowledge is appreciated. Also in Tigray farmers who join in seminars have become more common in the last years. The first experiments with this approach were carried out in 1998 and turned out to be successful. Consequently the regional government started to organize similar events such as farmers' fora where farmers come together and share their experience on farming, SWC and water

[12] Francesco Sambalino, Program Manager, MetaMeta. 2015. *Personal Interview*. Interviewed by Luwieke Bosma. [Interview Notes]

harvesting technologies.[13] In the box below an example is provided of how farmers adapt technologies as introduced by the government.

Decentralized knowledge

Capacity building comes from the government higher offices in many instances, but some shining cases of locally developed; highly contextual knowhow is sometimes present at Woreda and Kebele offices. Ato Deribe from Doba Woreda in West Hararghe is one of these individuals that adapted the government technical guidelines to the local context. In 15 years of experience with Water Harvesting he adapted the technical design of many technologies to fit the needs and capacity of the communities he works with. In Doba Woreda people have used stone terraces for generations. Ato Deribe is aware of this locally available resource and adapted the design of stone terraces, bunds, herring bones and eyebrows according to it. He modified and improved the government design and made notes of all the specifications in his notebook that he updates constantly with new ideas and details (see Figure below). The new design of the technologies is well accepted by the community and it translates into an efficient implementation with improved quality and longer-lasting structures.



2.3.2 Technologies

According to the participatory community watershed development framework, all measures applied in a watershed are strictly interlinked and are part of a bigger plan. Water harvesting measures are therefore seen just as a piece of a more complex intervention that also include agricultural, forestry, livestock and income generating interventions. The different watershed parts influence one another. Instead of only focussing on the more vulnerable rain fed cultivation on gentle slopes, it is also important to take the upper slopes into regard as erosion problems are starting in these areas and they can be used to catch rainfall and increase soil moisture. As a result WHT in upper slopes can also improve soil moisture and fertility in lower slopes and lower irrigate areas, on which most cultivation is taking place. This is also called a landscape approach, in which the different assets of the landscape are taken into account. Different methods can enhance each other's functioning, and therefore an integrated approach is needed.

The different technologies of SWC and WHT are very diverse and involve physical, biological and agronomic measures. In addition, one technology can have different functions within a plot. Some technologies are fixed, such as bench terraces, and some are mobile and can for instance function to improve fertility. There are techniques in use that harvest water, or drain excess water, which can happen in the same field at different times of the year. These measures can be combined with agronomic practices, such as ploughing, seeding and intercropping. Technologies implemented in Tigray region Ethiopia include bench terraces, percolation ponds, check-dams, shallow groundwater wells and soil moisture improvement. But all these can be developed and implemented in an incorporated manner. Different methods can enhance the functioning of the various techniques.

[13] Fetien Abay et al., 2001, Facilitating farmer-to-farmer communication about innovation in Tigray, From Farmer innovation in Africa

Bench terraces have been introduced in Tigray as part of government campaigns of SLM and WHT, and they are now becoming among the highly accepted technologies used for creating productive land and enhancing food security. Bench terraces are a series of levelled strips that run across a slope at vertical pre-identified intervals, often supported by steep banks or risers. Level bench terraces can be used for crops that need flood irrigation and impounding water. Upland bench terraces are mostly in use for rain-fed crops, or crops that require water only in the dry season, these are sometimes given a gentle side slope to drain excess water. Bench terraces have a positive effect of reduction of runoff and its velocity, in minimizing soil erosion, and conservation of soil moisture and fertility.[14]

Percolation ponds are a multi-purpose conservation structure depending on its location and size. It can both store water for livestock and recharge groundwater, the latter in turn improves soil moisture and mitigates the effects of drought. It can be constructed either by excavating a depression to form a small reservoir, or by an embankment to form an impounded type of reservoir. Percolation ponds can also aid in the recharge of shallow wells, boreholes and springs.

Check dams are small dams constructed across a water way, mostly in concentrated-flow areas, in which they reduce flow velocity in order to reduce erosion. Under conditions of low-flow, water ponds behind the structure after which it can seep through the check dam, infiltrate or evaporate. When there is high-flow the water will flow over the structure. They have been of great contribution in a number of ways: reducing gully erosion, enhancing groundwater recharge, storing sediments and buffering moisture, and enhancing moisture availability at landscapes.

Shallow groundwater wells: The extraction of shallow groundwater potential is determined by the soil type, static water level, and user requirements. Hand dug wells are common throughout Ethiopia and are constructed in many different ways, manual wells, however, are still the most common. Water in shallow wells is commonly available year-round and therefore provides an alleviation of water scarcity in dry seasons. Moreover, it can be used ad hoc and is therefore beneficial for irrigation practices, also because it allows for low-cost pumping technologies. There are also a number of constraints linked to this technology, these include clay layers which decrease water yields and pollution hazards in shallow groundwater.[15]

Soil fertility improvement measures have proven to have a good potential for enhancing productivity as these methods would increase rainwater use efficiency.[16] It often occurs that the excess moisture available through WH is not fully benefitted from if some forms of fertility enhancement are not in place.

2.3.3 How to innovate jointly?

In the past, promoting SWC was rather about transferring technologies that were introduced from outside. In Ethiopia, these interventions depended mainly on mass campaigns and externally financed food-for-work schemes. Traditional practices and local knowledge of farmers was barely taken into account in these campaigns, more important there was little attention to what motivates farmers to improve their land husbandry systems and what fits to their specific situation.

The Indigenous Soil Water Conservation (ISWC) program took a different approach from what has been done in Ethiopia and commenced with its work in Tigray. It deliberately sought to include a wide array of people from agricultural research, extension and education institutions in order to identify and encourage farmer innovation. The program has a people orientation, focusing on what motivates people and working on the attitudes. The objective is to encourage scientists and development agents to join farmers' ongoing

[14] Food and Agricultural Organisation of the UN, (Publication Year Unknown). *Continuous Types of Bench Terraces*. [Online Document Repository] Available at: http://www.fao.org/docrep/006/ad083e/ad083e07.htm [Accessed 04-01-2015].

[15] Spate rrigation Network, 2015. *Status and potential of groundwater use in Ethiopian Floodplains*. [pdf] Available at http://spate-irrigation.org/wp-content/uploads/2015/03/OP17_Flood-wells-Ethiopia_SF.pdf

[16] Woleadregay,K., Ouessar,M., Sawadogo,H., Wamunyima,S., Hessel, R. [eds], 2015. *Final Report on Adaptation and Performance of Water Harvesting Technologies*. Wageningen: Alterra.

experimentation. In this sense scientists and DAs become participants in farmer-led agricultural development. For this the ISWC program is discussed below in order to find out about how farmer-led innovation has been implemented in Ethiopia. [17]

The idea behind ISWC is to encourage local knowledge and creativity in order to give it public recognition and raise its social esteem. The following means are examples of how this can be done:

- *Awarding top innovators*: the staff of Bureau of Agriculture and Natural Resources (BoANR) has organized meetings in which local farmers with outstanding innovations are honoured. Top innovators at district level were selected in each village and they were awarded prizes, this consisted of a certificate as top innovator and a sum of money. The ceremony also included visits from locals to the farmers of the innovators to see what they have invented. At a regional ceremony the zonal winners were invited to explain their innovations and to share their ideas on how to spread this innovation. These meetings were attended by a wide range of actors, including regional policy-makers, agricultural researchers and ISWC-Ethiopia. In addition prizes were handed out to women innovators especially, in order to encourage them and give them public recognition. This is an example of both vertical and horizontal upscaling, vertical in the way of attempts to mainstream innovations on different levels, and horizontal by including women in particular.

- *Audiovisual and written media*: ISWC-Ethiopia contacted radio and television reporters to broadcast their visits to farmers to see and spread their innovations. The award ceremonies as described above were also broadcasted by local news media. In addition, researchers were given the possibility to publish on farmer innovations and Participatory Technology Development (PTD). This is an important motivation to researchers and also raises the status of local innovation in the eyes of scientists, DAs and farmers.

- *Exchange visits*: A travelling seminar brought farmer innovators in different land husbandry activities together to exchange ideas and learn from each other. These visits stimulate cross-fertilization of ideas. (See box below)

- *Workshops and seminars*: Village workshops have been organised by BoANR to bring farmer innovators together, have a closer look at the innovations, and discuss what is useful and what to develop further. Farmers have presented their innovations at regional and national meetings of educational, research and development organizations in Ethiopia, and this process and its findings are presented also at international symposia.

- Collaborate with community leaders: in order to give recognition to farmers who initiate new ideas and innovations the support of community leaders is of great importance.

- *Involve other development agencies*: visit other development agencies in order to explain the program and invite them to farm visits and workshops. So to create more support in a larger number of institutions.[18]

[17] Haile, M. et al. 2002, Chapter 6 Joining forces to discover and celebrate local innovation in land husbandry in Tigray, Ethiopia. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 58-73

[18] Haile, M. et al. 2002, Chapter 6 Joining forces to discover and celebrate local innovation in land husbandry in Tigray, Ethiopia. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 58-73

Travelling seminar and farmers' fora
Through the Integrated Soil Water Conservation (ISWC) program farmer innovators have been identified, and seven men and two women, together with researchers and Development Agents DAs, took part in a travelling seminar. Together they visited agricultural sites from which the participants came. On the sites they witnessed farmers' demonstrations and took part in discussions. Whereas before there was often a reluctance to value farmers' innovations as their ideas opposed extension packages, these visits often resulted in appreciation for the work that farmers had done.

Farmers were happy with the seminar and the recognition they received by being invited to this seminar. In addition they valued the fact that they could see many different farming conditions and systems in Tigray. During the seminar the innovators themselves were the key actors, they showed their technologies to fellow farmers and outsiders. This experience gave them self-confidence and also developed their capacity to explain their technologies to others. Especially in the case of women innovators, this was a striking result. Farmers were encouraged by ideas from other innovators and keen to share the experience they had gained with the farm community in their home area. However, they also advised to make use of more audio-visual aids to have these innovations be shown more widely.

After the seminar, *Farmers' fora* have been set up to bring together innovators and other farmers in their area. ISWC together with their partners, have organized field based workshops at village and district level focused on farmer innovation in land husbandry. There existed an atmosphere in which farmers could express their opinion, both positive and negative, to officials and discuss about this. Also newly introduced technologies were compared and reflected upon, various options were discussed and suggestions for improvements made. Many actors were involved in these fora, it included people from all stakeholder groups that were in connection to farmer innovators.

While only a few people were involved in the travelling seminar, a large number of people can be involved in sharing information. Exchange visits and farmer-to-farmer communication appear to be very inspiring. Government agencies, NGOs and farmer associations can combine strengths to create more opportunities for such events. Especially the fora show how knowledge exchange of local innovations can be promoted. This kind of platforms enrich the extension system and opens up new doors for presenting and developing technologies. This broader development has caused a change of attitude towards indigenous knowledge and creativity, shown in the fact that local innovation is now taken in consideration by the extension system. In this way the relations between farmers and policy-makers are brought closer together, which enables local innovations to infiltrate into formal procedures. In this manner not only external knowledge is imposed on farmers, but vice versa farmers also inform policy making. And it is especially policy that has a great effect on the inclination of farmers in Tigray to innovate. Discussing the benefits of innovation from both economic and agronomic perspectives in the presence of policy makers and experts is an effective way to lobby for policy change, and it creates encouragement for farmers to continue innovating. Certainly more platforms to allow exchanges between policy makers and farmers need to be in place to stimulate a wider uptake of WH. [19]

2.3.4 Analysis

Resource-poor farmers in the Tigray region of northern Ethiopia face harsh environmental conditions, such as unreliable rainfall, recurrent drought periods, severe soil erosion, pests and diseases to crops and livestock. These households seek mechanisms to cope with stress situations and to adapt to changes they perceive in their environment. Despite this difficult situation, they have been reluctant to adopt new technology packages introduced by conventional extension programs. The reason; these packages do not

[19] Abay, F. et al. 2002, Chapter 18 Facilitating farmer-to-farmer communication about innovation in Tigray. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 185-197

address their priority problems, such as moisture stress, or cannot be adopted easily by families with very limited resources. In the past, farmers in Tigray region were not encouraged to experiment with these new technologies, they were imposed on them in a top-down manner. Besides farmers not being encouraged, also the extension agents were not motivated by this way of working. Given these difficult agro-economic conditions and the way in which Ethiopian government took on extension work, there was a need to find a way to develop technologies that fit to farmers' preferences, suit their economic circumstances and fit into the local agro ecological conditions.

In other words there was a need for a participatory approach in which farmers, scientists and DAs began to work together. Such an approach has been developed by several programs and organizations, of which some examples have been explained in this chapter. Bringing farmers, scientists and DAs together, resulted in farmer-led research that brought benefits for all the involved stakeholders. Farmers felt that they benefited mainly by being encouraged and stimulated to use their own creativity. By being actively involved in the process of innovating and trying out new technologies, they had become better able to identify and decide on potential solutions and how these could be assessed. Besides this they were proud to be doing their own experiments and felt involved in decision-making at all stages of the joint research. The staff members, scientists and DAs mention they have greater recognition and appreciation of farmers capacity to experiment. They indicate that stronger partnerships and friendships have been built up with farmers and they recognize the value of farmers as resource persons and partners in extension. This points out that farmers mainly felt encouraged through this participatory approach and learned how to better do experimentation and assessments, while staff members mainly learned to appreciate farmer innovators and realized everybody can benefit from their ideas.[20]

Farmer-led innovation:
Participatory innovation can take place in a farmer-led manner when DAs can recognize local innovation and informal experimentation. Then both they and the farmers will become more confident in farmers' capacity to experiment. Farmers have always combined their own ideas and experienced, with knowledge introduced from outside. And if they are supported to do so, they can select new technologies for their farming system, and can modify these. The DAs can then support this process for instance by suggesting possible technologies to farmers to test and modify. They can also set up the networks to put farmers together, and in addition link them with researchers and others. This way farmers who have similar problems can help each other, and they can benefit from shared solutions. This approach is therefore based on the best farming practices approach as developed by the TPLF. Furthermore this approach can be strengthened by bringing in scientists who can help to explain the farmer's results. In this way the linkages between farmers and scientists and policy-makers can be more direct and stronger. It can then potentially be scaled-up to a policy level in order to incorporate these innovations in extension services. A key activity in farmer-led innovation is that farmers are the central actors in the evaluation process. When farmers are stimulated to experiment with new ideas, they also have to decide on which technology is suitable to them. DAs can support farmers, and bring them together, in assessing technologies into a process of more systematic monitoring. Joint evaluations by doing experiments and bring different farmers together becomes a key method of disseminating information about what techniques have, and have not worked, and most important, the reasons why. Finding out these reasons behind the workings of a technology is key to developing a technique which is suitable to one's specific conditions.[21]

How to build on 'best farming practices' in extension service?
When the ISWC 2 program commenced it came from two different traditions of extension; one from the previously centralized system of technology transfer and one from the extension activities during the struggle for liberation against the communist Derg regime. During the period of liberation, the extension

[20] Miruts, G. and Abay, F. 2002, Chapter 22 Farmer-led experimenetation in the drylands of Central Tigray. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 234-247
[21] Hailu, B. and Haile, M. 2002, Chapter 29 Liberating local creativity: building on the 'best farming practicies' extension approach from Tigray's struggle for liberation. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 310-324

services focused on disseminating the practices of successful farmers who were making the most of local resources. This is key in understanding how a participatory extension approach is developing in Ethiopia. Alongside with mass mobilization campaigns in SWC, the extension approach of promoting the best farming practices was continued. Nevertheless, its participatory nature highly varies between kebeles and is highly dependent on the capacity, integrity and motivations of Kebele leaders. Innovation is not alway easy to identify, especially by trained agronomists (i.e. DAs) that tend to see what their experience and trainings have thought them.

Under the Tigray People's Liberation Front (TPLF) agricultural development was prioritized. From the beginning, a major principle was community participation. The villagers had the decision-making role, while selected staff in the Department of Agriculture (DoA) was to facilitate the implementation. In this period of rehabilitation they depended on collective self-reliance, external aid added to the principles of mutual help. The work of DoA had two major objectives, to motivate farmers in farming and rehabilitation efforts, and to help them to make most out of available resources. They could not rely on introducing new technologies, but they focussed to extend the best farming practices already existing in the communities.

DoA with its participatory extension program, paid attention to both content and methods of training. It was decided to have as little formal classroom knowledge and as much practical work as possible. This often resulted in discussions in the field between several farmers, trying to find out best practices. Additionally it took much discussion to bring about a change in attitude, in order to recognize, accept and promote the best of what is local. In addition to local innovations, DoA also opened up ways to introduce technologies from outside the region and had farmers visiting these and assessing whether they would be useful to them.

The vision of the ISWC 2 program was founded on building up interest in, and support for, a participatory approach by including all staff in government institutions and in NGOs, and through networking, field visits, publications and moreover seeking dialogue. These activities were designed to raise a broad awareness for the creativity of farmers. Hence they aimed to influence attitudes of people at all levels in extension, research, education and policy-making. This focus is rather widely inclusive in order to institutionalize support of farmer innovation and experimentation in the formal research and development system. This approach was adopted in the project in order to encourage as many people and organizations as possible to take small steps. This started with recognizing farmers innovation, finding out how to feed farmer experimentation and furthermore establish more systematic collaboration for further development in land husbandry.

Initially the focus of ISWC 2 was on grassroots extension workers who work closely together with farmers, and therefore can develop an appreciation for farmers' capabilities. The methods that were developed focused on improving communication with each other, especially to stimulate discussion and mutual learning. In several training sessions farmers could present their ideas and immediate feedback and discussion took place by farmers and DAs. In this way DAs can support existing informal experimentation processes, they can 'feed' farmer experimentation and bring farmers together to evaluate results. Further on farmer innovations can be promoted through educational networks, in order to incorporate these into the formal extension system.

In sum the farmer-led approach as developed by ISWC 2 was a streamlined form of extension that motivated farmers to learn from each other. Promoting best practices encouraged farmers to innovate, women in particular. While the approach to focus on 'best farming practices' was at the time taken out of necessity, has now appeared to be a progressive approach to develop smallholder agriculture. "The pride in knowledge, creativity and hard work of good farmers during the struggle has been carried through to the

present day in Tigray, and is reinforced by the concept introduced by the ISWC of recognizing and encouraging local innovation in land husbandry."[22]

2.4 Key findings on options and enabling conditions

This concluding section contains a short discussion on the key findings on options and enabling conditions of the spread of WHT in Tigray area. Based on what has been discussed in this chapter a number of key findings can be identified and an attempt is made to delineate what nature of approaches are significant in the process knowledge spread. The following key findings have been derived from the research into the participatory approach to the spread of WHT in Tigray.

The first key finding is that a direct and wide uptake of innovations is preferred in Tigray, this means no pilots in just a small area, but rather immediate action by many people.

Such a wide uptake of WHT also indicates that coordination is needed on a large scale, Ethiopian government has a strong stake in agricultural policy and has invested greatly in large scale implementation of WHT with a catchment approach. Compared to household techniques, catchment approaches have a wider impact and can improve water availability on a larger scale, including groundwater recharge. These objectives are explicitly mentioned in agricultural policy in recent decades. The ways in which government, NGOs, private sector and farmers have initiated projects to reach these objectives has varied over time. Overall a strong government framework has been responsible for a large scale operation of WHT. While it must also be said that such an approach demands a greater level of coordination and management on the other hand. A system that can facilitate a type of catchment approach is often more expensive and complex and can hamper spontaneous adoption, compared to household techniques.[23] In the case of Tigray the large scale implementation of WHT was carried by government institutions mobilizing communities to implement WHT on a large scale. However, in this light it is unclear whether farmers and communities are enabled to jointly innovate and create interconnected knowledge transfer. Where in recent programmes there has been more and more attention for active farmer involvement and horizontal upscaling of WHT for example in ISWC programs, what lies ahead is the need to integrate this with the strong lead of governmental institutions in the spread of WHT.

Secondly, in line with the first finding, it is important to consider the position of farmer innovators, as they can be entry points in the process to systematically incorporate local innovation in formal agricultural research and development. The interest in this sense is to strengthen existing farmer experimentation as quickly as possible. It is considered less necessary to go into research about how farmer experimentation is taking place, apart from the content of these experiments. More importantly it should be identified what is being developed through PTD, and thereby also looking into how informal experimentation can be disseminated. In this manner you kill two birds in one stone, both knowledge is gathered on innovative techniques and insight is gained in how this knowledge and knowledge-process can be integrated into a more formal governance framework. Nevertheless, the importance of local innovations does not commonly go far beyond its formal recognition. In most cases local SWC and WH measures are poorly recorded and taken into consideration by experts[24].

In addition to this, in Tigray it is found important to make use of institutions that are in place, as there is a strong basis to enforce NRM on a large scale. The ISWC program developed farmer innovation and farmer-led experimentation within the formal research and development system within Tigray. In Tigray the conditions were favourable to integrate this approach into the formal system, favourable conditions include: openness and spirit for renewal due to a phase of liberation and period of reconstruction, strong

[22] Hailu, B. and Haile, M. 2002, Chapter 29 Liberating local creativity: building on the 'best farming practicies' extension approach from Tigray's struggle for liberation. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 310-324

[23] Abebe, A. et al. 2012, Chapter 5 Ethiopia: opportunities for building on tradition – time for action. In Critchley, W. and Gowing, J. Water Harvesting in Sub-Saharan Africa, Routledge, USA, pp. 70-84

[24] Haregeweyn et al., 2015, Soil erosion and conservation in Ethiopia: a review, Progress in Physical Geography

support of the extension service, linkages between government agencies and NGOs, experience of NGOs, practical orientation of university teaching and close links to policy-makers.[25] A challenge however remains in the working programmes of DAs which are still pressing to continue a transfer-of-technology approach. They view farmer innovation only as a sideline to their work and are not completely opened up to absorb local innovations into their programmes. Changing the DAs training programmes and integrating local innovation is therefore key to create substantial support at all levels. This can be achieved by working together with TVETs which are in charge to form prospect DAs.

Lastly, participation of local communities is of paramount importance, as they have knowledge about specific local circumstances and they are the future users. This is key in establishing horizontal upscaling, by encouraging farmers and make them aware of their creativity to innovate. Besides this the notion of leadership in communities is an important aspect to consider in order to get public support and gathering grassroots knowledge. The oft-cited example of Abraha We Atsbeha village shows how an enlightened leader can push its community to take the initiatives in rehabilitating its environment with a diversified portfolio of interventions including WH.[26] Leadership at woreda level is also often the key to stimulate innovation and wide application of WH at lower level. Too often at Woreda level there is a high turnover of specialized staff, which disrupts the continuity of vision, planning and implementation of a clear strategy including Water Harvesting uptake.

In order to improve the functionality of SWC and WHT and its maintenance, it is adequate to combine strengths with researchers and DAs, and together decide on implementation.[27] Special attention should be appointed to capacity building among farmers, and especially women and other marginalised groups. Strengthening of farmers' capacities can be done by facilitating monitoring and evaluation done by farmers. Creating feedback and assessment mechanisms enables them to gain more insight in the workings and potential of the WHT throughout the whole process, and they can link this to the impact they experience in their farming practice. This provides a key understanding into the underlying functionings of their innovations, which opens up potential for further development. Through monitoring, and iterative feedback and assessment, farmers can continually develop and fine-tune new innovations.

Farmer- to- farmer exchanges are highly valued both by communities and by the lower tiers government. The exchange visits are both functional to open the eye of the community and to provide to them a form of horizontal knowledge sharing between the more knowledgeable farmers and the apprentice community. In other regions such as Hararghe, model farmers are commonly part of formation programs whereby these individuals spend weeks with other communities to show them how to plan and implement SWC and WH. This is both a cost effective, and an efficient way to encourage adoption of innovative technologies. One farmer explaining to another farmer the benefits and practicalities of WH is more likely to be heard than a DA coming from outside the community. This approach can be easily implemented by the government and NGOs alike. There are many successful examples from around the world that can inform efforts made with this approach.

Tigray, among all Ethiopian regions, has some peculiar characteristics that made the uptake of WH a success story for the rest of the country. The rough terrains, shallow soils, erratic rains and high population make the environment particularly difficult to achieve sustainable production from rainfed agriculture. Small shocks to this production system can easily condition the seasonal production if some sort of safety net or buffer system to maximize the resources is not in place. In the late 70s Tigray was one of the areas most affected by drought and famine, thus sparking a number of initiatives to make the most from the

[25] Haile, M. et al. 2002, Chapter 6 Joining forces to discover and celebrate local innovation in land husbandry in Tigray, Ethiopia. In Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 58-73

[26] World Agroforestry Centre, 2014. *Trees for Sale, Annual Report 2013-2014.* Nairobi: World Agroforestry Centre

[27] Abebe, A. et al. 2012, Chapter 5 Ethiopia: opportunities for building on tradition – time for action. In Critchley, W. and Gowing, J. Water Harvesting in Sub-Saharan Africa, Routledge, USA, pp. 70-84

erratic precipitation - this included Water Harvesting. This fact stimulated initiatives such as the food for work programs of WFP. These humanitarian programs evolved over time in all-inclusive interventions which now include Income Generating Activities which make WH and SWC more appealing to farmers, who now see a tangible benefit linked to these technologies. This aspect linked to the efforts of a well-established government, which evolved from TPLF to EPRDF, together with Endogenous NGOs such as REST, gave continuity of thought in managing land and water. In the last 40 years the process was refined and grew more participatory in nature. The branched nature of the government, which reaches the smallest hamlet with its DAs, make the spread of technologies easier. This top down approach is enriched by participatory planning which entails the involvement of community watershed teams. As stated before this hybrid horizontal/vertical knowledge spreading mechanism heavily relies on the skills and integrity of individuals - especially kebele, woreda and community leaders.
The tangible success of some communities in uplifting their livelihood through watershed management and water harvesting has played a key role in inspiring communities and leaders and is likely to continue in the coming decades, since the government is heavily investing in this development model.

In the WAHARA project the integration of resources and knowledge is a clear example on how actors that follow the same development model (i.e. participatory watershed development) can easily come together and work on the same objective to favour the uptake of WH. In this specific case, Saint Mary College, Mekelle University, REST and the local level state administration decided to work conjunctively to maximize the impact of their initiatives. Mekelle, provided innovation and science based knowhow on WH technologies, while the government facilitated the process and Saint Mary College and REST provided resources and skills for the implementation of the interventions. This close cooperation between farmers/community, government institutions, NGOs and academia is a successful example on how the different strengths of the actors can be pooled together and create synergies for WH spread.

3. Burkina Faso

3.1. Introduction

Burkina Faso is one of the poorest countries in the world, with over 73% of the people living below the USD 2-a-day poverty line. About 90% of the population is engaged in agriculture. Topographically, it is a flat country lying 25-400 metres above the sea level. Vulnerable to erosion by wind and water, the soils are characterised by a high degree of weathering, and low organic matter content. [28] Perennial rivers are but few and groundwater resources have been harnessed to a very low degree.

Water harvesting in Burkina Faso has been for long considered a fast developing track endorsed by the government and by other non-governmental actors. The first impulse was given by the dramatic droughts that hit the area in the '70s. In the 80's the campaigns against desertification got a new impulse.[29] Water harvesting was recognised as being key to the efforts. In fact, the country was considered a 'laboratory' for water harvesting during this period. [30] Fortunately, there were traditional water harvesting methods that could be revisited, adapted and implemented in the current scenario. Local and international NGOs developed a number of participatory approaches to do the same. At the same time bilateral and multilateral cooperation initiatives took place in the country following different paths of knowledge transfer and community participation.

At present, Water Harvesting Technologies continue to be high up the policy and research agenda. With limited irrigation coverage, the government values WHTs in recognition of their importance to rainfed agriculture, particularly to soil moisture management. Overall there is an enabling environment for the spread of WHTs, following which area-specific technologies are being promoted in the various regions.

---

[28] Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

[29] Grace, D. 2003. *Participative trypanosomosis control in Burkina Faso: lessons learned, ways forward.* Working Paper 2. International Livestock Research Institute. Nairobi, Kenya. 53 pp.

[30] Kabore-Sawadogo, S., Ouattara, K., Balima, M., Ouedraogo, I., Traore, S., Savadogo, M., Gowing, J., 2012. Burkina Faso: A cradle of farm-scale technologies. In: Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

Apart from a number in-situ water harvesting technologies that have helped improve soil moisture retention, small reservoirs and basins (called 'Banka' and 'Bouli' locally) are being widely promoted.

3.2. How farm knowledge spreads: Agricultural Extension Landscape

In Burkina Faso, a multitude of organisations are engaged in the dissemination of rural knowledge-- which includes knowledge related to water harvesting within the ambits of agriculture and livestock. From the government's side, rural extension is the mandate of the Ministry of Agriculture, Water and Fishery Resources; Ministry of Livestock; and the Ministry of Secondary and higher Education and Scientific Research.

Public research institutions with extension units include

- Institut de l'Environnement et de Recherches Agricoles (INERA),
- Centre International de Recherche-Développement sur l'Elevage en Zone Subhumide (CIRDES),
- Agency for the Promotion of Small and Medium-sized Agricultural Enterprises and Handicrafts (APME), and
- Agricultural Research and Development Investments and Capacity ASTI in Burkina Faso.

Additionally, the Polytechnic University of Bobo-Dioulasso has extension units (with support from the now-completed SAFE project by the Sasakawa Africa Association (SAA). [31]

A key component of the rural extension landscape are NGOs. This is to a large extent due to the shortage in capacity of government extension agencies. "Rural advisory services (from the government sector) do not have enough personnel. The NGOs are much closer to the people, better positioned to make them aware of best agricultural or water harvesting practices," says Felix Compaore from the Permanent Intergovernmental Committee for Drought Control in the Sahel (CILSS). [32] This includes INGOs (from over 20 countries, in particular from Western Europe, the United States and Canada), as well as local NGOs such as Le Conseil à l'Exploitation familiale (CEF) at the Fédération Nationale des Groupements Naam (FNGN- a farmers' union) located in Ouahigoya town in Yatenga province. NGOs are crucial to the delivery of extension services in Burkina Faso. They fill the gap left by the limited reach and capacity of the government extension services, which farmers value considerably. "Farmers facilitate our extension workers' visits by paying for their fuel. This shows there is a genuine demand for their services," says Herman Togo from FNGN.

FNGN is a prominent farmers' association. The Ministry of Agriculture has over the years directly and indirectly supported the formation of such farmers' associations to provide them advisory services and technical assistance in an efficient and targeted way. The largest of these is the Federation des Unions des Groupements (FUGN) also known as "Naam." Completely independent of the government, it comprises over 300,000 farmers in more than 1,200 villages. [33]

The private sector-- comprising agri-dealers, input suppliers and banks-- often works closely with farmers and is touted as having great potential for providing valuable extension and advisory services. At the moment, such services are developing only in areas where lucrative commercial opportunities exist, such as cotton production and horticulture. [34]

---

[31] Sasakawa Africa Association, 2014. *SAA in Burkina Faso*. [online] Available at: < http://www.saa-safe.org/www/burkinafaso.html> [Accessed 5 december 2015].

[32] Herman Togo, Fédération Nationale des Groupements Naam (FNGN), Burkina Faso. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

[33] Global Forum for Rural Advisory Services. *Burkina Faso.* [online] Available at <http://www.g-fras.org/en/world-wide-extension-study/africa/western-africa/burkina-faso.html#extension-providers>

[34] SWAC. 2005. The Family Economy and Agricultural Innovation in West Africa: Towards New Partnerships. *Overview*. An Initiative of the Sahel and West Africa Club (SWAC) Secretariat. Transformation of West African Agriculture.

3.3. Spread of Zaï Pits in Burkina Faso

3.3.1. Background

In Burkina Faso, desertification has been a perennial threat, with the threat perception based on recurring droughts (1910-14, 1969-75, 1980-85, 1987-88, 1998, and 2002). [35] Loss in vegetative cover is especially acute in the north of the country that borders the Sahara.

Government/NGO-led interventions started in the early 1960s with the 'GERES' project, under which heavy machinery was used to construct earth bunds over entire catchments, over agricultural as well as non-agricultural land (over 60,000 hectares treated in total). The bunds were meant to drain runoff away from the fields in order to reduce erosion. However, participation of local communities in the process was minimal and therefore the project could not take into account that this was the opposite of what people wanted (they wanted runoff to stay in the field and increase soil moisture). [36] Therefore, people did no maintenance of the bunds and within 3 years they just disappeared. The same bunds, and the same approach, made an appearance again 10 years later under the FDR project and met with the same fate. [37]

Besides, a number of tree-planting campaigns have been carried out over the last 30 years, most notably the colourfully named *'8000 villages, 8000 forests'* program started in the early 1990s. While millions of seedlings were planted, survival rates were poor. Again, this was largely because farmers were not involved in the campaign in a way that provided them incentive to take care of the seedlings after they had been planted. [38]

However, in the Yatenga region (also in the north), there was a massive increase in the number of trees in the 1990s, with a large number of farmers growing trees in their fields. This is down to the practice of growing trees in pits traditionally called Zaï and used for growing plants. One particular farmer, Yacouba Sawadogo from Gourga village, is credited with developing the improved version of Zaï pits, which he and some other farmers are credited with popularizing across Yatenga and the neighbouring Zondoma region.

An examination of the pathways through which Zaï spread among farmers in northern Burkina Faso offers valuable insights into what facilitates the spread of water harvesting technologies in general among rural communities.

3.3.2. Yacouba Sawadogo

Zaï are planting pits that farmers dig in rocky, barren land. They are about 20-30 cm in diameter and 15-25 cm deep. Apart from the seed, they contain organic fertilizer. The organic fertilizer provides nutrition to the plants as well as attracts termites, which dig channels and improve the structure of the soil, improving their water retention capacity.

---

[35] FAO, *Drought Occurrence in Burkina Faso.* [online] Available at <http://www.fao.org/ag/againfo/programmes/en/lead/alive_toolkit/popup/popup_drought_report.html> Accessed 5 December 2015

[36] FAO Corporate Document Repository, *Looking after our land…* [online] Available at <http://www.fao.org/docrep/x5301e/x5301e02.htm> Accessed 5 December 2015

[37] Kabore-Sawadogo, S., Ouattara, K., Balima, M., Ouedraogo, I., Traore, S., Savadogo, M., Gowing, J., 2012. Burkina Faso: A cradle of farm-scale technologies. In: Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

[38] Sawadogo, H., Hien, F., Sohoro, A.,Kambou, F., 2012. Namwaya Pits for trees: How farmers in semi-arid Burkina Faso increase and diversify plant biomass. In: Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan. Chapter 4.

Images Courtesy: MetaMeta

While Zaï are a traditional farming technique, the credit for improving their design and initiating their spread across northern Burkina Faso goes largely to Yacouba Sawadogo, a farmer from Gourga village. He started working with Zaï in 1979 to rehabilitate his land and grow more cereals. "The 1975 famine in Burkina and Mali was really tough. People were migrating to other countries just in search of food. That's when I withdrew into the bush, and started experimenting with different ways of growing food," he says. [39]

Yacouba started working with the traditional Zaï pits, then tried out several modifications, such as digging them deeper and wider and introducing various types of organic fertilizers. He also discovered various tree species spontaneously growing the pits, so he started cutting the stalks of plants at 50 cm at the time of harvest (so the stalks that remained, protected the young trees). Thus, he developed the use of Zaï for growing trees.

Another technique that Yacouba (and now other farmers in the region) uses in conjunction with Zaï pits are stone lines— small structures, at most three stones wide and sometimes only one stone high positioned manually along the contour. The stone lines were products of participatory testing by the PAF project (*Projet AgroForestier* in French) with support by OXFAM (1979-82), and extensive promotion over a 15-year period. [40]

Within a few years, his once barren farm turned into a 12 hectare forest with numerous tree species. This is due to his constant, tireless effort to collect seeds of local tree species. "I want to introduce many kinds of fruit trees in the area, as well as medicinal plants. The species that do well can be taken from here and spread across the area," says Yacouba. Dotted with Zaï pits and criss-crossed by stone lines, '*Yacouba Farms'* is now an internationally recognised centre for research on these and other related techniques. Yacouba hosts there representatives from national governments, researchers, and students from Burkina, Europe, United States, and India. "I have good collaborations with researchers. I have had visitors in groups of 3-4 as well as groups of 30-40. They have stayed with me for 1 day, 1 week, and also 1 year," he says.

[39] Yacouba Sawadogo, Association des Groupements Zai pour le Developpement du Sahel, Burkina Faso. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

[40] Hamado Sawadogo (2011) Using soil and water conservation techniques to rehabilitate degraded lands in northwestern Burkina Faso, International Journal of Agricultural Sustainability, 9:1, 120-128

Yacouba Sawadogo walking along stone lines at his farms. (Image Courtesy: MetaMeta)

Apart from researchers, policy makers, filmmakers and others with academic interest in the efficacy of Zaï, stone lines and other techniques, Yacouba makes concerted efforts to spread the use of Zaï among those whose adoption of these techniques will make an actual difference to the region—farmers from Yatenga and neighbouring provinces. He organises 'market days' at least twice a year. The first time is shortly after the harvest when farmers bring him samples of crop varieties they have grown in their Zaï pits. Yacouba stores the seeds until the next market day, which is shortly before the wet season, where visiting farmers can select and take with them the varieties they would like to plant given the improved growing conditions. Each market day also has a specific theme, such as best practices in growing certain crops, innovative tree planting methods, exhibition of tools to dig Zaï, etc. [41]

Yacouba has also created an "*Association of Zaï Groups for the Development of the Sahel*" (*Association des Groupements Zaï Pour le Developpement du Sahel*) of which he is the chairman. The main objective of the association is to mobilise resources for the spread of Zaï in the region and beyond. The market days are also when the Association's general assembly takes place.

[41] Ouedraogo, A. and Sawadogo, H., 2002. Three models of extension by farmer innovators in Burkina Faso. In: Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan. Chapter 20.

At the entrance to Yacouba's farm in Ouahigouya, which is also the headquarters of the 'Association of Zai Groups for the Development of Sahel.' (Image Courtesy: Rudi Hessel, Alterra)

3.3.3 Evidence of Change

The efficacy of Zaï pits and complementary techniques in terms of reversing land degradation and improving the profitability of farming has been widely recognised. This is evident in the large number of governmental and non-governmental interventions that promote them[42] and is visible as having been adopted by farmers as a standard practice as one drives through rural areas in Yatenga and Zondoma provinces. After observing Yacouba's work and its effect in Yatenga province, several other farmers from neighbouring Zondoma and Sanmatenga provinces have adopted and adapted the Zaï and related techniques and continued to achieve much success in agroforestry. Some of them have been inspired enough to invest their own time and resources in training other farmers in their region in Zaï and related techniques, just like Yacouba does.

3.4. Key findings on options and enabling conditions

Analysis: What facilitated the spread of Zaï and Stone Bunds in Burkina Faso?

This report focuses on Yacouba Sawadogo's efforts, but not to suggest that one individual operates in isolation or that he is single-handedly responsible for the spread of Zaï and related WHTs in Burkina Faso. Government policies have contributed towards an enabling environment for the spread of WHTs since the late 1980s. [43] Given the limits to state capacity in Burkina Faso and the periodic phases of political turmoil, NGOs have played a crucial as well. Nevertheless, Yacouba's role as a pioneer is acknowledged across the board.

[42] Kabore-Sawadogo, S., Ouattara, K., Balima, M., Ouedraogo, I., Traore, S., Savadogo, M., Gowing, J., 2012. Burkina Faso: A cradle of farm-scale technologies. In: Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

[43] Reij, C., and Steeds, D. (2003) 'Success Stories in Africa's Drylands: supporting advocates and answering sceptics,' A paper commissioned by the Global Mechanism to Combat Desertification, Vrije University and Centre for International Cooperation, Amsterdam, Netherlands

Yacouba Sawadogo (Image Courtesy: MetaMeta)

Nevertheless, the fact remains that he started working with Zaï pits completely on his own accord in the late 1970s, without any government incentives or NGO support. His efforts to spread the Zaï-system through his bi-annual market days (starting 1984) predate most governmental or NGO efforts. The objective of the discussion here is to focus on Yacouba's efforts as a unique intervention that can be isolated, analysed, and conclusions drawn as to what underlying characteristics made it successful and whether they can be replicated for the benefit of other ongoing efforts. "I believe in leadership by example, so I would like the world to see what he (Yacouba) has been able to do… with almost nothing. If we could use his example to disseminate…. or scale-up (Water-Harvesting Technologies)… we would certainly be able to do a lot in the fight against desertification," told Luc Gnacadja, Executive Secretary, UNCCD, to the UN Convention to Combat Desertification in South Korea, 2011. [44]

Yacouba's efforts can be characterised by the following:

- **Farmer-to-farmer learning:** As a farmer himself, Yacouba possesses credibility in the eyes of farmers that he targets with his dissemination efforts. He talks to them in a language they understand, his pitch about Zaï comprises of references they can relate to. Yacouba being one of them, farmers trust his intentions and motivation to promote water harvesting. Part of Yacouba being a real farmer is his body of work--- his 12-hectare farm dotted with Zaï pits, stone lines, biodigesters, and a large variety of trees-- that he has developed over the past 35 years. He started off as an individual farmer with limited resources, just like all his students. So when they visit his farm on market days they see a story that they are convinced can be theirs too.

  It is very difficult for a governmental or nongovernmental agency to garner this kind of credibility and trust, as the NGOs and even the state itself has been around in Burkina Faso for less than 60 years. To their credit, many of them work with Yacouba, facilitating visit by farmers they work with to his farm.

[44] 1080 Film & Television, 2012. *What Yacouba did next....* [video online] Available at: https://www.youtube.com/watch?v=wezxNnkcsW8

Yacouba Sawadogo visiting a group of farmers, teaching them how to make improved Zai pits
(Images above and below are screengrabs from films, courtesy: 1080 Film & Television)

- **Simple, farm-level technologies based on traditional farming techniques and their improvement**: Zaï is a traditional technique that Yacouba worked with and adapted to current soil and water conditions. Although it is quite labour intensive, it is simple to implement and requires only a basic hand hoe. [45] The use of organic fertilizer is encouraged inside the Zaï pits, which can be produced at the farm using locally available ingredients. Stone lines, similarly, are simple to construct and maintain. Most smallholder farmers can implement these without using any additional labour beyond what is available within their family. Most can afford to try them out and fail. Thus, these technologies are easy to experiment with, adopt and adapt. This is a key reason why they scaled up so successfully.

  Besides, being farm-level technologies, it is also easy to demonstrate their effect. Within his farm, Yacouba has several test-plots where he has dug Zaï pits of varying dimensions next to each other and the difference in terms of the quality of output is easily seen. In contrast, it is much more difficult to convince farmers about larger- scale, ex-situ water harvesting technologies such as dams and reservoirs; as their effects play out over a long/medium term and over a larger area than the field itself. [46]

[45] Mechanised Zaï (made using animal-drawn tools) has also been tested and developed. Its use is limited however.

[46] This should be qualified with an acknowledgement that ex-situ, larger scale WHTs are key to achieving landscape-level transformation. This has been established by several studies, including research carried out under WAHARA in Ethiopia's Tigray region. # It follows from that, that larger scale ex-situ WHTs are key to the fight against desertification and to achieving food security in Burkina Faso. The government as well as NGOs have already shown intent in this direction by investing in small and medium reservoirs (called *Banka* and *Bouli*), as well as in optimizing road design so they can be used as dams.

- **Participation and agency:** Yacouba's strategy to disseminate WHTs among a large number of farmers involves simply convincing them about the returns in terms of higher yields and higher incomes. Through all his demonstrations, market days, and travels, this is the basic point he tries to get across. This respects the farmer as an entrepreneur and his agency (defined as the ability of individuals think and act in their own interest, as opposed to relying on intervention by others). [47] Therefore, Yacouba's message brings along a sense of empowerment. In contrast, government and NGO programs can often be top-down, with formulators of the program often far removed from the farmers (as was the case with GERES and FDR programs discussed above). Where politicians are involved, they often try to score political points, and subsidies and support passed on to the farmer often assume a tone of philanthropy and benevolence. This can hamper uptake.

  An additional factor that helps appeal to farmers' agency is the fact that the techniques Yacouba advocates are simple, farm-level techniques that farmers can go ahead and implement with the resources they usually have available (just as Yacouba did when he started working with Zaï pits in the late 1970s). Because of these characteristics of the technique of Zaï pits were appropriate for horizontal upscaling among other farmers.

- **Uptake among other stakeholders:** Yacouba's success and his efforts to share his methods with other farmers have been recognised nationally and internationally. They have been extensively documented. This has contributed greatly towards Zaï and related WHTs going higher up the agenda of research organisations, and government agencies and NGOs (almost all interventions in soil and water conservation since the 1990s incorporate some or all of these WHTs). [48] The overall policy environment has also been made conducive to facilitate efforts to spread WHTs in various parts of the country. This is an example of vertical upscaling in which the much hailed technique of Zaï pits is mainstreamed into policy, and is spread out to other farmers through government, companies, NGOs and private sector.

3.5 Conclusion: Promoting Farmer-Farmer Learning

The story of spread of Zaï in Burkina Faso reveals the importance of (a) promoting simple, farm-level Water Harvesting Technologies and (b) of farmer-to-farmer learning.

The former has already found traction in policymaking and at the implementation level, with a number of interventions promoting/implementing a mix of Zaï Pits, stone lines, demi-lunes, and land preparation practices borrowed from Conservation Agriculture such as ripping. Research and documentation of these technologies has also gained impetus in recent years.

The other factor that catalysed the spread of these WHTs in Northern Burkina Faso was farmer-to-farmer learning. This was pioneered by Yacouba Sawadogo. His decision to share his knowledge was born out of his personal orientation. He invests considerable amount of his time and resources organising market days for farmers and hosting students, researchers and policymakers at his farm. Each of the two market days he organises every year involves people from more than 100 villages. Yacouba has also inspired his students to spread WHTs among as many farmers as possible. Ouesseni Zorome from Somyanga (also in Yatenga province) is an example. He started training farmers in Zaï in 1992. He has been supporting the creation of

[47] Pettit, Jethro. 2012. Empowerment and Participation: bridging the gap between understanding and practice. Paper presented to the UNDESA Expert Group Meeting on Promoting people's empowerment in achieving poverty eradication, social integration and productive and decent work for all. Available at: http://www.un.org/esa/socdev/egms/docs/2012/JethroPettit.pdf

[48] Kabore-Sawadogo, S., Ouattara, K., Balima, M., Ouedraogo, I., Traore, S., Savadogo, M., Gowing, J., 2012. Burkina Faso: A cradle of farm-scale technologies. In: Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

Zaï schools, which are 21 in number and count 1000 members in total. As of 2002, Ali Ouedraogo from Gourcy village had trained 12 farmers since 1993, each of whom had been training several other farmers.[49]

The Burkina example also demonstrates the the contribution of Farmer-to-Farmer learning systems to horizontal and vertical upscaling. The initial effect was horizontal upscaling of Zaï and related WHTs among farmers. However, after a certain scale was reached amongst farmers, other stakeholders-- government, NGOs, researchers-- took notice and engaged with the WHTs as well. Thus, vertical upscaling followed horizontal upscaling. This observation leads to the conclusion that reaching a certain horizontal scale can trigger the process of vertical upscaling.

Effective as these efforts are (see 3.3.3), and widely lauded as they have been, their only sources of sustenance has been the farmers who are making them. While the WHTs themselves have been adopted and incorporated in soil and water conservation programs, the element of farmer-to-farmer learning has not been developed and capitalised upon. Based on a global review of extension approaches[50] and interviews with farmers, extension workers, researchers and policymakers carried out in July 2015, the following suggestions can be made as to how existing farmer-to-farmer learning initiatives can be supported and the development of new ones be encouraged.

- **Financial Support:** Yacouba Sawadogo's efforts have been widely appreciated. He has received recognitions and awards from the Burkina government as well as foreign countries. However, he has not received much by way of substantial, systematic monetary support. [51] Ousseni Zorome's Zaï school receive a 5000 CFA membership fee from farmers who join his Zaï school. Ali Ouedraogo receives gifts from time to time as a token of appreciation from his students. [52] What, then, is their motivation to pursue their endeavors? "I won't be around forever. I would like to leave behind a legacy," says Yacouba. "I am not a rich person. I do not possess much money or things. But if I have shown a large number of farmers how to improve their land, I would have accomplished my mission." Others have similar motivation-- social prestige, respect, a concern for their communities. However, even though they are not actively chasing funds, providing financial support to some of these initiatives can help expand their activities, which can help the spread of WHTs in general.

- **Supporting exchange visits:** Supporting farmers to visit other farmers for experience sharing, or attending Zaï schools like Ouesseni's, is another possible point where support can be injected into farmer-farmer-learning systems. Such support can especially target farmers in specific parts of Burkina Faso where WHTs are not being practiced as widely as in the north. "Our challenge now is to convince farmers in other parts of Burkina to adopt and practice Zaï plantation," concurs Halidou Compaore, Deputy Director, Institut de l'Environnement et de Recherches Agricoles (INERA), Burkina's premier agriculture research organisation.

- **Better Linkages with Research and Educational Institutions:** There is an acute shortage of good quality data and rigorous studies on the impact of WHTs in Burkina Faso. [53] Research institutions stand to gain much in terms of filling these gaps by collaborating more closely with farmer-to-farmer learning systems. Farmers, in return, can also benefit with good quality data informing their decision-making.

[49] Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan

[50] MetaMeta, 2016. *WP6: Adoption, knowledge transfer and dissemination to rainfed AfricaHarvesting.* Wageningen: WAHARA Project (Internal Deliverable).

[51] Yacouba Sawadogo, Association des Groupements Zai pour le Developpement du Sahel, Burkina Faso. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

[52] Ouedraogo, A. and Sawadogo, H., 2002. Three models of extension by farmer innovators in Burkina Faso. In: Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan. Chapter 20.

[53] Kabore-Sawadogo, S., Ouattara, K., Balima, M., Ouedraogo, I., Traore, S., Savadogo, M., Gowing, J., 2012. Burkina Faso: A cradle of farm-scale technologies. In: Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

To their credit, several research institutions like INERA already collaborate with farmers like Yacouba Sawadogo. The recommendation here is to pursue such collaboration as standard procedure wherever applicable. In line with the general idea of generating much more research and study in areas relevant to smallholder farmers in the region, linkages can also be increased between farmer-to-farmer learning systems and educational institutions such as universities, colleges and vocational training centres.

- **Generating farmer-relevant learning material:** As important, and even more rare than quality research on WHTs, is quality learning/awareness-building material on WHTs. While much material is generated by extension agencies in French, it is a challenge to produce books, posters, and pamphlets in the multitude of local languages that can vary from district to district in Burkina Faso. With an adult literacy rate of 28.7%, the focus needs to be on language-neutral graphics, audiovisual material and broadcast media such as radio and television.

  An existing initiative with potential for replication and scaling-up is the *'La Voix du Paysan' (The Voice of Peasants)*, an FM radio service run by the Fédération Nationale des Groupements Naam (FNGN) in Ouahioguya.[54] The service broadcasts programming on various aspects of farming such as land preparation, water harvesting, crop harvest, marketing, access to credit and relevant government/NGO programmes. Another tool that has been employed effectively is street theater. INERA organises several interactive street plays, especially during the sowing season and the harvest season. Actors play out various scenarios pertaining to decisions that a farmer has to make (For e.g. Zaï pits or no zaï pits? organic fertilizer or chemical fertilizers?) and the audience is asked to discuss what they would do and why.

[54] LES VOIX DU MONDE. *Chronique Agriculture et Peche- La radio «la voix du paysan» dans la région Nord du Burkina Faso*. [online] Available at: <http://www.rfi.fr/emission/20150711-radio-voix-paysan-region-nord-burkina-faso> [Accessed 19 August 2015].

At a folk theatre in Gourcy village, actors enact a discussion between two farmers, one in favour of using fertiliser in Half-moon structures and the other opposed to the idea (top image). The audience listens to both arguments and direct a third farmer preparing his field to do what they think is the best option (bottom image) (Image Courtesy: Hamado Sawadogo, INERA, Ouagadougou).

4. Tunisia

4.1 Introduction

At 165,000 square kilometres and with a 11 million population, Tunisia is categorically a 'small country.' At the same time, it is remarkably diverse in many ways. Geographically, the green mountainous Dorsal and Tell regions in the north contrast with the semi-arid/desert south. In between, the 'Sahel' coastal plains along the eastern Mediterranean coast and the Steppes south of Gafsa complete a continuum of sorts. The climate of Tunisia is temperate in the northern, mountainous region, with cool moist winters and hot, dry summers. Overall, it is warm throughout the year. The central region of the country is hot and dry plain while the southern part is desert.[55] About 66% of the cultivable area receives less than 400 mm rain per year. In southern Tunisia major rural livelihood systems have coexisted; sedentary farming by agro pastoralists in the Matmata mountain range and the nomadic herding of camels, sheep and goats in the adjacent plains between the mountains and the Mediterranean sea. In sedentary farming mainly olive, fig and palm trees. [56] [57]

Tunisia is a water-stressed country, with a renewable water availability of 486 cubic metres per capita- well below the average of 1200 cubic metres per capita in the larger MENA region.[58] In nearly two-thirds of Tunisia, mainly central and southern part of the country, average annual rainfall is less than 200mm. In this area, except for irrigation systems or oases, agriculture would be impossible without water harvesting. One of the most widely used traditional techniques for water harvesting is the *Jessour*- a water harvesting system comprising of *impluvia* (small basins), terraces, and dykes--- used for collecting runoff from long slopes. In the mountainous areas in Tunisia this technique is still used in agriculture. Across the valley floors farmers have built earthen dams (*'tabias'*) to trap runoff water and silt.

Despite accounting for 12% of the GDP, the agricultural sector is the biggest water-user, responsible for 86% of the withdrawals from Tunisia's known water resources in 1996.[59] The Ministry of Agriculture estimates the demand for water to stabilize somewhere between 2.7 cubic kilometres and 3.1 cubic kilometres by 2030. Therefore, there is much emphasis on achieving efficiency in water use and developing new sources to expand supply, especially in the farm sector. This is also reflected in the agricultural research agenda and forms of incentives/support extended by the government to farmers.

Socio-economic

Tunisia is known for its diverse market-oriented economy and has long been seen as a success story in Africa and the Middle East. Amid countries around the world and in its neighbourhood following socialist economic policies in the 1960's, Tunisia followed a more liberal strategy. Their policy was focused on supporting exports, foreign investment and tourism. These have become central to its economy nowadays and sparked a 4-5% GDP growth for decades. However, after the fall of former President Zine el Abidine Ben Ali (1987-2011) there was a decline in tourism and investments, which had several negative effects on its economy. Currently Tunisia faces several challenges, such as that of reassuring businesses and investors,

[55] CIA: The World Factbook, *The World Factbook: Tunisia,* viewed; November 28, 2013 https://www.cia.gov/library/publications/the-world-factbook/geos/ts.html>

[56] Chris Reij and Ann Waters-Bayer, 2001, Farmer Innovation in Africa. A Source of Inspiration for Agricultural Development. Earthscan Publications Ltd, UK, p 1-362.

[57] G-fras: http://www.g-fras.org/en/world-wide-extension-study/africa/northern-africa/tunesia.html accessed online on 11-01-2016

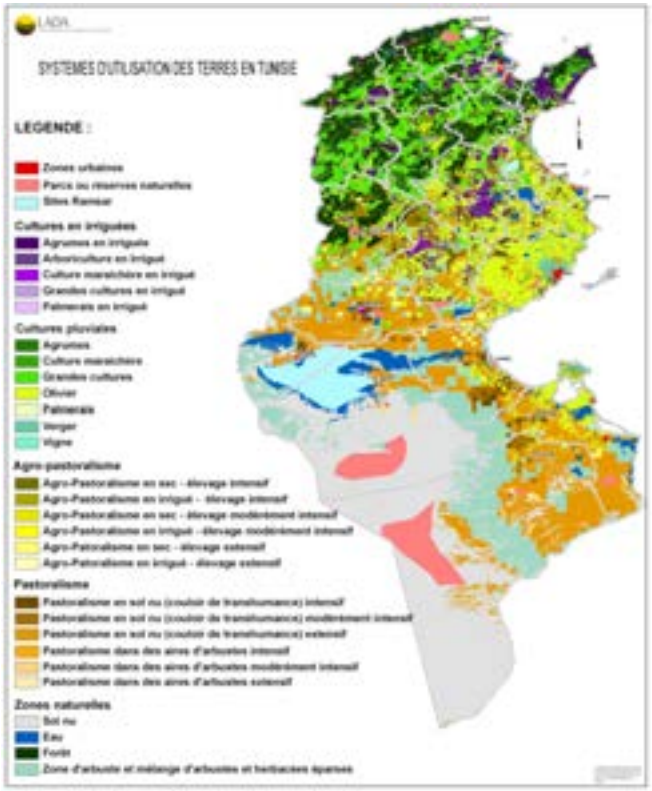
[58] Shetty, S 2013, 'Treated Wastewater Use in Tunisia: Lessons learned and the Road Ahead' in C.A. Scott, N.I. Faruqi and L.Raschid-Sally (eds) *Wastewater Use in Irrigated Agriculture: Coordinating the Livelihood and Environmental Realities,* CAB International, p.p. 163-172

[59] Earth Trends, The Environmental Information Portal, *Water Resources and Freshwater Ecosystems- Country Profile- Tunisia,* viewed November 26, 2013.

arranging its financial systems, bringing down unemployment and reducing economic disparities between the more developed coastal regions and the impoverished interior. [60]

There are three important socio-economic changes that have had a profound impact on rural livelihood systems. The first is the migration of men to urban centres to seek employment, this diversified income sources for rural families. The second is the once-booming tourist sector, which generated a demand for fresh fruits and vegetables. And third is the descent of sedentary farmers into the plains. The government has invested fairly extensively in water harvesting systems in the plains, both for flood protection as well as groundwater recharge. This created opportunities for agriculture based on water harvesting. This has led to an abandonment of Jessours in the most isolated mountain valleys and reduced grazing lands for pastoralists. Due to high labour, low productivity and high risks associated with farming in mountainous areas, many young men abandoned these farm lands. Therefore the challenge is to reduce the maintenance requirements of Jessours and to increase the productivity of farming based on rainwater harvesting.[61]

The climatic regions in Tunisia © Atlas de l'eau en Tunisie (ed. Latifa Henia), University of Tunis, 2008



Land Use in Tunisia (Courtesy: FAO, 2008)

4.2 How farm knowledge spreads: Agricultural Extension Landscape

[60] CIA: The World Factbook, *The World Factbook: Tunisia,* viewed November 28, 2013 <https://www.cia.gov/library/publications/the-world-factbook/geos/ts.html>

[61] Chris Reij and Ann Waters-Bayer, 2001, Farmer Innovation in Africa. A Source of Inspiration for Agricultural Development. Earthscan Publications Ltd, UK, p 1-362.

Agriculture employs about a quarter of the workforce, thus supporting livelihoods and controlling urban migration.[62] Therefore agriculture, and agricultural Research and Development in particular, figure high on the priority list of the federal government. Agricultural research is primarily funded by the government. Most of it is overseen by the Agricultural Research and Higher Education Institute (IRESA)[63], an institution established in 1990.

The primacy of agricultural research in Tunisia dates back to the end of the 19th century, when The Livestock Laboratory was established in 1897 by the then colonial government. A number of research institutions were set up thereafter, around a variety of themes including agronomy, reforestation, 'rural engineering,' olive plantation and fisheries. In 1990, the federal government set up (IRESA) as part of the World Bank-supported Agricultural Research and Extension Project (PRVA),[64] to administer and coordinate the research being done through all these institutions. IRESA is entrusted with a number of tasks that mainly focus on promoting agricultural research through the establishment of linkages between agricultural research , higher education institutions, as well as agricultural extension and producers. IRESA does not directly provide extension services to the farmers but does play an important role. IRESA comprises of, among other organizational arms, four directorates and one of them is responsible for dissemination of innovations and forging of linkages between research and extension.

This points to an extensive network of research that extends into a variety of themes, which befits the variegated nature of Tunisia's geography and agro-climatic regions. There is an inherent danger in such a structure of the whole gamut of agricultural research being driven by a central agenda (IRESA's), thus limiting the extent to which the research agenda is informed by and relevant to local realities. In response to this possibility, (through a process that began in 1995) IRESA decentralized into seven regional branches. The seven regions correspond to Tunisia's seven agro ecological zones, each representing a distinct scenario with respect to (among other aspects) hydrology and water use (see maps above).

Several donors, notably the World Bank, provided financial and technical assistance to Tunisia to strengthen agriculture in general and agricultural research in particular. This was executed through four different projects (1990-2001), mainly by creating coordinating agencies for research and extension, strengthening regional facilities, and improving links between research and extension. Of late, the government has been experimenting with various modalities of decentralization and privatization of extension in the country.

Role of NGOs and Private Sector

For long the policy of Tunisian Government has been to modernize the agricultural sector through liberalization and mechanization. Mechanization of farming has led to the creation of large farmers because farm labourers could be replaced by machinery. This was also one of the triggers that led to an increased migration of rural people to urban centres. Although liberalization policies and an agricultural sector adjustment program have encouraged the entry of private sector in various areas including extension, it did not lead to a sufficient development of the private sector in agriculture. Presently, there is no private company that provides significant extension and advisory services to the farmers. Similar is the case with NGOs. Of the several NGOs active in Tunisia, none is involved in agricultural extension. Furthermore there are no financially-independent farmers associations. The only major farmers' association is the Tunisian Association for Agriculture and Fishery (UTAP), which is almost entirely financed by the Ministry of Agriculture and Water Resources.[65]

---

[62] Moufida Touayi, 2004, 'Proceedings,' *Sub-regional Workshop on Application of ICT for Enhancement of Extension Linkages, Coordination and Services*, Hammamat, 22-24 November

[63] IRA is affiliated to INESA. It is categorically a government organization. (http://www.ira.agrinet.tn/ang/)

[64] Various, 2003, *Implementation Completion Report (SCL-42780) on Loan in the Amount of US$ 42 million to the Republic of Tunisia for a Second Agricultural Sector Investment Loan*, The World Bank, Washington DC

[65] G-fras: http://www.g-fras.org/en/world-wide-extension-study/africa/northern-africa/tunesia.html accessed online on 11-01-2016

4.2.1 Agricultural extension

Following the guidelines of the agricultural extension master plan, the current system in Tunisia has been built so that it has presence at central, regional and local levels. At the central level, the Agricultural Training and Extension Agency (AVFA) is in charge of mass agricultural extension, support, follow-up and coordination of field extension. At the regional level the Agricultural Development Regional Commissions (CRDA) is in charge of field agricultural extension through Extension Territorial Cells (CTV) and the Agricultural Radiance Centres (CRA). The CRDA makes use of a network of Coordination Units (UC) and CTV and CRA to operate field agricultural extension on a local level. They are in charge of planning, organizing and follow-up of agricultural actions and training, and providing technical services. CTVs are in charge of implementing extension programs; managing the allocation of means of transport and equipment; and providing technical support. CRAs are in charge of making technical information and options available to farmers. They participate in the selection of research topics based on key issues identified by farmers, awareness raising and training, and helping farmers organise into groups.[66]

At present the main responsibilities of extension workers include planning and implementation of extension programs, follow-up and impact assessment, follow-up of agricultural campaigns, and assessment of yields. Field agricultural extension and training is based on a participatory approach. This is based on participation of various stakeholders in different activities and aims to extend research to relevant parties. Intensive extension campaigns are routinely carried out and consist of dissemination by mass media, target groups methods, written supports, etc. The following numbers provide some indication with regards to the reach of the system in place and the volume of its activities (as per government figures available till 2003-04):

- **Number of active extension workers:** The field-level agricultural extension network comprises of 854 workers. This includes 593 personnel who work directly with farmers. They are helped by 261 personnel in planning their activities, administration and coordination with regional and federal government units.
- **3,500 information days** (covering 43,000 farmers) annually
- **2,300 practical sessions** facilitated by extension workers or scientists (covering 19,300 farmers) annually
- **500 demonstration plots** for the benefit of 3,100 farmers
- **60 visits** organized in the benefit of 700 farmers
- **186,000 individual field interventions**

In addition, there are outputs produced and disseminated through the mass media: 180 TV spots, 365 radio programmes, 144 radio releases, 48 radio files and 5 technical fiches (average annual numbers). These numbers, even if insufficient, are certainly substantial. In any case, the underlying system provides ample scope for further expansion of extension services within the existing framework.[67]

4.2.2 Hierarchies and blind spots in current knowledge systems

Tunisian federal governments have put a strong focus on generating quality research and reaching this out to farmers through their extension network. At a workshop organised by the FAO (in 2003) representatives of the Agricultural Extension and Training Agency (AVFA) identified measures in order to expand and improve the efficiency of the system already in place. However there are a number of questions which are not addressed by the current system sufficiently, such as: What is agricultural knowledge? Who creates it? Who is the custodian of such knowledge? Does knowledge transfer takes place from scientists to farmers? Is it worth examining this assumption?

---

[66] Moufida Touayi, 2004, 'Proceedings,' *Sub-regional Workshop on Application of ICT for Enhancement of Extension Linkages, Coordination and Services*, Hammamat, 22-24 November

[67] Moufida Touayi, 2004, 'Proceedings,' *Sub-regional Workshop on Application of ICT for Enhancement of Extension Linkages, Coordination and Services*, Hammamat, 22-24 November

Agricultural research is ideally instrumental, contributing towards solving real problems that farmers face. The process, therefore, is served very well by inputs from farmers at various stages: data collection, analysis, technology development, implementation, impact assessment etc. However, incentives available to scientists in order to advance their careers are stacked too heavily towards doing research that would get published in scientific journals. This creates bias towards certain topics of research and certain research methodologies that are not necessarily informed by farmers' concerns, or involve them in the process. [68]

The Indigenous Soil and Water research programme (ISWC), a collaboration between the Vrije Universiteit, Amsterdam (The Netherlands), ETC Ecoculture (The Netherlands) and Institut des Regions Arides (IRA, Tunisia)[69] raised such questions. The programme began in Tunisia in 1997. Through a series of workshops, awareness raising activities and field research, it sought to instil in scientists and extension agents the value of participatory approaches to research and extension.

The programme highlighted that there are two blind spots in the current systems. Firstly, there is a tendency among scientists to consider 'scientific' knowledge as the sole form of agricultural knowledge worth passing down to farmers through extension efforts. With this attitude the knowledge generated and shared among farmers was being overlooked, such as rainwater harvesting techniques that pre-date modern scientific research by hundreds of years.[70] Secondly, the role of women who play a key role in rain-fed crop production is overlooked. Women bring a high degree of innovation to their work every day, such as fashioning water saving devices out of household objects and efficient cropping techniques.
The current practice of agricultural extension therefore is a rather one-way approach with little attention to knowledge and practices prevalent among farmers. Institutionalising processes to facilitate inter-linkages between farmers and scientists can contribute to empower farmers in their ability/willingness to innovate.[71]

4.3 Innovation in Tunisia: co-creation of knowledge

This section describes how a participatory approach to the development of WHT has developed over time in Tunisia and by what mechanisms. It starts with a short explanation of the *Jessour*, a key WHT implemented in dry mountainous regions. This is followed by a discussion on the processes in place that seek to encourage joint innovation by farmers and other stakeholders. Thereafter, a roundup is provided of various strategies and practices of dissemination of agricultural knowledge.

4.3.1 *Jessours*

Since the 1960s, major socio-economic changes have led to a decline in farming in the mountainous areas of central and southern Tunisia and gradual abandonment of traditional techniques of harvesting rainwater, such as the *jessour*. In these arid areas, farmers together with scientists, undertake joint experiments in order to reduce maintenance for jessours. The aim is usually to reduce labour requirements, and to increase the productivity of rainfed agriculture, and thereby improve the image of farming as a livelihood option. A small number of scientists were initiated to get informed about the innovations that were being developed in the field.[72] The *Jessour* system is indigenous to Tunisia. Built using stone masonry, it has supplied fig and olive trees with sufficient water in very dry environments for hundreds of years. It

[68] Nasr,N, 2002, 'Impact of the farmer innovation approach on the attitudes of stakeholders in agricultural development in Tunisia,' in Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 325-330

[69] IRA is affiliated to INESA. It is categorically a government organization. (http://www.ira.agrinet.tn/ang/)

[70] Video: *'Rainwater Harvesting in Tunisia'*, produced by Sapien Productions and 'Centre de Recherche et des Technologies des Eaux, Tunisia, Viewed on November 29, 2013 <http://thewaterchannel.tv/en/videos/categories/viewvideo/597/water-harvesting/rainwater-harvesting-in-tunisia>'

[71] Nasr N, Chahbani, B & Reij, C, 2002 'Women's innovations in rural livelihoods in Arid Area of Tunisia,' in Chris Reij & Ann Waters-Bayer (eds) *Farmer Innovation in Africa: A Source of Inspiration for Agricultural development,* Earthscan, UK, pp. 132-135

[72] Nasr, N., Chahbani, B. and Reij, C., 2002, 'Innovators in land husbandry in arid areas of Tunisia' in Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 122-131

has helped farming communities become self-sufficient and provided neighbouring areas with agricultural products.

Jessour is a water harvesting method within the category of macro-catchment and floodwater methods (*Wadi*-bed systems). The wall/dyke structures are built across relatively steep *wadis*[73] in southern Tunisia and function as barriers that hold back sediment and runoff water. The walls are usually high to account for the steep slopes. They are made of earth, stones or both; but always have a spillway, usually made of stone. Over several years, as water is stopped behind these walls and sediments settle and accumulate, new land for planting is created which is mainly used to cultivate figs and olives but also other crops. In the cropping area water is collected from the catchment through the wall structure and therefore trees can be grown. Jessours are mostly in use in semi-arid to arid areas with average rainfall of around 100 mm per year, by means of jessours it is possible to provide an equivalent of 400-500mm of rainfall per year to the crops.[74] .

Usually there is a series of *jessours* along a *wadi*, originating from a mountainous catchment. These systems require maintenance to keep them in good shape. Due to the fact that the importance of these systems for food production has declined recently, maintenance has also reduced, resulting in many systems breaking down. A similar water harvesting system in place is the '*tabia'*, used in the gently-sloping foothill and piedmont areas. It is a relatively new technique, developed by mountain dwellers who migrated to the plains.

Although the jessour technique was developed for the production of various agricultural crops, it now also plays three additional roles: (1) aquifer recharge, via runoff water infiltration into the terraces, (2) flood control and therefore the protection of infrastructure and towns built downstream, and (3) wind erosion control, by preventing sediment from reaching the downstream plains, where wind speeds can be particularly high.[75] [76] [77]

Aerial View of a Jessour System (Image Courtesy: WOCAT)

[73] valleys

[74] WAHARA Project – Jessour Water Harvesting structures applied in Tunisia. https://vimeo.com/153217772 –Accessed online on 11-01-2016

[75] Oweis, T., D. Prinz and A. Hachum. 2001. Water Harvesting: Indigenous Knowledge for the Future of the Drier Environments. ICARDA, Aleppo, Syria. 40 pages.

[76] WOCAT https://qt.wocat.net/qt_summary.php?qt_id=239 accessed online on 23/12/2015

[77] Mekdaschi Studer, R. and Liniger, H. 2013. Water Harvesting: Guidelines to Good Practice. Centre for Development and Environment (CDE), Bern; Rainwater Harvesting Implementation Network (RAIN), Amsterdam; MetaMeta, Wageningen; The International Fund for Agricultural Development (IFAD), Rome.

Jessours are one particular WHT, but they merit a mention in the discussion here on the general topic of WHT, agricultural knowledge and innovation. This is because they are ancient structures and quite widespread within arid regions. Besides, much innovation has taken place around them as farmers tried to increase their efficiency and diversify their usage, in order to adapt to changing climatic and socio-economic demands.

4.3.2 Participatory innovation

The ISWC programme in Tunisia started in 1997 and its lead agency is the Institut des Regions Arides (IRA). This programme initiated activities, such as workshops and trainings, for researchers, development agents and staff of agricultural training centres. A primary objective of the programme was to change attitudes and behaviour of scientists and development agents to extension work. Secondly, it sought to create awareness about farmer-led innovation. Pursuant to that, the ISWC started with an exercise in identification of local innovators and analysing their innovations in a systematic way. A highlight of this exercise was that a large number of women were trained to interview women farmers and document the agricultural innovations they were carrying out. This was to account for the cultural beliefs that would have inhibited male extension agents to interview women.

In 1998 and 1999, ISWC-Tunisia organized visits to farmer innovators by farmers and researchers. Some of the farmers were inspired to try out what they had seen. These visits were also broadcast on television, to further increase the outreach of the innovations among farmers. In the following year, farmers and extension workers started joint experimentations. If the experiments led to good results, the government contributed with financial support, consisting of subsidies up to 60% of the costs of the technologies that economized on agricultural water use. One promising example of an innovation identified through this process was a system wherein water was stored temporarily in a small concrete dam, then pumped into a large cistern downslope, from where it was used for irrigation. This innovation was carried out by a single farmer at first, after which researchers documented it and other farmers got encouraged to try it out themselves when they visited these systems or saw it on TV.

This is but one example of innovations that came out of ISWC; there are many more. At the core of this process was joint experimentation and cultivation of linkages between farmers, researchers and extension workers; which sparked new ideas and creativity of all involved. Farmers have been stimulated to improve upon the scientist's ideas, and changes brought in by farmers have in turn stimulated new ideas among scientists.

Joint Experimentation and Innovation

Innovations in agriculture around the use of *Jessours* includes diversification of crops and grafting, in order to improve soil moisture and soil fertility. Other improvements include concrete dams and sediment traps. One farmer has started with these innovations in order to reduce the silting of his dam in which he had invested considerable money. He used the water behind the dam for supplementary irrigation to grow a wide range of fruit trees and vegetables. Many innovators practice more than one innovation. For instance growing various fruit trees, grafting, supplementary irrigation for the trees by means of a cistern, and using and adapting a water-saving technique that was tested by IRA scientists in a neighbouring farmer's field.

Besides socio-economic constraints, traditional water harvesting techniques, such as *jessours* face a number of technical constraints. Joint experimentation has been known to help develop technical innovations to overcome such constraints. One of these is the high ratio between the catchment and the cultivated area, which is at least 20:1. This means that large catchments guarantee adequate runoff in years of low and average rainfall, but can cause flooding and damage to the fields with occasional high-intensity rainfall. A researcher developed a technology to evacuate excess water which was tested in a farmer's field. The researcher was not positive about the results, but a farmer suggested improvements which were then incorporated and the technique tested again. Another example is the testing of 'buried stone pockets' to increase the efficiency of water use for irrigation of fruit trees in Jessours. Farmers have not simply adopted this technology, but also adapted and improved it to fit to their specific circumstances. Farmers modified and fine-tuned the initial technique and also started to document the details of their experiments. This

allowed them to compare their results with a control plot in their own fields, and adapt researchers' approaches as well.

In short, these developments come down to a raised awareness of researchers and development agents about farmers' innovations, and in return farmers becoming more active in modifying and improving upon innovations. New links have been created between various stakeholders, which created much interest in joint experimentation and innovations, also among policymakers. The intention now is to strengthen the links made and to expand the farmer innovation approach.[78]

4.3.3 Spreading the 'good news' through Mass Media

Among the three key elements of ISWC 2, use of mass media is the one that has a multiplier effect as it reaches out to those not directly involved in the project. Despite its great potential, its use is relatively uncommon outside the public sector. As mentioned above, some of the exchange visits by farmers and researchers were **broadcast on national television**. However, the key mass media vehicle was weekly radio programmes on agricultural innovation.

The radio programmes invites farmers to share their innovations, and besides they involve researchers, training specialists and development agents into debates about these innovations. During the first year, about 85 men and 15 women farmers took part in the broadcasts and presented or discussed a wide range of innovations. In the course of time it became evident that the radio programmes had four major types of impact. Firstly, they were an incentive to continue innovating. As for most men and women farmers who had presented their innovations, this experience was considered an important social incentive to them to continue to develop their innovations. Secondly, after speaking on the radio most innovators have been visited by other farmers and agricultural technicians. This led to new relationships evolving and strengthening between farmers, development workers, research scientists and policy-makers. Thirdly, they stimulated adoption and adaptation of the innovations on the radio by the listeners. And fourth, the broadcasts have started to change the attitudes of researchers and development agents. Since the radio programmes started there has been a growing positive interest in seeking local innovations to stimulate rural development. All-in-all, the programme has contributed immensely to the process of spread of agricultural knowledge becoming more bottom-up than in the past.

Listeners requested that the programmes be continued well beyond their scheduled end, and even to be extended to other regional stations as well as to national radio. This can be done only when development agencies and farmers' organizations accept responsibility for and 'ownership' of these radio programmes. This can be done by establishing linkages between local innovators, encouraging farmers to listen in and so on. Also other mass media can be used to share the message of farmer innovators who develop useful technologies in farming.[79] The use of mass media, in this case a radio programme, proved very valuable for both horizontal and vertical upscaling. Farmers could listen to each other's ideas and connect to new innovations and ideas in order to adapt it to their specific situation if possible. And at the same time researchers and DAs would listen to the ideas that farmers brought up on the radio and they could incorporate these ideas into extension programmes and agricultural policies.

4.4 Impact

IRA, the lead implementing agency of the ISWC programme, is spearheading the farmer innovation approach in Tunisia. Their strategy hinges on three key elements:

---

[78] Nasr N, Chahbani, B & Reij, C, 2002 'Women's innovations in rural livelihoods in Arid Area of Tunisia,' in Chris Reij & Ann Waters-Bayer (eds) *Farmer Innovation in Africa: A Source of Inspiration for Agricultural development,* Earthscan, UK, pp. 132-135

[79] Nasr, N., Hdaidi, E.A. and Ayed, A.B., 2002, 'A bridge between local innovation, development and research: the regional radio of Gafsa, Tunisia' in Chris Reij & Ann Waters-Bayer (eds) *Farmer Innovation in Africa: A Source of Inspiration for Agricultural development,* Earthscan, UK, pp. 293-299.

- joint experimentation with farmers
- organizing exchange visits
- use of mass media to promote dissemination of farmers' innovations

When ISWC 2 started in Tunisia in August 1997, there was some resistance from within the formal research and development agencies because the approach was entirely new to them. They were not convinced that farmers could innovate and develop new technologies. Furthermore, scientists and development agents were not used to working in a manner as collaborative as the ISWC required them to. Three years into the ISWC programme, significant change could be observed in the perceptions and attitudes of all stakeholders who had to work together in field experiments and dissemination of results.

In addition to this, the contribution of the Ministry of Agriculture (MoA) and the Director General (DG) provided substantial support to this program and other initiatives based on participatory approaches. WHT specialists from the regional MoA office worked together with scientists from IRA, extension workers, and farmer innovators as they jointly selected the experimental sites and agreed on tasks for execution.

As a result of their involvement in various activities supported by ISWC (exchange visits, joint experiments, radio broadcasts, workshop presentations, visits by policy makers and foreign guests), the attitudes of local innovators have changed remarkably. Farmers have become more aware of their creative potential and several innovators began to experiment more deliberately. Furthermore, backing from the national government also helped legitimize the farmer innovation approach in the eyes of scientists. So there was change in attitudes all around.[80]

4.5 Key findings on options and enabling conditions

The context of Tunisia is one of a country that has put great effort in agricultural development and especially in extension services. Support to do so mainly comes from governmental organizations and is organized in a decentralized manner. A vast extension network is in place in Tunisia, although some voices also claim there is a need to boost manpower in the extension services in order that it can reach out to more farmers. In addition to the possible human resource gap, new challenges have arisen in the past few decades that demand a different approach. The pressures of various socio-economic and ecological developments on the landscape are increasing exponentially. Livelihoods and land productivity are being challenged by climate change and increasing population. Therefore, many farmers either left farming, or have had to find ways of making their farm operations more productive.

So productivity is now a key target. There is a need to reduce costs and make maintenance of traditional WHTs more economical (such as *Jessours*). This is a theme that for farmers has been a key reason to innovate. It is around this particular need that they have collaborated with scientists and extension workers under projects like the ISWC. It would be important to recognise this, and have it guide future choice of research and extension themes.

The lead that the government has taken in the process of agricultural extension has been of pivotal importance to the integration of new innovations in extension programs and on the ground. Experiences from the ISWC project show that participatory development and extension of innovative practices is an effective way of capitalising on the government's focus on agriculture. Discussed below are three key features of the initiative.

4.5.1 Change in Attitudes

One of the key changes achieved by the process of joint learning and innovation is the removal of barriers that limited interaction between researchers, extension workers, and farmers. Greater interaction among them effected changes in their attitude towards each other. A large number of researchers and extension

[80] Nasr,N, 2002, 'Impact of the farmer innovation approach on the attitudes of stakeholders in agricultural development in Tunisia,' in Chris Reij & Ann Waters-Bayer (eds) Farmer Innovation in Africa: A Source of Inspiration for Agricultural development, Earthscan, UK, pp. 325-330

workers recognise the potential of farmers to innovate, and that they need to be encouraged and made aware of their potential. Farmers are now less skeptical of the value of research and extension work to their practical needs, better informed about sourcing information and assistance from them, and more confident of adapting technologies innovatively. The gains made in this direction through individual projects like ISWC need to be built upon, so this change in attitudes can be achieved through a critical mass of stakeholders all over Tunisia.

4.5.2 Shared learning and experimentation

Attitudinal change provides the foundation for shared learning and experimentation. This refers to the co-creation of knowledge by various stakeholders, in contrast to the top-down nature of agricultural extension that was the norm for most of the developing world until the 1970s and 80s. Much has been discussed already about how shared learning and experimentation foster empowerment on part of the farmer, and produce knowledge that is more relevant to his practical needs. Additionally, bridging of the disconnect between farmers and policymakers improves the quality of the research itself. [81] With farmers participating in field experiments, better quality data can be generated. Decision-making and policy based on good quality data is naturally better. Apart from Tunisia, this has been demonstrated through Farmer-Field School experiences from around the world (such as the FAO-funded APFAMGS project in Andhra Pradesh, southern India). [82] Besides, such an approach creates the opportunity for traditional knowledge systems and the physical sciences to interact with, inform, and enhance each other.

4.5.3 Linkages

Co-creation of knowledge with the participation of various stakeholders also achieves the seemingly simple but rather important task of creating and deepening linkages between the various stakeholders. From the point of view of the analytical framework adopted by this report, this helps achieve vertical upscaling of innovations and technologies such as WHTs. Achieving a certain degree of vertical upscaling stimulates horizontal upscaling through a large number of farmers. It is when a technology finds approval across the gamut of stakeholders (vertical scaling up) that comparative advantages are identified, value chains develop, and efforts harmonized. All this then boosts uptake by a larger and larger number of farmers (horizontal scaling up).[83]

4.6 Conclusion

Attitudinal change among the various stakeholders was key to joint innovation and spread of WHTs in Tunisia, as envisioned by the ISWC project. As an intervention, its key value addition was the platforms it created for scientists and extension workers to work with farmers on technology development. It harnessed the potential of radio as a mass medium for documentation of innovations as stories, and their horizontal and vertical upscaling. All in all, it validated the idea that small farmers should be at the centre of agricultural innovations meant for them. Thus, it appealed to the agency of farmers to not just adopt innovations but also to adapt them to their specific needs. Robust assessments of the program's impact are forthcoming. However, its uptake amongst the government, NGOs, the scientific community, and farmers directly involved in the program provides some indication of the potential of farmer-centric interventions.

By creating linkages across the various stakeholders in its present state, ISWC project has achieved a fair amount of vertical scale in its present form—that of a standalone intervention. Up ahead lies the more difficult task of institutionalising its basic approach and achieve horizontal upscaling—scaling it out to cover a larger number of farmers, scientists, and extension workers across the country.

---

[81] Personal interview, with Mohammed Ouessar, Agronomist, IRA

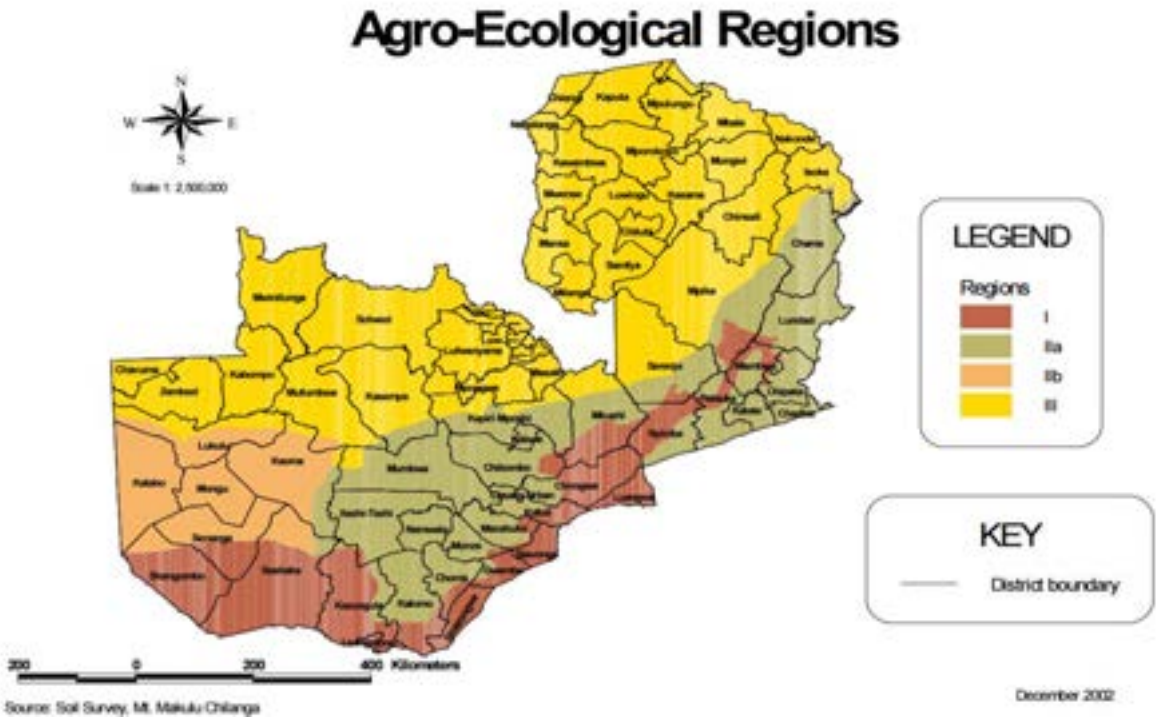
[82] FAO and Bharithi Integrated Rural Development Society (BIRDS), 2010. *Andhra Pradesh Farmer Managed Groundwater Systems Project (APFAMGS Project)- Terminal Report*. Secunderabad: BIRDS

[83] See Section 1.2 of this report.

5. Zambia

5.1. Introduction

Zambia has one of the best land and water endowments in Africa that constitute a huge agricultural potential. About 22% of all the land is suitable for agricultural production [84], of which 15% is being cultivated. 85% of this land under cultivation is rainfed.



The country is divided into three main agro-ecological regions: the dry south-west where an abundance of acacia trees grow; the central region stretching east to west - the most agriculturally productive with higher rainfall; and the third region to the north which receives the highest rainfall and is suitable for cultivating rice, cassava, pineapples and bananas.

A distinctive feature of Zambia's agricultural sector is its dual nature. On the one hand, there is a small number of large commercial farms concentrated along the length of the Great North Road, from Livingstone through Mazabuka (large sugarcane), Kafue, Lusaka, Kabwe, Mkushi (called the 'bread basket' of Zambia), and a little further north towards Mpika. This farming is commonly high-tech and high-input, reliant on subsidized fertilisers and high yielding varieties, since most farmers will also irrigate parts of their land during the winter/ dry season for second crops. Specific soil and water conservation practices are not carried out, although most large scale farmers will either maintain (private) surface water reservoirs or tubewells, to use the water for irrigation.

The commercial farms produce bulk of the market output. In stark contrast are the 40% of rural households engaged in mostly rainfed farming.[85] The nature of their farming is mostly subsistence, although they

[84] Zambian-German Agricultural Knowledge and Training Centre, 2015. *About Us* [online] Available at: <http://www.aktczambia.com/about-us/> [Accessed 20 December 2015].

[85] Online Agricultural Extension and Advisory Services World Wide, Facilitated by IFPRI (http://www.worldwide-extension.org/africa/zambia/s-zambia)

dominate certain value chains like maize[86] that have low requirements with respect to capital investment, irrigation and farm inputs. Nevertheless, socio-economic differences between the smaller farmers, compared to commercial farmers and urban populations is large, making Zambia one of the most unequal countries in the world. [87]

5.2. Agri-extension landscape

The following box outlines the government's National Agricultural Policy until 2015

Box 1: National Agricultural Policy 2004 – 2015, Extension Services

Objective: To provide efficient and effective crops extension and technical services, especially through participatory approaches, to assist farmers increase agricultural production and productivity and diversify crop production and utilization.

Specific objectives:

i) To extend proven technological messages and innovations to resource poor farmers including women and young farmers so as to increase agricultural production.
ii) To provide liaison and links between farmers and farm support organizations responsible for credit, marketing and research.
iii) To support farmers gain management and marketing skills in order to operate on a commercial basis.
iv) To facilitate the transfer of and improvements in on-farm crop handling and storage technologies in order to minimize post–harvest losses.
v) To promote and ensure availability of good quality food to enhance nutrition, especially among the poor and vulnerable communities.

Strategies

i) Promote and strengthen farmer groups and farmer field schools as targets for technology transfer.
ii) Create and strengthen the zoning of agricultural camps in order to improve service delivery and infrastructure development.
iii) Use electronic and printed media as communication tools to support extension information delivery.
iv) Promote and encourage the involvement of the private sector and NGOs in the provision of extension services.
v) Promote crop diversification and use of improved technologies.
vi) Promote gender responsive agricultural extension services.
vii) Facilitate delivery of skills training and technology transfer to small scale farmers using Farmer Training Institutes at staff level and Farmer Training Centres at farmer level.
viii) Promote food crop processing and utilization.

Institutional Framework

The Ministry of Agriculture and Livestock (MAL) will provide extension and information through its network at national, provincial, district, block and camp levels. ***Farmer organizations, the private sector, Non-Governmental Organisations, and Community Based Organizations (CBOs) are expected and encouraged to provide extension services to farmers.***

A key focus area of the policy was bolstering private sector participation in agriculture. It is important at this point to mention here the Zambia National Farmers' Union (ZNFU), that counts among its members

[86] Colliard Hamusimbi, Head-Outreach and Membership, Zambia National Farmers Union (ZNFU). 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.
[87] The World Bank-Poverty Reduction and Economic Management Group, Africa Region, 2012. Stagnant Poverty and Inequality in a Natural Resource-Based Economy. Washington D.C.- The World Bank

600,000 smallholder farmers, 1,000 large commercial farmers, and 42 agro-businesses. Representing such a wide range of agri-sector stakeholders and their variegated interests, it carries out lobbying and advocacy to make sure that "policymaking in Zambia is attuned to the needs of private-sector driven agricultural development,"[88] By representing smallholder farmers and at the same time advocating market-driven, commercially-viable growth of the farm sector, it has been a key proponent of the idea that smallholders belong in the private sector just like agri-businesses, that they are not restricted to the public sector with government subsidy and support being their lifeline.

With multiple agencies carrying out agricultural extension and advisory, Zambia's extension landscape has been described as 'pluralistic'[89].

Public Sector- At the top of the government sector's institutional setup is the Principal Agriculture Officer at the Ministry, overseeing Senior Extension Methodologists at the 10 provinces. Reporting to them are 107 District Extension Methodologists representing each district, under whom operate the Block Extension Officers (one from each of the 385 blocks) and Camp Extension Officers (or CEOs, one each from the 1845 camps).[90] It is the Camp Extension Officers (CEOs) that communicate directly with the farmers, and so need to be trained regularly in technologies that need to be reached down to the farm level. The CEOs also are the ones who assess the extension needs of farmers, collect feedback on applied technologies, and pass it up the hierarchy. They also interface between the agri-industry and the farmers; private companies introduce their products-- seeds, implements etc., through the camp extension officers.

Private Sector: Agri-businesses and Retailers- Outside the government sector, there are agri-businesses and farm input retailers. In certain value chains such as maize and cotton, smallholder farmers often produce the crop and supply to bigger corporations for processing and distribution (such an arrangement is known as contract farming). In such cases, the bigger corporations have much incentive to keep their smallholder suppliers updated with the latest farm knowledge and even equip them with the latest technology. For example, food processing giant Cargill works with 60,000 cotton farmers in Eastern Province alone, and services them through 1000 plus Cotton Schools and 800 Women's Clubs.[91] Private companies like Cargill provide their smallholder suppliers extension and advisory also through trade association formed around specific products, such as the Zambia Cotton Ginners Association (ZCGA), Grain Traders Association of Zambia (GTAZ), Zambia Seed Traders Association (ZSTA), etc. Farm input retailers, big and small, provide advice on how to best use fertilizers, herbicides, and other inputs in order to cultivate a loyal customer base.

There are several farmer unions in Zambia, providing extension and advisory services to their members. Most of them are affiliated to ZNFU.

---

[88] Colliard Hamusimbi, Head-Outreach and Membership, Zambia National Farmers Union (ZNFU). 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

[89] Modernising Extension and Advisory Services (MEAS), 2014. *Assessment and Recommendations for Strengthening the Pluralistic Agricultural Extension System in Eastern Province, Zambia*. Cornell University, MEAS, University of Illinois, USAID, Catholic Relief Services

[90] Henry Migomba, Principal Agriculture Officer, Ministry of Agriculture and Livestock, Zambia. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

[91] Modernising Extension and Advisory Services (MEAS), 2014. *Assessment and Recommendations for Strengthening the Pluralistic Agricultural Extension System in Eastern Province, Zambia*. Cornell University, MEAS, University of Illinois, USAID, Catholic Relief Services

Images courtesy: Zambia National Farmers Union

Public-Private Partnerships: Specialised Research/Extension Organisations- A key part of the extension jigsaw in Zambia are specialised agri-research and extension organisations. Some of them have been set up by the government, such as Golden Valley Agricultural Research trust (GART) [92] and the Cotton Development Trust (CDT). [93] Others such as the Conservation Farming Unit (CFU) [94] have originated from the private sector. All of them work closely with both public and private sector organisations; and specialise in specific areas such as cotton farming, conservation agriculture, etc.

The idea of specialisation also manifests in how private and public sectors facilitate organising farmers into groups around specific crops and farming methodologies, and targeting extension and advisory accordingly. "We are focussing on identifying comparative advantages of different regions and providing targeted extension services, so those aspiring to grow from smallholders to commercial farmers can benefit and grow," says Henry Mugomba, Principle Agriculture Officer (Farm Management) at the Ministry of Agriculture and Livestock[95]. "We try to reach extension services to small farmers by organising them into formidable groups, and facilitate their exchanges with specialised organisations like GART and CFU," says Coillard Hamusimbi, Head-Outreach and Membership, ZNFU.

Extension needs of large, commercial farmers: The larger commercial farmers need extension services too. Graham Douse is the proprietor of Riverdale Farms in Magoye, Mazabuka (Southern Province). Among other activities, he grows sugarcane over 400 hectares and is counted among the major commercial farmers in the area. He gets his market-related information (prices, etc.) from the ZNFU's weekly market briefs. He gets his updates on the latest in sugarcane farming technology and best practices from ZNFU's technical briefs and monthly magazines. He has built on his property a small dam which caters to 75% of his water needs. He depends on the government advisory services for hydrological data and information related to sharing of water rights with his neighbours. "My neighbours are several smallholder farmers, with whom the government extension services are intimately involved," he says. "So in effect they are also

[92] Golden Valley Agricultural Trust, 2015. *Profile.* [online] Available at: <http://www.gartzambia.org/GV-WO.html> [Accessed 5 December 2015]

[93] Cotton Development Trust, 2008. *Zambia Country Report to the 67th ICAC Plenary Meeting.* (17th to 21st November, 2009. Ouagadougou, Burkina Faso) - Report, Together with Formal Minutes. Mazabuka: CDT.

[94] Conservation Farming Unit, CFU, 2015. *About Us.* [online] Available at: <http://conservationagriculture.org/about-us>

[95] Colliard Hamusimbi, Head-Outreach and Membership, Zambia National Farmers Union (ZNFU). 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

a key source of information to me. They are an independent arbitrating source of information on issues that affect both me and my neighbours."

The difference between commercial farmers such as Graham and his smallholder neighbours is that there are several kinds of extension/advisory services that he can avail, as he can afford to pay for them. For example, he hires a consultant engineer to advise him on the dam's storage capacity and extension plans. By hiring a seismic surveyor, he has been able to site and prioritized 30 boreholes. He will develop them as and when the requisite capital is available to him.

Graham Douse's sugarcane farm (above) and the dam he has built on the property (below). (Images Courtesy: MetaMeta)

5.3. Spread of Conservation Farming in Zambia

5.3.1. Context

Conservation agriculture is a farming system based on three main principles: minimal soil disturbance, permanent soil cover, and crop rotations.[96] Known as 'Conservation Farming' in Zambia, it has been able to find much traction in the country since the early 1990s [97], particularly in the Eastern Province and the Southern Province.

This report will focus particularly on the spread of Conservation Farming in the Southern Province, as that is where the WAHARA study site is located and where most of the primary research was carried out . The region had traditionally been a net exporter of agricultural products. However, over the years the farm sector in the region got afflicted with a number of issues-- livestock numbers dwindled due to an outbreak of the corridor disease in the early 1990s; HIV-related deaths resulted in a shortage of labour; persistent droughts led to a shortening of the growing season; and land degradation became widespread due to excessive use of inorganic fertilizers and conventional tillage. All these factors combined to wreck the small--scale farmer's livelihood and made him an extremely unattractive business partner for the large commercial agricultural sector. [98]

---

[96] FAO-Agriculture and Consumer Protection Department, 2015. *Conservation Agriculture.* [online]. Available at: <http://www.fao.org/ag/ca/> (Accessed December 29, 2015)

[97] Conservation Farming Unit, CFU, 2015. *History of the Conservation Farming Unit, Zambia.* [online] Available at: <http://conservationagriculture.org/history-of-the-conservation-farming-unit-zambia> (Accessed December 15, 2015)

[98] Baudeon, Frédéric; Mwanza, Herbert M.; Triomphe, Bernard; Bwalya, Martin. 2007. Conservation agriculture in Zambia: a case study of Southern Province. Nairobi. African Conservation Tillage Network, Centre de Coopération Internationale de Recherche Agronomique pour le Développement, Food and Agriculture Organization of the United Nations

Among the several benefits of Conservation Farming, those that match Southern Province smallholders' farming needs particularly well are improved soil fertility, soil moisture conservation, lower labour requirements, and economic use of animal draft power. The relevance of Conservation Farming has found acknowledgement across stakeholders-- farmers, the government, private sector, as well as donors. Despite several dry spells in recent years, Zambia has seen bumper outputs of maize, most recently in the 2013-14 farming season. [99] This is significant as maize is the staple crop and its output considered a proxy for food security. Most of it is grown in the Southern Province.

5.3.2. Conservation Farming Technologies

The Conservation Farming system is implemented through a bouquet of techniques. The most prominent ones disseminated in Zambia are:

1. **Permanent Planting Basins:** These are 30cmx15cmx20cm pits dug using hand hoes, dug season after season in the same place. Seed and other inputs such as fertilizer and lime are placed precisely within them. So the soil is disturbed only where it needs to be (around the plant), inputs are used efficiently, and water infiltration is improved. This method is ideal for the smallest of smallholders who have no access to land preparation tools other than the hand-hoe. Being too labour intensive, it is difficult to implement over large plots. *(See image below, courtesy Conservation Farming Unit-CFU).*

2. **Ripping:** Ripping involves using a ripper to create rows of linear grooves in the soil, where seeds are planted and inputs applied. Spaced 80-90 cms apart, these rip lines are created at the same places every year so the soil between them stays undisturbed. To break the plough pan [100] and to increase water infiltration capacity, ripping is ideally done during the dry season. *(See image below, courtesy Conservation Farming Unit-CFU).*

[99] May 5, 2014. 'Zambia in bumper harvest as 2013/2014 production estimates show a 23 % jump in Maize output.' *Lusaka Times,* [online]. Available at <https://www.lusakatimes.com/2014/05/05/zambia-bumper-harvest-20132014-production-estimates-show-23-jump-maize-output/> [Accessed January 5, 2016]

[100] Plough Pans are created due to continuous ploughing of the land using drawn implements during periods of high moisture content, usually at the same depth. Plough pans restrict water movement, oxygen availability, and inhibit normal root growth. In Zambia's Southern Province, this has been a big enough problem to trigger significant outmigration.

3. **Strip Tillage:** Similar to ripping, strip tillage is a process optimized to work in moist soil so it requires less animal draft force. It is meant to be a transitional technology for farmers intending to adopt Conservation Farming in degraded soils.

4. **Zero Tillage:** Animal Draft Zero-Till involves the use of an animal drawn mechanical planter to plant directly in untilled soil to minimise soil disturbance and leave a cover of crop residues to conserve the soil.

5. **Residue and Biomass Management:** Conservation agriculture practices require a critical level of crop residues and cover crops to maintain or enhance soil chemical, physical and biological properties and prevent land degradation.[101]

6. **Weed Control:** Weed control becomes especially crucial in Conservation Agriculture, as reducing tillage tends to increase aggressive weed growth. Weeding can create extra demand for labour, so herbicides are being promoted as a feasible alternative. Certain cover crops (such as cowpea) can help control weed growth too.

7. **Crop Rotation:** Apart from weed control (as mentioned above), crop rotation can help improve soil structure, increase soil fertility (by use of nitrogen-fixing legumes), supplement income, and manage risk of crop-failure.

5.3.3. Spread of Conservation Farming in Zambia

By the early 1980s a wide consensus had been reached that intensive tillage and lack of soil cover were the key reasons for soil degradation in Zambia. By the late 1980s, a number of agriculture-sector institutions in the country had started testing Conservation Farming techniques such as low tillage, crop rotation, etc. Around that time ZNFU facilitated exchanges between commercial farmers from Zambia, and those practicing Conservation Farming in Australia and the US. These farmers were exploring Conservation Farming methods with an interest in reducing their fuel consumption. [102]

[101] FAO-Agriculture and Consumer Protection Department, 2015. *Conservation Agriculture-Livestock Interactions.* [online]. Available at: <http://www.fao.org/ag/ca/> (Accessed December 29, 2015)

[102] Agricultural Development Economics Division-FAO. (Adoption and intensity of adoption of conservation farming practices in Zambia) (ESA Working Paper No. 13-01, April 2013). Rome: FAO.

In 1995, ZNFU and GART started trials on permanent basins. In that very year, CFU (Conservation Farming Unit)[103] was set up as a ZNFU affiliate with the mandate to experiment with permanent basins and optimize their design for Zambian conditions. CFU has since then played a major role in promoting Conservation Farming, especially among smallholder 'hand-hoe' farmers.

Since then, a large number of donors and the Ministry of Agriculture and Livestock (then the Ministry of Agriculture and Cooperatives) have made substantial investments in research and testing of various aspects of Conservation Farming. This reflects a growing acknowledgement of the methodology as a tool for making smallholder farming profitable, and for rural poverty alleviation in general. In 2000, the government formally embraced Conservation Farming as an official national policy.[104] It initiated the process of training extension staff in principles of the methodology; and started providing input packages of seeds, fertilizer and lime to farmers as incentive to adopt it. In 2001, the ministry's Technical Services Branch established a national conservation farming steering committee, with representation from all major stakeholders in the agricultural sector, to help coordinate information flows and facilitate collaboration[105].

5.4. Key findings on options and enabling conditions

The government has been actively promoting Conservation Agriculture in seven of the nine provinces in Zambia: Eastern, Central, Lusaka and Southern Provinces in agroecological regions I and IIa; Northern, Luapula, and Copperbelt Provinces in agroecological region III (see figure above).

It is reasonable to conclude that that Conservation Farming as a package of Water Harvesting Technologies, or as a holistic farming system, has spread widely at the policy level . Its adoption as a focus area by the government, NGOs, donor agencies, and right down to the Camp Extension Officers at the grassroots level makes for ample evidence to this effect. Zambia is therefore often regarded a success story in terms of CF uptake in Sub-Saharan Africa. That farmers are getting increasingly convinced about the methodology is reflected in the demand for buying and renting ripping and strip tillage implements. Small farmers engaged in contract farming for agri-business giants like Cargill and Dunavant have been reportedly adopting CF techniques even without any government/NGO support.[106]

However, hard data on its adoption and dis-adoption at the farm-level is inadequate, and one should therefore desist from viewing it as an unqualified success in Zambia. According to CFU, 170,000 farmers in Zambia had adopted CF technologies wholly or partly on their plots, as of 2011. Haggblade and Tembo (2013) report that in the 2002-03 growing season, 20% of CF farmers were spontaneous adopters while 80% were implementing these techniques as it was the condition for receiving subsidized input packages.

Through an analysis of how CF has made inroads into the policy and agenda of institutions, and why it is yet to achieve a matching level of implementation at the farm level, it is possible to identify effective strategies, impediments, and opportunities, to spread WHTs in general.

Effective Strategies

- **Coordination of efforts:** CF's very introduction in Zambia was a result of coordinated efforts between various organisations. Apart from the government itself, ZNFU, NGOs, donors and the

[103] Conservation Farming Unit, CFU, 2015. *Home Page.* [online] Available at: <http://conservationagriculture.org/ >

[104] Haggblade, S., and Tembo, G. 2003. *Conservation Farming in Zambia*. Environmental and Production Technology Division-IFPRI and Michigan State University, United States.

[105] Ministry of Agriculture, Food and Fisheries (MAFF). 2001. Conservation farming and land use: 5 year programme proposal for ASIP Successor Programme. Lusaka: MAFF.

[106] Haggblade, S., and Tembo, G. 2003. *Conservation Farming in Zambia*. Environmental and Production Technology Division-IFPRI and Michigan State University, United States.

private sector played important roles in transfer of CF technologies and their adaptation for the Zambian context. The ZNFU, due to representation of large commercial farmers, smallholders, and agri-businesses among its members played an important role in ensuring that a wide range of needs were taken into account. Its close working relationship with the government has helped the government minimize disconsonance between policymaking and needs of the private sector. The National Conservation Farming steering committee set up by the government have helped minimize duplication efforts and maximize outreach among target farmers. Establishment of research and extension organisations with specialized focus on conservation agriculture (such as CFU) have helped their comparative advantage getting cross-sectoral recognition. They are, therefore, duly engaged in projects across the board. So data collected, technology developed, and outreach achieved by various agencies are consolidated and harmonized.

Thus, a large number of stakeholders at various levels stand firmly behind the concept and implement it in their work. This underscores the high degree to which vertical upscaling of Conservation Farming has been achieved in Zambia. . The multiplicity of stakeholders also creates the need to manage vertical upscaling after it has been realised—a role that the government has assumed in the case of Zambia.

- **On-farm demonstrations:** Organisations in Zambia involved in technical development and dissemination processes associated with Conservation Farming develop their technical packages mostly on station. However. a significant amount of testing and most of the demonstration is done on-farm. Trials are conducted on farmers' fields, and learning, modification and promotion are done there. Farmers are closely involved in the process. CFU alone has gathered more than 3200 observations from farmers' trials and demonstrations capturing how Conservation Farming techniques affect key indicators such as yields, soil moisture, biomass.[107] Apart from contributing to the scientific rigour of the experiments and the quality of the data collected, this ensures that the solutions developed correspond closely to farmers' real needs and that their uptake is high. Besides, demonstrations at the field reach not only the farmer who owns the field but also his/her neighbours. Thus, on-farm demonstration contribute to horizontal upscaling.

  It is in keeping with this practice that the study sites for the experiments carried out under WAHARA are actual fields of real farmers. Nawa Sifuba, who grows maize over about half-a-hectare in Magoye, uses strip tillage over most of his land but has been working with GART to employ ripping, zero tillage, and conventional ploughing over small patches as well. When asked why he participates in the activity, he said "...because my neighbouring farmers can then observe the difference in yield and plant sizes achieved by the different land preparation techniques." Nawasfoye is most convinced about strip tillage, which he uses over most of his land. Why, then, bother to waste part of his land by using conventional ploughing which (as explained above) can create plough pans? "Because its not just my neighbours who learn by observing the different parts of the field, I learn too," he says. "By comparing with plant size and yield under conventional ploughing I can assess whether strip tilling is worth the costs/effort. Besides, we rip over the parts under conventional ploughing every two-years or so, so the plough pans are broken from time to time."

[107] Agricultural Development Economics Division-FAO. (Adoption and intensity of adoption of conservation farming practices in Zambia) (ESA Working Paper No. 13-01, April 2013). Rome: FAO.

Nawa Sifuba at his farm in Magoye (Image Courtesy: MetaMeta)

It was by observing CF methods in the fields of one his more illustrious neighbours that Valentine Mooka in Monze learnt how ripping and strip tillage work and that they can help get decent yields during dry spells. He started farming in 2006 and is now counted as an 'upcoming' farmer, meaning that on top of what he needs for his family's subsistence, he produces enough maize to sell in the market and turn in a profit. His favored method of land preparation is ripping. He can afford to hire a tractor to do that. He too works with GART and has earmarked part of his field which he strip tills and ploughs, so the difference can be observed for use in the WAHARA study but also by his neighbouring farmers. "I would like other farmers to learn about the techniques that I learnt from another farmer just like me. I am not calling myself successful, but I have not gone hungry for 6-7 years. I would like my neighbours to be as comfortable as me."

Valentine Mooka (Image Courtesy: MetaMeta)

- **Private Enterprise Contribution to Extension:** As mentioned above, a key focal point of Zambia's National Agricultural Policy is bolstering private sector expansion in agriculture. Zambia National Farmer's Union, the largest farmers' organisation in the country, considers lobbying and advocacy as one of its key functions, with the overarching objective being to "ensure that national

policymaking is conducive to private-sector-driven agricultural development." [108] It is due to this orientation at the highest level that agri-businesses, both national and international, have a strong presence in Zambia. While large commercial farmers are the most attractive customer segment of agri-businesses dealing in farm input, they are also a key supplier of seeds, fertilizer and other farm inputs to small farmers. Along their retail chain are dealers and retailers-- local entrepreneurs that operate at district, block, or even camp levels. These entrepreneurs are usually farmers themselves or at at least members of overwhelmingly farming communities. Apart from selling farming to their customers, these entrepreneurs are also a source of information and advise on land preparation, application of the inputs, etc.

"I am a farmer too. There were no agri-inputs shops in my area, so I set up one," says Scou Mabaonenge from Cherebina camp, Monenga block in Mazabuka district. Scou sells seeds and herbicides to farmers in the area, but advice on planting and managing weeds are for free. "If I give them good advice, they will be loyal customers to me," he says. The companies that supply him his stock provide him the information he needs to keep himself updated. Besides, he is an important partner of government extension workers in his area. "We organise plant clinics at his shop every week. Farmers with ailing crops bring over their plants, we look at them and advise what they can do," says Scott Agift, the local Block Extension Officer. Scou's shop is a good place to hold such clinics. "He has got all the remedies that we can suggest," says Scott.

Besides, many agri-businesses engage smaller farmers in contract farming. They have much incentive to keep their smallholder suppliers updated with the latest farm knowledge and even equip them with the latest technology. (detailed above in Section 5.2)

Across these interactions, Conservation Farming topics and inputs feature prominently, suggesting that the vertical scale-up of the technology encompassess the private quite well.

Impediments

- **Labour/ animal draft requirements:** Labour requirements are one of the biggest constraints to adoption of CF technologies. [109] [110] Land preparation is quite labour intensive, however it is weeding that creates additional labour requirements over conventional land preparation methods as weeding is a bigger need on CF plot. Other techniques such as preparation of planting basins is highly labour intensive too.

  Although the requirements of animal draft power (using ripping, strip tillage) in CF are significantly lower than conventional land preparation methods, they are still substantial. This is an especially important issue in Southern Province where farmers report that livestock availability has been on the wane. "We used to have many big oxen in the area, our farmers are now losing that resource," says Joe Aka, a farmer as well as manufacturer of 'Magoye Rippers' [111] and strip tillage implements. This has made mechanisation an important requirement for the further upscaling of Conservation Agriculture.

- **Inadequate Investment in Extension:** Econometric studies have revealed that availability of extension services in a village is one of the most important determinant of whether farmers there

[108] Colliard Hamusimbi, Head-Outreach and Membership, Zambia National Farmers Union (ZNFU). 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.
[109] Agricultural Development Economics Division-FAO. (Adoption and intensity of adoption of conservation farming practices in Zambia) (ESA Working Paper No. 13-01, April 2013). Rome: FAO.
[110] Umar, Bridget B., Jens B. Aune, Fred H. Johnsen, and Obed Lungu. I. 2011. Options for Improving Smallholder Conservation Agriculture in Zambia. *Journal of Agricultural Science* 3.3: 50–62.
[111] Joe Akombaetwa (Aka), Farmer, Fabricator based in Magoye. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

take up Conservation Agriculture. [112] Despite the government's significant efforts and investments made by the government, the reach of government extension and advisory services remains inadequate compared to the task at hand. "I have to reach out to 1800 farmers, each with their own unique issues," says Peter Chawe, Camp Extension Officer for Cherebina Camp in Mazabuka. "That's way too much." "I have to cater to 2600 farmers," says Scott Agift, Block Extension Officer for Monenga. "I can visit a farmer only once a month; I should be able to visit them every week or at least every two weeks," he says.[113] Both Scott and Peter complain about lack of funds to maintain their motorbikes and buy the fuel that they need to service all the farmers they are in charge of. To compensate, Peter talks to farmers over the phone until he can reach them. Scott puts some of the farmers he trains in charge of training other farmers.

Peter Chawe, Camp Extension Worker (Left) and Scott Agift , Block Extension Officer (Right) (Image Courtesy: MetaMeta)

While extension and advisory from agri-businesses and farm input retailers play an important role, within the larger picture they cannot plug the entire gap created by the shortfall of government extension workers. Much of the advisory offered by private sector stakeholders is routed through Camp Extension Officers. "If private companies want to supply inputs to farmers in my camp they need to go through me," says Peter. "They present their products to me, explaining what it does and how it works."

Nationally, only 76% of extension officer positions were filled as of 2015. [114] The Sixth National Development Plan envisioned an increase the staffing to 4,965 agricultural extension workers by 2015. However, as of December 2015 the number stood at 2,347.

It is, then, no surprise that when asked what they think is most necessary to the scaling up Conservation Agriculture, both Peter and Scott list recruiting more extension workers as the biggest priority. More funds for motorbike maintenance and fuel comes a close second.

- **Competing uses of crop residue:** With Conservation Farming farming systems, crop residues are to be left on the field to enhance the chemical, physical, and biological properties of the soil and minimize degradation. However, there are competing uses of crop residues, most notably for

[112] Umar, Bridget B., Jens B. Aune, Fred H. Johnsen, and Obed Lungu. I. 2011. Options for Improving Smallholder Conservation Agriculture in Zambia. *Journal of Agricultural Science* 3.3: 50–62.

[113] Peter Chawe, Camp Extension Officer, Cherebina Camp, and Scott Agift, Block Extension Officer. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

[114] Modernising Extension and Advisory Services (MEAS), 2014. *Assessment and Recommendations for Strengthening the Pluralistic Agricultural Extension System in Eastern Province, Zambia*. Cornell University, MEAS, University of Illinois, USAID, Catholic Relief Services

consumption by livestock which plays an important role in Conservation Farming in the first place. Of all the uses crop residue can be put to, farmers are least willing to abandon this one. Tenure rights and tenure security can also affect adoption decisions. For instance, even where an individual farmer wishes to incorporate residues on her own plot, customary tenure systems often traditionally allow animals to graze freely on harvested fields in most parts of Africa, making this practice difficult in the absence of the right fencing. [115]

Opportunities

- **Internet as a Resource for Extension Workers:** Internet connectivity in Zambia has gone from 0.2% of the population in 2002 to almost 18% in 2014. It is still on an upward trend. [116] The percentage is likely to be higher among the educated, such as extension workers who have at least completed a certificate course in agricultural studies. Many of them refer to online resources for information they require to carry out their work. "I don't use the internet as a primary source of information, but use it quite frequently to clarify things I am not clear about," says Scott Agift, Block Extension Officer for Monenga. "I also go online to verify and double check information."

  With the extension setup in Zambia trying to cope with under-investment and under-staffing, there is a strong case to invest in ICT tools to at augment the capacity of extension workers and develop an additional route to reach farmers who can access the internet. An additional factor that positions Zambia suitably for ICT tools to be effective here, is that a significant proportion of the population speaks English which is the language of the internet. [117] Around 56% of all online content is in English. It is also the default language of software development platforms, so developing online and mobile applications for use by farmers and extension workers becomes that much easier.
  The ZNFU, which has been developing and running various SMS-based extension and market information services, is currently exploring the idea of mobile applications and developing online environments optimized for extension workers.

  Online platforms can help reach a larger number of farmers and thereby contributing to horizontal upscaling. They can also help researchers, companies, government agencies, and farmers themselves to collaborate over content creation and data collection. Thus, they can also help achieve a certain amount of vertical upscaling.

- **Awareness of 'Climate Variability':** In Zambia, a widespread awareness of Climate Variability has been documented among farmers, extension workers, policy makers, private sector, and the government alike.[118] A survey of 469 farmers in 12 districts also identified a positive correlation between perceptions of increased climate variability and adoption of CF among farmers.[119] Zambia's 2014-15 planting season had to cope with what was perhaps the worst dry spell in the past 20 years. [120] After 5 years of 'bumper' output, maize production subsided for the first time

[115] Agricultural Development Economics Division-FAO. (Adoption and intensity of adoption of conservation farming practices in Zambia) (ESA Working Paper No. 13-01, April 2013). Rome: FAO.
[116] Google World Development Indicators [online] Available at: https://goo.gl/NzphcM [Accessed on January 5, 2016)
[117] Wikipedia, 2016. *Languages Used on the Internet.* [online]/ Available at: https://en.wikipedia.org/wiki/Languages_used_on_the_Internet [Accessed on 6 january, 2016]
[118] Peter Chawe, Camp Extension Officer, Cherebina Camp, and Scott Agift, Block Extension Officer. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.
[119] Nkala, Peter, Nelson Mango, Marc Corbeels, Gert Jan Veldwisch, and Jeoroen Huising. 2011. The Conundrum of Conservation Agriculture and Livelihoods in Southern Africa. African Journal of Agricultural Research 6.24: 5520-28

[120] August 19, 2015. 'Zambia faces crisis as biggest man-made reservoir dries up at Kariba; it's worst spell in 20 years.' *Mail & Guardian Africa,* [online]. Available at <http://mgafrica.com/article/2015-08-19-zambia-faces-crisis-as-biggest-man-made-reservoir-dries-up-its-the-worst-spell-in-20-years> [Accessed January 5, 2016]

during the season.[121] Farmers, big and small, were hit by this phenomenon. However, those practicing Conservation Farming reported that they felt more cushioned from the worst effects of this setback, especially compared to their neighbours.

"At least me and my family have enough to eat. I think this is because I have been preparing my land using ripping," says Nawasfoye, whose field is one of the WAHARA test sites (see above). "I am not calling myself successful, but at least my family has not gone hungry for the past 5-6 years " says Valentine Mooka from Monze (see above). The perceived connection between Conservation Farming and resilience is the strongest argument in favour of the latter that can be presented to a farmer. This can be built upon through systematic documentation of CF farmers in times of drought and concerted outreach efforts. Efforts to promote other ex-situ Water Harvesting Technologies can also piggyback on this appreciation of in-situ water harvesting technologies employed in conservation farming.

- **Promoting Local Innovation and Product Development:** Joe Aka from Magoye is a farmer like his neighbours but also a "fabricator and service provider to my fellow farmers," in his own words. [122]He worked closely with Piet Stevens from the Golden Valley Agriculture Research Trust (GART) as they developed the 'Magoye Ripper,' an ox-driven ripping implement right there in Magoye. GART distributed 2000 Magoye Rippers among farmers across Zambia in 2002-03. The implement met with significant amount of success in terms of uptake by farmers and increased yield, etc. The demand for Magoye Ripper has dropped of late in Zambia. It is currently not available in the market (although it is being manufactured and sold in Zimbabwe and India). Nevertheless, its design has formed the basis of more evolved implements such as the strip tiller.

Joe Aka: Farmer, Fabricator (Image Courtesy: MetaMeta)

Joe is a farmer himself; he took to design and manufacture of implements "...out of both interest and the need to sustain myself." He was busy through the development and dissemination of the Magoye ripper and continues to be busy with its later avatars such as the strip tiller, as well as a variety of other implements like planters, improved hand-hoes etc. He is now working with Piet again on developing the 'Kapandula,' a version of the Magoye Ripper optimised for the needs for

[121] May 2, 2015. 'No bumper harvest in 2015 after five years of large surpluses.' *Lusaka Times,* [online]. Available at <https://www.lusakatimes.com/2015/05/02/no-bumper-harvest-in-2015-after-five-years-of-large-surpluses/> [Accessed January 5, 2016]

[122] Joe Akombaetwa (Aka), Farmer, Fabricator based in Magoye. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

farmers in Northern Burkina Faso. [123] Much of the innovation in these products is what he has brought to the table, and that is because he understands Conservation Farming as a system and not just in terms of individual techniques such as ripping or weeding. "I developed my understanding over my long-term association with GART," he says. Joe is important to farmers in his area-- they buy/rent implements from him and get their implements repaired. They also provide him the feedback he needs in order to improve the designs in their successive versions. It will be no exaggeration to state that he has been a significant factor in farmers in his vicinity taking up Conservation Agriculture. Therefore, cultivating and supporting local enterprise like his across Zambia can be seen as an important opportunity to upscale Conservation Agriculture in particular, as wells as much-needed smallholder mechanisation in general.

Based on Joe's story, two possible lines of support to such enterprise can be identified:

i) Training and Extension: One of the reasons Joe is able to innovate and develop products that are effective, is that he has developed a holistic understanding of Conservation Farming as a system, not just as a set of disjointed farming techniques. On the other hand, responses to the question "What is Conservation Farming?" put to a number of farmers in Magoye and Monze (Mazabuka district, December 2015) were mostly on the lines of "It is the kind of farming that involves ripping and strip tillage." [124] It is therefore important that extension and advisory efforts emphasize upon this idea and try to instill in farmers a systems understanding of Conservation Agriculture, investing the necessary time and resources.

This relates to a larger point about how concepts like Water Harvesting Technologies and Conservation Agriculture are incorporated in vocational training and educational curricula. According to GART Director, Douglas Moono, these concepts have for too long been confined to Masters and PhD programmes. "Until such basic principles are incorporated in bachelors and vocational-level curricula as well, they will not fan out to farmers," he says. [125]While PhD-level research and Masters level work does trickle down to farmers over time, its Bachelor and Vocational students who will eventually work with farmers on a day-to-day basis.

ii) Financial Support: As is true for most small-scale entrepreneurs, capital investments (such as tools, machinery, workshop) and, initially, recurring expenditures (raw material, power) can be formidable barriers. Joe Aka struggles to source raw materials at a viable cost as he has to source them all the way from Lusaka. Financial support to such entrepreneurs in the form of concessional credit lines can go a long way towards encouraging them to set up shop and invest in product development. Various programmes to provide access to credit to farmers for farm operations are already in place. Extending such support to farm local-level implement manufacturers/ repairers such as Joe will have a positive effect on adoption of desirable technologies.

With sufficient support, local innovators and craftsmen like Joe Aka can strengthen the value chain of Commercial Farming inputs and implements at the local level and thereby trigger horizontal upscaling among a larger number of farmers.

[123] Exchanges between GART, the Zambian partner in the WAHARA project and INERA (Institut de l'Environnement et de Recherches Agricoles), the Burkina Faso partner in the project led to implementation of the Magoye Ripper in Burkina Faso in 2013. The 'Kapandula' is being developed based on feedback received on the ripper by farmers and researchers testing them at the WAHARA study site in Burkina Faso.

[124] By WAHARA staff, December 2015

[125] (Late) Douglas Moono, Then Acting Director, Golden Valley Agricultural Research Trust. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

- **Large Commercial Farmers:** As mentioned before, the dual nature of Zambia's agriculture sector accommodates more than 1,500 large-scale commercial farmers alongside more than 1.1 million small-scale farmers. [126] With farm size upwards of 60 hectares, the large-scale farmers are well-endowed and ahead of the curve in terms of agricultural technology. As mentioned before, the first forays into Conservation Agriculture in Zambia were made by commercial farmers who were looking to cut down their fuel consumption. They continue to be early adopters of technology, and therefore key to the process of adoption and adaptation. "Large commercial farmers these days have a lot of interest in different crop varieties," says Tembo Howard, Chief Agricultural Officer, Zambia Agricultural Research Institute (ZARI). [127]" ZARI is public sector institute, the largest research organisation in the country. "We often try out different varieties of wheat on test plots on large commercial farms. The results benefit all of us," he says.

  In April 2015, the Ministry of Agriculture and Livestock co-organised an Exposition of farming technologies in Chisamba, where commercial farmers showcased innovative technology and practices they were using. "We facilitated the visit of hundreds of small and medium farmers to the event, so they could observe these innovations, learn from them, and hopefully adopt some of the practices in their own fields," says Henry Mugomba, Principle Agricultural Officer at the Ministry. Drawing its membership from among both big commercial farmers and small/medium farmers, the ZNFU is another organisation well positioned to facilitate exchanges between the two. Apart from physical events, it also shares case studies and data collected from both sides through publications and on-demand information services available to both.

  It is the large commercial farmers that are driving the adoption of ex-situ water harvesting technologies such as storage dams like Graham Douse's in Magoye (see 5.2). The water in the dam makes extra water available for use by livestock and for growing vegetables. It is an earthworks dam, so the water stored in the reservoir seeps through and recharges ponds and aquifers downstream. With dry spells increasing in frequency and duration, investment in such storage structures might well be the next big idea to test, adapt, adopt and upscale. This is well-recognised across the board-- commercial farmers like Graham as well as public sector research organisations such as ZARI are in agreement. "That is definitely something we should go for,"says Howard. "the government recognises this and it is already building such dams with support from the World Bank." "Storage structures can be crucial water sources during the dry period," says GART Director Douglas Moono. "Enough have not been built so far because funding has been a problem." The resources of commercial farms can be leveraged to partly address the shortage of funds, possibly by supporting them to build such storage structures by through funding and/or technical inputs. The increasing awareness among large and small farmers of the need to manage the risks of climate variability can be cultivated to build consensus around the idea.

[126] The World Bank (Agriculture and Rural Development (AFTAR), Sustainable Development Department, Country Department AFSC2, Africa Region, June 2009. (Commercial Value Chains in Zambian Agriculture: Do Smallholders benefit?) (Report No. 48774-ZM). Washington DC: The World Bank.

[127] Tembo Howard, Chief Agricultural Officer, zambia Agricultural Research Institute. 2015. *Personal Interview: Options and Enabling Conditions for spread of Rural Technology in Burkina Faso.* Interviewed by Abraham Abhishek, MetaMeta.

6. Conclusion

The cases from Ethiopia, Burkina Faso, Tunisia, and Zambia discussed above highlight what worked with respect to knowledge transfer and spread of WHTs in their agro-socio-economic contexts; and why. An oft-expressed idea was context specificity. Approaches that worked took into account local needs and were driven by local changemakers. What can we learn from them about spread and upscaling of WHTs in Africa and beyond? Section 6.1 tries to draw some conclusions and identify ideas that are applicable beyond the four countries. They were found to be grouping under six categories: Governance, Participation of Stakeholders, Attitudes and Behaviour, Technology, Communication, and Education. Based on 6.1, Section 6.2 discusses the prospects of the spreading of WH in Africa.

6.1 Components of enabling conditions for the spread of Water Harvesting

Governance

Coordination of Efforts: In all four countries, WH and agriculture fall within the purview of multiple actors. It is important that policies and initiatives of the various actors achieve a certain degree of coordination and harmonization. In Zambia, this has helped the upscaling of Conservation Farming. In northern Ethiopia, this helped scale up a bouquet of Soil and Water Conservation (SWC) techniques to an extent that degraded lands could be restored to their healthiest state in 145 years.

Zambia and Ethiopia present two different approaches to coordinating the various WHT initiatives. In Ethiopia, the government assumed a more central role. It has taken the lead in mobilizing communities to take part in large-scale SWC activities, with national and international NGOs capitalizing on this mobilization. The government also led efforts to develop a set of guidelines on "Community Based Participatory Watershed Development" in partnership with key research institutes and NGOs.[128] It lays down steps to be followed, interventions and technologies to be implemented, and standard impact assessment tools while carrying out watershed development activities of which WHTs are a large part. In Tunisia also a strong government led development is visible, although to a different extent compared to Ethiopia. The stronghold of agricultural development and coordination of participatory WHT efforts is in the hands of government institutions. From there mechanisms are put in place to facilitate joint experimentation and spreading of knowledge.

On the other hand, in Zambia the key role in coordination of Conservation Farming-related efforts have been played by the Zambia National Farmers Union, an organisation representing 600,000 small farmers, 1500 commercial farmers, 43 agri-businesses; and best described as belonging to the private sector. To its credit, the government did declare Conservation farming as an official national policy in 2000 and did establish a National Conservation Farming Steering Committee in 2001.[129] However, ZNFU led the introduction of Conservation Farming in Zambia in the 1980s and has ever since continued to bring diverse stakeholders (many of which are represented among its members) around the topic. Its emphasis on lobbying and influencing government policy helps further the cause of harmonization.

[128] Lakew Desta, CarUCCi, V , Asrat Wendem-Ageliehu and Yitayew Abebe (eds). 2005. Community Based Participatory Watershed Development: A Guideline. Ministry of Agriculture and Rural Development, Addis Ababa, Ethiopia.
[129] MetaMeta, 2016. *Report on Options and Enabling Conditions to achieve the Spreading of Water Harvesting, Section 5.3.3: Spread of Conservation Farming in Zambia.* Wageningen: WAHARA Project.

Multiplicity of actors and the need to coordinate/harmonize their efforts are true for several other countries in Africa and, indeed, worldwide. Ethiopia and Zambia present some options as to how that can be managed to turn into an enabling condition for the spread of WHTs.

Land Rights: Yacouba Sawadogo [130] might end up losing a big part of the 15-hectare land that he helped regenerate, as the government goes ahead with plans to repossess it for urban development. [131] [132] He had acquired the land through a transaction within the traditional land rights system and does not have a title deed. The only way he can get back his land is by buying it back from the government, something he can definitely not afford. What's more, the government plans for his land involve dividing his father's grave into two.

It has been amply demonstrated how land rights and tenure security are key incentives for the farmer to invest in land improvement measures such as WHTs. [133] Yacouba's is an inspiring story, but the threat to his land will do much to discourage other farmers in Burkina Faso from investing in WHTs and trying to reclaim the land from desertification. Ethiopia, too, views land as public property and prohibits sale or transfer. [134] [135] Though uncommon, government sponsored periodic redistribution of land is provided for by the constitution. [136] The lack of property rights and lack of transferability of land have restricted access to credit and hampered investment in land improvement. [137]

Insecure land rights are an issue across Africa and discourage investments in land improvement just as they do in Burkina Faso and Ethiopia. Addressing it will be key to stimulating upscaling of WHTs. A 1975 position paper from The World Bank proposed three basic principles that should inform land policy reform: (a) owner-operated family farms were efficient and thus desirable, (b) there should be freely operating land markets to permit land transfers to more efficient and productive users, and (c) there was a need for a more equitable distribution of assets. To this list, B. Nega et al (2003) add the following conditions: (a) a recognition, under certain circumstances, that communal tenure could be a cost-effective mechanism for land allocation compared with formal titling; and (b) that formal titling, when desirable, should be evaluated in terms of both its potential efficiency benefits and its implications for equity and the significance of expanded land rental markets on productivity and agrarian developments in general. [138]

---

[130] MetaMeta, 2016. *Report on Options and Enabling Conditions to achieve the Spreading of Water Harvesting, Section 3: Burkina Faso.* Wageningen: WAHARA Project.

[131] Phakathi, Mantoe., 2011. AFRICA: The Man Who Stopped the Desert. *IPS News,* [online] 19 October. Available at: http://www.ipsnews.net/2011/10/africa-the-man-who-stopped-the-desert/

[132] CAUX IofC, 2011. *Interview with Yacouba Savadogo.* [video online] Available at: https://www.youtube.com/watch?v=x_B28NSOsS8

[133] Goldstein, M., & Udry, C.. (2008). The Profits of Power: Land Rights and Agricultural Investment in Ghana. *Journal of Political Economy*,*116*(6), 981–1022. http://doi.org/10.1086/595561

[134] Constitution of the Federal Democratic Republic of Ethiopia, 1994

[135] Except for a restricted short-term leasing of land use right that has been allowed since 1991

[136] Mulat, Demeke. 1999 Agricultural Technology, Economic Viability and Poverty Alleviation in Ethiopia. Paper Presented to the Agricultural Transformation Policy Workshop Nairobi, Kenya, 27-30 June 1999

[137] Gebreselassie, S., 2006. Land, Land Policy and Smallholder Agriculture in Ethiopia: Options and Scenarios. *Future Agricultures*. [online] Available at: [Accessed December 2015] http://www.future-agricultures.org/publications/research-and-analysis/discussion-papers/25-land-land-policy-and-smallholder-agriculture-in-ethiopia/file

[138] B. nega et al, quoted in Gebreselassie, 2006 (Reference 139)

Participation of Stakeholders

Agency: With enough resources, it is possible to demonstrate WHTs to a large number of farmers. However, beyond that point it is up to the farmer to adopt them. Subsidies and coercion can only go so far, as spread of WHTs requires farmers to innovate and adapt them to their biophysical condition and socio-economic capacity. [139] To do this, it is important to appeal to farmers' sense of agency; to address them as entrepreneurs rather than beneficiaries of subsidy. In Burkina Faso, Yacouba Sawadogo's efforts to spread Zaï and related WHTs among farmers are based on convincing them about the returns in terms of higher yields and incomes (see section 3.4 above). Several of his students have been innovators in their own rights, developing methods of land restoration through tree plantations using WHTs. [140] The Zambia National Farmers Union counts smallholders as belonging to the private sector (see section 5.2 above), as key parts of the maize and cotton value chains. In Ethiopia, young farmer entrepreneurs are playing a key role in applying and spreading innovative practices in WHTs as well as irrigation. [141] In Tunisia farmers' agency is recognized by researchers after they could share and discuss their ideas through exchange visits and a radio program. Following on this farmer's creative potential is acknowledged and actively used in a participatory technology development.

Harnessing the agency of farmers requires that governments, NGOs, and businesses a acquire the right attitude and outlook towards them. Besides, concrete steps that can be taken in order to appeal to farmers' sense of agency, such as carrying out WHT experiments on-farm wherever possible and investing in the dissemination of field-level WHTs (as has been done in Burkina Faso, Zambia, Tunisia; see Chapters 3, 5 and 6 above). This is relevant to countries across Africa, where smallholder farmers across Africa have developed many effective innovations over the years. [142] It is in keeping with this idea that the field-testing of field-level WHTs under the WAHARA project in Burkina Faso and Zambia was carried out on fields of actual farmers and with their close involvement (see Section 5.4 above).

Farmer-to-farmer learning: Related to the idea of agency are examples of how effective farmer-to-farmer learning can be. In WAHARA this was observed in flagship examples like that of Yacouba Sawadogo in Burkina Faso, as well as near-universal arrangement of rural societies in Zambia, Ethiopia, and Tunisia where the most credible sources of information are fellow farmers and elders. While the idea of farmer-to-farmer learning is widely recognised, there is less of a consensus on what are ideal modalities of how such learning systems are best supported. Based on findings from Burkina Faso, Section 3.5 in this document provides and details some specific suggestions; such as financial support, support to exchange visits, improving linkages with research and formal education, and investing in farmer-relevant learning material. Section 4.3.3. shows how a radio program in Tunisia helped farmer-to-farmer learning as well as helped connect formal education and research sectors to farmer learning systems. Section 3.5 discusses based on the Burkina Faso case study as to what are the different ways in which Farmer-to-Farmer learning systems can be supported. One or more of these suggestions are applicable in most contexts in Africa and beyond.

---

[139] Sturdy, Jody D., Jewitt, Graham P.W., Lorentz, Simon A., 2008. Building an understanding of agricultural innovation adoption processes through farmer-driven experimentation. *WaterNet Online*. [online] Available at [Accessed December 2015] http://www.waternetonline.ihe.nl/downloads/uploads/symposium/zambia-2007/Water%20and%20Society/Sturdy.pdf

[140] Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan

[141] Van Steenbergen, F., 2012. Changemakers: Future of Irrigation in Africa. *TheWaterBlog,* [blog] 27 August. Available at: http://www.thewaterchannel.tv/thewaterblog/109-changemakers-future-of-irrigation-in-africa

[142] Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan

Supporting champion farmers: In all the four WAHARA countries, individual farmers could be identified who were exceptional due to their innovations and/or dedication to sharing their knowledge with other farmers. They were sources of inspiration to other farmers as well as key partners of governmental and non-governmental agencies in their efforts. While these individuals are usually highly motivated, it is worth considering how they can be supported so their efforts continue and help the cause of spread of WHTs. Studies done under WAHARA present some suggestions.

- Telling their stories: When a number of Burkinabe farmers were asked why they went that extra mile to experiment with different WHTs and invest in training other farmers, their answers suggested that the key reasons were gaining respectability, responsibility, and popularity in their communities. [143] In *Tunisia*, under the ISWC programme, a radio program was set up which broadcast innovative ideas and experiments being carried out by farmers. Apart from helping formal research and education plug into farmer learning systems, the program encouraged farmer innovators by featuring them. This highlights the scope for mass media and local broadcast media to be put to similar use in other countries.

- Awards and Recognition: Conferring awards and recognitions upon champion farmers is quite common. It goes a long way towards motivating them for reasons similar to those stated above.

- Training: Ali Ouedrogo from Gourcy, Zandoma province in Burkina Faso, was trained by an Oxfam project in the layout and construction of stone bunds in 1986. He soon discovered that trees start growing along the bunds as they trapped the seeds washed up by runoff. Since then he has rehabilitated 12 hectares of land, and trained 12 farmers between 1993 and 2002 who went on to teach many other farmers how to make Zaï pits and construct stone lines. [144] Ali is an example that illustrates how training highly motivated champions can have a ripple effect with respect to spread of knowledge, and therefore investment in training them has high returns.

- Financial Support: The ability to innovate can at times come down to availability of financial means. It is for this reason that large, commercial farmers are often looked at as a source of innovation in Zambia. This is also illustrated in how special credit lines are helping young farm entrepreneurs experiment with and adopt modern irrigation practices in Ethiopia. [145]

Willingness to invest

The WHTs employed across successful initiatives in Ethiopia, Tunisia, Burkina Faso, and Zambia do not represent hi-tech. In many cases (such as Zaï pits in Burkina Faso and Jessour in Tunisia) they are traditional technology that just needs to be retooled to match current needs. This is true for many of the WHTs that were selected for WAHARA and proved to be effective. Even recently developed technologies such as the Magoye Ripper and Gabion cages are simple in design and relatively easy to fabricate. This is, in fact, an advantage as it makes it cheap and low-risk to experiment with WHTs, fail, learn, and improve. Besides, the simple nature of WHTs makes it possible for farmers to engage in their development and adapt them according to their needs.

[143] Taonda, J., Hien, F., Zango, C., 2012. Namwaya Sawadogo: the ecologist of Touroum, Burkina Faso. In: Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan. Chapter 13.
[144] Ouedraogo, A. and Sawadogo, H., 2002. Three models of extension by farmer innovators in Burkina Faso. In: Reij, C. and Waters-Bayer, A. eds., 2002, *Farmer Innovation in Africa.* London: Earthscan. Chapter 20.
[145] Van Steenbergen, F., 2012. Changemakers: Future of Irrigation in Africa. *TheWaterBlog,* [blog] 27 August. Available at: http://www.thewaterchannel.tv/thewaterblog/109-changemakers-future-of-irrigation-in-africa

All these factors highlight that spread and upscale of WHTs should be intrinsically simple. This also means that the limiting factor is often the willingness to invest in the technology, rather than the size of the investment. What inhibits the willingness to invest? The Burkina example shows that with all their good intentions, the natural inclination of the government NGOs was towards technology-intensive, large-scale technologies such as catchment-wide earth bunds constructed under the GERES project (detailed in Section 3.3.1). Zaï Pits and Stone Lines were recognised as worthwhile investments when scientists and policymakers took notice of how innovative farmers were using them to reclaim unproductive land. A lesson this holds is that willingness to invest in WHTs can be cultivated, and facilitating regular exchanges between farmers and other stakeholders is one of the ways. This is also an argument in favour of Participatory Technology Development for agriculture to ensure that research is sufficiently informed by farmers' needs as well as contributions.

Technology: Level of Application

WHTs include solutions for treating landscapes such as check dams, bunds, storage structures; as well as field-level measures to retain and improve soil moisture in-situ-- such as Zaï pits, half-moons, stone lines, ripping, etc. In Ethiopia, landscape-level application of WHTs has been carried out with much success. [146] On the contrary, there is greater emphasis on field-level technologies in Zambia and Burkina Faso. This reflects different biophysical conditions, different needs, and different priorities across different countries.

The general point to be made over here is that both sets of technologies and approaches perform complementary functions and there is usually a simultaneous need for both. As mentioned under the previous point (*'Willingness to Invest'*) for long governments, NGOs, and researchers have shown a preference for landscape-level WH. However, as the Burkina and Zambia cases show, promoting field-level WHTs can go a long way towards reclaiming land and increasing farm productivity.

Communication

Radio programs in Tunisia (Section 4.3.3.) and *La Voix du Paysan* in Burkina Faso (Section 3.5) represent attempts to creatively use radio to facilitate transfer of agricultural knowledge. While systematic impact assessment of either initiative is lacking, the farmers interviewed and literature reviewed suggest they are much valued by various stakeholders. At the core of the utility offered by the audiovisual medium is their accessibility to those with low literacy levels (as a large number of farmers across Africa have).

Another way of managing the literacy barrier is a less-discussed area of intervention with great potential of impact --- developing learning material tailored to farmers' needs. Using language-neutral graphics, video and audio mediums, it is possible to generate instructional manuals and learning material that are useful to farmers. A global review of extension methods and aids highlight the large potential of innovative media tools such as participatory video.[147] Digital Green, which is based in Ethiopia, is one example. [148]

---

[146] Minang, P. A., van Noordwijk, M., Freeman, O. E., Mbow, C., de Leeuw, J., & Catacutan, D. (Eds.) (2015). Climate-Smart Landscapes: Multifunctionality In Practice. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

[147] MetaMeta, 2016. *Report on Options and Enabling Conditions to achieve the Spreading of Water Harvesting.* Wageningen: WAHARA Project.

[148] Gandhi, R., Veeraraghavan, R., Toyama, K., Ramprasad, V., 2009. Digital Green: Participatory Video and Mediated Instruction for Agricultural Extension. *Information Technologies and International Development,* [online] Available at: [Accessed December 2015] http://itidjournal.org/itid/article/view/322

At the same time, the traditional rural media such as folk theatre should be harnessed as is being done in Burkina Faso (Section 3.5). Outreach efforts of government agencies, research organisations, and NGOs seldom utilise them.

Education

A common refrain across the four WAHARA countries was that there is an acute shortage of good quality data and rigorous studies on the impact of WHTs (especially in Burkina Faso, as recorded by Critchley et al). [149] Research institutions stand to gain much in terms of filling these gaps by collaborating more closely with individual farmers, farmer organisations, and farmer-to-farmer learning systems. Farmers, in return, can also benefit from good quality data informing their decision-making.

In particular, there is need to increase linkages between farmers and educational institutions such as universities, colleges and vocational training centres. "Many do their PhD research on Water Harvesting. Many Masters programs discuss WHTs. And this is great," says Douglas Moono, Director, GART. "However, there is a great need to discuss these topics more at the undergraduate level and vocational schools. It is these schools that cater to those engaged in extension work; those who work with farmers at the grassroots level," he says.

6.2. Prospects of the Spreading of Water Harvesting

The table below lists the impact promised by interventions addressing the components identified in Section 6.1 alongside constraints to their implementation, as well as the potential they hold on balance. Thus, it attempts to visualise the prospects of the different possible approaches in the four WAHARA countries as well as the larger region of Africa.

[149] Kabore-Sawadogo, S., Ouattara, K., Balima, M., Ouedraogo, I., Traore, S., Savadogo, M., Gowing, J., 2012. Burkina Faso: A cradle of farm-scale technologies. In: Critchley, W., and Gowing, J. Eds., 2012, *Water Harvesting in Sub-Saharan Africa.* Oxon: Earthscan.

	Potential Impact	Potential Constraints	Potential Action
Governance			
Coordination of WHT Efforts	• Harmonization of efforts; • Resource optimization;	• Multiplicity of actors; • Limited government capacity and inadequate policy/legislative oversight	Regional/ national governments have the mandate to coordinate WHT efforts. Their efforts/capacities can be complemented at: <u>Research Organisations</u> • Research providing overview of organisations/projects engaged in WHT work <u>Policy level</u> • Support to governments in policymaking
Securing Land Rights/ Land Tenure of land users	• Creates incentives to invest in WHTs • Improves access of landowners to credit, enhancing capacity to invest	• Property/traditional rights not well-defined • Traditional land rights not recognised by government s	<u>Government</u> • Reconfiguration land rights systems, recognising traditional rights and providing for tenure security • Development of land markets that facilitate land transfer (through selling/rental) to more willing and productive users <u>Non-governmental Organisations</u> • Making legal advice available to farmers on land ownership and land use options
Participation of Stakeholders			
Encouraging farmers' agency	• Farmers more willing to innovate and adopt innovations • Farmer innovation can inform	• Prevalent attitudes and behaviours, especially disconnect between practicing farmers and agricultural	<u>Government</u> • Clarity in and security of land rights

	scientific research • Starting point for Farmer-farmer learning can be facilitated	scientists • Low educational achievement among farmers, limiting their capacity to absorb relevant research and innovations	<u>Research Organisations</u> • Field experiments with WHTs carried out in partnership with farmers, on their farms (as done under the WAHARA project) <u>Multiple Stakeholders</u> • Attitudinal change on part of governments, NGOs, agri-businesses, and research organisations. Treating farmers as clients and partners. • Training programs for farmers
Farmer-to-Farmer Learning Systems	• Fast dissemination and scaling up of WHTs • Agricultural knowledge generated is credible among farmers • Agricultural knowledge generated can inform scientific research • Can partner governmental/ non-governmental organisations, complement their investments and boost their efforts. • Farmer-to-farmer learning systems efficient platforms to introduce and scale-up new research/innovations among a large number of farmers	• Limitations of resources (time/money) among farmers to invest into such systems • Lack of capacity among farmers to document knowledge • Limited scope for upscaling beyond local/regional level	<u>Multiple Stakeholders</u> • Financial Support to such learning systems • Supporting exchange visits among farmer groups <u>Research Organisations</u> • Improving linkages with formal research sector and educational institutions <u>Media/Communication Organisations</u> • Generating farmer-relevant learning material- in regional languages and using visual tools • Using mass media to disseminate knowledge generated through such learning systems, and disseminated knowledge generated through formal research
Supporting Champion Farmers	• 'Champion farmers' are early adopters of WHTs, inspire others	• Champion farmers are often based in remote locations; accessible largely to	<u>Multiple Stakeholders</u> • Widening the spread of their story,

	to try them, and so are key to their scaling up. • They catalyse the set-up and running of Farmer-Farmer learning systems. • Can be partners in scientific research.	stakeholders in their immediate vicinity • Inadequate recognition of champion farmers by stakeholders (especially the government)	through mass media and other communication tools • Awards and recognitions (especially the purview of the local government • Trainings, as necessary • Financial support, where necessary
Willingness to Invest	• Investments (by farmers, governments, private sector) a precondition for scaling up of WHTs	• Inadequate evidence available on the impact of WHTs • Competing investment priorities, e.g. in farming and amenities/schooling etc. (Or in risk reduction and in improving productivity, as highlighted by Choice Experiments carried out under WAHARA)	<u>Multiple Stakeholders, esp. Research Organisations</u> • Documenting evidence on the potential of WHTs, capturing examples from social and biophysical conditions local to potential investors • Disseminating evidence among various stakeholders, to get their buy-in • Invest in field-level WHTs that are simpler, cheaper to test, implement and upscale.
Technology: Promoting Field-Level WHTs	• Field-level WHTs easier, cheaper to test, implement, and upscale. • Field-level WHTs can be implemented, experimented with, adapted by farmers themselves. They can foster farmer-level innovation and farmer-farmer learning.	• Bias among governments and NGOs towards large-scale WHTs	<u>Multiple Stakeholders</u> • Documenting and disseminating evidence of potential of field-level WHTs to bring about large-scale change. (such as in Burkina Faso). • Supporting farmers and other land users with training, subsidies and policy-level support. <u>Government</u> • Adequate policy support to incentivize investment by small and medium farmers in field-level WHTs

Communication	• Radio and television programming have proven to be effective medium for dissemination of good agricultural practices among farmers. • New media and communication tools can be used to create literacy-neutral, non-technical learning products suited for needs of farmers in large parts of Africa. • Interactivity of new media can be used to develop feedback channels to get farmers' inputs into agricultural process.	•These are relatively new tools, so best practices are not yet established.	<u>Multiple Stakeholders</u> •Including communication tools and processes in intervention-designs •Learning from global best practices •Widening the WHT-sector through partnerships with journalists, media professionals, educators.
Education	• With closer linkages between WH and formal education, those working in the WH sector will be better informed about the topic.	•Current state of affairs: Formal education's engagement with the topic of WH mostly at PhD level, inadequate at undergraduate/vocational level.	<u>Government and Private Educational Institutions</u> •Developing Curricula with adequate emphasis on WH

Viewed from the analytical framework set out at the beginning of this report (Section 1.2), the interplay of these components demonstrates that for WHTs to truly spread, efforts need to be made to achieve both horizontal and vertical upscaling. To realise the potential impacts of WHTs, to overcome the potential constraints, actions taken need to involve stakeholders at various levels of policy and implementation. For example, to realise the very horizontal exchanges of Farmer-Farmer learning systems it is not sufficient to work only with farmers and farmer groups. To really make this oft-discussed idea work, it would be necessary to get buy-in from research organisations (who will provide the necessary scientific inputs to such learning systems from time to time and pick up inputs to inform their own research agenda), the government extension system (who are often the only link between farmers and formal knowledge systems, as well as media/communication organisations (as channels of dissemination as well as producers of knowledge products).

It is a cliched expression, but the core ideas extracted from experiences in Tunisia, Ethiopia, Zambia, and Burkina Faso point to one thing: what works is putting the farmer at the centre of it all, respecting his agency, treating him as a client rather than a beneficiary. The spread of WHTs among farmers should essentially be a process of pitching WHTs to them. When farmers are convinced about their benefits to productivity and income, they will take them up, innovate and adapt them to their specific needs. That's when WHTs truly spread. Support can be provided to this core process by securing farmers' land rights, facilitating farmer-to-farmer learning systems and linking them with formal education & research systems. All this requires investments, and it is essential that there is willingness to make those investments. For effective use of resources, it is necessary that there is a certain degree of coordination amongst the multiple actors promoting WHTs so that their efforts strengthen each other.