Wellness for Agriculture and Life Advancement Activity (WALA): A retrospective of three studies on the impact of watershed restoration

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James Omar, 31, with one child, is showing one of 800 mango seedlings grown locally. He uses WALA-taught grafting techniques to grow his trees which they sell at 300MK each.

Cover photo by Megan Collins for CRS

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Acronyms

CA	Conservation Agriculture
CCT	Continuous Contour Trench
CEC	Cation-Exchange Capacity
CRS	Catholic Relief Services
FFW	Food for Work
FGD	Focus Group Discussion
FUE	Fertilizer-Use Efficiency
GOM	Government of Malawi
ha	Hectare
LDF	Local Development Fund
MG	Marketing Group
N	Nitrogen
NGO	Non-Governmental Organization
NRM	Natural Resources Management
NWP	Nature, Wealth and Power
PSP	Private Service Provider
RUE	Rainfall-Use Efficiency
SM	Sasakawa Method
SOM	Soil Organic Matter
SWC	Soil and Water Conservation
VSL	Village Savings and Loan
WALA	Wellness and Agriculture for Like Advancement
WAT	Water Absorption Trench
WMC	Watershed Management Committee

Introduction

The watersheds of southern Malawi are home to the country's most food-insecure districts (Soroko, 2017) and are the source of eroding run-off and floods that further threaten the security of the population. Population pressure and an erratic climate have increased the urgency for the populations in these watersheds to take measures that increase their productivity and reduce vulnerability to droughts, floods and other shocks.

The Wellness and Agriculture for Life Advancement (WALA) project—implemented between 2009 and 2014 through a Catholic Relief Services (CRS)-led consortium of eight non-governmental organizations (NGOs)—helped farmers and communities in 32 watersheds increase crop yields and reduce erosion and flooding by turning watershed liabilities into assets. WALA-supported farmers constructed soil and water conservation (SWC) structures that trapped and concentrated rainfall where it was most needed. These structures were further enhanced utilizing Conservation Agriculture (CA) and the Sasakawa Method (SM)[1], building up soil organic matter and recycling plant nutrients, thereby reducing soil erosion. Together, these interventions helped farmers increase dryland maize yields by 63%. Additionally, the area utilizing irrigation was enlarged (Amadu, 2020), enabling farmers to harvest one or two extra crops a year and diversify their crop mix, tap new markets and improve diets (Reichert, 2014).

To manage protected hillsides, communities established Watershed Management Committees (WMCs) that developed and enforced watershed management rules. In one pioneering case, two communities sharing a sub-catchment collaborated to make and implement a management plan that helped the upslope population increase productivity while protecting the irrigation perimeter of the downslope community. To provide investment capital and add value to the increased production, WALA helped communities establish Village Savings and Loan (VSL) Groups and Marketing Groups (MGs). Operating in tandem with watershed management and agricultural practices, these interventions increased productivity, incomes and resilience. VSL participants received basic financial management training, which in turn helped generate new enterprises/income streams and diversify household economies (Soroko, 2018).

The watershed component of WALA was designed as a pilot "to evaluate and demonstrate the value of the watershed management approach in southern Malawi, rather than an effort to generate large-scale impacts" (Amadu, 2020). As a pilot, WALA showed that an integrated approach that twinned land-management practices with community-based financial and governance institutions was effective in improving livelihoods and reducing communities' vulnerabilities to climatic and other shocks. WALA also showed that the success of this integrated approach depended on local competency in enterprise and organizational management at the community level, hence the importance of WALA's capacity-building components.

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[1] CA uses minimum tillage, continuous soil cover, crop rotation and the use of fertilizer trees *(such as Faidherbia albida)*; SM reduces the space between rows and planting hills and number of seeds per hill (Amadu, 2020).

When applied to communities of high risk and poverty, this integrated approach helped the communities become more productive and resilient (Soroko, 2018; Amadu, 2020). Also, by showing the costs, risks and benefits of establishing, protecting and maintaining watershed management structures and irrigation perimeters, WALA provided information and experience that watershed communities, District Councils, the Government of Malawi (GOM) and their development partners can use to maintain, expand and potentially scale effective watershed management strategies.

The purpose of this brief is to summarize key studies of the WALA program and share the impacts watershed restoration had on the resilience of WALA communities. These findings and lessons learned make the case for continued and deeper investment in restoration of degraded land as a means to address root causes of food and livelihood insecurity. It is believed that lessons herein have application in other parts of Malawi and many other areas of the continent. Hence, when appropriate, they will be discussed in the broader sense.

While this brief draws from several studies and technical papers, most of the findings came from the data and keen insights of the following:

- ***Watershed Development in Malawi—A Study from the WALA Program***, reports the findings of a study conducted by Christopher Michael Reichert and his team in 2014, shortly after the end of the WALA project. The study documents the communities' and WALA staff's perceptions of the program's benefits and results. Reichert's team visited 5 of the 32 watersheds, covering about 20% of the area treated by SWC structures. It interviewed 89 people including participants, WALA staff, external subject matter experts and a government staff member.
- ***Assessment of the Wala Activity***, is the report of David Soroko's assessment conducted in 2017. It explores the project's "watershed development impact on rural household food security and resiliency." It analyzes the status of WALA's watershed development investments, assesses their sustainability and determines the impact WALA interventions had on household resiliency. More than 300 WALA beneficiaries participated in Focus Group Discussions (FGDs) at 24 watershed development sites.
- ***The WALA Project's Community Watershed Restoration in Southern Malawi*** was prepared in 2020 by Festus Amadu and Paul McNamara from the University of Illinois. This technical report was based on Dr. Amadu's doctoral dissertation research conducted in 2016, with the objective to estimate the impact of WALA's watershed restoration program on 1) adoption and sustainability of soil and water conservation practices at the landscape-, community- and farm-levels in the project area, 2) soil fertility characteristics and 3) grain yields. Information was collected from 450 households within the watershed management sites and 358 households outside the sites. Soil fertility characteristics were determined by comparing 900 soil samples within the sites and 716 comparable locations outside the sites. The study is notable for matching changes in crop yields with changes in soil characteristics, thereby allowing practitioners to make informed inferences about sustainable outcomes of various practices.

Problem Statements

Below are some of the key challenges that the WALA-supported communities faced. Since most of these challenges are shared by many agricultural communities across Sub-Saharan Africa, the lessons and knowledge produced by WALA have the potential to help many beyond the project area.

PRODUCTIVITY AND PRESSURE ON NATURAL RESOURCES

Malawi has the highest population density in southern Africa with a high proportion of very poor subsistence farmers (Messina, 2017). Population pressure has reduced average farm sizes in southern Malawi to 0.5 hectares (ha), forcing some onto marginally productive lands (Soroko, 2017) and reducing their ability to fallow, i.e., the traditional means to maintain soil productivity. Estimates showed only 1.1% of plots were left entirely fallow in 2008/2009 and 2009/2010 and that 95.7% of plots had not been fallowed in recent memory (Sapp, 2014). Absent fallowing, increasing productivity will require further intensification, including the use of fertilizer, particularly nitrogen (Snapp, 2014). Given fertilizer's cost and subsequent financial risks to marginal farmers (e.g., a dry spell during the growing season could significantly reduce fertilizer's effects), increasing its broader use will require farmers taking measures to maximize its efficiency (e.g., allowing the crop to absorb a higher percentage of fertilizer) and reduce its risks. As will be discussed below, increasing soil organic matter levels is an effective way to increase fertilizer-use efficiency (Snapp, 2014).

WEATHERED SOILS

About 90% of Africa's soils have lost most of their nutrient content through millions of years of erosion and leaching (Breman, 2007). In Malawi, "decades of intensive smallholder maize cultivation, in the absence of significant fertilizer use, have depleted soil nutrients, particularly nitrogen (Soroko, 2017). Weathered soils are characterized by weak structures that easily crust, reduce infiltration, increase run-off (Stroosnijderi and Hoogmoed, 1984) and by reduced pores that constrict the flow of water, nutrients and air flow to crops' root systems. Per a study of weathered soils in Mali, rainfall-use efficiency (RUE) can be very low where "only 15–20% of rainfall is used for productive crop growth" (Kablan, 2008).

Soils in southern Malawi are poorly endowed, not only in nutrients but also in soil organic matter (SOM)—a key component in retaining nutrients and moisture in the crop's root zone—and in strengthening soil structure, particularly in weathered soils. Messina (2017) reported that Malawian agriculture "has reached a tipping point, where soil organic matter is below a minimum threshold for support of crop productivity… soil organic matter status has degraded to a level that no longer supports vigorous maize growth or responsiveness to fertilizer. Malawi country-wide surveys…suggest that maize response to fertilizer is very low, with farmer-reported maize yield gains of about 10 kg grain per kg of fertilizer nutrients applied. This is less than half of the expected response, and only 20% of the typical agronomic trial response." Therefore, due to poor yield response and high costs, fertilizer use in Malawi is low.

EXTENSIVE SOIL EROSION

Hillside farmers in southern Malawi's watersheds are particularly vulnerable to run-off and erosion (sheet and gully), further reducing RUE. Sheet erosion is characterized as a thin sheet of water flowing somewhat uniformly over the soil, eroding topsoil that contains soil organic matter and relatively productive clays while leaving behind less-productive sands (Russell, 1973). Gulley erosion occurs when run-off is concentrated into a stream that cuts into the land, forming a channel or gulley. As more water is funneled through the gully, the cut widens and deepens, eating away productive fields. Each type of erosion requires its own treatments.

ERRATIC CLIMATE AND PERIODIC CATASTROPHIC DROUGHTS

Much of Africa's climate is characterized by intensive rainfall events separated by long dry periods (Rockstöm, Barron and Fox, 2003). Intensive rainfall destroys weakly-structured soils, exacerbating crusting and run-off. During early-season droughts, low rainfall infiltration and retention rates increase the mortality rate of newly germinated crops. This forces farmers to replant, moving crop establishment and maturity further into the rainy season, thereby cutting into the growing season and reducing production. Snapp (2014) reported that over a quarter of farmers surveyed in the period between 2006/2007 and 2008/2009 reported yield loss due to adverse weather conditions.

During years of drought or heavy flooding, hillside farmers may lose a high proportion of their staple crops, no matter what they do. "To cope with food deficits, households reduced daily maize consumption, increased consumption of alternative and sometimes less nutritious calorie sources (such as cassava), sold assets (such as livestock) and sought employment on estates or in towns" (Soroko, 2017). In 2015/2016, "Malawi and other countries in southern Africa experienced the El Niño drought, which caused massive crop failure and acute food price hikes in the region" (Amadu, 2020).

LIMITED LOCAL INSTITUTIONAL CAPACITIES

Effective watershed management requires that people work collectively to achieve outcomes they could not otherwise accomplish by working in isolation. A prime example is the creation/execution of watershed management rules within and between villages on how treated areas are managed. This is no small endeavor: reaching an accord between two or more villages adds complexity and requires effective hillside management from the summit to the valley. With different communities typically occupying the top and bottom of a catchment area, 1) downslope treatments may be marginalized or destroyed without treatment of up-slope sources of flooding/erosion and 2) poorly managed contours across the entire width of a hillside may cause run-off to be concentrated and funneled through a break, producing catastrophic gulley erosion below. Effective control requires that these villages collaborate on developing and implementing a common, mutually beneficial management plan, using community-level institutions that have the skills and authority to negotiate, develop processes and enforce agreements. In addition to increasing control over hillsides, stronger community-based institutions have proven effective in helping small scale farmers gain access to capital and leverage in markets.

WALA's Responses to the Watersheds' Challenges

In the face of these challenges, WALA participants in the watershed restoration areas increased yields/incomes and reduced food aid requirements following a severe El Niño-driven drought. They achieved this by building hundreds-of-kilometers of SWC structures, promoting better dryland production practices, improving/expanding irrigation perimeters, establishing community-based institutions for managing hillsides, increasing access to credit/markets and upgrading/diversifying household diets. These benefits allowed many to become more self-reliant and strengthen their resilience to shocks.

INCREASING PRODUCTION AND DIVERSIFYING AGRICULTURAL OUTPUT

Farmers participating in the WALA watershed restoration areas gained control over rainfall run-off (Box 1) through the construction of SWC structures, the use of improved soil management practices (Amadu, 2020) and expanding irrigation perimeters (Soroko, 2018). As a result, grain yields within the watershed areas averaged 880 kg/ha versus 541 kg/ha by non-participants. Moreover, communities within the watershed areas required less food aid than non-WALA communities following a severe drought in 2015/2016.

Run-off Management

A stream clear of silt indicates very little hillside erosion upstream. People from Makande reported that "the stream used to be full of silt, but now it has less sand and sediments." When visited by the Reichert team, "The Makande stream was very clear in February even though February averages the second highest precipitation month per year" (Reichert, 2014).

SOIL AND WATER CONSERVATION STRUCTURES

SWC IMPACTS

Between 2010 and 2014 WALA-assisted hillside farmers in 32 sites trapped and concentrated rainfall on 2,883 ha through the construction of 1,981 km of SWCs. The structures included water absorption trenches, continuous contour trenches, stone bunds, check dams, marker ridges and the planting of 339,336 trees. Farmers were provided with technical assistance and compensated with Food-For-Work (FFW). To complement the structures, WALA extended Conservation Agriculture and the Sasakawa methodology (Amadu, 2020 and Reichert, 2014).

These structures directly helped farmers increase production by recharging the water table, reducing erosion and converting eroded areas to productive fields (Box 2). Gully plugs (small rock dams placed in eroded gullies) trapped productive sediment behind the dams, allowing gullies to fill up with productive soil and enlarge the arable land area. Trapping and storing run-off in the soil slowed the release of groundwater, enabling streams to flow longer and more evenly. Reichert (2014) reported that streams and bore holes that had formerly dried up had become perennial, increasing the area under irrigation that produced two or three crops/year instead of one (or none). A two-year quantitative time-series data from the Makande Watershed corroborates the observations on stream flow by noting that "the stream's flow rate nearly tripled, and the two observation wells' metrics increased by 49% and 64%, respectively...The flow rate started at 3.2 L/s in October 2011 and two

Members of the Watershed Committee standing on a large (about 12-m) check dam, which has reclaimed a barren gulley, Lingoni. Photo by Chris Reichert for CRS.

Rain Use Efficiency

Lingoni member said, "We have new soil, more water and increased water flow in our streams." Her colleague added, "We have a higher amount of water in perennial stream; our shallow wells and two bore holes used to go dry around November, but now they are perennial." Another Lingoni member explicitly linked water capture to the rise in water tables: "We saw how the water absorption trenches captured water, and we thought that it must eventually come out in our bore holes" (Reichert, 2014).

years later in the same month was measured at 9.1 L/s." This exemplifies increased rainfall infiltration and ground water recharge.

The restored arable land area was significant, especially given that the average farmer cultivates only 0.5 ha of land. As an example, in the Lingoni Watershed, a series of nearly 20 check dams reclaimed much of a large gulley (2m x 12m) within three rainy seasons (Box 3). Farmers planted maize 3m into either side of the gulley and vegetables were growing along the top of the dams (Reichert, 2014).

All watersheds visited by Reichert's team reported improvements in livelihoods following the development of the watershed treatments. In one, during a lean season, the price of food *decreased* after construction of SWC structures, reflecting that higher yields likely led to increased food availability in markets (Reichert, 2014).

SWC SUSTAINABILITY CONSIDERATIONS

SWC Diffusion. Following the end of WALA, Reichert (2014) reported that WALA's watershed technologies spread through autonomous and remunerated diffusion. Using *autonomous* diffusion, people who had worked as FFW labor constructing structures outside of their communities used their experiences to establish SWC structures in their own neighborhood; additionally, one community requested assistance following members' visit to a pilot village during WALA's Field Days. Using *remunerated* diffusion, local leaders utilized Malawi's Local Development Fund (LDF) to hire technical assistance from other watersheds and provide cash-for-work for labor (Reichert, 2014).

"Guarding the Commons." All the communities visited by the Reichert team had created watershed regulatory systems to protect their investments in watershed management. Each community developed their own "membership fees, watershed rules and decentralized enforcement mechanisms." Fines were the typical punishment and enforcement was generally administered at the local level with the rare case when police became involved. As one example, free grazing dropped from 80% to zero, reducing damage to structures and increasing manure supplies for gardens and fields (Reichert, 2014).[2]

Current State of SWC Structures. Even as SWC structures produced benefits, SWC expansion and maintenance declined over time. Reichert (2014) reported that about half of the visited communities had maintained the structures while Sokoro (2018) found little evidence of "consistent watershed treatment maintenance or expansion," except for outliers (e.g., Lingoni) or those supported by WALA follow-on projects. Soroko thought that this trend threatened the resilience that had been strengthened by WALA's interventions. Reasons given for the declines included lack of labor, conflicts over the SWC benefits and poor appreciation of the SWC's value. The latter may have been linked to the fact that some farmers had not participated in the original construction of the structures on their own lands. Soroko also noted that higher levels of maintenance correlated positively with a longer period of technical support. Soroko suggested that follow-on projects provide communities time to fully appreciate the value of watershed management and that projects simultaneously promote revenue-generating activities (e.g., VSL Groups and Irrigation Groups) that add value to the benefits produced by the structures.

Land Reclamation

"If a farmer reclaims the two [gullied] edges of his/her farm, the farmer can reap an additional $20 in revenue per season. Not insignificant, $20 corresponds to 11% of the Malawi's gross domestic product (GDP) per capita of $180...A series of eight check dams (one for every 10 m) costs the equivalent of $140 in FFW incentives...thus the dams 'pay for themselves' in seven seasons" (Reichert, 2014).

SWC Sustainability and the Future of Agriculture in Malawi's Southern Watersheds. Based on the three key reference reports, the future of watershed populations depends on controlling and managing rainfall run-off. Yet, as previously noted, cases where these structures have been regularly maintained and/or expanded, are the exception (see Key Findings).

IRRIGATION PERIMETERS

In the years following the end of WALA, irrigation perimeters were identified as vital income generators and sources of improved diets and emergency food. Irrigation increased yields, produced more than one crop per year, grew high-value crops for the market and nutritious crops for their families. Irrigation perimeters also played a key role in reducing communities' vulnerabilities to climatic shocks. Following the El Niño-induced drought of 2015/2016, WALA participants within the watersheds were substantially less affected than non-participants and WALA participants that were not in the watershed management areas. "Nine of 24 WALA communities did not require any food aid during the El Niño" and "an additional ten needed less food aid than in past droughts" (Soroko, 2018).

Although some WALA communities that irrigated had perimeters prior to the project, most communities acknowledged that those perimeters were more productive after WALA for a few reasons: 1) SWC structures increased the volume of ground and stream water available for irrigation, which extended the time during

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[2] Reduction of free-roaming livestock by the WMC may increase small scale farmers' soil fertility. As per Dr. Geoffrey Heinrich, CRS Soil Scientist, "A major constraint to retaining biomass is the fact that livestock is allowed to wander and graze in the cropped fields in an unrestricted manner in most communities in southern Malawi. There is very limited (non-farmed) grazing area in most communities due to population pressure. The result is that any crop stover that remains on the field after harvest is almost entirely eaten by free ranging livestock and is not returned to the soil where it was produced. Since most livestock is owned by a relatively few (wealthy) members of the community, most of the manure ends up on their land, resulting in a net transfer of nutrients from the fields of poor families onto the fields of a few wealthier families."

Timothy Machika prepares a treadle pump for irrigating his corn fields in Kimu Village, Malawi. Photo by Sara A. Fajardo/CRS

it was available and protected the infrastructure from flooding; 2) WALA provided technical assistance in laying out the perimeter and funds for capital equipment (e.g., weirs, canals, pumps and night reservoirs); 3) several irrigation groups told Soroko (2018) that WALA training and assistance helped them "to better organize their operation"—a key to increased productivity.

Irrigation perimeters varied in their sources of water. Some were gravity-fed from streams or night reservoirs while others used pumps to draw water from boreholes that were recharged by groundwater. While WALA typically covered the initial costs, some irrigation groups charged member-fees to cover new investments and recurring costs (Soroko, 2018).

Lingoni proved to be an exceptional model in using their own initiative to build on WALA's lessons after the end of the project. In addition to negotiating an inter-community agreement, the Lingoni Irrigation Group expanded the irrigated area from 10.8 ha to 30 ha and the size of fee-paying Irrigation Group grew from 6 to 105. It "was one of nine irrigation sites with an operable night reservoir (indicating a gravity-fed system) and one of only four sites that raised fish in the night reservoir and as individuals in their own ponds, for consumption and sale" (Soroko, 2018).

The Lingoni-Chaone example has elements of a potential model for developing and implementing watershed-wide management plans. The Lingoni WMC acted on its own initiative to negotiate an agreement that provided mutual benefits for each party. A locally managed regional committee allocated public funds to the project and the Lingoni WMC provided technical assistance. Given that the benefits likely extended to the region, the allocation of public funds was justified. Beyond those elements, the initiative showed the importance of strong, confident and determined leadership that inspired others to act.

CONSERVATION AGRICULTURE AND SASAKAWA

Soil degradation on crop fields is high in much of Malawi due to continuous cropping and rainfall run-off (Thierfelder, 2013). To combat that, WALA promoted CA and the SM. CA uses minimum tillage, continuous soil cover, the use of rotations and the use of fertilizer trees *(such as Faidherbia albida)*; SM reduces the space between rows and planting holes and number of seeds per hole (Amadu, 2020). Participants reported that crop rotation and mulching enhanced crop production by reducing soil erosion, conserving soil moisture and protecting crops from being washed away by storms. To complement the soil stabilization measures WALA also promoted the application of manure fertilizer (Eire). Farmers linked conservation agriculture and watershed activities. One reported his crops were often washed away before SWC, making it impossible to effectively use CA. Another said that her yield increased from one to eight bags after using CA and SWC in tandem (Reichert, 2014).

CA has the potential to be a powerful tool in addressing climate resilience, as further documented in a study by Thierfelder et al. (2013). Thierfelder's team compared the effects of CA and conventional ridge and furrow systems on soil characteristics and yields. In some cases, CA yields were double those of conventional methods. They attributed the yield increases to a 24–40% greater rainfall infiltration under the CA systems, particularly during periodic dry spells. They also reported that full effects sometimes required several years and that the system used in the study required additional herbicides and labor.

Both the CA and SMs are examples of farmers improving productivity by working at both farm and landscape levels. The SWC structures controlled and channeled run-off coming from the full catchment, protecting the fields from erosion and allowing farmers to apply CA and SM to their individual fields. Operating at both scales created synergies: applying CA on fields where run-off was rampant or building SWC structures without improving cultivation methods on individual farms marginalized the impacts of the other; doing them together amplified the impacts of each. Working at both scales requires collaboration among farmers, if not communities, sharing the same slope.

IMPACT OF WALA'S WATERSHED WORK ON SOIL PRODUCTIVITY

Thanks to the soil tests taken by Fetus Amadu of the University of Illinois, we have a better appreciation of WALA's watershed conservation impact on soil productivity. These findings have implications beyond Malawi's watersheds. The tests found that soils on WALA-treated watershed fields had 2.4% organic matter versus 0.3% in non-participants' fields—a statistically highly significant difference. In addition, treated watershed fields had significantly more nitrogen (41%) and potassium and non-significant increases in calcium, magnesium and phosphorus (Amadu, 2020). These nutrients are critical for crop growth.

The increase in SOM is particularly important in explaining yield increases and in the potential for the results to be sustained over time. As noted by Sn app (2014), soil organic matter "is a cornerstone to sustainable intensification in Africa" due to its capacity to increase rainfall infiltration, stabilize soil structure and retain nutrients and moisture in the root zone (Ahn, 1970). Most of SOM's benefits come from humus, the relatively stable organic matter component that is left behind after the breakdown of SOM's more easily decomposed substances (Ahn, 1970).

Beyond its direct effects on crop production, soil organic matter plays a critical role in improved crop yields. By helping increase rainfall infiltration and retaining nutrients in the root zone, SOM significantly increases both fertilizer and RUEs, making fertilizer more cost efficient and less risky. Research carried in northern Togo found that an average of 41% of applied nitrogen was utilized by crops on SOM-rich soils, while only 33% was utilized on SOM-poor fields (Wopereis et al., 2006). In Niger, researchers found that every kg of nitrogen produced an extra 35 kg of millet grain per ha on the SOM-poor fields, and an extra 47 kg on the SOM-rich fields (Breman, et al., 2007).

For these benefits to continue, adequate SOM content levels must be maintained through regular applications of biomass. If not, "reductions in the amount of humus may lead to spectacular decline in soil productivity" (Ahn, 1970). Given the decline of fallowing in Malawi, getting enough biomass to build and maintain SOM levels is a challenge. Intercropping with legumes is one option for providing biomass (Snapp, 2014). "Not only do legumes produce relatively large amount of biomass, the residue contains 3–5% percent nitrogen compared to 1–2% nitrogen in cereals. Long duration legumes produce copious amounts of vegetative matter over 6–10 months" (Snapp, 2014). Data also suggest that maize-pigeon pea intercropping (a system common in Malawi) can increase biomass production by 300% while increasing maize yields over time. Also, intercropping with the shrub gliricidia can significantly increase biomass production while increasing maize grain yield and resilience in the face of drought. This system was tested in the food security project UBALE, which followed WALA and is still expanding in southern Malawi. Finally, native to Malawi, the *Faidherbia albida* is a leguminous tree that drops its leaves at the beginning of the rainy season and maintains a bare canopy throughout the growing season, allowing crop production under its crown. In studies in Senegal, the humus content under the *F. albida* crown was 1.21% versus 0.85% outside the crown. This difference was due to the large leaf drop at the beginning of the rainy season, ranging from 5,350 kg/ha of biomass to 11,580 kg/ha under densities of 20 and 44 trees/ha respectfully (Charreau, 1965).

The University of Illinois soils' analyses quantitatively corroborate the findings of the other two studies in terms of the effectiveness of the WALA approach in building soil health and productivity. Two years after the end of WALA, these studies showed that the interventions continued to reduce erosion, recharge soil water and replenish plant nutrient stocks. The soil test results reported by Amadu (2020) clearly show the need for continued biomass production to sustain soil health and productivity. As such, they have implications for program design, suggesting that intercropping, agroforestry and residue management are vital components for sustainability.

ACCESSING CAPITAL AND MARKETS: VSL GROUPS AND GROUP MARKETING

Community-based VSL Groups and Group Marketing (GM) allow members to achieve financial objectives that most could not achieve as individuals operating alone. WALA-supported GMs negotiated better prices with produce buyers and agricultural input dealers. And, because they deliver in larger quantity and variety, GMs give

A group of farmers weighs produce on market day. Group organization and connections to markets were critical in incentivizing farmers to take up land restoration practices by helping them capitalize on increased production through enhanced market opportunities and increased income. Photo by Sara A. Fajardo/CRS

members access to a broader and more remunerative range of markets than before WALA. The VSLs are local financial institutions that build up capital from local savings deposits and lend it to members. These new and additional sources of income and capital provide opportunities for improved livelihoods and resilience that were not available before WALA and lead, in many cases, to higher levels of self-sufficiency.

While most of the VSL loans, savings and share-outs are invested in agriculture, members also used these funds to invest in livestock, household businesses, improved housing, school fees, diversified diets and solar panels. During emergencies, small scale farmers used these funds or sold livestock instead of having to borrow at high rates and/or depend upon food aid to feed their families. This new source of liquidity during an emergency was particularly vital for the poor; VSL members had less onerous options for finding the funds to purchase food, and not being in a deep financial hole, were in a much better position to "bounce back" quickly. This resilience was especially evident in the Soroko finding of little to no food aid needed among most WALA watershed communities during the 2015/2016 drought.

VSLs have particularly benefitted women by helping them increase agricultural productivity, invest in/manage agribusinesses and assume leadership roles. "Most successful women…were often members and leaders of multiple groups. They combined [their] efforts…[of] saving and accessing more money with Savings Groups, improving agricultural production in cash crops and learning/engaging in collective crop sales of the agribusinesses. They also referred to the value of maternal and child health and nutrition care group training for helping them eat better and stay healthy…The disaggregated data continues to show successes in engaging women in economically and nutritionally productive and resilient activities through participation in VSL, agribusiness, small-scale irrigation and livestock activities" (Soroko, 2017).

During interviews in 2017, the Soroko team observed that VSL activities "led to participant and community feelings of empowerment, confidence and enhanced planning and problem-solving ability." This is another example of the power of using VSLs, GMs and other revenue-generating activities to help participants take more control over their financial futures.

The use of Private Service Providers (PSPs) is a way to enhance the sustainability of these important financial services. PSPs are typically community members trained to develop VSLs, manage accounts, provide training and ensure sound loan applications/correct payouts. While WALA paid PSPs during the project, most VSLs compensated them at project end. Four years later, Soroko (2018) reported that most communities still provided PSPs with some form of compensation for their services. As watershed populations continue to diversify and strengthen their economies through more complex relationships and business arrangements, well-trained PSPs will likely become a more vital community asset.

Key Findings

1. **WALA helped watershed communities bring about transformative changes.** By controlling rainfall run-off, more effectively organizing how they produced and marketed crops, providing reliable and accessible sources of capital and converting new enterprise management skills into promising household business, many WALA-supported small scale farmers within the watersheds went from subsistence farmers, with little control over improving their livelihoods, to entrepreneurs with diversified income streams and more options to cope with shocks. Many who could only focus on protecting against the downside before WALA, now have multiple ways to climb up the economic ladder toward self-sufficiency, along with needed skills and the confidence to do so.
2. **Overall, the SWC structures positively impacted soil and water productivity and set the stage for greater agricultural intensification.** By most accounts in the three key WALA reports, crop fields were recharged with moisture, water availability for irrigation increased, erosion was significantly reduced, soil health was restored, and the area of productive land was enlarged. These outcomes were the result of *inter alia*, i.e., farmers using SWC structures to collect much of the rain that fell on an entire watershed and concentrating it in the most productive spaces (e.g., crop fields and irrigated perimeters). By increasing agricultural water and soil organic matter while reducing erosion, these structures removed barriers to investing in fertilizers and improved seeds and in expanding irrigation—a major source of new revenue streams for smallholding households. As Soroko (2018) found in his interviews with WALA-supported communities, people reported being more food secure and financially more diversified than before WALA.
3. **Creating synergies is a WALA strength.** As observed by Soroko (2018), by layering complementary activities, WALA created outcomes that were significantly greater than if each activity had been done in isolation of the others. Natural resources management (NRM) activities, complemented by improved livelihood activities (VSLs, GMs, household enterprises) aided targeted households and communities to convert increased production potential into increased income and resilience. WALA created multiple synergies: while SWC structures removed barriers to use of fertilizers and improved seeds, procuring those inputs at the optimal time was made easier by timely loans or share-outs provided to farmers by VSLs. Absent this source of capital, the returns to the SWC structures would likely have been much less; conversely, absent the higher yields from the construction of SWCs, the returns to VSL's sources of capital would certainly have been less. Since the returns to VSLs and GMs ultimately depend on soil and water management, those institutions are a key, but largely untapped, incentive for participants to invest in the extension and maintenance of SWC structures.
4. **Based on Amadu (2020), the production practices promoted by WALA were effective in increasing soil health and productivity.** Amadu (2020) reported that WALA-supported farmers produced yields 63% higher than non-WALA farmers, even in the face of Malawi's worst drought in 30 years. Much of this productive expansion is explained by increases in available plant nutrients and SOM as reflected in the soil test results. These data infer that the treated soils were

structurally stronger, that water and air infiltration and circulation were higher and that the capacities to maintain nutrients and moisture in the crops' root zone were greater. The data also show that SOM played critical roles in soil productivity. Given that the lack of fallow eliminated a major source of biomass, WALA's Conservation Agriculture and agroforestry components made it up on a regular basis, thereby contributing to the maintenance of SOM levels. Intercropping with legumes would be another regular source of biomass.

5. **Strong local organizations at multiple levels played key roles in WALA's successes.** Restoring degraded soils established a foundation upon which additional interventions were layered. Access to financing through VSLs and Local Development Funds provided capital necessary to make investments in production and watershed management. Stronger organizational and governance skills also played critical roles in increasing production and gaining control over run-off and stream flow (e.g., WMCs). The agreement between the Lingoni and Chaone communities, done on their own initiative following the end of WALA, demonstrated how community-based organizations, guided by strong leadership, successfully worked together to manage rainfall run-off at the scale of a sub-catchment, if not at the scale of the whole watershed. In particular, the Lingoni WMC proved that it did not have to wait on a project to conceive and implement a watershed management plan that extended beyond its borders.
6. **With exceptions, it is not evident that the establishment and maintenance of SWC structures achieved the degree and breadth of appreciation and acceptance necessary to spur self-motivated watershed management at either the community or watershed scale.** The richness of WALA's lessons and knowledge provides much to build on, if capitalized. However, with exceptions, such as Lingoni discussed above, it is not clear that WALA's body of lessons and knowledge is fully or broadly appreciated, at either the community or regional level. Soroko (2018) reported a significant drop-off in maintenance and expansion of SWC structures during the four years prior to his study. Even after having seen significant changes produced by SWC structures, few communities maintained them without FFW. Soroko suggested that lack of labor and time could explain some of the poor maintenance and that many households were also managing businesses and other revenue-generating activities. It should be noted, however, that those communities which maintained and expanded SWC structures provided important lessons on the critical roles of strong and competent leadership and institutional strength.

   While the uptake of community-based management and expansion of SWC structures was uneven, Soroko reported that groups involved in revenue-generating activities, such as VSLs, marketing and irrigation schemes, increased both in number and level of activity. Since most of the new and additional generation of revenue was tied to the soil and water conservation of the anti-erosion structures, it would seem that local NGOs and others would have opportunities to raise awareness of successful VSL, GM and Irrigation Groups about the future benefits of investing in improving management and in expanding the SWC structures, perhaps in collaboration with other communities on the slope.

Conclusion

As a pilot, WALA was successful in establishing key "proofs-of-concept" and in setting the stage for scaling-up watershed restoration initiatives in Malawi and elsewhere. These demonstrated the following:

- **Watersheds can be converted from liabilities to assets.** Instead of watersheds being a source of destructive floods and rainfall run-off, WALA-supported communities used simple technologies to channel and consolidate rainfall where it was most productive and increased crop productivity. Increasing rainfall-use efficiency increased fertilizer-use efficiency, allowing farmers to intensify with less risk. By increasing water available for agriculture, the SWC structures reduced farmers exposure to droughts and made it possible for them to get two or three harvests a year instead of one or zero. Increased water and extended cropping seasons allowed farmers to produce a diversity of crops, reducing farmers vulnerability to droughts, pests, floods and other threats.
- **Community-managed savings and lending groups can meet the financial needs of community members.** The VSLs provided loans and pay-outs to farmers according to the agricultural schedule, i.e, at planting time, so farmers could purchase fertilizer at the time required for optimal impact. This was instrumental in increasing area under agricultural intensification.
- **Small scale farmers can gain access to competitive markets through community-based Marketing Groups.** Instead of marketing produce as an individual grower along the road, members of Marketing Groups increased their margins by selling in large quantities to attract buyers.
- **Individual households can use enterprise management training to establish household enterprises and diversify household economies.** As farms decrease in size and become less viable as a source of livelihood, household enterprises provide a possible option to make a living.

WALA should be considered a laboratory that provided conditions for creative communities and individuals to experiment with innovative approaches. The aforementioned proofs-of-concept were robustly demonstrated, while others were "exceptions," and only adopted by particular communities. In Soroko's detailed case studies, there were several instances where communities broke paradigms and provided innovative ways forward. For instance, the Lingoni-Chaone agreement, negotiated between two neighboring watershed communities, led to their collaboration in bringing a portion of the watershed under better control for the mutual benefit of both communities. Although this and other successful "experiments" were not the rule, they have the potential to be consequential if scaled-up. As such, they should be put to their best advantage and not ignored. Further exploration of successful and innovative cases—such as outlined in the report—will be a key step in increasing watershed management.

References

Ahn, P. M. (1970). *West African Soils*. Oxford University Press, Ely House, London W.

Amadu, F. and P. E. McNamara (2020). *The Wellness and Agriculture for Life Advancement Project's Community Watershed Restoration in Southern Malawi.* The University of Illinois.

Bohn, H. L., B. L. McNeal, G. A. O'Connor (1979). *Soil Chemistry.* John Wiley and Sons, New York.

Breman, H., B. Fofana and A. Mando (2007). *The Lesson of Drent's 'Essen': Soil Nutrient Depletion in Sub-Saharan Afrida and Management Strategies for Soil Replenisment.* In: Braimoh, A.K & P.L.G. Vlek, 2007. Land use and soil resources. Springer Media B. V., 145–166.

Charreau Charreau, C. and P. Vidal (1965). *Influence de l'Acacia albida sur le sol, nutrition mineral et rendements des mils pennisetum au Sénégal.* Institut de Recherche Agronomiques Tropical et des Cultures Vivrières Centre de Recherche Agronomiques de Bambey, Senegal.

Kablan, R. and et al. (2008). *Amenagement en courbes de niveau: Increasing Rainfall Capture, Storage and Drainage in Soils of Mali.* Arid Land Research and Management, 22:62–80.

Marenya, P. P. and C. B. Barrett (2009). *State-Conditional Fertilizer Yield Response on Western Kenya Farms.* Amer. J. Agr. Econ. 91(4) (November 2009): 991–1006.

Messina, J. P., B. Peter and S. Snapp (2017) *Re-evaluating the Malawian Farm Input Subsidy Programme.* Nature Plants 3, 17013. Macmillan Publishers Limited.

Reichert, C. M. (2014). *Watershed Development in Malawi: A Study from the Wellness and Agriculture for Life Advancement Program.* Catholic Relief Services.

Rockstöm, J., J. Barron and P. Fox (2003). *Water Productivity in Rain-fed Agriculture: Challenges and Opportunities for Smallholder Farmers in Drought-prone Tropical Agroecosystems. I*n J. Kijne, R. Barker and D. Molden, Water Productivity in Agriculture: Limits and Opportunities for Improvement, CAB International.

Russell, E. W. (1973). *Soil Conditions and Plant Growth.* Longman Group Limited, London and New York.

Snapp, S., T. S. Jayne, W. Mhango, T. Benson and J. Ricker-Gilbert (2014). *Maize Yield Response to Nitrogen in Malawi's Smallholder Production Systems.* Working Paper 9, Malawi Strategy Support Program, International Food Policy Research Institute.

Soroko, D. (2018). A*ssessment of The Wellness and Agriculture for Life Advancement Activity.* Report of an assessments of the WALA project conducted in 2017, Catholic Relief Services.

Stroosnijderi, L., and W. Hoogmoed (1984). *Crust formation on sandy soils in the Sahel, Tillage and its effect on the water balance*. Soil and Tillage Research, 4, 321–337.

Thierfelder, C., J. L. Chisui, M. Gama, S. Cheesman, Z. D. Jere, W. T. Bunderson, N. S. Eash and L. Rusinamhodzi (2013). *Maize-based conservation agriculture systems in Malawi: Long-term trends in productivity.* Field Crops Research 142, 47–57.

Tisdale, S. M. and W. L. Nelson (1975). *Soil Fertility and Fertilizers.* Third Edition, Macmillan Publishing Co., Inc., New York.

Verduijn, R., J. Downen, T. Walters and J. Wyeth (2014). Final Evaluation: *CRS Malawi WALA Program 2009–2014, Volume 1—Main Report.* Tango International, funded by the United States Agency for International Development.

Wopereis, M.C. S., A. Tamelokpo, K. Ezui, D. Gnakpe´nou, B. Fofana and H. Breman (2006). *Mineral fertilizer management of maize on farmer fields differing in organic inputs in the West African Savanna*. Field Crops Research 96, 355–362.

Yishay, A. B., K. Velyvis, K. Nolan, L. K. Khatiwada, C. Dolan, D. B. Guzman and T. Purekal (2019). *Long-term Impact Evaluation of the Malawi Wellness and Agriculture for Life Advancement Program*. Expanding the Reach of Impact Evaluation (ERIE) Consortium. This publication was produced at the request of the United States Agency for International Development.

Annex A: Soil and Water Conservation Structures Used in WALA

The following are descriptions of SWC structures and their applications, based on the Reichert (2014) and Amadu (2020) reports.

- **Water Absorption Trenches** are large diagonal pits that capture and retain run-off while recharging the water table. They are designed to capture large amounts of run-off so are relatively wider and deeper than trenches used within crop fields (described below). Because of the substantial area they require for operation, water absorption trenches are used at the boundaries of fields and are used to control sheet erosion (Reichert, 2014).
- **Continuous Contour Trenches** are smaller than water absorption trenches and used to trap run-off flowing within crop fields. They are diagonal pits running along the contour of fields trenches (Reichert, 2014). As the water absorption trenches, they are designed to recharge the water table as well as reduce sheet erosion.
- **Stone Bunds** are low, semi-permeable rock walls built by farmers to follow a slope's contour (Reichert, 2014) and to slow the flow of run-off. If well built, every point along the barrier will be at the same level, hence water should flow downhill and not along the barrier where it could concentrate at a particular spot. Since its velocity is slowed by the barrier, the run-off drops much of its sediment load on the uphill side of the barrier. Over time, the deposited sediment can form into a terrace, thereby increasing a farmer's arable land. Because the run-off would have likely transported topsoil that contained SOM and finer soil particles—such as clay—the soil deposited behind the structure would have been enriched at the expense of the soils above (Russell, 1973).
- **Check Dams** are stone walls built within gullies perpendicular to the flow of the run-off. They are built at strategic points in gullies in order to slow the erosive power of run-off and force the deposition of soil being carried by the flow (Reichert, 2014). Over time the gully behind the dam fills up, often with soil that was richer than the resident soil. Check dams not only reduce gully erosion but convert an unproductive and erosive gully to highly productive farmland.

Annex B: Soil Characteristics

The following soil characteristics were briefly discussed in the previous sections. This section provides additional information about the roles they play in affecting productivity.

SOIL ORGANIC MATTER

Most of SOM's benefits come from humus, the relatively stable organic matter component that is left behind after the breakdown of SOM's more easily decomposed substances (Ahn, 1970). The properties of humus, listed below, are particularly important for sandy and/or weathered soils.

- Humus is a sticky substance that coats soil particles and binds them together to form crumbs. It is particularly important in giving body to sandy soils in order to stabilize its structure and resist crusting—characteristics that increase infiltration and moisture retention.
- Humus holds many times its weight in water, making it important in retaining soil moisture in crops' root zone. This property is particularly important in sandy soils during extended dry periods.
- Humus has a very high capacity to retain nitrogen and other key nutrients in the root zone. Sandy soils have the lowest capacity and clay soils are in between, hence the value of having clay carried by the run-off becoming part of the terraces that build up behind the contour barriers.
- While relatively stable, humus is ultimately broken down by microbiota into simpler substances, thereby acting as a slow-release source of nutrients as well as a source of nutrients for the microbiota.

HUMUS PROPERTIES AFFECT SOIL CHARACTERISTICS AND PRODUCTIVITY

CATION-EXCHANGE CAPACITY

The term "cation-exchange capacity" (CEC) is important for explaining SOM's impacts on yields. The CEC is a measure of a soil's capacity to retain nitrogen (N) and other nutrients in the crops' root zone. All else being equal, the greater the CEC, the greater the percentage of nutrients will be absorbed by a crop and the greater the yield response to fertilizer. Phrased differently, increasing SOM increases fertilizer-use efficiency (FUE) and increases farmers' returns from investments in fertilizers. To assess SOM's effect on FUE, researchers in northern Togo compared the N-recovery rates by maize on a SOM-rich field with recovery rates on a SOM-poor field. Over three years, the average N recovery rate on the SOM-rich field was 41% versus 33% on the SOM-poor fields (a significant difference).[3] The greatest difference was in a drought year where yields and recovery rates on the SOM-rich field were 2.0 tons/ha and 33% respectively versus 0.8 tons/ha and 21% respectively on the SOM-poor fields (Wopereis, 2006). These very significant differences during a drought year indicate that SOM was affecting both FUE and RUE by retaining both nutrients and moisture in the crops' root zone during times of stress.

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[3] As noted by Marenya and Barrett (2009), "When farmers apply inorganic nutrients on soils depleted of SOM, much of the nutrient applied leaches away or is otherwise unavailable to plants."

SOIL MOISTURE

Crop yields in weathered soils that are low in SOM are often adversely affected by extended dry periods. Those soils are also likely to form crusts that reduce rainwater infiltration (Stroosnijderi and Hoogmoed, 1984). The capacity for humus to resist crusting and to store multiple times its own weight in water increases the opportunities for crops to continue to grow and develop during these dry intervals.

SOIL ACIDITY

A soil's acidity level, as measured by its pH, affects crop's growth. Acidic soils (low pH) increase the concentrations of soluble aluminum and manganese, both toxic to many crops. Soluble aluminum also adheres to and affects the availability of phosphorus to crops. High soil acidity also restricts the availability of molybdenum, a micronutrient required for legumes to fix nitrogen (Bohn, 1979). In acidic soils, soil organic matter plays a role by adhering to aluminum and manganese taking them out of solution and reducing their toxicity (Tisdale, 1979).

Stone bund on upper slopes. Photo by Geoff Heinrich for CRS

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