

Unlocking the potential of enhanced rainfed agriculture



THE SUSTAINABLE
DEVELOPMENT
GOALS
CENTER FOR
AFRICA



Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship



Stockholm
University



This document has been written on behalf of the Transforming Investments in African Rainfed Agriculture (TIARA) initiative, which is led by the Stockholm International Water Institute (SIWI), the Stockholm Resilience Centre (SRC) and the Sustainable Development Goals Center for Africa (SDGC/A). The author is Len Abrams. Valuable contributions have been made by Xanani Baloyi (SIWI), Jennie Barron (Swedish University of Agricultural Sciences), Belay Begashaw (SDGC/A), Anton Earle (SIWI), Amare Hailelassie (International Water Management Institute), Torgny Holmgren (SIWI), Henk Holtslag (The SMART Centre Group), Ashley Huft (SDGC/A), Stephen Hussey (Dabane Water Trust), Régis Jourdan (GIZ), Jan Lundqvist (SIWI), Katherine Madden (SIWI), Malesu Maimbo (World Agroforestry Centre), Stephen Ngigy (Kenya Rainwater Association), Tekalign Tsige Sahilu (SDGC/A), Anna Tengberg (SIWI), Katarina Veem (SIWI), Yigrem Kassa (SDGC/A), Enock Nyorekwa Twinoburyo (SDGC/A) and Gert Verburg (SDGC/A).

Copyright © 2018, Stockholm International Water Institute (SIWI) ISBN: 978-91-88495-14-3

How to cite: Abrams, L., (2018), Unlocking the potential of enhanced rainfed agriculture. Report no. 39. SIWI, Stockholm.

Cover photo: iStock
Language editing: Clarity Editorial.
Design: Laura Inkapööl.

For electronic versions of this and other SIWI publications, visit www.siwi.org/publications

Content

Foreword	4
The challenge	5
The reasons behind the crisis	5
The consequences of the crisis	6
Responses to the crisis	7
Green water – the hidden key	8
Investing in green water	10
Understanding the potential of rainfed agriculture	10
Supporting enhanced rainfed agriculture	11
Making green water work for Africa	12
Putting the farmer first	12
Building sustainable livelihoods	12
A multifaceted challenge	13
Contributing to existing pan-African and global initiatives	16
Financing green water	17
The case for public financing of green water	17
Green water and blue water investments	17
Potential sources of finance	18
Conclusions	19
References	20

Foreword

Africa is facing a crisis. One-third of people across the continent are food insecure. Two-thirds of the population are trapped in a cycle of poverty, exacerbated by climate change and rapidly rising population growth. Water is an increasingly scarce resource. At the centre of this crisis is the African farmer, typically engaged in rainfed subsistence farming.

Rainfed agriculture depends on infiltrated rainfall, which is stored in the upper layers of the soil and is available to plant roots, called “green water”. There is a significant opportunity to maximise the capture, storage and use of green water and unlock the potential of enhanced rainfed agriculture. This builds climate resilience and moves farmers beyond subsistence farming towards sustainable livelihoods, development and growth.

Over 95 percent of African food production is rainfed, yet only 5 percent of public agricultural water investments support rainfed agriculture. Scaling up enhanced rainfed agriculture will require a significant investment, but there is a clear value proposition in making this happen. The estimated cost of green water management in rainfed smallholder farming is only \$250-500 per hectare, a cost-effective and sustainable increase in productivity with multiple knock-on effects.

Transforming Investments in African Rainfed Agriculture (TIARA) is an emerging advocacy effort to scale up green water and enhance rainfed agriculture across Africa through financial investments and political leadership. Led by the Stockholm International Water Institute, the Stockholm Resilience Centre and the Sustainable Development Goals Center for Africa, the initiative helps to achieve Sustainable Development Goals 1, 2 and 6 by understanding the challenges and opportunities of

implementing green water solutions; enabling high-level leadership and political commitments on green water; and unlocking public and private investments across Africa.

TIARA builds on existing approaches including landscape management, sustainable agriculture and agro-ecology and complements the work of programs such as the Comprehensive Africa Agricultural Development Programme and the African Union’s Agenda 2063. However, TIARA is unique in that it is focused on investing in green water – the foundation of agriculture in Africa – to enhance rainfed agriculture.

This document opens with a reminder of the water, food and poverty challenges faced by Africa before arguing that the highest potential for improved food production and poverty reduction lies with improved rainfed farming, enabled through green water management. Based on calculations of yield per dollar invested, the paper makes a strong case for investing in enhanced rainfed agriculture by managing green water and provides a fresh look at overcoming barriers to rural poverty. The paper concludes with a discussion on how to integrate green water into broader strategies and identifies potential options for financing water for enhanced rainfed smallholder agriculture.

The first objective of this paper is to inform about TIARA and help shape future priorities and activities. The second objective is to stimulate interest and engage decision makers on the key issues surrounding green water. Over the longer term, both these objectives will stimulate financing and the expansion of enhanced rainfed agriculture across Africa.

Dr. Belay Begashaw
Director General
Sustainable Development Goals
Center for Africa

Dr. Line Gordon
Director
Stockholm Resilience
Centre

Mr. Torgny Holmgren
Executive Director
Stockholm International
Water Institute

The challenge

Africa's rural population, which makes up nearly two-thirds of the continent (740 million people), faces increasing food insecurity and widespread poverty. The difficulties they experience have far-reaching impacts: national economies are affected as the large rural populations are mostly unable to contribute to their country's growth and development.

The reasons behind the crisis

The reasons for the high levels of poverty and food insecurity in rural areas are varied and complex. Factors pertinent to this report include both naturally occurring climate and geographical circumstances, and human-driven factors.

Natural factors | Most of the rural population is employed in smallholder agriculture, which is undertaken in harsh conditions.

- Land and water characteristics**
 Only a small proportion of cultivable land (5.5 percent) is suitable for irrigation because of limited water availability and soil/topographical characteristics. Most agricultural activity is thus rainfed (94.5 percent)*.
- Climate variability and climate change**
 Most of Africa has limited and highly variable natural rainfall. Rainfall variability and evapotranspiration are predicted to increase, while annual average rainfall is likely to decrease in much of Africa as a result of climate change, increasing the vulnerability of rainfed agriculture.

* Note: There are opportunities to enhance rainfed agriculture across Africa; however, much of the data that exists at sub-continental level is covering either Sub-Saharan Africa or the Middle East and North Africa region.

Table 1. Land area.¹

Total land area in Africa (ha)	2,970,316,800
Cultivable area	771,335,050
% of total land area which is cultivable	26%
Irrigable area	42,504,370
Rainfed cultivable area	728,830,680
% of cultivable area which is irrigable	5.5%
% of cultivable area which is rainfed	94.5%
Total land area currently under cultivation	210,673,190
Total area currently under irrigation	13,444,875
% of cultivable area under cultivation	27%
% of irrigable area under irrigation	32%
% of area under cultivation which is irrigated	6.4%
% of total cultivable area currently irrigated	1.7%

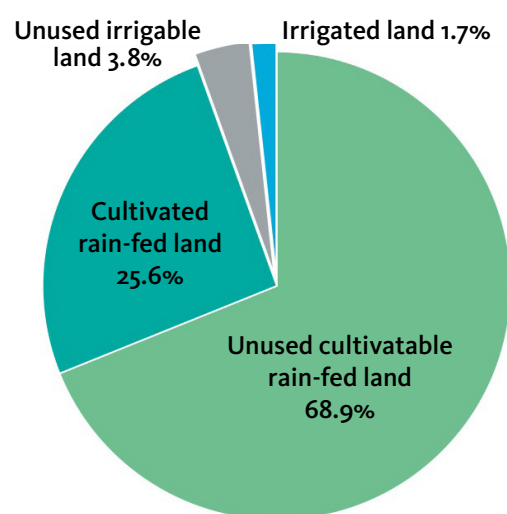


Figure 1. Types and use of cultivable land in Africa.²

Table 2. Population figures.³

Population Figures	
World population	7,632,819,000
% world rural population	44%
Africa population	1,287,920,518
Urban population	547,602,182
% urban population	43%
Rural population	740,318,336
% rural population	57%
Sub-Saharan Africa population	1,050,135,841
Urban population	423,958,015
% urban population	40%
Rural population	626,177,826
% rural population	60%

Human-driven factors | These can be attributed to farming methods and broader public policy issues.

- Farming methods**

Although there is increasing population pressure on the land, the proportion of cultivable land which is being farmed is relatively small (27 percent) and only 32 percent of irrigable land is being irrigated. The productivity of rainfed agriculture is also low, with low crop yields (maize: Africa, 1.8-2 tons per hectare; world average, 5.11 tons per hectare) due to poor farming methods, including the impacts of land degradation, inefficient water usage, low fertilizer use, inadequate pest control, low mechanisation and poor support infrastructure.
- Public policy**

The level of public expenditure on rainfed agriculture is insufficient to underpin viable, productive and sustainable rural livelihoods, given the harshness of the natural conditions noted above (see Figure 2). Low levels of public and private expenditure on infrastructure and services, institutional deficiencies, land tenure insecurity, lack of access to credit and extension services, regional conflicts and other factors all contribute to smallholder farmers being forced into high-risk subsistence practices where they must largely fend for themselves.

The consequences of the crisis

The consequences of this crisis are critical and far-reaching.

Food shortages and malnutrition | The Food and Agriculture Organization reports that 22.7 percent of the population in Sub-Saharan Africa are undernourished, with 31 percent of the population experiencing food insecurity.⁴ Food shortages and malnutrition negatively impact people’s health and development, and can lead to stunted growth.

Expensive food imports | Africa is not feeding itself. Net food imports to Africa cost, on average, \$35 billion to \$42 billion a year and are predicted to reach \$110 billion by 2025. Yet, 60 percent of the world’s unused arable land is in Africa. “Africa’s annual food import bill weakens African economies, decimates its agriculture and exports jobs from the continent”.⁵ In comparison, the African Development Bank has pledged to invest \$2.4 billion annually in African agriculture over 10 years. In addition to distorting African food production, the costs of food imports are greater than the estimated costs of investing in enhanced rainfed agriculture.

Land degradation | Land degradation reduces the productive capacity of land and agricultural output. This in turn increases poverty, forcing people into short-term coping strategies such as deforestation. A recent study of the Zambezi River basin, shared by Angola, Botswana, Namibia, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe, determined that 51 percent of land in the basin is moderately degraded and 14 percent is highly degraded.⁶ This degradation leads to reduced water-holding capacity of soils (soil water retention) and reduced soil water infiltration, reducing the amount of water in the soil available for crop growth. It also leads to high sediment loads in rivers and the silting up of water courses and dams, undermining investments in large-scale water storage, especially for irrigation and hydropower production.

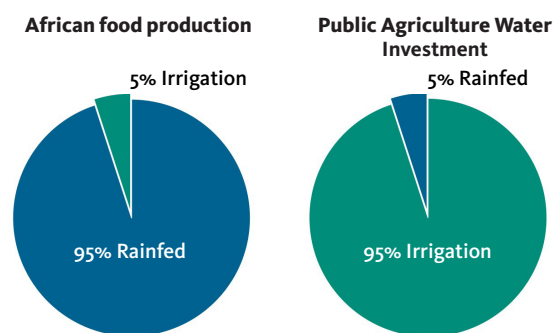


Figure 2. Public investment in agricultural water.⁷



Photo: iStock

Macro-level “drag” on national economies | Rural poverty across Africa has economy-wide impacts. This is primarily because each country is deprived of two-thirds of its potential workers, who, instead of working in skilled employment, are living off increasingly infertile land.

Responses to the crisis

Awareness of this dual crisis of widespread rural poverty and increasing food insecurity is growing. The African Union Heads of State have, for example, endorsed the Comprehensive Africa Agriculture Development Programme as a programme of the New Partnership for Africa’s Development (NEPAD).

Development agencies, development banks and United Nations agencies have also initiated various programmes and projects targeting rural agricultural development.

Most private and public investments in agriculture have, however, targeted commercial irrigated schemes and the “industrialisation” of agriculture. Much of this is directed towards non-food, export-targeted output, which does not improve Africa’s food self-sufficiency or address rural poverty. With about 60 percent of the world’s uncultivated arable land in Africa, there are concerns that substantial foreign direct investment in African agriculture is aimed more at meeting the strategic food interests of the investing countries than in meeting Africa’s needs. In many cases, local people are alienated from their land.

These programmes and approaches adopted over the past few decades are not solving the crisis. The bill for food imports is increasing, rural poverty continues to deepen and the impacts of climate change create further uncertainties. It is becoming increasingly clear that new approaches are needed to support and transform the rural economy.

Tackling poverty and food insecurity is complex and requires a multifaceted approach that supports smallholder and communal dryland, rainfed agriculture at a large scale. It’s worth noting that subsistence agriculture is a type of farming in which most of the produce is consumed by the farmer and his/her family, leaving little or nothing to be sold. This is a type of farming, not a type of farmer. Farmers engage in subsistence agriculture by force of circumstance and will produce a surplus wherever possible to provide income.

Five decades of rural development work across the continent has illustrated that a range of supporting infrastructure needs to be in place – functional governance and administrative structures at all levels down to the village and farmstead; transport and marketing infrastructure; finance and credit; training and agricultural extension services; and, critically, water.

Green water – the hidden key

Water can be classified according to where it is found and how it is used. Two types of water are of interest to African rural development – blue water and green water.

“Blue” water refers to the water in rivers, lakes, dams, wetlands, and aquifers and other groundwater sources. It is initially derived from rainwater runoff. Across Africa most blue water is found in large transboundary river basins that are shared between two or more countries. All conventional water resources management and development for direct human consumption, irrigation, hydropower generation, industry and urban development is blue water.

Due to limited rainfall (less than 500 mm/year), topography and surface conditions, only 10-25 percent of rainfall in the arid and semi-arid areas of Africa contributes to runoff and hence increases blue water supplies. About 75-90 percent of rainwater infiltrates into the soil, from where it can percolate deeper into groundwater, evaporate into the atmosphere or be used by plants as transpiration (see Table 3).

“Green” water is water derived from rainfall that is available in the soil for plant growth through transpiration. However, not all the water that infiltrates into the soil is used by plants – a proportion will return to the atmosphere through evaporation. Crops generally use less than 30 percent of rainfall in semi-arid regions – up to half the rain evaporates directly from the soil and the remainder runs off the surface or seeps into the groundwater.

Table 3: African rainfall.

African Rainfall		100%
Blue water	Runoff	10-25%
	Infiltration to groundwater	10-30%
Green water	Evaporation	30-50%
	Transpiration	15-30%

Table 4: Typology of agricultural water management systems.⁸

Agricultural water management type	Agricultural water management system	Main technologies
Improved water management in a rainfed environment	1. Pure rainfed cropped area	Managing soil moisture
	2. Improved rainfed	Small-scale water harvesting
Small-scale irrigation (individual, community-based)	3. Individual low-cost irrigation	Pump irrigation, both manual and motorised
	4. Community-based irrigation	Low-cost diversion; flood recession; communal pump schemes
Large-scale public irrigation	5. Large-scale irrigation	Dams or weirs; surface canals; furrow irrigation
Large farmer irrigation and Public-Private Partnership (PPP)	6. Private commercial irrigation	Dams or weirs; surface canals; furrow irrigation
	7. Market-oriented irrigation on a PPP basis	Piped irrigation; drip, sprinkler; protected (greenhouse) agriculture



Photo: Len Abrams

The key to successful rainfed agriculture is to maximise the water available to support plant growth, and to use water efficiently and productively by using improved plant varieties and increasing soil nutrients (fertiliser use) and pest control.

There are critical points in the growth cycle of crops where plants need moisture – brief dry spells in the growing season may result in significantly reduced yields, even when the overall seasonal rainfall may be sufficient. Capturing and maintaining soil moisture to ensure it is available when the plants most need it is key to productive rainfed agriculture.

Green water capture and green water storage are critical for increasing the availability of green water for plant growth. Water capture increases water availability by reducing rainwater runoff and groundwater seepage, while water storage reduces evaporation. Ways to capture

or harvest rainwater include terracing, ponding and the use of small dams. Soil moisture storage can be achieved through zero tillage, using conservation tillage methods, and applying agro-ecology methods such as mulching, intercropping, windbreaks, using the right fertiliser, timely planting, weeding and pest control.

None of this is new – many of the methods and technologies have been available for decades and are based on well-established scientific findings that have been proved in practice throughout the world.

Regenerating the rural economies of Africa is a complex process that will take time. However, it will only be effective if water is available. Given that 95 percent of cultivable land and agricultural activity is rainfed, approaches should target green water and enhanced rainfed agriculture.

Investing in green water

Understanding the potential of rainfed agriculture

A recent World Bank study⁹ makes the case for investing in irrigation in Africa’s drylands. The study, which draws on the work of the International Food Policy Research Institute (IFPRI), notes the limited potential for large-scale blue water investments in irrigation (1.27 percent of cultivable area in dryland zones). Small-scale irrigation undertaken by individual farmers and communities is also only possible on a limited scale due to the lack of available water in the dryland zones (7.2 percent of cultivable area). Both large- and small-scale irrigation are promoted as potentially profitable enterprises with reasonable internal rates of return of 5-12 percent. The World Bank study compares estimates of the cost per hectare of developing large and small-scale irrigation with the cost of managing rainfed green water, together with estimated yields (see Table 5).

For the purposes of this paper, small-scale irrigation supplied by small dams and other water harvesting techniques are regarded as part of green water management, where it is combined with in-field green water conservation techniques and is used by smallholder farmers to augment rainfed agriculture. Small-scale irrigation is only possible in limited areas – 7.2 percent of the cultivable area in dryland zones.

Several important observations can be made from the World Bank/IFPRI and other studies:

- Production in the remaining 92.5 percent of the dryland cultivable area depends solely on rainfed soil moisture.
- The estimated cost of green water management in rainfed smallholder farming is \$250-500 per hectare. This is the cost of small-scale rainwater harvesting and in-field soil moisture retention techniques and is largely low-technology and labour intensive.
- The estimated yield per hectare for rainfed African cereals is deliberately quoted conservatively at 1-2 tons. The yields could be increased through activities that do not involve water such as fertilising and pest control. The key, however, is resilience and risk reduction – ensuring that soil moisture is available so that even modest yields are achievable, particularly in dry spells, and that the benefits of inputs such as fertiliser will be realised.
- Even when using conservative yield figures and the higher end of the cost estimate, the yield per \$1,000 of investment is 4 tons for improved rainfed farming, 0.44 tons/\$1,000 for small-scale irrigation and 0.67 tons/\$1,000 for large-scale irrigation. The yield per dollar of in-field expenditure is six times larger for improved rainfed agriculture compared to commercial irrigation.

Table 5: Development potential in dryland zones in Sub-Saharan Africa.¹⁰

Agricultural water management type	Cost/ha	Production /ha	Cost/kg	Potential area *	Production	Investment cost	Water type
Improved water management in rainfed farming	\$250-500	1-2t**	\$0.25	126,000,000ha	126-252Mt	\$31.5 billion	Green water
Small-scale irrigation (individual, community-based)	\$4,500	2t	\$2.25	9,075,000ha	22.7Mt	\$40.5 billion	Intermediate
Large-scale public & private commercial irrigation	\$12,000***	8t	\$1.5	1,601,000ha	12.8Mt	\$19 billion	Blue water

* Potential cultivable areas within the climatic zones defined as “drylands” from Harvest Choice, IFPRI (2013).

** Chosen as an average estimate – yields are 400-1,500kg/ha with 400-500kg/ha attributed to improved soil moisture.

*** Note that this excludes the cost of storing water in dams and the cost of transferring water to the irrigation schemes.

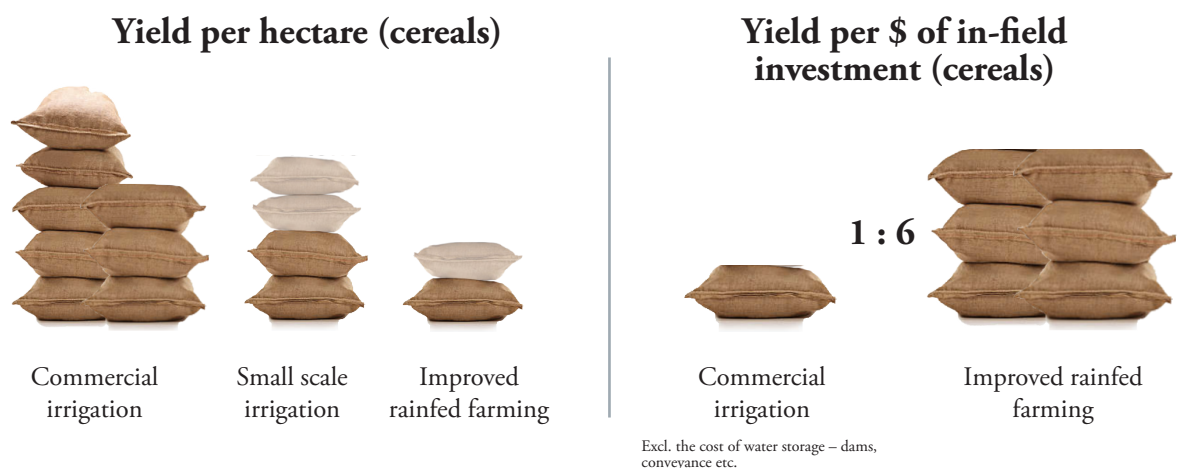


Figure 3: Yield comparison between commercial irrigation, small scale irrigation and improved rainfed farming systems.

- Although the yield of commercial large-scale irrigation is some eight times per hectare more than rainfed yields, the constraints on the area which can be irrigated means that irrigation alone can only meet a fraction of the continent’s food needs. Commercial large-scale irrigation is not a solution to rural poverty in Africa as it only directly benefits a very small number of people. Commercial large-scale irrigation should certainly be undertaken wherever it is possible but should be self-financed on its own commercial merits.
- Small-scale irrigation by individuals and communities has significant potential for food production, but it is also limited. Extensive small-scale irrigation could provide direct benefits to an estimated 60 million people, thus reducing rural poverty.¹¹

A 1 percent increase in productivity in rainfed agriculture would be equivalent to a 10 percent increase in irrigated agriculture in Africa.

Table 6 illustrates the potential investments required and the possible yields in the dryland zones of Sub-Saharan Africa. These investments are comparable to Africa’s food import bill, which costs the continent about \$35 billion to \$42 billion each year.

These estimates make a strong case for investing in enhanced rainfed agriculture by managing green water. The question then arises as to how this can be done at scale to help regenerate rural economies across Africa, increase food security and contribute to the continent’s growth and development.

Supporting enhanced rainfed agriculture

Enhanced rainfed farming has the highest potential to improve food production and reduce poverty, enabled through managing green water in the vast tracts of rainfed cultivable land in Africa.

The yield per dollar invested in improved rainfed agriculture is potentially nine times that of small-scale irrigation and six times that of large-scale irrigation and the land available is almost limitless if it is recovered and restored from the degradation caused largely by poverty.

Table 6: Investments and yields by water management type.¹²

Agricultural water management type	Investment required	Possible annual yields
Large-scale commercial irrigation	\$19 billion	18 million tons
Small-scale irrigation	\$40.5 billion	22.7 million tons
Improved rainfed agriculture	\$31.5 billion	126 million tons

Making green water work for Africa

Putting the farmer first

Africa's rural population is continually managing risk. Most of them are engaged in smallholder rainfed agriculture, which provides 90 percent of the continent's food. Given that the only way to increase their water resilience is to adopt green water techniques, how can they be supported in doing this farm by farm, at a scale that will ultimately make a difference to the continent?

There are anecdotal examples of communities that have successfully achieved a level of resilience in difficult circumstances with different types of green water schemes. There are also examples of country programmes of community-based soil and water conservation that have had lasting benefits, such as in the Central Plateau of Burkina Faso.

The smallholder farmer

Smallholder farmers live in continual uncertainty about whether or not the rains will come, when they will come, and in what form – torrential downpours causing floods or rains spread out over the growing season when the crops need the water most. The greater the uncertainty and the fewer their resources (based often on what happened last season), the greater the risk and the fewer their options.

Farmers become increasingly risk averse because the consequences of failure are severe – starvation is a stark possibility. Introduction to anything new will be very carefully weighed up in terms of cost, effort, risk and possible benefit: “Will the benefits be lasting and repeatable? What are the implications if it does not work – will I be worse off than if I had not tried it? Show me – I need to be convinced that it will work before I can take the chance.”

While this may be undertaken and advised from the outside with the best of intentions, it is the farmer and their family who will live with the consequences.

A key lesson from such projects and decades of rural development experience throughout Africa is that the results are far more likely to be sustainable and replicable at scale when people are placed at the centre of their own development. Communities and individual farming families must be empowered to make decisions and fend for themselves, with the support of external resources that reduce their risk and provide access to improved farming methods.¹³

Building sustainable livelihoods

The availability of water determines productivity. As Figure 4 illustrates, a farmer is able to function along a farming continuum, depending on water availability, which stretches from failed subsistence to small-scale agrobusiness, where the farmer is able to produce and market cash crops. Farmers who contend with variable annual rainfall and inconsistent rainy seasons face uncertainty as to where on the continuum they will be in any particular year. Because of this uncertainty, they cannot risk expenses such as fertiliser or more expensive high-yield seed varieties, which will be wasted if there is no rain.

If there is a high likelihood of unpredictable dry years – which is the situation in African dryland zones – farmers become trapped in a risk-averse subsistence state. In some years, this will result in failed crops and them being unable to feed themselves; in all other years they will produce average yields. In seasons with average and good rains, they will not be able to take advantage of greater potential yields because they could not risk the costs of inputs such as fertiliser, not knowing beforehand what the rainy season would be like.

The first step in building sustainable livelihoods is ensuring that, at the very least, farmers do not fall below the “subsistence point” (see Figure 4) by securing green water, which will be available in all but the most persistent droughts. Removing the risk of failed subsistence from the farmer is a major step in enabling them to invest in inputs that will allow them to take advantage of average and above average rainfall and thereby begin to build their livelihoods and wealth.

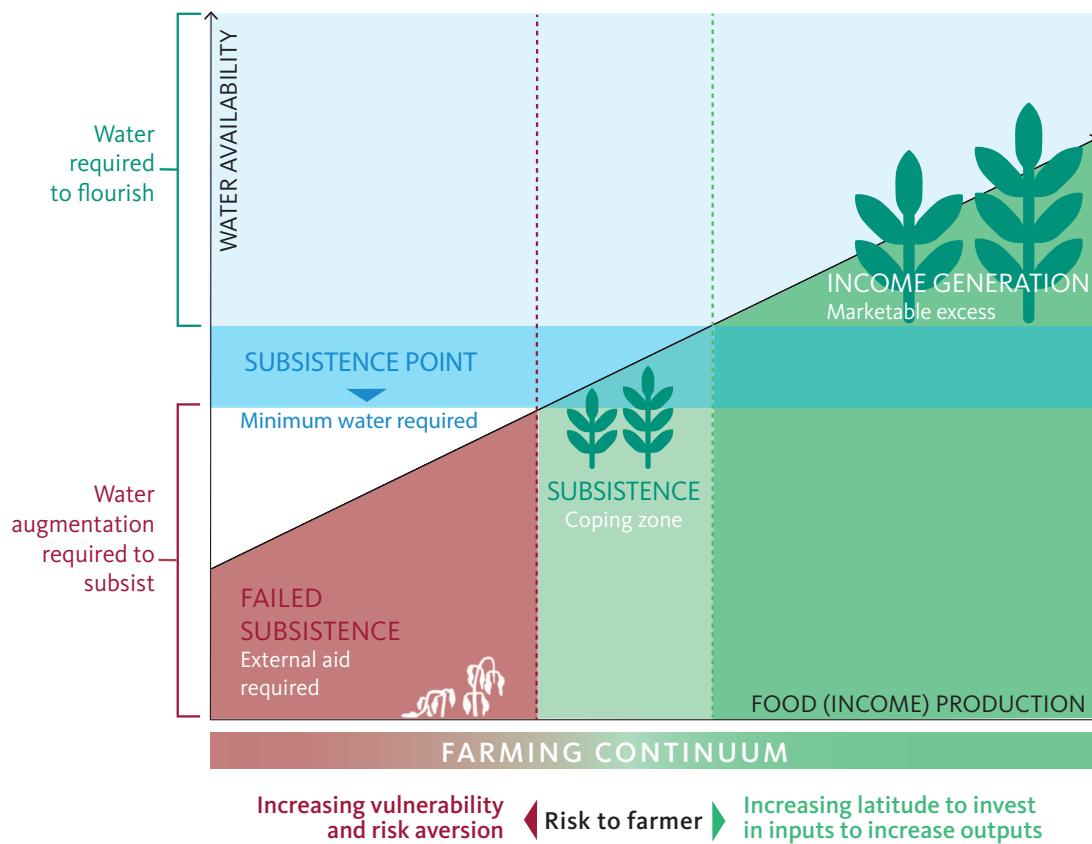


Figure 4: The farming continuum and water.

Securing green water removes uncertainty and increases sustainability – reducing the cycle of increasing poverty with improving wellbeing.

It must be stressed that this is only meant to be the first step – further processes would be required to help increase enhanced rainfed agriculture. To improve food production across the continent, as many farmers as possible need to get to the first stage of basic water security, where they are able to confidently meet their own needs in bad years and begin to produce excess outputs in good years.

This will not only have an impact on those directly involved in farming, but will also provide the basis for other economic activities in rural areas as demands increase for agricultural inputs and markets develop as a result of increased outputs. This in turn will drive other commercial activities not directly related to the agricultural value chain.

A multifaceted challenge

Managing green water is critical to reducing poverty in Africa, but it is only one piece of the puzzle and other elements are needed to realise the benefits. There needs to be a range of related on-farm factors in place such as improving soil nutrition, holistic natural resource management, access to markets, land tenure security, credit, training and extension services. Enabling public policy also needs to be addressed for enhanced rainfed agriculture to succeed including an actively supportive political context; broad public awareness and support, particularly in rural areas; an inclusive context involving a wide range of stakeholders; and the engagement of external support.

The full engagement of the public sector will also be required. This includes the commitment of public expenditure; supportive public institutional structures at all levels; a multi-sectoral approach involving agriculture, water, land and rural development sectors; and a supportive policy and regulatory context.

Small dams in Matabeleland South, Zimbabwe

The Matope and Mabate dams were constructed in 1999 in Matabeleland South in Zimbabwe as part of a scheme undertaken jointly by communities, a consortium of nongovernmental organisations and Rural District Councils in response to the devastating droughts of 1992. The Give a Dam programme put communities at the centre of the process. The small dams provide communities with water for small-scale irrigation and stock watering through a gravity-fed irrigation system. The Matope scheme serves 150 families in three villages and the Mabate scheme is worked by 21 families.

When the Zimbabwean economy collapsed in 2008, all support activities from outside the schemes stopped. However, when visited five years later in 2013, both schemes were fully functional and productive, although the dams needed maintenance.

The committees of both schemes indicated that local self-governance through a clear constitution that sets out how the schemes are operated and how plots are allocated is a key factor of their success as it relieved tension between different water users.

The dams provide sufficient water for a single crop each year. The committees estimated that the irrigation schemes provide for direct consumption needs for six months each year and the equivalent of the value of three goats cash income per family each year, which amounts to about \$120. (Since the days of hyperinflation in Zimbabwe, community members measure wealth in livestock equivalents.) The communities consider themselves fortunate to have access to these assets.

Active political support | Focused political commitment is needed to transform local rural economies through incremental improvements in rainfed agriculture. There is a need to counter political scepticism of the merits of investing in rural subsistence agriculture and to overcome the inertia of public institutions to embrace change. Political leadership is needed to change institutional cultures that have largely favoured the financing of high-profile blue water investments as these will not significantly improve Africa's food security and only benefit a relatively small number of people. Instead, political leadership at the highest level should clearly mandate the public sector to prioritise enhanced rainfed agriculture at large scale. One approach to overcoming scepticism and inertia is to identify a small number of champions at the highest political level to commit to large-scale rural regeneration projects in their countries, catalysing the uptake of the approach more broadly across Africa.

There is considerable and growing emphasis on addressing the food crisis in Africa and on developing commercial agriculture within the African Union. However, this tends to be in terms of producing high-value, export-oriented agro-industrial outputs aimed at decreasing balance of payment deficits. In some quarters, supporting subsistence agriculture is resisted as this is regarded as perpetuating a negative perspective of Africa. There is a need to combine scientific and traditional methods to modernise rainfed agriculture, stabilise subsistence farming and ultimately transform it into a source of income for farmers and nations.

The role of the public sector | The public sector will be essential to transforming and scaling rainfed agriculture, meeting Africa's food needs and addressing rural poverty. Government needs to be included at all levels, including:

- Regional and continental level – This is essential to promote shared perspectives and share experiences of enhanced rainfed agriculture programmes where green water capture, conservation and use has been key to success.
- National level – The national level is where political commitment is translated into policy and subsequently into budgets and mandates for ministries and departments, without which action at scale will not be possible. Critical to success is the need for a multi-sectoral approach that integrates the activities of different government departments such as water, agriculture, conservation, land and rural development. Green water offers a particular challenge as it has not traditionally been considered as an area of activity or responsibility in either agriculture or water. This needs to be rectified, with clear mandates and responsibilities outlined. National governments also play a critical role in ensuring that an enabling environment exists to support, promote and regulate the role of the private sector in the agricultural and food production and marketing sectors.

- Local government level – Local government in the form of local district development councils or their equivalent, including traditional governance structures, are critical to communicating with and supporting smallholder farmers to ensure the success of large-scale support programmes.

Private sector involvement | The formal and informal private sector plays a key role in Africa. It is estimated that one in two rural households operate an informal small business of some sort, from vending to transport.¹⁴ Much of this non-farming activity is to supplement income in case of crop failure and is intermittent, with small businesses opening and closing continuously. Reducing the occurrence of failed crops by stabilising rainfed agriculture would enable farmers to meet their direct needs and produce excess crops to trade. This would provide opportunities for farmers to enter the agricultural value chain and build household wealth, in turn strengthening local economies.

There are a number of initiatives throughout the continent aimed at improving the health of rural economies by supporting smallholder farmers and rural small and medium enterprises. Some of these are supported and driven by national governments and others by donors, nongovernmental organisations and large companies in such areas as financial services (providing credit and insurance), out-grower schemes, marketing support and support with farming inputs such as fertiliser and seed varieties.

The role of the private sector and social enterprise (the use of instruments such as community saving clubs, cooperative local banks and bulk-buying clubs) is critical in rejuvenating rural economies and building wealth, as this cannot be done by the public sector alone.

Public awareness and support | Widespread promotional campaigns targeting the general population and smallholder farming communities are needed to communicate the vision and intention of smallholder farmer support policies and programmes. The campaigns should raise awareness of the potential for increasing productivity and income, together with what support is available. Raising awareness will help overcome risk aversion, misconceptions and poor practices such as crop preferences, which have often become entrenched.

An inclusive context | Successful smallholder farmer support programmes have the common trait of involving a wide range of different players and stakeholders, including traditional leadership structures, local government, community structures such as water committees, faith-based communities and organisations, civil society, farmers' organisations, the private sector, financiers and nongovernmental organisations. This

diverse spectrum provides a support base for smallholder farmers, especially the most vulnerable in terms of poverty, through which the messages of enhanced rainfed agriculture can be variously interpreted.

The role of external support | The role of external support for investments in enhanced smallholder rainfed agriculture in Africa is critical. While the political mandate and implementation of large-scale programmes to improve rainfed agriculture through the use of green water has to come from the countries themselves, a great deal can be done to support such initiatives. This includes supporting government by:

- Helping develop rural regeneration policies and regulations to create the enabling environment for large-scale implementation.
- Supporting integration of different sectors, including rural development, agriculture, water, transport and marketing, by promoting interaction, training and capacity building.
- Helping the public sector engage with stakeholders and support farmers by mobilising and supporting a range of different players which government may not have worked with previously.
- Providing technical assistance in the technology and practice of green water capture and soil moisture use, including training and extension services.
- Financing large-scale rural regeneration projects that support smallholder rainfed agriculture. This is addressed more fully below.

External support can play an important role in funding research and analysis through large-scale pilot programmes covering technical aspects of green water capture and use, and the social aspects of smallholder support related to risk management and perceptions.

Support is needed to underpin advocacy for political alignment to support rural regeneration by supporting regional and continental initiatives aimed at promoting and adopting green water-based enhanced rainfed agriculture.

Supporting smallholder farmers and rural community groups need independent, external support and access to resources. Although the public sector should be the primary motivator and implementer of enhanced rainfed agriculture at scale, alternative sources of finance for farmers and community rainfed farming initiatives could be useful, especially as demonstration projects at small to medium scale to test the practice and methodology and provide state actors with confidence to expand.

Contributing to existing pan-African and global initiatives

African initiatives | Rural poverty in Africa is not a new topic. There are a number of related and complementary initiatives at the continental and regional levels. The African Union's Agenda 2063 provides the overarching pan-African context. Agenda 2063 is a strategic framework for the socioeconomic transformation of the continent over the next 50 years. It builds on, and seeks to accelerate, the implementation of past and existing continental initiatives for growth and sustainable development, including:

- Lagos Plan of Action (1980).
- Abuja Treaty (the African Economic Community Treaty, 1991).
- NEPAD (2001).
- Comprehensive Africa Agricultural Development Programme (2003).
- Minimum Integration Programme (2010).
- Programme for Infrastructural Development in Africa (2012).
- Kigali Communiqué, African Green Revolution Forum, Kigali (2018).
- Plans of the Regional Economic Communities.
- National plans.

Other initiatives that endorse action to address rural poverty and hunger, improve agriculture, and promote economic development include the Malabo Decision on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods, and the African Development Bank through Technologies for African Agricultural Transformation, which is a key priority of the African Development Bank's agricultural transformation agenda, also known as the Feed Africa Strategy. There are also specific agricultural water management projects such as the Billion Dollar Business Alliance, which aims to improve the livelihoods and resilience of smallholder farmers in the drylands of Sub-Saharan Africa.

The Sustainable Development Goals | The Sustainable Development Goals (SDG) provide an important global framework for change and are designed to integrate global ambitions around poverty reduction, climate change and ecosystem management. It will be difficult to achieve the SDGs in Africa without tackling enhanced rainfed agriculture. Green water management will contribute directly and indirectly to seven of the SDGs.



Figure 5: UN Sustainable Development Goals

Financing green water

The following discussion highlights the key issues around financing enhanced smallholder rainfed agriculture in Africa.

The case for public financing of green water

Investments in green water should primarily be the responsibility of national governments. Reasons for this include the following:

An issue of national importance | The wellbeing and productivity of two-thirds of the population who depend on rainfed agriculture for food and income is a matter of national concern in most if not all African countries. To address the multifaceted problem at scale, political leadership and governance is required through the organs of state.

Food production | Africa is a net importer of basic food. Internal food production is substantially underperforming. However, the continent could meet its own needs through enhanced rainfed agriculture. Food imports are required to address recurrent large-scale food crises faced in many parts of the continent due mainly to weather-related crop failure, which results in high levels of malnutrition. Food requirements cannot be met through irrigated agriculture alone but could be met with enhanced rainfed agriculture that harnesses the continent's green water potential. However, to do so at scale requires the state's commitment and involvement.

Disaster risk management | Substantial state resources in many countries are committed to disaster risk and emergency management, often geared towards coping with the impacts of drought and failed harvests at large scale, particularly in subsistence rainfed areas, which is where the majority of Africa's population lives. Most of this is reactive and is not geared towards preventative measures at scale.

National productivity | There is a strong drive throughout Africa to provide jobs and thereby increase the productivity of African economies. Much of this drive is urban and industrially based. Where it is agriculturally

oriented, it usually targets high-value commercial agriculture, mostly related to irrigation. Little emphasis is placed on addressing smallholder rainfed agriculture to contribute to national productivity. Regenerating rural economies by supporting improved rainfed agriculture at scale could potentially contribute greatly to national productivity.

Reduction of food imports | Enabling the continent to be self-sufficient in food production will reduce the drain on national accounts due to the costs of importing basic food, thereby improving the balance of payments accounts of Africa as a whole.

The public sector will likely need to lead large-scale programmes to improve rainfed agriculture, supported by the international development sector and, where feasible, the private sector. Public sector financing could include a range of different fiscal mechanisms and activities such as subsidies, public work programmes, farmer support and extensions services, micro-credit for inputs, market access roads, and small-scale infrastructure such as small dams and rainwater harvesting systems. Multilateral development agencies such as the World Bank and the African Development Bank could provide governments with credit to invest in enhanced rainfed agriculture and regenerating rural economies.

Green water and blue water investments

The relative scarcity of irrigable agricultural land in Africa is a strong motivation to ensure that all such land is optimally used. However, given the realities that Africa faces (the food crisis, the prevailing levels of rural poverty, the constraints on blue water irrigated agriculture potential and limited available public finances), there is a strong case for advocating that large-scale private sector commercial irrigation should not be financed with public funds. Instead, it should be financed by conventional commercial financing sources on the strength of each scheme's commercial merit. This, however, is not how public funds have been spent in the past. Most public infrastructure financing in the water sector has targeted blue water projects, with limited

funds being allocated to small-scale productive water projects in rural areas (apart from WASH projects in support of potable water and sanitation services).

Emphasis should instead be placed on financing green water for enhanced rainfed agriculture. The difficulty with this is that green water has not been a traditional area of responsibility and expertise in either water or agriculture government departments. Awareness about the importance and management of green water needs to be strengthened, and better cross-sectoral coordination between the water and agricultural sectors is urgently required.

The cost-benefit rationale for the public financing of large-scale enhanced rainfed agriculture programmes is strengthened by the observations made in the section on investing in green water and illustrated in Figure 3. The yield per dollar invested in enhanced rainfed agriculture is six times that for each dollar invested in large-scale irrigated agriculture.

Potential sources of finance

There are a range of potential sources of funding including redirecting existing sources of funding, as well as identifying new sources. The following list provides some initial ideas but will need to be further investigated and analysed.

Redirect drought disaster funding | Review existing funding of disaster risk management and response programmes, especially those related to drought risk management. Assess the potential for redirecting some of these funds to enhanced rainfed agriculture as a sustainable risk management strategy.

The role of financial institutions | Finance institutions (including commercial banks, microfinance institutions, savings and credit cooperative organisations, and village savings and loan associations) will play a critical role in facilitating finance and other services for enhanced small-holder rainfed agriculture.

The role of microfinance | Microfinance institutions can play an important role in scaling up the intervention and enhancing sustainability by reducing total dependence on government subsidies and external funds.

The role of the private sector | The private sector (particularly small and medium enterprises) plays an important role in increasing the use of rainwater harvesting techniques and promoting production and distribution chains on a commercial basis to unreachable rural areas.

Redirect emergency food funds | Assess whether existing emergency food response planning and financing can be redirected to reducing the occurrence of crop failure and hence the need for emergency feeding through enhanced rainfed agriculture. Research the costs of emergency feeding interventions compared with investing in enhanced rainfed agriculture.

Climate change funding | Enhanced rainfed agriculture is essentially a process of building local resilience to climate variability and climate change. It could meet the access criteria of various climate change funding sources in terms of both mitigation and adaptation.

Existing development funding | Green water-based rainfed agriculture is likely to meet the funding criteria of various existing rural development, agricultural and food security funding sources of the bilateral and multilateral development financing agencies.

Payment for environmental services | Adopting enhanced rainfed agriculture using green water approaches, and the reduction of poverty as a result, would have considerable downstream benefits, thus effectively functioning as a catchment management programme. This constitutes an environmental service as it would result in reduced erosion and sediment loads, which decrease downstream water storage and increase water treatment costs. A case could therefore be made for meeting some or all of the costs of such a scheme from the savings made by downstream beneficiaries.

Mobilise new sources of finance | Various sources of possible new funding need to be investigated. Such funds, together with the sources noted above, could be used to establish and capitalise a green water fund dedicated to supporting green water use in Africa.

Conclusion

Africa has the potential to produce enough food to more than meet its own needs. However, due to natural constraints, 95 percent of its potential cultivable land is rainfed, most of which exists in dryland zones with highly variable rainfall. Sixty percent of Africa's population live in rural areas, where most of them depend on rainfed smallholder agriculture for their food, employment and income.

Water is critical to rainfed farming. Most investments made in agricultural water management and development target blue water, yet 90 percent of food production and 95 percent of agricultural land depends on green water. Adopting scientifically tested and traditionally proven methods of farming that capture and preserve green water, together with rainwater harvesting techniques, can substantially improve rainfed agriculture and reduce rural poverty. Investments in enhanced rainfed agriculture have been shown to produce six times more crop yield per dollar invested than investments in mechanised irrigated agriculture.

More investment is needed in enhanced rainfed agriculture throughout Africa. Smallholder farmers should be supported so that they can feed their families, but also contribute to and benefit from the agricultural value chain, thus contributing to Africa's growth and wellbeing as a whole. Achieving these goals is complex and requires the involvement and engagement of many different players at all levels, including, most importantly, political leadership and commitment at the highest level.

Enhanced rainfed agriculture can be financed through a combination of new sources of funds and the reallocation of existing resources that are used to respond to the consequences of the current widespread failure of rainfed agriculture. New approaches are needed to significantly and sustainably regenerate Africa's rural economies.

Endnote references

- 1 AQUASTAT website, Food and Agriculture Organization of the United Nations (FAO) <http://www.fao.org/nr/water/aquastat/main/index.stm>.

FAO; (1997); Irrigation Potential in Africa: A basin approach, FAO.

AMCOW, (2018), Africa Regional Synthesis Report, for the Eighth World Water Forum, AMCOW.
- 2 AQUASTAT website, Food and Agriculture Organization of the United Nations (FAO).
- 3 United Nations Population Division, Mid 2018.
- 4 FAO, (2017), Regional Overview of Food Security and Nutrition in Africa 2017. The food security and nutrition–conflict nexus: building resilience for food security, nutrition and peace. <http://www.fao.org/3/a-i7967e.pdf>
- 5 President of the African Development Bank, Akinwumi Adesina, 2017.
- 6 SARDC (2015), Zambezi Environment Outlook 2015. ZAMCOM, SADC.
- 7 Primary research by author.

FAO, (1997); Agriculture Water Investments: World Bank National Annual Public Expenditure Reviews, Southern and East Africa, Water and Agriculture sectors.
- 8 Ward, C., Torquebiau, R., and Xie, H., (2016). Improved Agricultural Water Management for Africa’s Drylands. World Bank Publications.
- 9 Ward, C., Torquebiau, R., and Xie, H., (2016). Improved Agricultural Water Management for Africa’s Drylands. World Bank Publications.
- 10 Ward, C., Torquebiau, R., and Xie, H., (2016). Improved Agricultural Water Management for Africa’s Drylands. World Bank Publications.
- Thornton, P., (2014). "Impacts of Climate Change on Length of Growing Period," Atlas of African Agriculture Research & Development: Revealing Agriculture’s Place in Africa, International Food Policy Research Institute (IFPRI).
- 11 Ward, C., Torquebiau, R., and Xie, H., (2016). Improved Agricultural Water Management for Africa’s Dry-lands. World Bank Publications.
- 12 Ward, C., Torquebiau, R., and Xie, H., (2016). Improved Agricultural Water Management for Africa’s Drylands. World Bank Publications.
- 13 Abrams, L, (2013), The Invisible 60%: Rural Livelihoods Briefing Paper, CRIDF. United Kingdom.
- 14 Nagler, P. and Naudé, W., (2014). The birth, life and death of SMEs in rural Africa.

Additional references

- Abdur, R, and Alfa S, (2017, April) Why is Africa importing \$35bn in food annually? - AfDB boss asks, Afri-ca News <http://www.africanews.com/2017/04/21/why-is-africa-importing-35bn-in-food-annually-afdb-boss-asks/>
- Abrams, L. (2013). Deliverable D1-3: Assessment of the Matabeleland North and South Small Dams Projects. CRIDF. United Kingdom.
- AFDB, (2017), Technologies for African Agricultural Transformation. African Development Bank. <https://www.afdb.org/en/projects-and-operations/project-portfolio/p-z1-a00-016/>
- Agricultural Transformation Agency, (2014). Transforming Agriculture in Ethiopia. Annual Report 2013/2014. Addis Ababa, Ethiopia.
- Balié, J., Nelgen, S. and Strutt, A., (2018). Infrastructure investments for improved market access in sub-Saharan Africa: A CGE analysis. African Journal of Agricultural and Resource Economics, 13 (2), pp 152-168.
- Basvi, S., (Revd), and Musekiwa, D., (2017), Food and Nutrition Security Programme -2017 and Beyond, Internal report of the Anglican Diocese of Central Zimbabwe, Zimbabwe.
- Buchenau, J. (2016) Rabobank Foundation and the World Bank team up to strengthen financial cooperatives for agrifinance. Blogs, World Bank. <https://blogs.worldbank.org/psd/health/rabobank-foundation-and-world-bank-team-strengthen-financial-cooperatives-agrifinance>.
- Bullock A, and Abrams L, (October 2004), Guidelines for Small Dams for Poverty Reduction (Draft Final Ver-sion), Unpublished report of the World Bank, Africa Region, Washington DC, USA.
- Clarke, D and Lung, F. (2015, September). Should governments support the development of agricultural insurance markets? Blogs, World Bank <https://blogs.worldbank.org/psd/ppps/should-governments-support-development-agricultural-insurance-markets>.
- FAO, I., IFAD, W. and UNICEF, (2017). The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. Rome: FAO. Accessed, 10(07), p.2017.
- FAO, (2011). The state of the world's land and water resources for food and agriculture – Managing systems at risk. Food and Agriculture Organization of the United Nations, Rome and Earthscan, London.
- FAO, (2015). Towards a Water and Food Secure Future. Critical Perspectives for Policy-Makers. Food and Agriculture Organization of the United Nations. FAO & Water World Council, Rome <http://www.fao.org/3/a-i4560e.pdf>
- FAO, (2017). Regional Overview of Food Security and Nutrition in Africa 2016. The challenges of building resilience to shocks and stresses. Accra <http://www.fao.org/publications/rofsn-africa/en/>
- FSIN, (2017). Global Report on Food Crises. https://documents.wfp.org/stellent/groups/public/documents/ena/wfp291271.pdf?_ga=2.150314550.1650721271.1529580884-292485562.1529580884
- Fundira, T. (2017) Africa's food trade: Infographic. Stellenbosch: Tralac.
- Green, A. (2013, May). Africa's rising food imports, The Financial Times Limited 2018. <https://www.ft.com/content/acf845a3-79a3-3718-93d2-ebd4cfb58cf6>.
- Gumede, W (2017, May). Social enterprise sector is missing link in Africa wealth-creation chain. Business Day. <https://www.businesslive.co.za/bd/opinion/2017-05-02-social-enterprise-sector-is-missing-link-in-africa-wealth-creation-chain/>.
- Lending for African Farming. (2015, June). New \$15 Million Lending Facility to Finance African Agricultural Enterprises. LAFCo. <https://www.lendingforafricanfarming.com/en/press/new-15-million-lending-facility-to-finance-african-agricultural-enterprises/#objectives>.

- Mekonnen, M.M. and Hoekstra, A.Y., (2010). The green, blue and grey water footprint of farm animals and animal products (Vol. 1). Delft: UNESCO-IHE Institute for Water Education.
- Mekonnen, M.M. and Hoekstra, A.Y., (2011). The green, blue and grey water footprint of crops and derived crop products. *Hydrology and Earth System Sciences*, 15(5), p.1577.
- Molden, D. (Ed.). (2007). *Water for Food Water for Life: Water for food water for life: a comprehensive assessment of water management in agriculture*. London: Routledge.
- Nagler, P. and Naudé, W. (2014). *Labor Productivity in Rural African Enterprises: Empirical Evidence from the LSMS-ISA*, IZA Discussion Paper No. 8524.
- OECD/FAO (2016), *OECD-FAO Agricultural Outlook 2016-2025*, Chapter 2 Agriculture in Sub-Saharan Africa: Prospects and challenges for the next decade. OECD Publishing, Paris, https://doi.org/10.1787/agr_outlook-2016-en.
- Organization of African Unity, (1982). *Lagos Plan of Action for the Economic Development of Africa, 1980-2000*. International Institute for Labour Studies.
- Panel, A.P., (2014). *Grain Fish Money: Financing Africa's Green and Blue Revolutions: Africa Progress Report 2014*. Africa Progress Panel. <http://africaprogressgroup.org/>.
- Pesche D., Losch B. et Imbernon J. (eds.), (2016). *A New Emerging Rural World - An Overview of Rural Change in Africa*, Atlas for NEPAD Rural Futures Programme, Second Edition, Revised and Enlarged Mont-pellier, CIRAD, NEPAD Agency.
- Rakotoarisoa, M., Iafrate, M. and Paschali, M., (2011). *Why has Africa become a net food importer*. Rome: FAO.
- Rockström, J. and Falkenmark, M., (2015). Increase water harvesting in Africa. *Nature*, 519(7543), p.283.
- Rockstrom, J., Hatlbu, N., Owels, T.Y. and Wani, S.P., (2007). *Managing water in rainfed agriculture*.
- Secretariat, C.G.I.A.R., (2016). *Technologies for African Agricultural Transformation (TAAT) CGIAR Council Meeting*, Washington, DC, February 8-11, 2016. <https://www.cgiar.org/wp-content/uploads/2016/01/CGIAR-FARA-Support-to-Feed-Africa-Initiative.pdf>
- Tambi, E. (2013). *The CAADP country process*. Forum for Agricultural Research in Africa (FARA), Accra, Ghana. https://www.slideshare.net/Nawsheen_Hosenally/caadp-country-process.
- Union, A., (2014). *Malabo declaration on accelerated agricultural growth and transformation for shared prosperity and improved livelihoods*. Doc. assembly/au/2 (xxiii). Malabo, Guinea Bissau: African Union.
- Union, A., (2015). *Agenda 2063: The Africa We Want*. African Union Commission.
- United States Department of Agriculture (2013), *Agricultural Imports Soar in Sub-Saharan Africa*. <https://www.fas.usda.gov/data/agricultural-imports-soar-sub-saharan-africa>.
- Wani, S.P., Rockström, J. and Oweis, T.Y. eds., (2009) *Rainfed agriculture: unlocking the potential* (Vol. 7). CABI.
- World Bank, *Sub Saharan Africa Populations* (2015): *World Development Indicators* <http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>
- World Food Programme, (2017), *World Food Assistance 2017 - Taking Stock and Looking Ahead*, Rome <https://www.wfp.org/content/2017-world-food-assistance-taking-stock-and-looking-ahead>

About the partnership

The Transforming Investments in African Rainfed Agriculture (TIARA) initiative is an emerging effort to scale up green water solutions and enhanced rainfed agriculture across Africa through financial investments and political leadership. The idea emerged from the 2016 Malin Falkenmark Symposium at World Water Week, where experts called for a revolution to alleviate the world water and hunger crisis.



Working through a number of local, national and international partners, the TIARA initiative is scaling up green water solutions and rainfed agriculture by i) understanding the challenges and opportunities of implementing green water solutions; ii) enabling high level leadership and political commitments on green water and iii) unlocking public and private investments in green water across Africa. With funding from Sida for initial work during 2018, TIARA is led by:

Stockholm International Water Institute (SIWI) is a water institute who leverage knowledge and convening power to strengthen water governance for a just, prosperous, and sustainable future. <http://www.siw.org/>

Stockholm Resilience Centre (SRC) is an international centre that advances transdisciplinary research for governance of social-ecological systems. <https://www.stockholmresilience.org/>

Sustainable Development Goals Center for Africa (SDGC/A) is an international organization that supports governments, civil society, businesses and academic institutions to accelerate progress towards the achievement of the Sustainable Development Goals (SDGs) in Africa. <https://sdgcafrica.org/>



This work is supported by a grant from the Swedish International Development Agency. The views in this report are those of the author and not representative of Sida or any other organisation.

About SIWI reports

At the core of SIWI's work is sharing the research results and knowledge that the institute's experts generate. Our goal is that SIWI's reports will enlighten and inspire the global discussion about water and development issues, thus helping to build a water wise world.

To access SIWI publications,
please visit www.siw.org/publications

a water wise world
9 M9f6L M!26 M0rJq