Micro-Agricultural Water Management Technologies for Small Scale Farmers in Southern Africa: An Inventory and Assessment of Good Practices and Experiences

Douglas Merrey, Regassa Namara, & Marna de Lange

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IWMI International Water Management Institute

Overview of Presentation

- Introduction: Objectives, sources of support
- What is "micro-AWM"?
- Food insecurity, poverty, hunger in SADC
- Why is micro-AWM relevant?
- Methodology, limitations of study
- Selected high-potential technologies
- Conclusions
- Recommendations

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Objectives

- Fill gaps in knowledge of adoption, impacts & sustainability of micro-AWM
  - ✓ Special reference to Southern Africa (but more broadly relevant)
  - ✓ Increase food security through more effective agricultural water management
- Identify suitable innovative AWM techniques and approaches
  - ✓ Assess policies, institutions, implementation strategies
  - ✓ Determine costs to support investment planning

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Sources of Support

- **Southern Africa Regional Office of the Office of Foreign Disaster Assistance, United States Agency for International Development**
  - ✓ Main interest to improve development effectiveness of aid through NGOs
- **Investment Center, Food and Agriculture Organization of the United Nations**
  - ✓ Main interest to support planning for an investment project: SADC Agricultural Water Management Project for Food Security (African Development Bank)

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Reports are Available

- **Final report submitted to USAID and FAO is available from IWMI**
- **Final report, country reports, report on impact of treadle pumps in Malawi, other literature, photo gallery are all contained on a CD available from IWMI Sub-Regional Office for Southern Africa:**

141 Cresswell Street, Weavind Park, Pretoria, South Africa

Iwmi-africa@cgiar.org

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What is "Micro-AWM"?

- "Agricultural Water Management" (AWM) – technologies, practices to capture, store or drain water, lift and transport it, and apply it to crops in the field
  - ✓ In-field application and management of water and land is the common denominator
- "Micro-AWM" – Large set of low-cost small-scale AWM technologies and practices

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Food Insecurity, Poverty, Hunger in SADC

- 60% of SADC households earn per capita income of <$2.00/day
- Incomes highly skewed—poorest 20% of the population receives 3.7% of regional income.
- High contribution of agriculture to GDP (25%) but stagnant yields

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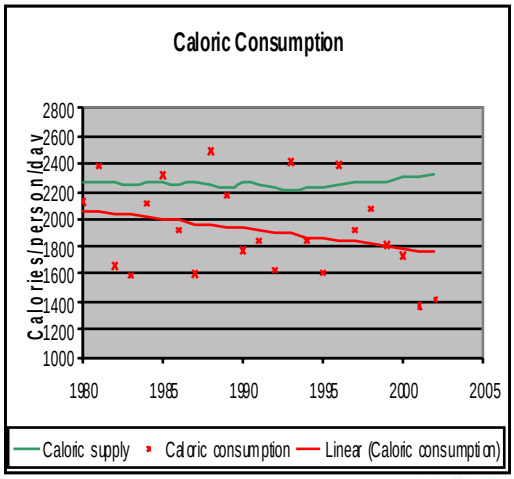
Food Insecurity, Poverty, Hunger in SADC

Consumption levels in calories is declining—high levels of chronic under-nourishment



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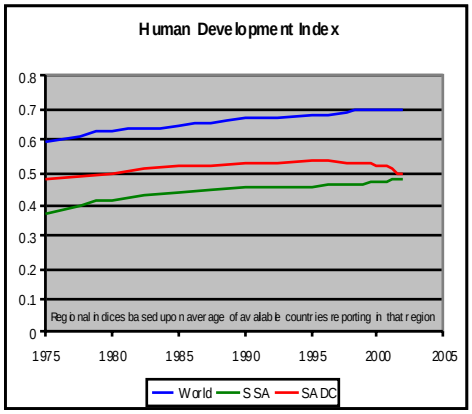
Food Insecurity, Poverty, Hunger in SADC



UN Human Development Index improving worldwide and even in SSA—but declining in SADC region despite good progress on literacy levels, access to drinking water

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Why is micro-AWM important?

- Highly variable and unreliable rainfall combined with low soil fertility is a major impediment to improving and stabilizing agricultural production
  - ✓ Not only drought years, but lack of rainfall for 10-15 days during season can reduce yields to nothing
- Some reports emphasize the role of irrigation to address this problem
- Formal irrigation is relatively expensive, has a mixed record in Africa, takes decades to become fully productive
  - ✓ Scarcity of water further limits potential

<u>Both</u> have important roles

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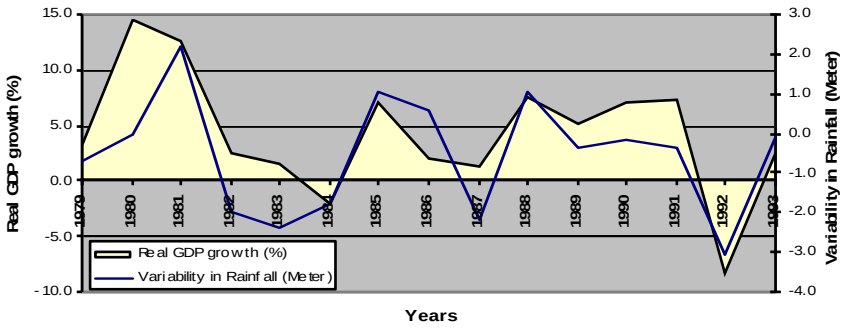
Correlation between GDP and Rainfall in Zimbabwe



From World Bank

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Why is micro-AWM important?

- **Low-cost small-scale technologies and practices are a promising alternative:**
  - ✓ Relatively low cost per household
  - ✓ Rapid impacts: minimal gestation period
  - ✓ Individualized—lower transaction costs than communal or government irrigation
  - ✓ Lend themselves to being promoted through markets, and to being targeted
- **Not a panacea, but high potential intervention if done right, in the right circumstances**

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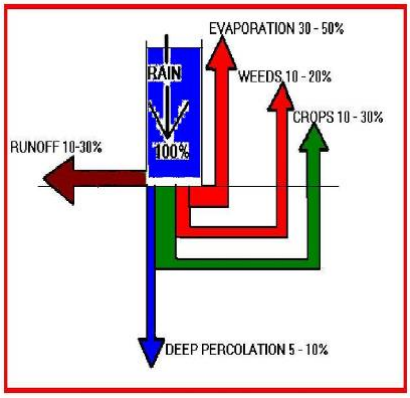
Where does the water go?

Partitioning of rainfall—weeds, evaporation, runoff account for most of the rain falling in a field—so reducing losses makes more water available for crops

From Hatibu and Rockström



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Get the rainwater into the root zone— It makes a big difference!

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From N Hatibu

Study Methodology

- Extensive, not in-depth: 9 SADC countries
- Inventory and reports done by partners in the 9 countries using a given format
  - ✓ Based largely on interviews, documents, field reconnaissance in some cases, partners' experiences
- Review of international and regional literature, internet searches
- One in-depth case study: treadle pump impacts in Malawi

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Limitations of Study

- Quality of inventories varied somewhat
  - ✓ Cannot claim full coverage of any country
- No reliable data on scale of use of micro-AWM technologies
- Very little in-depth field-based data
- No proper quantitative surveys available
- Very little data on benefits and costs

Study is an initial step to fill a gap in knowledge

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Selected high-potential technologies

Based on country partners' views, and authors' experiences in Asia and Africa

- *Water lifting*: treadle and motorized pumps
- *Water application*: drum/bucket and drip irrigation kits; clay pots
- *In-situ* soil and water conservation including conservation agriculture
- *Ex-situ* rainwater harvesting and storage

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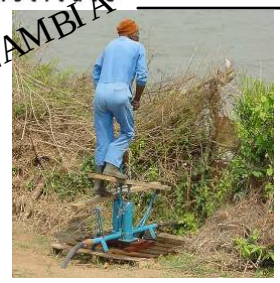
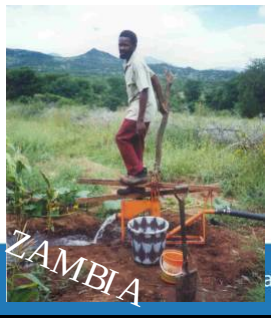
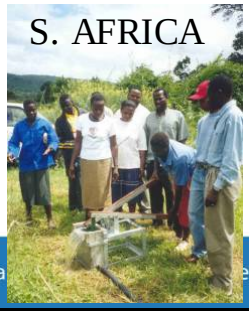
Treadle Pumps--Types







Treadle pumps

- High-capacity pump powered by body weight and leg muscles
  - ✓ Operate 2 pistons by stepping motion
- Lift water 5-7 meters—suction pump
- Lift water to a level above the pump—pressure pump
- Capacity up to 7 cubic meters/hour—sufficient to irrigate almost a hectare (less in practice)
- No purchasing of fuel, minimal maintenance
- Multiple uses—not only irrigation

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Treadle pumps

Advantages

- ✓ Versatile, durable
- ✓ Low cost to purchase--$50-$100
- ✓ Maintenance low cost and easy
- ✓ Portable
- ✓ Increase labor productivity
- ✓ Can be targeted to poor, women

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Treadle pumps

Issues

- **Weakness of input markets—spares, finance—and unpredictable policies (sudden subsidies)**
- **Cultural issues in some countries (height of pump exposes women's legs)**

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Treadle pumps—Malawi study

- Impact study comparing 50 adopters and non-adopters in 2 districts, Malawi (Mangisoni 2006)
  - ✓ Adopters have significantly higher productivity & incomes, better food security, ability to improve lives; created employment
  - ✓ Non-adopters (using water cans)—poorer, with higher risk of falling deeper into poverty
  - ✓ Consistent with results in other East and West African countries
- Kenya, Tanzania, West Africa—considerable evidence for positive impacts of treadle pumps

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Motorized pumps

- Basis for dramatic gains in agricultural production, incomes in some South Asian countries
- African experience is mixed
  - ✓Positive examples from West Africa (e.g., Nigeria)
  - ✓SADC--for larger farmers with access to good markets for high value produce may be good
    - ❖Disadvantages for small farmers are currently overwhelming

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Motorized pumps

Disadvantages

- Poor availability, expensive
- Spare parts, repair capacity limited
- High fuel costs
- Limited markets for the necessary scale of high value produce
- Weak policy and institutional support

This is a future technology for SADC region.

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From Treadle to Motorized Pumps

Irrigating eggplant with motorized pump purchased with profits from treadle pump—Zambia (A. Daka)—a route to prosperity

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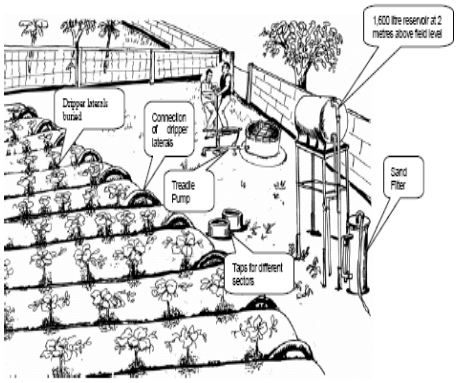
Drip Irrigation Kits

- Enables precise application of limited amount of water to crop root zone
- Reduces losses from evaporation, weeds, runoff
- Combine with bucket or drum to hold the water



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Bucket and Drip Irrigated Cabbage

Drip irrigation kits

- Costs $15 for 15 square meters to $200-400 for 500 square meters
- Labor reduced compared to hand watering
- Higher production, better quality produce
- High returns reported in some places
  - ✓ Limited sustainable impact on poor farmers unless effective support system is in place
- Effective program for promotion and support critical
- Need reliable water source, suitable soils, perception of water scarcity, access to good output markets

Currently no case of effective program in SADC targeted to poor

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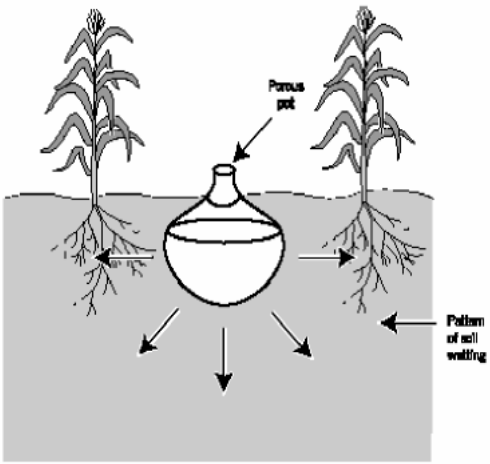
Clay Pot ('Pitcher") Irrigation



- Low-cost indigenous sub-surface drip irrigation
- Unglazed fired pots buried in the ground, with plants adjacent
- Zambia case—low labor, high returns, suits handicapped

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Clay Pot Irrigation

Advantages

- Cost-effective, easy to implement alternative to drip kits ($4.50/800 plants)
- High productivity of labor, water, land
- Pots can be made locally
- Low maintenance

Disadvantage

- Not much experience in SADC

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In-Situ Soil and Water Management Technologies

- Refers to practices that reduce losses of water and soil and maximize their availability in crop root zone (*"in-situ"*)
  - ✓Examples: terraces, bunds, ditches, mulching, minimum tillage, "conservation agriculture"
  - ✓Very wide range of technologies
- Important—Africa has very low rate of fertilizer use and soils are being depleted

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Conservation Agriculture

- Menu of techniques including mulching, ridging, reduced tillage, planting pits, etc.
- Early years high labor requirement, but lower labor inputs once established

Photo: mulching, Tanzania

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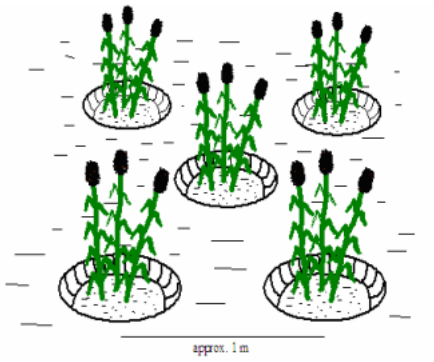
Conservation Agriculture



- Very large menu of technologies available
- Can package to create synergies and adapt to local needs
- Key is combining water and soil nutrient management
- Participatory approaches to help farmers try new ideas and combinations

Photo: zai pits, Tanzania

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Zai pits in Tanzania, and drip irrigation of coffee in Zambia

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Conservation Agriculture

Advantages

- Reduces labor (less weeding, land preparation) and fertilizer costs in long run
- Increases and stabilizes yields
- Can be implemented incrementally

Disadvantages

- Initially high costs for many practices & low returns
- Special tools needed for some practices (e.g., rippers)
- Lack of institutional and policy support

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Ex-situ Water Harvesting and Storage

- Range of technologies to catch water falling on adjacent surfaces (roads, footpaths, household compounds, etc.) and directing it to where it is needed (in field) or into storage facilities.
- Here examine household and roof top harvesting, and above- and below- ground storage tanks

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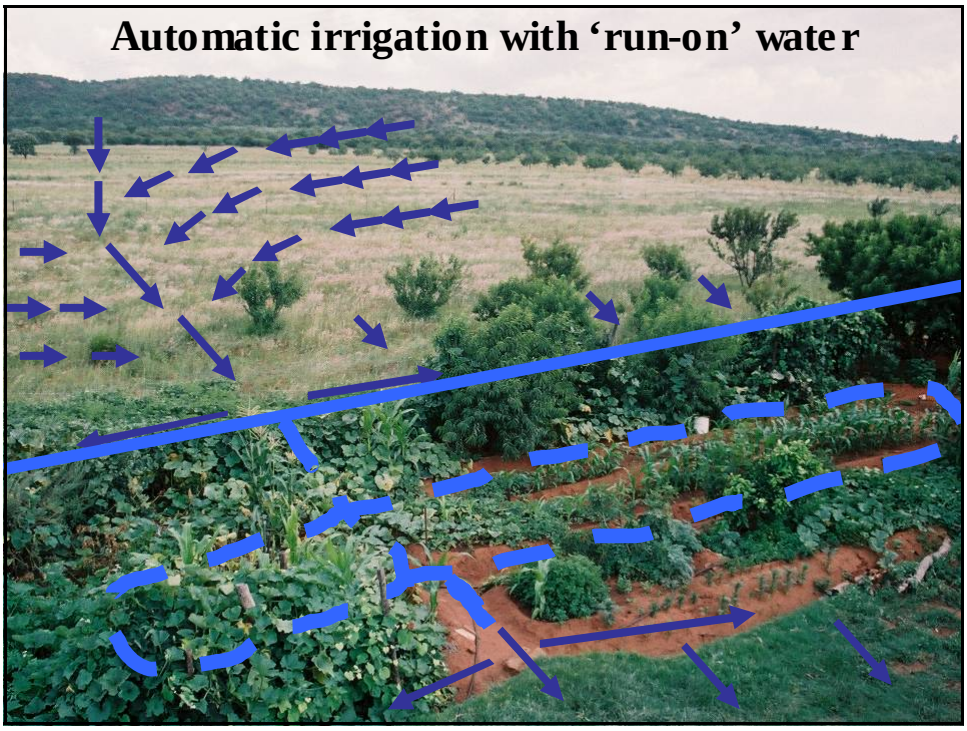
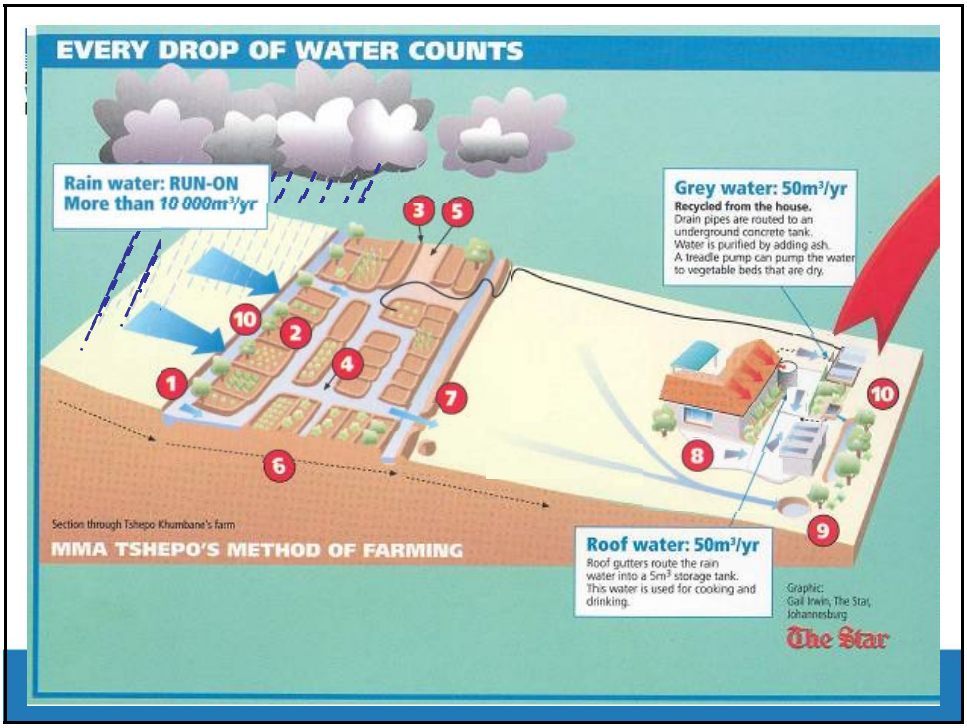

Automatic irrigation with 'run-on' water


EVERY DROP OF WATER COUNTS
Rain water: RUN-ON
More than 10 000m³/yr
Grey water: 50m³/yr
Recycled from the house.
Drain pipes are routed to an underground concrete tank. Water is purified by adding ash. A treadle pump can pump the water to vegetable beds that are dry.
Section through Tshepo Khumbane's farm
MMA TSHEPO'S METHOD OF FARMING
Roof water: 50m³/yr
Roof gutters route the rain water into a 5m³ storage tank. This water is used for cooking and drinking.
Graphic: Gail Irwin, The Star, Johannesburg
The Star

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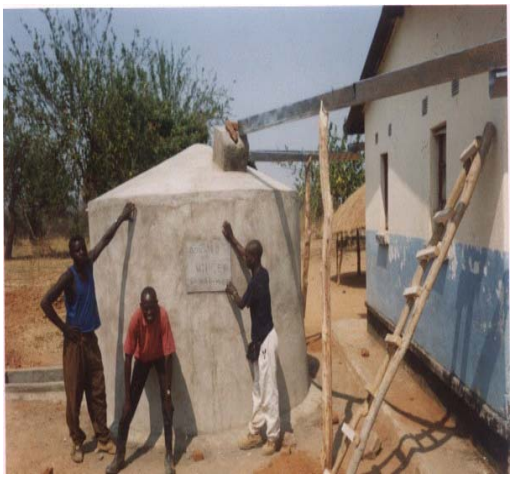
Rooftop water harvesting and storage tanks

- Increasingly common, institutions and homes
- Can use water for domestic and productive purposes

Photo from A. Daka, Zambia



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Underground Storage Tanks

- Lower cost, but water must be lifted
- Main impediment is lack of expertise to design and construct
- Cost estimates $200-700 for 10-215 m^3; over $1000 for 50 m^3

Photo—excavating RWH tank, South Africa

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Ex-situ Water Harvesting and Storage

Wide range of practices and technologies!

Advantages

- Storage: water available when needed
- Construct from local materials, some at relatively low cost
- Combine with water-application technologies
- Adoption at household level, can empower women
- Potentially high returns in production, nutrition, health status

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Ex-situ Water Harvesting and Storage

Disadvantages

- Underground tanks cheaper but vulnerable to contamination
- Low-cost plastic lining still vulnerable to puncture
- Cost effective only for small amounts of water

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Underground tanks still are being pilot tested

Ready for plastic lining! Fiber-cement RWH tank

Photos: Marna de Lange

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Main Conclusions-1

1. **In SADC region, improving reliability of water and soil fertility necessary though not sufficient for improving food security and generating faster agricultural growth**
2. **Reasonable evidence micro-AWM technologies can lead to substantial gains in food security and incomes, in a cost-effective manner**
3. **Many initiatives and actors with no mechanism for sharing lessons and assessing what works and why**

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Main Conclusions-2

4. Diverse climate, soils, cultures, household needs, market opportunities—no single solutions
   - Adapt technologies to needs, conditions
   - Integrate different technologies, e.g., treadle pump with drip irrigation
   - Integrate water and soil nutrient management
   - Integrate support services, improved production, and demand side

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Main Conclusions-3

5. Vicious cycle undermining resilience, creativity in many rural areas—poor are getting poorer
6. Government policies and macro-economic conditions discourage, even sometimes undermine, potential for wider adaptation and adoption of micro-AWM technologies

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Major Recommendations-1

Micro-AWM Technologies

1. Where water is <7 meters deep and <200 m away, treadle pumps offer potential for high returns and impacts—we recommend widespread promotion
2. Many farmers have benefited from low-cost drip irrigation kits but not yet implemented widely; need longer term institutional support on input, production and output sides—we recommend promotion under specified conditions

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Major Recommendations-2

3. Clay pot irrigation, though not yet implemented at scale, offers high productivity alternative to drip kits—we recommend adaptive research and promotion if favorable results
4. "Conservation agriculture" covers a large range of *in-situ* water and land management practices, some of which offer low-cost but potentially high returns
   - Integrate water and land management
   - Recommend encouraging & supporting farmers to try new ideas and combinations

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Major Recommendations-3

5. Range of promising *ex-situ* RWH and storage technologies
   - Encouraging innovation is critical
   - We recommend wider dissemination and support

Strategic

6. Critical importance of participatory approaches, supporting creativity and innovation, by offering choices and support: Strongly recommend supporting creativity, offering choices

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Major Recommendations-4

7. Micro-AWM offers opportunity to effectively target poorest and most food-insecure including women as way to achieve MDGs

Although improving market access is critical in the long run, allocating more to targeting poorest to help them achieve food security can have very big impacts

We recommend building on low-cost and divisible characteristics of micro-AWM to target poorest & most vulnerable

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Major Recommendations-5

8. We recommend scaling up investments in micro-AWM as a faster and more cost-effective way to achieve MDGs and better food security than major water infrastructure
   - Not against infrastructure development, but these have impacts in longer run
9. Governments should streamline policies for micro-AWM, & create a 'lead' institution for implementation

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Major Recommendations--6

10. NGOs and governments should move from short-term relief to longer-term development
    - Institutionalized support services, integrated approach critical to success
11. Although supporting market-based approach is necessary in the long term, we recommend governments consider kick-starting micro-AWM by consistent limited-term programs to provide large number of subsidized units that can in future be manufactured and repaired locally
    - This may create a market for support (spares, repairs) and for replacement units after the program ends

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Major Recommendations--7

12. We recommend SADC countries create a larger regional market for micro-AWM technologies
    - High costs in many countries a function of small national markets
13. We recommend much more investment in monitoring, assessment, pilot testing, sharing lessons at regional level
    - Network with South Asia to promote learning and capacity building

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IWMI Sub-Regional Office
for Southern Africa
141 Cresswell Street
Weavind Park, Pretoria
Mail: P/Bag X813, Silverton
0127, Pretoria
SOUTH AFRICA
Phone: +27 12 845 9100
Fax: +27 12 845 9110
Email: iwmi-africa@cgiar.org

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